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Advances in Intelligent and Soft Computing

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Preface

International Science & Education Researcher Association (ISER) puts her focus on studying and exchanging academic achievements of international teaching and scientific research, and she also promotes education reform in the world. In addition, she serves herself on academic discussion and communication too, which is beneficial for education and scientific research. Thus it will stimulate the research interests of all researchers to stir up academic resonance.

CSISE 2011 is an integrated conference concentrating its focus upon Computer Science, Intelligent System and Environment. In the proceeding, you can learn much more knowledge about Computer Science, Intelligent System and Environment of researchers all around the world. The main role of the proceeding is to be used as an exchange pillar for researchers who are working in the mentioned field. In order to meet high standard of Springer, *Advances in Intelligent and Soft Computing*, the organization committee has made their efforts to do the following things. Firstly, poor quality paper has been refused after reviewing course by anonymous referee experts. Secondly, periodically review meetings have been held around the reviewers about five times for exchanging reviewing suggestions. Finally, the conference organization had several preliminary sessions before the conference. Through efforts of different people and departments, the conference will be successful and fruitful.

CSISE 2011 is co-sponsored by International Science & Education Researcher Association, Beijing Gireida Education Co. Ltd and Wuchang University of Technology, China. The goal of the conference is to provide researchers from Computer Science, Intelligent System and Environment based on modern information technology with a free exchanging forum to share the new ideas, new innovation and solutions with each other. In addition, the conference organizer will invite some famous keynote speaker to deliver their speech in the conference. All participants will have chance to discuss with the speakers face to face, which is very helpful for participants.

During the organization course, we have got help from different people, different departments, different institutions. Here, we would like to show our first sincere thanks to publishers of Springer, *Advances in Intelligent and Soft Computing* for their kind and enthusiastic help and best support for our conference. Secondly, the authors should be thanked too for their enthusiastic writing attitudes toward their papers. Thirdly, all members of program chairs, reviewers and program committees should also be appreciated for their hard work.

In a word, it is the different team efforts that they make our conference be successful on September 24–25, Guangzhou. We hope that all of participants can give us good suggestions to improve our working efficiency and service in the future. And we also hope to get your supporting all the way. Next year, In 2012, we look forward to seeing all of you at CSISE 2012.

July 2011

Helen Zhang
ISER association

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FPD Image Quality Evaluation Based on Visual Ergonomics

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Abstract. Image quality is one of important factor for FPD. In order to evaluate FPD image quality effectively, the evaluation method based on visual ergonomics is proposed. Firstly, the evaluation content is described which includes the background and the definition of the evaluation factors; secondly, the evaluation method is introduced which has four parts. These are equipment, test method, test evaluation and overall uncertainty. Finally, one of evaluation result is provided aiming at FPD image, and the result shows that this method is able to evaluate FPD image quality effective.

Keywords: FPD, image quality, visual ergonomics.

1 Introduction

FPD becomes one of common work tools for users in different types of professions, and image quality is one of important factor for FPD. Good visual ergonomics is a very important aspect of quality that can also have direct effect on the health and comfort of the user [1-4].

In addition to, televisions and multifunction displays are nowadays also common wording tools in many professions, e.g monitoring or to show moving graphic materials on the display. Therefore the picture quality of the moving images has also become an important quality aspect for that type of displays [5-9].

In order to ensure that FPD develops of FPD healthily, the health effects of various parameters have been taken into account since in developing requirements for visual ergonomics, as well as other features that characterizes good quality displays [9].

There are three main ways which are used to determine the suitable level for each labeling program. One is based on acceptable visual levels determined by scientific research. The second is based on statistics from tests carried out in accordance with FPD. The third way is based on manufacturers' knowledge and experience, which is invaluable. Manufacturers, consumer groups and other organizations with interests in the visual ergonomics field have contributed with a great deal of valuable information and ideas through discussions [10-11].

2 Evaluation Content

Pixel array requirements are the first evaluation content. Image quality is negatively affected by a low fill factor, visible “jaggies”, poor rendering of details, etc. All of these parameters are related to the pixel array of the display. For pixel array characteristics, it is important to take the viewing distance into account. When rendering moving images, the viewing distance is normally further away than for usual computer displays. Therefore the 30 pixels/degree requirement is tested at 4 image heights instead of at 1.5 times the display diagonal. A pixel is defined as being able to the full range of luminance and colors. In normal video definition this is represented by three subpixels consisting of one Red, one Green and one Blue subpixel. The pixel array is the number of pixels in the horizontal direction by the number of pixels in the vertical direction that the display can present..

The second evaluation content is luminance level. It shall be possible to set a sufficiently high luminance level with respect to the ambient lighting in order to present a comfortable viewing situation and to avoid eyestrain. Poor luminance can lead to low contrast and consequently affect legibility and color discrimination and by that cause misinterpretations. It shall possible to set the luminance level according to the lighting conditions of the surroundings. For moving images on displays it is more important to be able to present different levels of both high and lower luminance than for displays for office use. One reason is that the content of moving images varies much more in grayscale, for instance shadow details, than in common office application. These nuances have to be resolved and presented as accurately as possible. It is also important that it is possible to set the luminance to a suitable level in low ambient light and at a level where most video content is produced.

3 Evaluation Process

There are four parts for evaluation method which are equipment, test method, test evaluation and overall uncertainty. Firstly, the luminance of an FPD is angular-dependent i.e. that screen luminance decreases when the FPD is viewed slightly from the side. This can have a negative effect on contrast and can affect the legibility of the screen, especially if two or more users are looking at the screen from different viewing angles or from different heights.

$$\begin{cases} K_{r1} = K_{r - m_{m1\_n1} - d_{i1\_j1}} \\ K_{g1} = K_{g - m_{m1\_n1} - d_{i1\_j1}} \\ K_{b1} = K_{b - m_{m1\_n1} - d_{i1\_j1}} \end{cases} \quad (1)$$

Luminance uniformity is the capacity of the FPD to maintain the same luminance level over the whole active screen area. The luminance uniformity is defined as the ratio of maximum to minimum luminance within the fully active screen area. The angular-dependent luminance uniformity is defined as the ratio of maximum luminance to minimum luminance in the specified measurement areas, as shown in (3).

$$P_{color} = \begin{pmatrix} B_{r-m_{m-n}-d_{i-j}} & x_{r-m_{m-n}} & y_{r-m_{m-n}} & Y_{r-m_{m-n}} \\ B_{g-m_{m-n}-d_{i-j}} & x_{g-m_{m-n}} & y_{g-m_{m-n}} & Y_{g-m_{m-n}} \\ B_{b-m_{m-n}-d_{i-j}} & x_{b-m_{m-n}} & y_{b-m_{m-n}} & Y_{b-m_{m-n}} \end{pmatrix} \quad (2)$$

Luminance uniformity-angular dependence is the capacity of the FPD to maintain luminance level independently of the viewing direction.

$$\begin{cases} C_{r1} = C_{r-m_{m1-n1}-d_{i1-j1}} \\ C_{g1} = C_{g-m_{m1-n1}-d_{i1-j1}} \\ C_{b1} = C_{b-m_{m1-n1}-d_{i1-j1}} \end{cases} \quad (3)$$

Secondly, the degree of contrast is important for legibility and for distinguishing one character from another. Luminance contrast-characters is expressed as the ratio of the Lmax to Lmin difference over the sum of Lmax and Lmin, according to Michanelson's formula. It is measured at two different angles. Luminance contrast-characters is the capacity of the FPD to maintain a high luminance difference between a bright background and dark characters or parts of characters over the whole active area.

$$\begin{cases} x_{r1} = x_{r-m_{m1-n1}} \\ y_{r1} = y_{r-m_{m1-n1}} \\ x_{g1} = x_{g-m_{m1-n1}} \\ y_{g1} = y_{g-m_{m1-n1}} \\ x_{b1} = x_{b-m_{m1-n1}} \\ y_{b1} = y_{b-m_{m1-n1}} \end{cases} \quad (4)$$

Thirdly, for FPDs the luminance and consequently the contrast on the display is angular-dependent. The luminance variations can influence both the bright white and the dark areas of the screen, causing a change in contrast. This has a negative effect on the legibility of the screen, especially when two or more users are looking at the screen from different viewing angles or from different heights.

Finally, luminance contrast-angular dependence is the capability of the FPD to maintain the same contrast regardless of the direction from which the screen is viewed. The luminance at a point on a surface and in a given direction is the quotient of the luminous intensity in the given direction of an infinitesimal element of the surface containing the point under consideration, to the orthogonal projected area of the surface element on a plane perpendicular to the given direction. Luminance

contrast-angular dependence, is expressed as the ration of the $L_{\max}$ to $L_{\min}$ difference over the sum of $L_{\max}$ and $L_{\min}$, according to Michaelson's formual.

4 Conclusion

The following figures are the evaluation results of the image quality for Red, Green and Blue subpixels. It can be found from these figures that this method is able to evaluate the image quality effectively.

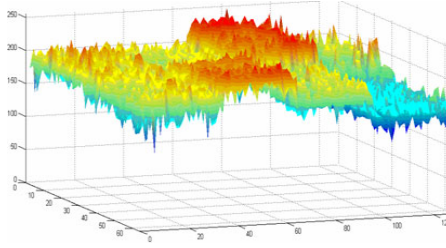


Fig. 1. Evaluation result of Red

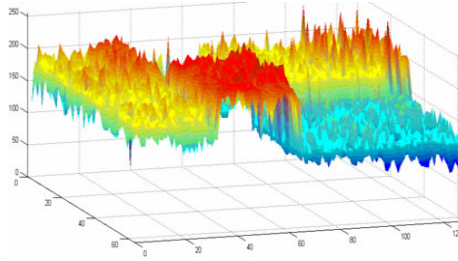


Fig. 2. Evaluation result of Green

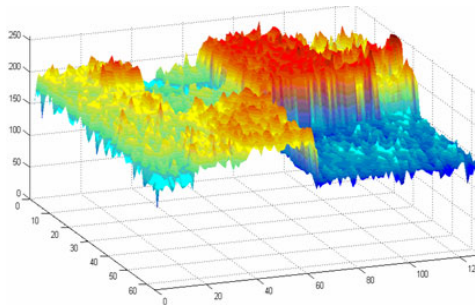


Fig. 3. Evaluation result of Blue

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An Improved Method of Image Enhancement Based on Wavelet Transform

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Abstract. For the problem of image enhancement, the theory and property of wavelet transform and mathematical morphology have been researched, the research situation of wavelet transform is fully analyzed, then the algorithms is improved for its characteristics, the method of image enhancement combined with mathematical morphology is proposed. Experiment results show that the method is simple and effective.

Keywords: Image enhancement, Wavelet transform, Mathematical morphology.

1 Introduction

Image enhancement is a basic technology of digital image processing, the aim is to highlight the information mostly concerned in the image, at the same time to weaken or remove some unwanted information, so to improve image quality, rich the amount of information. It is a image processing method that can strengthen the effects of image interpretation and recognition.

Wavelet transform is the inheritance and development of traditional Fourier transform. With good spatial and frequency localize properties of multi-resolution analysis of wavelet, it can focus on any detail of the analyzed object, Therefore it can be particularly suitable for the processing of image signal that is the type of non-stationary sources, The denoising method of mathematical morphology[1] is flexible and practical, so they have great advantages in image denoising and enhancement.

Currently, there is a lot of research in image enhancement based on wavelet transform, such as the algorithms of image edge enhancement based on wavelet transform was given by literature [2], the method of image enhancement of wavelet threshold based on edge detection was proposed in literature [3]. Because of the complexity of noise and the edge, there is also some limitations in the current algorithm of image enhancement based on wavelet transform[3]. In order to effectively remove the noise, keep the detail of edge, algorithm is improved in this paper, an improved method of image enhancement of wavelet transform combined

with mathematical morphology is proposed, and the accuracy and effectiveness of the method is verified by experiment.

2 Wavelet Transform

Wavelet analysis is the progress of milestones of the traditional Fourier analysis, and at present is a topic of a very wide range in many engineering and subjects.

2.1 Continue Wavelet Transform

In an arbitrary $L^2(\mathbb{R})$ space function $f(t)$ is expanded under the wavelet base, this expansion is called the continue wavelet transform of the function $f(t)$ (Denoted by CWT). The expression is:

$$WT_f(a, b) = \langle f, \varphi_{a,b}(t) \rangle = \frac{1}{\sqrt{|a|}} \int_{\mathbb{R}} f(t) \overline{\varphi\left(\frac{t-b}{a}\right)} dt \quad (1)$$

If the inverse transform exists, that is to say, the original signal can be accurately recovered according to the wavelet transform coefficients of the signal, its inverse (ICWT) formula is:

$$f(t) = \frac{1}{C_\varphi} \int_{\mathbb{R}} \int_{\mathbb{R}} \frac{1}{a^2} WT_f(a, b) \varphi\left(\frac{t-b}{a}\right) da db \quad (2)$$

Under the algorithm of the pyramid decomposition, after the wavelet decomposition of digital images, a series of sub-image with different resolutions is obtained. After the level of decomposition to form four sub-graphs of the size of 1/4: sub-graph HL1, LH1, HH1 carrying the intermediate frequency and high-frequency details of the horizontal, vertical and diagonal directions of the image edge and texture information, LL2, HL2, LH2, HH2 are low-frequency approximation sub-graphs, HL2, LH2, HH2 represent sub-graphs of intermediate frequency and high-frequency details. Image of secondary wavelet decomposition is shown in figure 1.

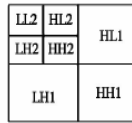


Fig. 1. Schematic diagram of the secondary wavelet decomposition of image

3 Mathematical Morphology

3.1 Basic Operations

Mathematical morphology is a nonlinear filtering algorithm, morphological dilation and erosion are the basis of mathematical morphology, which can be used to solve many problems of image processing.

First of all, the first to learn a few basic operations commonly used:

Structural elements B is used to dilate the image set A, first to do the image for B about the origin, and then shift its image x, the result of the dilation is the x-collection which is the intersection of B after translation and A, and is not empty. Mathematical expression is as follows:

$$A \oplus B = \{ x \mid (B)_x \cap A \neq \Phi \} \quad (3)$$

Structural elements B is used to erode the image set A, shift B x, the result of erosion is the x-collection, which is B fully included in the A after the translation of B, its mathematical expression is as follows:

$$A \ominus B = \{ x \mid (B)_x \subseteq A \} \quad (4)$$

Set A represents a binary image, B as the structural elements, then the morphological opening and closing transforms of X about B are defined:

$$\begin{aligned} A \circ B &= \left(A \ominus \hat{B} \right) \oplus B = \bigcup_{(B)_x \subset A} (B)_x \\ A \bullet B &= \left(A \oplus \hat{B} \right) \ominus B = \bigcap_{(B)_x \subset A^c} ((B)_x)^c \end{aligned} \quad (5)$$

4 Improved Algorithm of Image Enhancement

General idea of the algorithm in this paper is as follows: First of all, do wavelet transform for the original image, which is secondary decomposed; Then, enhanced threshold is obtained using the design method in this paper, according to the threshold, respectively increase and decrease the two parts of the wavelet coefficients; Finally, do the image reconstruction with the processed wavelet coefficients, combining with the denoising function based on mathematical morphology, transformed image is obtained.

The specific steps of the algorithm in this paper are as follows:

Step 1. Select the appropriate wavelet base and decomposing scale to do wavelet decomposition for the original image. Since wavelet Sym has good symmetry, it can reduce the phase shift of reconstruction. Therefore, in this paper, 'sym4' wavelet is used to do the second floor decomposition. Multi-wavelet coefficients are obtained after the decomposition.

Step 2. Wavelet coefficients are quantified according to the threshold. Appropriate threshold can effectively restrain noise, enhance the edge. In this paper, the method of optimal threshold is proposed, the median iteration strategy is used to determine the value of the threshold, first find the median T of the pixel, then make the accumulation of pixel which is larger than T, find its mean, make the accumulation of pixel which is smaller than T, and find its mean, again average the two groups of values obtained, comparing wavelet coefficients of different directions and different layers with the threshold calculated, then reduce the coefficient if it is smaller than the threshold; If the coefficient is larger than or equal to the threshold, then correspondingly expand it, in order to achieve the purpose of image enhancement.

Step 3. With the opening and closing operations of mathematical morphology, noise of image is removed, edges of image is enhanced.

Step 4. Make the reconstruction of the processed wavelet coefficients, then get the enhanced images of original image.

5 Experimental Results and Analysis

In this paper, the principle and nature of the wavelet transform have been researched, algorithm is improved, and a method of image enhancement combining with mathematical morphology is proposed. The following is the comparative experiments with the enhancement algorithm of traditional wavelet transform. The result is shown in figures.

First, make the traditional wavelet transform of the original image.



Fig. 2. The original image

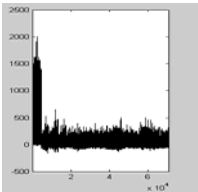


Fig. 3. Spectrum

First, the original image is wavelet transformed using wavelet 'sym4' when it is being enhanced, the spectrum is shown in figure 3.

The wavelet coefficients obtained is linear transformed, then reconstruct the image, enhanced image is obtained after the traditional wavelet transform.

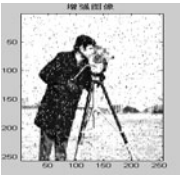


Fig. 4. Enhanced image after the traditional wavelet transform

The threshold is estimated using improved algorithm in this paper, then the wavelet coefficients is linear transformed, then reconstruct the image, enhanced image of improved threshold algorithm is obtained.



Fig. 5. Enhanced image of improved threshold algorithm

Clearly, the image enhancement method of traditional wavelet transform enhanced the image, at the same time, often brought some serious negative effects. For example, poor noise removal, the reservation of details on edge is not obvious. After algorithms is improved, this phenomenon has clearly been made better.

Algorithm in this paper is not only improving threshold algorithm, but also combining with mathematical morphology on denoising, with which enhanced image is obtained.



Fig. 6. Enhanced image of the proposed algorithm

Experimental results show that this algorithm can not only effectively restrain noise, but also upgrade the edge of image ideally, enhance the image contrast, and play a significant role on improving the image clarity.

From the view of the comparison with traditional wavelet transform, the benefits of this improved method of wavelet image enhancement can be summarized as the following two points:

After wavelet decomposition, the appropriate threshold can effectively restrain noise, enhance edges. The size of coefficients of wavelet transform domain can be changed before doing the inverse transformation, this ability can selectively enlarge the quantity of interest and decrease the unwanted part.

Since the removal of the noise by wavelet decomposition is poor, mathematical morphology has unique advantages in denoising, which is integrated in, then a combination of enhancement and denoising is achieved.

The disadvantage of this algorithm is that details on the image boundary is still not precise enough, how to further preserve details of image will be the focus of the next study.

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The Adaptive Material and Structure Analysis of Feedback Circuit in Industry Evolution and Enterprise Growth

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Abstract. From the perspective of material, structure, and growth, enterprise growth and industry evolution are a complicated dynamic process. They show various dynamic characteristics and structure from birth, growth, maturity to recession as an organism. According to the basic knowledge of system dynamics and science of material and structure, this paper gives a brief analysis of basic structure and mechanism in feedback circuit of industry evolution and enterprise growth. This paper analyzes the positive circuit and negative circuit in industry evolution and enterprise growth with adaptive material called Vensim software. Thus, we believe positive circuit is the driving or dragging force while a negative circuit has the effect of balance. We provide initial ideas and suggestions for managers to view the industries and enterprises.

Keywords: Industry Evolution, Enterprise Growth, Feedback Circuit.

1 Concepts Review of Industry Evolution and Enterprise Growth

1.1 Theory Review of Mechanism of Industry Evolution and Enterprise Growth

With the development of national economy, the industry evolution refers to the gradually increases of consumer purchasing power, the change of consumer preferences, the change of production factors' relative price so as to cause the change of market demand. The change of resources configuration will affect market supply within the industry, eventually determine the capacity of market within the industry. Thus, it will cause the change of division and specialization and make industry present different forms in different stages. [1] According to industry life cycle theory, every industry will experience four stages including development, growth, maturity and recession or transformation. Throughout different industries development process, industry evolution can be roughly divided into infancy stage, scale stage, gathering stage, balance stage and alliance stage. [2] Penrose believed enterprise which is established in managerial framework is an aggregation of all kinds of resources. Enterprise growth depends on whether it can utilize existing resources more effectively. [3] Chandler believed enterprise began to grow when hierarchical management can control and coordinate economic activities more effectively than

market mechanism. [4] Domestic scholars hold common views with western scholars about the concept of enterprise growth. This paper argues that putting industry evolution and enterprise growth in conceptual stage is not enough. The whole industry and every enterprise in it should be viewed as a living organism respectively. We should view the connotation and relationship of industry evolution and growth of enterprises from the perspective of system and concept of growth.

1.2 Connotation Analysis of Industry Evolution and Enterprise Growth Based on the View of System

System is an aggregation consists of different parts which have mutual difference and interact with each other. They can complete some function for the same purpose. According to the view of system, growth should be linked with the growth of some amount. If the growth of some amount stops, then its growth also stops and will stay in a stable state. [6] This paper argues that enterprise growth should show relevant growth of internal or external amount of a enterprise. From the perspective of growth, industry evolution should have the same characteristic with enterprise growth. An industry is an enterprise or a batch of enterprises. [7] Therefore, we view industry as a system.

2 The System Analysis Method of Industry Evolution and Enterprise Growth

This paper adopts the structure analysis of system dynamics to explore dynamic behavior characteristics of industry evolution and enterprise growth and the reasons behind the behavior pattern. By analyzing the system's basic structure, we can explain the dynamic behavior of the system so as to improve the system behavior.

Circuit analysis can analyze the structure of the nonlinear dynamic feedback system, thereby we can do the comprehensive analysis of interconnected variables within industry and enterprise system.

3 The Basic Structure Analysis of Industry Evolution and Enterprise Growth

According to the viewpoints of system dynamics, positive feedback makes system present the characteristic of rapid growth or sharp decline. Negative feedback makes the system state remain near the target. It has the function of stabilizing system. As positive feedback circuit and negative feedback circuit play an alternative action, the system presents complex dynamic behavior. When the system is in increasing or recession state, there must be a positive feedback circuit. When the system's growth or recession is restrained, there must be a negative feedback circuit. [8] For the enterprise growth, there exists a positive feedback circuit and negative feedback circuit to drive its growth

and restrain its endless growth. We believe this is the simplest system dynamics model for enterprise growth. [5] We depict causal circuit of enterprise innovation capacity model with the lowest cost constraint for an example. [5]

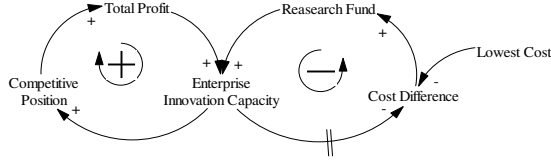


Fig. 1. Causal circuit of enterprise innovation capacity

For the industry evolution, we assume the basic structure is similar with the situation of enterprise growth. We depict causal circuit of Industrial demand growth model with the biggest market size constraint as an example. [9]

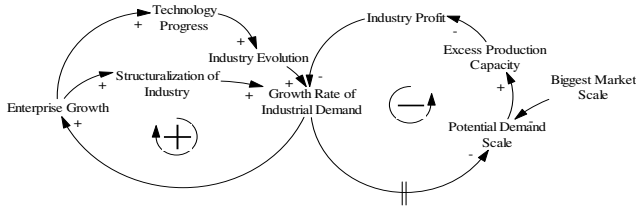


Fig. 2. Causal circuit of Industrial demand growth

We briefly analyze the flow diagram of First-order positive feedback system and First-order negative feedback system. Thus, we can provide some reference for exploring the dynamic properties of basic circuit of industry evolution and enterprise growth. The flow diagram of First-order positive feedback system:

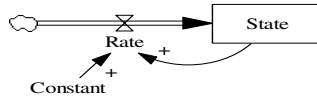


Fig. 3. The flow diagram of First-order positive feedback system

The sharp analysis form about constants (constant1=-0.05, constant2=-0.01, constant3=0, constant4=0.01, constant5=0.005):

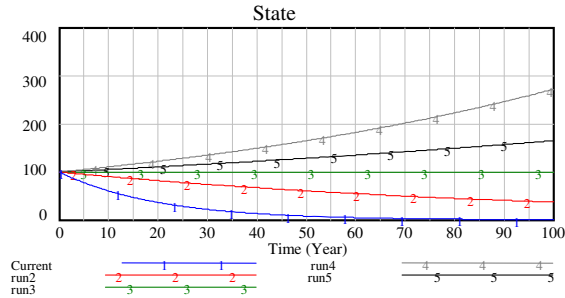


Fig. 4. The sharp analysis form about constants

The sharp analysis form about state (constant1 to constant4 are 0.05, state1=100, state2=200, state3=300, state4=400):

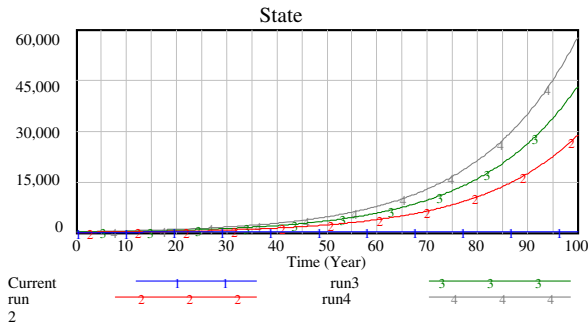


Fig. 5. The sharp analysis form about state

We can see that when constant remain unchanged, different state can lead to different system state at the same time. The flow diagram of First-order negative feedback system:

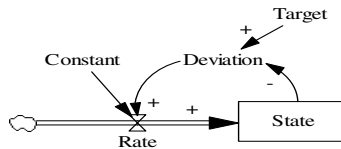


Fig. 6. The flow diagram of First-order negative feedback system

The sharp analysis form about desired value and constants (constant1=0.05, desired value=300; constant2=0.08, desired value=300; constant3=0.05, desired value=450; constant4=0.08, desired value=450):

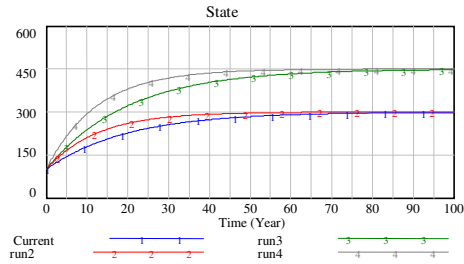


Fig. 7. The sharp analysis form about desired value and constants

The sharp analysis form about state (constant1 to constant4 are 0.05; desired value1 to 4 are 400; state1=100, state2=200, state3=500, state4=600):

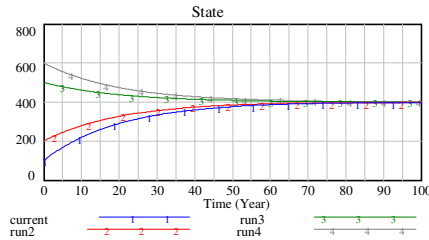


Fig. 8. The sharp analysis form about state

Comparing current and run3, run2 and run4, we find that when constant remain unchanged, different desired value can lead to different system state. Comparing current and run2, run3 and run4, we find that when desired value remains unchanged, different constant can lead to different system state. We can observe that the system state increase or decline near the desired value no matter its initial state is higher or lower than the desired value. The state is approaching to the target ultimately. This means negative feedback circuit has the function of adjusting and stabilizing system state.

4 Conclusion

Different initial states and structures can influence system's state by influencing the rate. This means even if internal structure doesn't change, the change of external environment and adaptive material or initial state can influence system's state of industry and enterprise. Designing positive circuit which has the strengthening effect is the core for driving enterprise growth. We should make sure that the common actions and structure of positive and negative circuit are the key reasons to determine the industry evolution and the growth of enterprise.

This paper analyzes the basic structure, dynamic characteristics, and formation reasons of industry and enterprise growth system from the view of the circulation of feedback circuit by using the adaptive material. Research shows that the process of industry evolution and enterprise growth is the result of common actions and structure of positive and negative circuit. The system presents the trend of fast development or rapid decline when the positive circuit plays a leading role. The system presents the trend of slow development until it stops or stay near the target when the negative circuit plays a leading role. In this sense, analyzing the industry evolution and enterprise growth from the angle of feedback circuit's mechanism and structure is a valuable research direction.

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Measurement of Decision-Making Mechanism under Different Governance Context: Quantitative Analysis Based on Manufacturing Industry Enterprises in Zhejiang

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Abstract. This paper considers scientific designing of decision-making mechanism is the key to solve corporate social responsibility problems. It compares the B-C index and finds stakeholder contingent governance arrangements can achieve better internal balance of power. Quantitative research evaluates corporate decision-making mechanism and results show that the coordination effectiveness and decision effectiveness are significantly impacted by corporate governance arrangements; favorable executive power of corporate governance is also can ensure the interests protection of stakeholder; otherwise, the external market governance can be regarded as a strong supplement.

Keywords: decision-making, social responsibility, manufacturing industry, corporate governance.

1 Introduction

News about corporate social responsibility came from the major media in the past 10 years continually, all of these typical events are just "abnormal" under the extreme performance, the number is just the tip of the iceberg. By contrast, the enterprise how to protect the interests of stakeholders in the "normal" situation should be more worthy of attention to academics and practitioners.

Based on the understanding of internal institutional arrangements, combined with the 21 interviews of manufacturing enterprises in Zhejiang and 176 valid questionnaire data, found the that the joint design of corporate governance system and decision-making mechanism in order to solve social responsibility problems is worth trying. The current decision-making mechanism is influenced by the "shareholders view of sovereignty," and more or less neglects the interests of stakeholders. Given results have shown that there is a high positive correlation between the satisfaction of stakeholder interests and enterprise value [1]. This paper analyzes the internal balance of power issues by the use of cooperative game analysis from the theoretical level. Secondly, based on theoretical results, this paper puts forward corresponding hypotheses, and conducts large sample empirical evaluation for verification and discussion.

1.1 The Power Balancing Model in Different Scenarios of Corporate Governance

The key to the cooperation game is to achieve a binding agreement, but it is harsh for developing countries. Therefore, it is necessary to conduct research of cooperation in the "non-binding agreement" environment: each participant dismantling defects of binding agreement which leads to interest conflicts, then cooperative game situation gradually becomes Pareto optimal state [2,3]. This paper introduces B-C index to illustrate the relationship between the power configuration and corporate governance system [4,5], if Participants joined the alliance is a decisive, then there is a swing, shows the total number of swing, it calculates as follows:

Taking a dispersed shareholding company for example: decision-making mechanism may restricted by shareholders, managers, employees and creditors, noted with $N = \{1,2,3,4\}$. It assumes that decision would be passed as long as the vote number is more than half. Assuming holdings of shareholders, managers, employees and creditors are 49%, 24%, 16% and 11%. The calculation of swing is: shareholders have 6 swings, managers, employees and creditors have 2 swings, $= (0.50,0.17,0.17,0.17)$.

Table 1. Summary table of power difference (unit: times)

Obj.	Gov. Body	A-Option configuration differences	B-Real power differences
Man.	+sha.	24% / 49%=0.49	0.17 / 0.50=0.34
	+emp.	24% / 16%=1.50	0.17 / 0.17=1.00
	+cre.	24% / 11%=2.18	0.17 / 0.17=1.00

Study found there is not directly linkage between corporate equity allocation and actual power. Comparison of A and B column values, it is not difficult to find actual shareholder power is larger than the voting power. In addition, although the equity allocation among the operators, employees and creditors is not the same, it got the same result. Thus, vulnerable groups can not be ignored in the design of decision-making mechanism. Based on this, we propose a corollary: the main body contains more interest demands can get better governance and decision-making results.

1.2 Empirical Analysis of Decision-Making Mechanism

Under the unilateral control behavior of enterprise managers agent theory can be traced back to Baumol, Marris and Willianmon and other scholars' researches [6,7,8]. Correspondingly, camera governance requires considering all parties' interests, namely the operator's multi-task principal-agent behavior[9,10]. Therefore this paper makes the following assumptions:

Hypothesis 1: The coordination effectiveness in camera governance is better than unilateral control.

Hypothesis 2: The decision-making effectiveness in camera governance is better than unilateral control.

Hypothesis 3: There is significant differences of satisfaction effects and comprehensive effects between camera governance and unilateral control.

The data come from manufacturing enterprises in Hangzhou, Taizhou, Wenzhou and Jiaxing in Zhejiang Province, 176 valid questionnaires from a total of 300, and it conducted a in-depth interview of 21 companies. This article uses the plural as a measure to distinct corporate governance types. This research references to Jia Shenghua (2005), COI stands for the effectiveness of coordination, SSI stands for interest satisfaction, SCI subject to: $COI_i = SSI_i / SCI_i$.

Table 2 shows the camera control situation can very significantly improve the effectiveness of coordination and decision-making, confirms the hypothesis 1 and 2. Based on the evaluation of two sub-dimensions of coordination effectiveness, it confirms the hypothesis 3 partly.

Table 2. Decision-making evaluation T test (N=83×2)

	Mean value (pair)		Differences (2 tails)
	Unilateral gov.	Camera gov.	
Decision-making effectiveness	3.6680	4.3628	-.69478*** (.000)
SSI / SCI	1.1029	1.4172	-.31434*** (.000)
SSI	3.3337	4.2566	-.92289*** (.000)
SCI	3.0205	3.0036	.01687* (.075)

Note: *,**,*** stand for 10%, 5% and 1% significance level respectively.

Table 3. Comparison of coordination and decision-making effectiveness (N=176)

		Sam.	Coordination eff.	Decision eff.
SOEs		23	1.1048(-0.1779 [△])	3.5217(-.51866**)
Collective		4	1.4025(0.1198 [△])	4.5556(.51516)
Private		128	1.3263(0.0436 ^{△△△})	4.1476(.10717**)
Foreign-funded		11	1.1691(-0.1136 [△])	3.9293(-.11111)
Institutions		8	1.2900(0.0073 ^{△△△})	4.0000(-.04040)
Others		2	(N/A)	(N/A)
Size	Large	37	1.2105(-0.0722 ^{△△})	3.7027(-.33770**)
	Median	75	1.3427(0.06 ^{△△})	4.2607(.22034***)
	Small	59	1.2508(-0.0319 ^{△△△})	3.9680(-.07242)
	One person	5	1.2940(0.0113 ^{△△△})	4.0889(.04849)
List com.	Yes	32	1.1613(-0.1214 [△])	4.1565(-.40498***)
	No, stock com.	73	1.2966(0.0139 ^{△△})	4.1050(.06462)
	No, non-stock com	71	1.3232(0.0405 ^{△△△})	3.6354(.11609)

Note: △、△△、△△△ stand for the state of interest coordination needs to be improved, sub-ideal and ideal respectively. *,**,*** stand for 10%, 5% and 1% significance level respectively.

Table 3 summarizes the information of coordination and decision-making between different classifications of enterprises. It extracts 1.2827 as average coordination for analysis critical point. In this paper, plus or minus 5% is defined as ideal range, and plus or minus 10% is defined as sub-ideal range, and the state of coordination needs to be improved if it is beyond the range of plus or minus 10%. Similarly, the critical point of decision-making effectiveness is average 4.0404. The coordination effectiveness of decision-making mechanism in private sector is much better than the state-owned (SOEs), collective and foreign-funded enterprises; which in large companies and listed companies are not very satisfactory. These results correspond to evaluation of decision effectiveness in a large extent: decision effectiveness of large-scale state-owned listed companies is not optimistic, while the medium-sized private enterprises in the surveys showed more promising results.

2 Conclusions and Suggestions

In the state of normal business operations, it is a desirable way to take the camera stakeholder governance model and corresponding decision-making mechanism in order to protect stakeholder interests. From both theoretical and empirical analysis, this paper verifies the balance of interests and decision-making mechanism can obtain better coordination and decision-making effectiveness. Especially for state-owned enterprises and listed companies, corporate decision-making mechanism should re-examine.

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An Approximate Algorithm Application to Solve the Location-Selection of Wireless Network Problem

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Abstract. The minimum Steiner tree problem has wide application background, such as transportation system, communication network, pipeline design and VISL, etc. It is unfortunately that the computational complexity of the problem is NP-hard. People are common to find some special problems to consider. Since the complexity of the Steiner tree problem, the almost of papers are relate to the object of small data problem, i.e., the number of involved objects is small. Those conclusions are useful to the theoretical research from which some algorithms are originated. For the practical problems, there are large number of objects are need to be considered. In this paper, we introduce an approximate algorithm and give an example with seven objects to consider the location-selection of wireless network problem.

Keywords: Steiner tree, computational complexity, location-selection, wireless network.

1 Introduction

On building communicating network problem, people should be considered in the construction of some cities (site) how lay cable, to make these cities become a connected networks and at the same time to consider how to minimize the cost of the total attachment in traffic. It has the similar problem in transmission system. Since the 1950s, information science has the vigorous development, such that promoting the shortest connection of this kind of problem, formed the research field of a very active combination optimization's topic. There are too much models on this area, roughly divided into two categories: the attachment problem in the plane and the network connection problems. For the former, it is considered the connection is the straight line of the plane and the definition of distance is Euclidean distance; For the latter the connection is considered the shortest path in the network, where the distance of two vertices is equals the distance of the shortest path between the vertices.

On location-selection of wireless network, the consumer always considers whether the network is smooth or not. In the common case, the signal of the network bases on the distance between the signal launch and consumer. If the distance is closer, then the signal is stronger. We want to build more launchers but the cost is too expensive. Then we want to find the suitable place to set the launcher such that the sum distance between the launcher and consumers is minimal. The problem is equitable to the famous Steiner tree problem. The computer complexity is NP-hard. In this paper, we

consider some special cases of the Steiner tree problem. If we want to build a launcher, then we have to consider the situation of the launcher, such as the geographical environment, the artificial construction etc. Without loss of generality, we demand the launcher in the fixed line L . We assume the launcher must be placed on the fixed line L and the consumers are on the same side of the line L , i.e., the restricted Steiner tree problem in [8] and [9].

In this paper we consider the connection line problems in the plane. In the plane of the shortest connection problem is divided into two types: the first kind only consider the connection among some fixed vertices and all attachment is constructed the spanning tree of these vertices. Therefore, this problem is called the spanning tree problem. The second is allowed to add some attachment vertices such that the distance of all attachment edges is constituted the shorted network; this is called the shortest Steiner smallest tree problem.

The minimal spanning tree problem is originated from the comprehensive work of Kruskal and Prim. In the plane of the minimum spanning tree problem can be stated as follows: Given a set N which has some fixed vertices and $|N|=n$ in a plane, where the distance of each line (or edge) $e=(u, v)$ is defined the Euclidean distance between the two vertices u and v . Then we can construct a weight graph G according to the model:

$$V(G) = N \cup P, w(e) = d(u, v),$$

where P is the Steiner vertex. Now for a spanning trees of G , namely a connection graph with the vertex set is N to make the sum weight of edges minimize. Kruskal and Prim has established by the famous Greedy algorithm, even applied to mastoid optimization problem. By using the algorithm, the spanning tree problem can be briefly described as follows:

- (1) for the graph G , we can sort the distance of the edges;
- (2) we choose a smallest edge to construct an edge set;
- (3) choose one the one the shortest edge e which is not selected, if e and selected edges does not constitute a circle, then we choose the edge to the edge set, otherwise, we abandon the edge;
- (4) the algorithm does not end until we choose $n-1$ edges to the edge set, such that we have a smallest spanning tree T of the graph G .

The algorithm time bound of the algorithm is $O(n^2 \log n)$, now there exists more effective polynomial algorithm. Minimum Steiner tree problem is originated from three-point sitting Fermat problem, where there are three villages whose position fitly constitute a triangle, and assumed the ground can be used anywhere for all road's construction. The problem is how to design a graph G such that the villages are connected and the distance of roads reached the shortest.

The answer to this question is very simple. We can choose one point inside the triangle such that the point attachment angle to the three points is 120° . This is an optimal plan (if the maximum angle among the triangle is at least 120° , then the optimal plan is the two shorter edges.)

There are many papers to consider the spanning tree problems. In [6], Bing Yao etc considered some properties: a spanning tree with minimum leaves such that it contains a longest path, and the spanning tree with the maximum leaves about the

diameter of the graph; In [7], Ming-yi Yue gives some new and simple proofs for the cases $n=3, 4$ and 5 , and a proof of the Steiner Ratio Conjecture. Some researchers consider some application on Steiner tree problem, such as Hui-min Jin, in [8], considered intelligent optimization algorithms for Euclidean Steiner minimum tree problem, and there are two intelligent optimization algorithms: the simulated annealing algorithm and the ant algorithm. In the paper, we give an approximate method to solve the large number of units, which the distance between the units and the recycle water station is minimum.

2 A Designed Approximate Algorithm

The problem is proposed by location-selection of wireless network. The model is there are n consumers, the plane coordinates (x_i, y_i) , $i=1, 2, \dots, n$, it is needed to build one station to connect the consumers such that

$$\min_{(x,y)} f = \sum_{i=1}^n \sqrt{(x-x_i)^2 + (y-y_i)^2}.$$

The distance between the units and the station is Euclidean distance. The problem is to select a suitable location such that the sum distance between the units and the station is minimal. It is easy to see that the problem is equitable to the minimum Steiner tree problem. Since the computer complexity is Np-complete, it is difficult to find the accurate Steiner vertex to minimize the distance. Therefore, there are lots of papers are considered the small data Steiner tree problem such that $|N|=2, 3, 4, 5$ and some special cases such as the restricted condition, like the Steiner vertex on the line, some curve etc. For the practical problem, like we proposed the location-selection of wireless network problem, maybe there are many consumers to connect the station, the previous achievements cannot to solve the model. We construct an approximate algorithm to solve the model.

Least square method is a kind of optimal technique. It can determine the unknown data and make deviation between these values of data and the practical data minimal. The method can also be used to curving fitting. There are n units, denoted the plane coordinates (x_i, y_i) , $i=1, 2, \dots, n$.

We use the Least square method to find a quadratic curve L . Nextly, we find a vertex P on the line L such that the distance between the vertex and all of units is minimum. Therefore, P is an approximate Steiner vertex of the problem.

Approximate Algorithm

(1) for units (x_i, y_i) , $i=1, 2, \dots, n$, we use the least square method to fine the quadratic curve $Ly = ax + b$, this is can be directly attained by the matlab computation;

(2) we find one vertex $P \in L$ such that the distance between P and the all of consumers is minimum, this is conditional extreme value problem, and we can use the Lagrange multiplier method to find the vertex.

Application of the algorithm

We use the approximate algorithm to solve an example. There are seven consumers and the according coordinates are

$x=[15,17,19,21,23,25,27]$, $y=[20,25,26,30,26,22,18]$.

Step 1 find the fixed line L using the Least square method by matlab.

The matlab procedure is

Input data $x0=15:2:27$;

$x0=[x0]$;

$y0=[20,25,26,30,26,22,18]$;

$[p,s]=polyfit(x0,y0,1)$;

p

$[y,delta]=polyconf(p,x0,s)$;

y

$\text{polytool}(x0,y0,1)$

the computation result of matlab is

$p = -0.2143 \quad 28.3571$

$y = 25.1429 \quad 24.7143 \quad 24.2857 \quad 23.8571 \quad 23.4286 \quad 23.0000 \quad 22.5714$

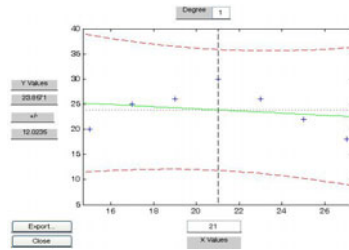


Fig. 1.

The figure 1 is the line L which curves fitting the vertices. Therefore we have the function of quadratic curve L $y = -0.2143x + 28.3571$.

Step 2 find a suit vertex P on L such that the distance between P and vertices is minimum using the Lagrange multiplier method.

To simplified calculation, we consider the square of distance instead of the distance.

$$\min f = \sum_{i=1}^7 ((x - x_i)^2 + (y - y_i)^2), \text{ where } y = -0.2143x + 28.3571.$$

We can have using the matlab computation

$$x \approx 21.37, y \approx 23.87, \quad \sum_{i=1}^7 \sqrt{(x - x_i)^2 + (y - y_i)^2} \approx 36.19,$$

and the distance between the each consumer and the station is approximate 7.4534, 4.5137, 3.1865, 6.1412, 2.6821, 4.0834, 8.1335, respectively.

3 Some Further Problems

Since the computation complexity of the famous Steiner tree problem is Np-complete we consider an approximate algorithm to solve it. We find a suitable vertex on a special line L to approximate the Steiner vertex using the approximate algorithm. Next, we can use the least square method to find some special curve, where locate the suitable vertex on the curve such that it approximates the Steiner vertex. Although the approximated vertex is not the accurate Steiner vertex, it provides a method to solve the location-selection of the Steiner tree problem. It is natural to think that if we add the power of the function, the distance may be shorter, i. e., the approximate is trend to the Steiner vertex when the power of function is more greater.

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An Intra-organizational Tacit Knowledge Transfer Model on Introduction of Talent

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Abstract. Base on introduction of talent, this paper establishes a differential dynamic model for intra-organization tacit knowledge transfer. We interpret the key role of talent introducing on tacit knowledge transfer, and explain the direct effects of new entrants and talent introducing rate of tacit knowledge on ultimate stability quantity of the core staff. The findings of this paper provide new theoretical thinking for organizational managers to understand the law of tacit knowledge transfer and to promote tacit knowledge transfer in practice.

Keywords: Talent introduction, tacit knowledge, knowledge transfer.

1 Introduction

Knowledge is recognized as critical resource to confer sustainable competitive advantage in knowledge-based economy. Organizations are a long-term accumulation of structured knowledge base, tacit knowledge is the main part of organization knowledge and the source of knowledge innovation (Nonaka, 1994) [1].

Tacit knowledge of organizations, such as skills, techniques, know-how, experience, insight and so on, is difficult to express precisely and to be imitated easily, so it is always mastered by few employees called as the organization's talent. Here, organization talent is defined as those employees who have some kind of special skills, know-how, excellent experience or outstanding capabilities through long-term education, training or exercise, and they can use the tacit knowledge to make a key contribution for the organization. Therefore, when the organization wants to get some new, scarce and necessary tacit knowledge from the outside, it often introduces special talents with the tacit knowledge to do so. And then, how to acquire and disseminate tacit knowledge through talent introduction is considered as a key process of organization knowledge management, but the process will be not fluky and always be impacted by some factors such as the introduction rate. Therefore, it is a critical and practical problem for organizational managers that how to understand the law of tacit knowledge transfer deeply and then to take appropriate incentive and control measures. Previous studies found have discussed the knowledge absorptive capability[2], the staff contact rate [2], knowledge forgetting rate [3,4], knowledge sharing rate [4], enterprises efforts [5] and knowledge dissemination capacity [6] and other factors' impacts on

knowledge transfer in organizations, but few scholars pay attention to the impact of talent introduction on tacit knowledge transfer.

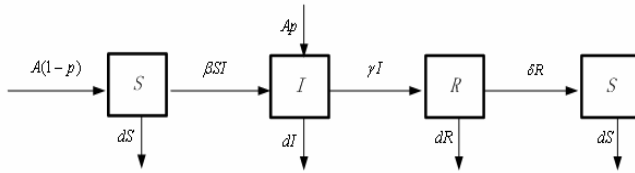
Therefore, based on the researches [7,8], this paper establishes a differential dynamic model for intra-organization tacit knowledge transfer from the perspective of talent introduction. We interpret the key role of talent introducing on tacit knowledge transfer, and explain the direct effects of new entrants and talent introducing rate of tacit knowledge on ultimate stability quantity of the core staff.

2 A Model of Tacit Knowledge Transfer Intra-organization

2.1 Model Formulation

Tacit knowledge transfer is defined as the dissemination process of tacit knowledge through the "mentoring system", "learning by doing" and other ways within an organization. After a certain time, tacit knowledge can be identified and mastered by specific people in an organization through a sustained communication between the owners and learners, and it becomes the organization's specific tacit knowledge.

In the transfer diagram:



recall that the number of learners, owners and forgetful individuals of tacit knowledge as a function of time t are S , I and R respectively and the organization's total population size is N . The parameter $A > 0$ is the immigration rate; $p (0 < p \leq 1)$ is the talent introduction rate, which means the ratio p of new members A already own tacit knowledge and Ap is the talent introduction; $d > 0$ is natural demission rate; $\beta (1 > \beta > 0)$ is transmission coefficient of tacit knowledge; $\gamma (1 > \gamma > 0)$ is the forgetting rate constant; $\delta (1 > \delta > 0)$ is the relearning rate. $A, p, \beta, \gamma, \delta$ are all constant. The total population is assumed the three classes to be disjoint, so that, for all time t

$$N = S + I + R > 0 \quad (1.0)$$

2.2 Equilibrium State

The following differential equations are derived based on the basic assumptions and using the transfer diagram:

$$\begin{cases} S' = A(1 - P) - \beta SI - dS + \delta R \\ I' = Ap + \beta SI - (d + \gamma)I \\ R' = \gamma I - (d + \delta)R \\ N' = A - dN \end{cases} \quad (1.1)$$

(1.0) is used to substitute for S in these equations, then (1.1) can be written as

$$\begin{cases} I' = Ap + \beta I(N - I - R) - (d + \gamma)I \\ R' = \gamma I - (d + \delta)R \\ N' = A - dN \end{cases} \quad (1.2)$$

Order (1.2) equals 0

$$\begin{cases} Ap + \beta I(N - I - R) - (d + \gamma)I = 0 \\ \gamma I - (d + \delta)R = 0 \\ A - dN = 0 \end{cases} \quad (1.3)$$

Obviously, $R = \gamma I / (d + \delta)$ and $N = A/d$, they are both used to R and N in the first equation of (1.3), we got

$$EI^2 + FI + G = 0 \quad (1.4)$$

Here, $E = \beta d(d + \delta + \gamma)$, $F = (d + \delta)[(d + \gamma)d - A\beta]$, $G = -Apd(d + \delta)$

According to earlier assumptions $A > 0, 0 < p \leq 1, d > 0, 1 > \beta > 0, 1 > \gamma > 0, 1 > \delta > 0$, it is easy to know $E > 0, G < 0, EG < 0$, so $\Delta = F^2 - 4EG > 0$, (1.4) must have two real roots: $I = (-F \pm \sqrt{\Delta}) / 2E$

Furthermore, I satisfies $I \geq 0$, equation (1.4) must have only one positive real root $I = (-F + \sqrt{\Delta}) / 2E$, and the only non-negative equilibrium of system (1.1) is:

$$E^* : \begin{cases} S^* = A/d - (d + \delta + \gamma)I_2^* / (d + \delta) \\ I^* = (-F + \sqrt{\Delta}) / 2E \\ R^* = \gamma I_2^* / (d + \delta) \\ N^* = A/d \end{cases}$$

Theorem 1. when $0 < p \leq 1$, The system (1.1) always has the only non-negative equilibrium E^* .

2.3 Stability of the Equilibrium E^*

From biological considerations, we discuss E^* in the closed set

$$D = \{(I, R, N) \in \mathfrak{R}^3 | T + R \leq N \leq A/d\}$$

where $\mathfrak{R}^{+3}$ denotes the non-negative cone of $\mathfrak{R}^3$ including its lower dimensional faces. It can be verified that D is positively invariant with respect to (1.1).

Theorem 2. Suppose that $0 < p \leq 1$, then E^* is a unique interior stability equilibrium of system (1.1).

Proof. The Jacobian matrix of (1.1) at a point E^* is

$$B = \begin{bmatrix} \beta N^* - 2\beta I^* - \beta R^* - (d + \gamma) & -\beta I^* & \beta I^* \\ \gamma & -(d + \delta) & 0 \\ 0 & 0 & -d \end{bmatrix}$$

Eigenvalues of B are solutions of the cubic equation

$$\lambda^3 - (b_1 + b_2 + b_3)\lambda^2 + (b_1b_2 + b_1b_3 + b_2b_3)\lambda - b_1b_2b_3 = 0,$$

with $b_1 = \beta N^* - 2\beta I^* - \beta R^* - (d + \gamma)$, $b_2 = -(d + \delta) < 0$, $b_3 = -d < 0$

When $\sigma = \beta A / d(d + \gamma) \leq 1$, it is easy verified that

$$\begin{aligned} b_1 &= \beta N^* - 2\beta I^* - \beta R^* - (d + \gamma) \\ &= [A\beta - (d + \gamma)] - \beta(2d + 2\delta + r)I^* / (d + \delta) \\ &< [A\beta / d - (d + \gamma)] + \beta(2d + 2\delta + r)F / (d + \delta)E \\ &= -[A\beta - d(d + \gamma)](d + \delta) / d(d + \delta + \gamma) < 0 \end{aligned}$$

So, either $\sigma \leq 1$ or $\sigma > 1$, we see that

$$\begin{aligned} k_1 &= -(b_1 + b_2 + b_3) > 0, k_2 = (b_1b_2 + b_1b_3 + b_2b_3) > 0, k_3 = -b_1b_2b_3 > 0. \\ k_1k_2 - k_3 &= -(b_2 + b_3)(b_1b_2 + b_1b_3 + b_2b_3 + b_1^2) > 0 \end{aligned}$$

According to the Routh-Hurwitz conditions, all eigenvalues of B have negative real parts, namely, E^* is interior stable.

Remark. By Theorem 2, if an organization introduces talent owned tacit knowledge, whether the initial number of I in organizations is many or few, the fraction of owner of tacit knowledge will gradually increase over time, and gradually stabilized at a particular level.

Deduction 1. I^* is an increased function of p and A .

Proof. When $0 < p \leq 1$, E has no relation with p and A , $-F$ is an increased function of A and has no relation with p , $|\sqrt{\Delta}|$ is an increased function of A and p , so $I^* = -F + |\sqrt{\Delta}| / 2E$ is an function of p and A . This completes the proof.

Remark. Deduction1 implicates that organization can regulate and control the personnel of owning tacit knowledge through two ways: one is to increase or decrease the number of new staff, another is to enhance or reduce the introduction rate of talent.

Deduction 2. The organization's total population size N^* is an increased function of A and an decreased function of p .

Proof. By $N^* = A/d$, the result of deduction 2 is obviously.

Remark. Deduction 2 showed that an organization can control the population size through two ways: one is to increase or decrease the number of new staff, another is to enhance or reduce the demission rate.

3 Results and Implication

This paper analyzes the importance of talent introduction for organizational development, discuss the contributions and shortcomings of previous studies, then we establish a differential dynamic model for intra-organization tacit knowledge transfer and put out two theorems and two deductions based on the model's solution.

This study shows that: (1) if an organization introduces talent owned tacit knowledge, whether the initial number of I in organizations is many or few, the fraction of owner of tacit knowledge will gradually increase over time, and gradually stabilized at a particular level. (2) An organization can regulate and control the ultimate number of employees owning tacit knowledge through two ways: one is to increase or decrease the number of new staffs, another is to enhance or reduce the introduction rate of talent. (3) An organization can control the population size through two ways: one is to increase or decrease the number of new staff, another is to enhance or reduce the demission rate. The contribution of this paper is that it illuminates the positive impact of talent introduction on the dissemination of tacit knowledge in an organization. However the natural turnover rate of learners, owners, and forgotten personnel is assumed the same in this paper, in fact, the turnover rate of owners of tacit knowledge should be considered alone because of its importance in the future research.

Acknowledgments. This work is supported by Henan Province Soft Science Project (112400430011).

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An Investigation on Chinese College Students' Web-Based Self-access English Learning

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Abstract. In this paper, a questionnaire is used to investigate the general attitude of Chinese students towards web-based self-access English learning; the problems that they meet when doing web-based self-access English learning; the preference of web-based English learning materials.

It can be clearly seen from the results of the study: Chinese college students have a positive attitude towards web-based self-access English learning; A large proportion (more than 50%) of Chinese college students do not often do web-based self-access English learning even though they know it is a good and important way of English learning; A large number of students strongly need guidance while doing web-based self-access English learning no matter it is technological or strategic guidance; Many (more than 60%) students do not know how to do online English learning; Many students do not know how to evaluate their learning effects when doing web-based self-access English learning.

Keywords: web-based, self-access English learning, Chinese college students.

1 Introduction

This study is based on a study program which was sponsored by Division of Ideological & Political Education and Social Science Research, Hubei Provincial Department of Education. The name of this study program is *A Study on the Three-Point-in-One-Unit Approach: a New Model of Chinese College Students' Web-based Self-access English Learning*. The study lasted for 2 years, from September 2008 to September 2010. This paper is the first part of the study program.

Self-access, according to Gardner and Miller [1], is an environment for learning involving resources, teachers, learners and the systems within which they are organized and a way of encouraging learners to move from teacher dependence towards autonomy. Web-based self-access English learning is a term that required by the Department of Education of China in *College English Course Teaching Requirements* which was published in 2004. The requirements represent the trend of foreign language teaching and learning in the 21-century and evoke a great reform in the teaching field.

This paper aim at finding out the general situation of college students' attitude towards web-based self-access English learning, their preference of useful online

learning materials and the problems that they meet when doing web-based self-access English learning.

2 Research Design and Methodology

Subjects

180 non-English majors (junior and senior) from Hubei University of Technology were selected to finish a questionnaire. Most of them are 19 to 22 years old. All of them have spent at least seven years learning English. The research subjects were selected randomly from non-English majors, concerning a proper ratio of the sex and major of the Arts and the Science so as to make the investigation more representative.

Questionnaire Design

Questionnaire items were generated from a number of sources: (1) the Belief Inventory for Language Learning from Cotterall[2] [3]; (2) investigation of frequency of internet and media use among university students by Shi Ling and Jessica Gisclair [4]; (3) investigation on the establishment of self-access language center by Hua Weifen [5]. The writer summarized and supplemented their questionnaires in table 1.

17 items were incorporated into a five-point Likert-type rating scale ranging from strong agreement to strong disagreement with each statement. The last item employed a forced choice format. In order to make sure the appropriateness of the questionnaire and the successful operation of the investigation, a pilot study was carried out. Specifically, the researcher asked five students to do it before handing out, collected their suggestions and made further improvement before the investigation. Later on, 180 questionnaires were handed out and 180 students finished them in about twenty minutes. 170 questionnaires were available.

Data Analysis

Subjects' responses were analyzed descriptively by calculating percentages in order to determine the trends in the data. The results and analysis are discussed in the followings sections.

3 Findings and Discussions

Research findings are reported and discussions are done accordingly in the following parts.

College Students' General Attitude towards Web-Based Self-access English Learning

Items 1-10 in the questionnaire concern the learners' general attitude towards web-based self-access English learning. From table 1, it is found that students have a positive attitude towards web-based self-access English learning. They subconsciously admit that online resources can help with English study and would welcome it, which is clearly shown in items 1, 7, 8 and 9. But it also reflects the deficiency that few students are involved in online study although they have much enthusiasm with it. Take item 4 and 5 for example, less than half students think that

they often study English online, let alone visit English websites. Moreover, a fact should not be neglected that most students strongly need guidance while study online no matter what is technological or learning guidance.

Table 1. Students' general attitude towards web-based self-access English learning

I think \ Scale	1	2	3	4	5
1. net resources is helpful for English study	23.4	62.8	13.8	0	0
2. net is easily available for me	23	35.2	9.6	26.5	5.7
3. I often study English online	10.3	25	12	32.7	20
4. I often visit English websites	9	9.6	5	61.4	15
5. I often study English online alone	60.1	25.6	10.3	5	0
6. I need guidance while study online	68.5	26.5	2	3	0
7. I welcome use of net or multimedia in class.	72	23	5	0	0
8. I hope there is a self-access learning center	45.4	40.6	14	0	0
9. Online resource can help self-access	50.3	29.7	12	5	3
10. Online study can replace classroom study.	3	9	19	62	7

Problems of Web-Based Self-access English Learning

Items in table 2 present some possible problems that may exist in online learning. The results are nearly close to the writer's hypothesis that they surely encounter frustration in some areas such as knowing how to do online study, weak self-discipline. The outcome of item 12 and 13 do not contradict with each other as to the quick search engine and vast online resources. But sometimes the resources are so diversified that learners may lose their attention. Item 16 reflects another problem that it is difficult to measure online study effects. The reasons may lie in that learners work independently, thus standardized tests are impossible to be conducted or there is no specific test associated with each learning content or the learning process is assessed more in abstract concept than in detailed account. Evaluation is an important step in self-access learning. Regarding this, how to measure web-based self-access learning effects must be taken into consideration.

Table 2. Problems of web-based self-access English learning

I think I can \ Scale	1	2	3	4	5
11. know how to study English online	10	14	11.2	34.8	30
12. find the necessary materials I need	21	27.3	14	31.6	6.1
13. be lost in the vast online resources	20	32.5	10	28.3	9.2
14. be absent-minded while study online	35	50	10	5	0
15. rarely encounter technological problems	17.6	13.5	3	48.2	17.7
16. know how to measure my online study effects	7.4	15	20	44.7	13.9

Students' Preference towards Online English Learning Materials

Item 17 aims at finding out the trend of students' preference toward online English resources so as to define the proper distribution of teaching content when designing the self-access learning model. Figure 1 suggests that most subjects favor listening and oral English practice on the Internet. The finding is also coherent with students' belief that listening and speaking skill are useful but difficult to master.

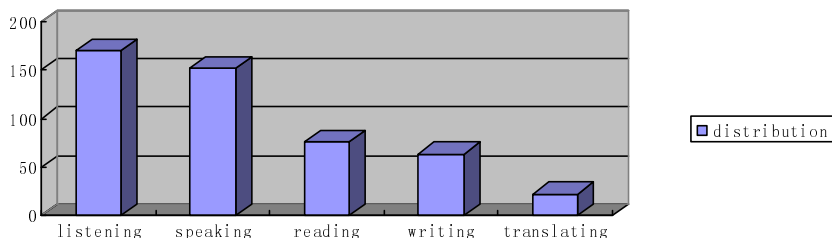


Fig. 1. Responses to preferences on online English resources

4 Pedagogical Significance of the Research Results

From the findings and discussions in the above section, it can be seen that web-based self-access English learning has been accepted by Chinese college students as an important means of English learning. However, students meet many problems when doing web-based self-access English learning. Some problems are very common to most students: they need guidance when doing web-based self-access English learning; they do not know how to use internet to learn English effectively; they do not know how to evaluate their own English learning effect.

Therefore, it is important that teachers give students relevant support during the process of web-based self-access English learning.

5 Summary

The following conclusions can be made from the results of the research:

- 1) Chinese college students have a positive attitude towards web-based self-access English learning.
- 2) A large proportion (more than 50%) of Chinese college students do not often do web-based self-access English learning.
- 3) A large number of students strongly need guidance while study online no matter it is technological or strategic guidance.
- 4) Many (more than 60%) students do not know how to do online English learning.
- 5) Many students do not know how to evaluate their learning effects when doing web-based self-access English learning.

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A Study on the Three-Point-in-One-Unit Approach: A New Model of Chinese College Students' Web-Based Self-access English Learning

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Abstract. This paper firstly proposed a new model of web-based self-access English learning. In this new model, the three points of classroom teaching, self-access center and students' independence online English learning are integrated into one systematic unit. This can new model enables students do their own autonomous learning and get their teachers' support if necessary. Then in the paper, the writer did an empirical study and proved that this new model can significantly improve students learning effects.

Keywords: web-based, self-access English learning, new model, three-point-in-one-unit.

1 Introduction

Sponsor of the Research

This study is based on a study program which was sponsored by Division of Ideological & Political Education and Social Science Research, Hubei Provincial Department of Education. The name of this study program is *A Study on the Three-Point-in-One-Unit Approach: a New Model of Chinese College Students' Web-based Self-access English Learning*. The study lasted for 2 years, from September 2008 to September 2010. This paper is the second part of the study program.

Theoretical Background

In the previous investigation of the study program sponsored by Hubei Provincial Department of Education, it was found that although Chinese college students welcome the idea of web-based self-access English learning, they do not know how to effectively do this new way of English learning; they meet many problems that they can not solve on their own; they need teachers' help; they do not know how to evaluate their self-access English learning. Therefore it is necessary for researchers to design a new model of English learning. This new on the one hand promotes students' ability of self-access English learning, on the other hand, it provides convenient channels for teachers and students to communicate conveniently with each other.

College English Curriculum Requirements which was published in 2004 by the Ministry of Education of China advocates “colleges and universities should remold the existing unitary teacher-centered pattern of language teaching by introducing new teaching models with the help of multimedia and network technology. The new teaching model should be built on modern information technology, particularly network technology, so that English language teaching will be free from the constraints of time and place and geared towards students’ individualized and autonomous learning”. The requirements also demand that a new model of foreign language teaching and learning be explored.

Three-Point-in-One-Unit Approach

Three-point-in-one-unit Approach refers to a new model of web-based self-access English learning which is to be proposed in this paper. In this new model, the three points of classroom teaching, autonomous English learning under the guidance of teachers in self-access English learning centers and students’ independent online learning are systematically combined together to significantly improve the effects of college English learning and teaching.

Purpose of the Paper

This paper firstly proposes a new model of web-based self-access English learning: the three-point-in-one-unit approach. And then an experiment is done to prove its effectiveness.

2 The Three-Point-in-One-Unit Approach: A New Model of Web-Based Self-access English Learning (WBSAEL)

The Structure of Three-Point-in-One-Unit Approach

In Crabbe’s[1] idea, autonomous learning “needs to become a reference point for all classroom procedure”. In order for this to happen he maintained that there must be an interface between “public domain” learning, that is, learning which is based on shared classroom activities and “private domain” learning, that is, personal learning behavior. We share Crabbe’s view that these two domains of learning should be integrated. It is for this reason that when designing the WBSAEL model, a closer relationship between self-access learning and classroom-based learning is proposed. Moreover, at the core of the idea of self-access language learning is the self-access center (a center which is characterized as a large space, hundreds of computers which are internet-accessible, free learning time for students, teacher-guided learning schedule, convenient system for teacher-student communication), which often functions as an indispensable unit with its own philosophy and routines for engaging learners in study outside the classroom.

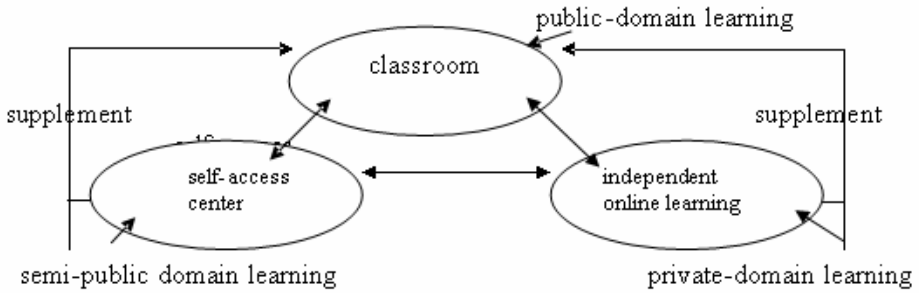


Fig. 1. The Structure of Three-point-in-one-unit Approach

Figure 1 shows the relationship among classroom, self-access center (SAC), independent online learning, suggesting there are at least three directions for assisting learner's self-access learning. When designing WBSAEL model, SAC and independent online study are considered the available activities after class, serving as the beneficial supplement to the classroom-based study. Though different in status, the three kinds of environment are all aiming at improving learners' self-access ability. Each point is interacting with each other. It is for this reason that three-point-in-one-unit WBSAEL model was named.

Practice of the Three-Point-in-One-Unit Approach

The model in figure 2 shows the practice of the three-point-in-one-unit approach. Under the guidance of this model, the 3 points of English learning can work independently and at the same time they are integrated into one unit and form a complete system. In the following parts, the operation of the 3 points are discussed respectively.

(1) Classroom

Compared with other two points, classroom is an important and ideal place to confer knowledge needed for fostering self-access. it is necessary for teachers to get students started in self-access learning by well-prepared activities on strategic training or cooperative learning. While students acquire the related skills and knowledge, they are less frustrated in the private-domain learning.

(2) SAC

SAC should be a good place for learners to improve their English level. As a semi-public learning domain, learners in SAC are more interactive with teachers, partners, and computers[3]. It requires both learners' involvement and teachers' well-organization. In SAC, students are encouraged to set their learning goal and learning plan and do the self-access learning with the help of teachers. Here they are assessed in three ways: teacher assessment, peer assessment and self-assessment.

(3) Independent online study

Learning English online alone requires that students do all the learning steps totally on their own, including setting learning goal and learning plan, choosing their own learning material, self-access learning, self-assessment.

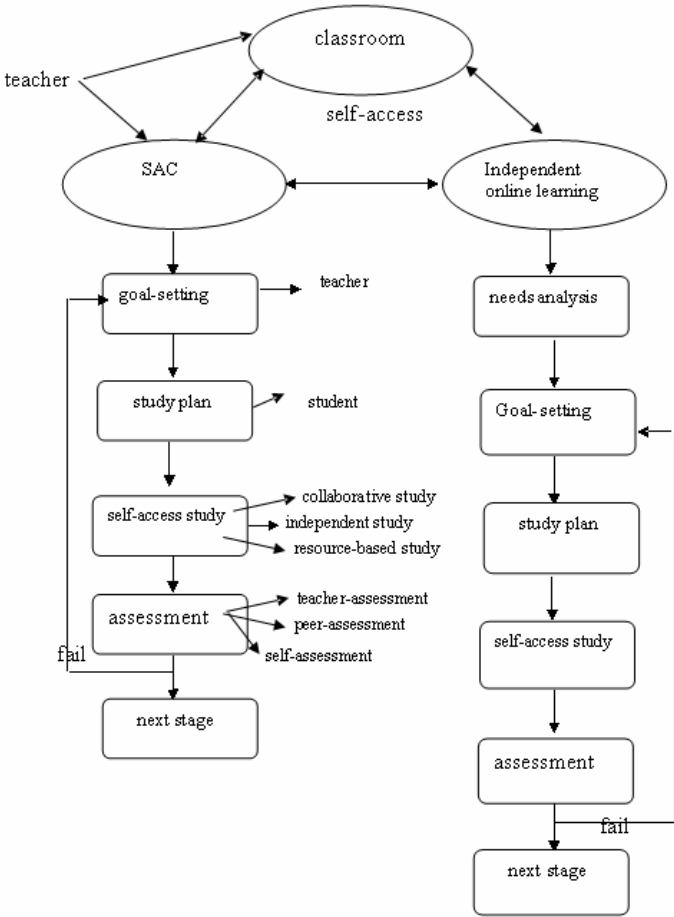


Fig. 2. Practice of the Three-point-in-one-unit Approach

3 An Empirical Study

Research Question

This research tries to find out whether the above proposed new model can significantly improve Chinese college students’ English learning effects.

Subjects

Two second-year classes were chosen from non-English majors in Hubei University of Technology. One of them was taken as the experimental group with the WBSAEL model while the other was taken as the controll group with traditional classroom-based teaching and learning model. The experiment lasted for one term.

The detailed information of the subjects goes as in table 1:

Table 1. Distribution of experimental and controlled group

group name	female	male	total
controll group(class 1)	15	18	33
experimental group(class 2)	12	19	31
total	27	37	64

Research Design

Pre-test and post-test were carried out to find out whether there is any significant English proficiency difference between the experiment group and the control group after the experiment.

Results and Discussions

Table 2 and 3 respectively presents the results of the pre-test and the post-test about students' English proficiency. In the table 2, it is found that students' learning proficiency is approximately close to each other. While in table 15, the average score of the experimental groups is significantly higher than the one of the controll group, which indicates that the WBSAEL model is better in improving students' learning proficiency than the traditional classroom-based teaching model.

Table 2. Results of the Pretest

	group	average	st.deviation	P value
pre-test	controlled G	74.5	6.7	>0.05
	Experimental G	75.2	7.2	>0.05

Table 3. Results of the post test

	group	average	st.deviation	P value
post-test	controlled G	83.5	7.4	<0.05
	Experimental G	79.7	8.1	<0.05

4 Summary

In this paper, the writer firstly proposed a new model of web-based self-access English learning. This model integrates the three points of classroom teaching, SAC and students' independent online learning into one systematic unit. Then the writer did an empirical study and proved that the new model can significantly help students with their English learning.

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Research on the Curve Fitting for Numerical Controller Based on Fuzzy Reasoning

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Abstract. In the cutting processing of numerical controller, curve fitting calculation of cutting path has an important influence on the cutting accuracy and path optimization. In order to improve the cutting accuracy, fuzzy reasoning method is used to determine the state of curve fitting and determines the membership function based on lines and arcs in this paper. In order to improve the reasoning efficiency, two fuzzy reasoning ways are used to reason curve fitting mode in the calculating process. The improved curve fitting way may boost the fitting precision easily. Experiment results show that the designed reasoning system can reason effectively in fitting curve through arc or line.

Keywords: numerical control machining, path, fuzzy inference, curve fitting.

1 Introduction

With the development of information technology, automatic cut systems play an important role in industrial production. The accuracy of numerical controller(NC) and path optimization have an important influence on manufacture processing and then the line or arc fitting of image curve has become one important work in the NC. J. H. Horng uses curve fitting based on a combination of polygonal and circular of dynamic programming[1]. These methods make certain progress, but they have higher computational complexity. In this paper, the curve fitting based on arcs and lines is proposed.

The fuzzy inference system can express people's experiential knowledge and also solve many practical problems through establishing accurate mathematical modes and simulating human reasoning way[2]. In order to get the fitting curve which can simulate the given original curve using reasonable segments and meet cutting requirements, this paper uses the fuzzy reasoning method to determine the state of curve fitting and membership functions of different factors based on lines and arcs.

2 Establishment of Lines and Arcs

Three data points express a short line: the initial point $A(x_1, y_1)$, the middle point $B(x_2, y_2)$, and the end point $C(x_3, y_3)$.

Arc fitting is given in figure 1.

Here, Flat non-circular curve $f[x(t),y(t)] = 0$, $P(x_p, y_p)$ is a center point of the circle composed with A, B and C. R is radius. Expressions are given as follow.

$$x_p = \frac{(y_2 - y_1)(x_3^2 + y_3^2 - x_2^2 - y_2^2) - (y_3 - y_2)(x_2^2 + y_2^2 - x_1^2 - y_1^2)}{2(y_2 - y_1)(x_3 - x_2) - 2(y_3 - y_2)(x_2 - x_1)} \quad (1)$$

$$y_p = \frac{(x_3 - x_2)(x_2^2 + y_2^2 - x_1^2 - y_1^2) - (x_2 - x_1)(x_3^2 + y_3^2 - x_2^2 - y_2^2)}{2(y_2 - y_1)(x_3 - x_2) - 2(y_3 - y_2)(x_2 - x_1)} \quad (2)$$

$$R = \sqrt{(x_1 - x_p)^2 + (y_1 - y_p)^2} \quad (3)$$

$D(x_4, y_4)$ is a random point in the curve. Where the distance(d) is shown as:

$$d = \sqrt{(x_4 - x_p)^2 + (y_4 - y_p)^2} \quad (4)$$

Arc(ABD_1C) is fitted by curve($ABDC$). D_1 is the intersection of PD and the arc. When error (ery = $R - d$) is too large, an arc can not express the curve's tendency and it is needed to step back again. If the error is small, the arc will fits this curve well.

Line fitting is given in figure 2.

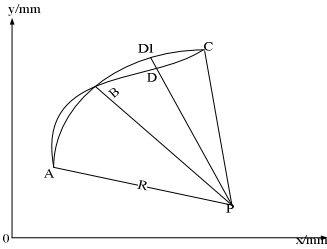


Fig. 1. Arc fitting of curves

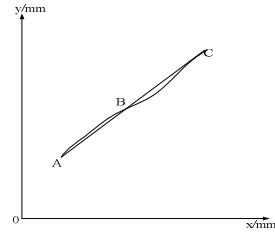


Fig. 2. Line fitting of curves

The curve(ABC) is expressed with a line segment determined by two points ordinarily. So the three points are almost in a straight line, that is to say, errors must be small or nonexistent. The error is given as follow.

$$er \tan = \frac{y_2 - y_1}{x_2 - x_1} - \frac{y_3 - y_1}{x_3 - x_1} \quad (5)$$

In the curve fitting, whether line or arc is used to characterize a curve, some effect factors should be considered. They are given as follow.

- (1) R. R is arc radius. If it is too big, the arc tends to a line segment.
- (2) ery. It determines whether the arc approximates the original curve.
- (3) ertan. It determines whether a line is generated and whether the line can express the original curve.

From figure 1, data points (A, B, D) are selected and fit as a line or arc that characterizes the curve(ABD) by above method. And then a set of data point is added which makes line or arc rebuilt. When it does not meeting error requirements, the new line or arc needs to step back, then the curve(ABD) is fitted. Otherwise it continue to add data points. If the arc or line(ABD)is determined, the next data point (C) is selected as a initial point and continue to fit curves through arcs or lines. Using such way, a complete image would be expressed through arcs or lines.

In real application, above reasoning way is complex and difficult in the data processing. In order to improve reasoning efficiency and write programs easily, fuzzy reasoning way is used to conclude arc or line in curve fitting.

3 Fuzzy Inference System

According to fuzzy inference system, the curve fitting mode which meets requirements of image recognition can be selected. In order to improve reasoning efficiency and programming convenience, the reasoning system is divided into three fuzzy inferences systems. The input of first reasoning is radius R, and the inference just determines characterization of states(arcs or lines). At the same time, it can not guarantee a good approximation. When the first reasoning conclusion is an arc, the second inference should be used. It decides whether the curve is expressed with the arc according to input variable ery. When the first reasoning conclusion is a line, the third fuzzy inference system based on input variable ertan determines the rationality of approximation with the line. In this system, the expression of fuzzy rules is given as follow[3].

IF A_1 THEN B_1 , IF A_2 THEN $B_2, \dots$

3.1 Preliminary Determination of Curve Representation

The first fuzzy reasoning determines the possibility of arc fitting.

The size of radius R is chosen as input variables, and Language variables are described as large(PB), middle(PM) and small(PS). So conclusions are expressed as "sure(B_3)", "possible(B_2)", "impossible(B_1)".

The membership function of R is shown in figure 3[4], where $R \geq 0$, the corresponding domain is $[0, 2000, +\infty]$. The domain of output variables whose membership function is given in figure 4 is $[0, 0.5, 1]$.

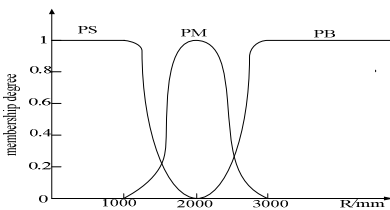


Fig. 3. Membership functions of R

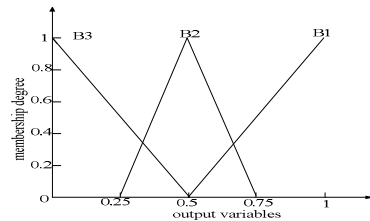


Fig. 4. Membership functions of output variables

From the input and output variables, inherent connection for fuzzy rules are given as follows.

If the radius R is small, then the curve is identified as an arc.

If the radius R is middle, then the result may be an arc.

If the radius R is large, then it is not possible for an arc.

3.2 Determination the Status of Arcs and Lines

The output of the first fuzzy inference determines the expression of graphic curve directly. But in order to approximate the original curve well and express it using less number of segments, it is needed to further define the arc or line which moves forward or back. According to the conclusion of the first fuzzy inference, fuzzy reasoning is used on the basis of the arc expression or line expression.

If the curve is expressed as an arc, the second fuzzy inference is needed. The size of ery is chosen as input variables, and Language variables are described as large(PB), middle(PM) and small(PS) whose corresponding domain is $[0, 0.5, +\infty]$. So Conclusions expressed as "sure(B_3)", "possible(B_2)", "impossible(B_1)". Membership functions of output variables and ery are shown in figure 4 and 5 respectively. The reasoning process is given as follow.

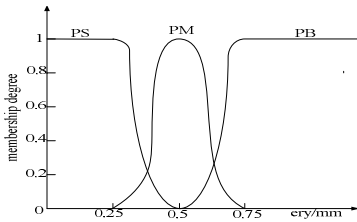


Fig. 5. Membership functions of ery

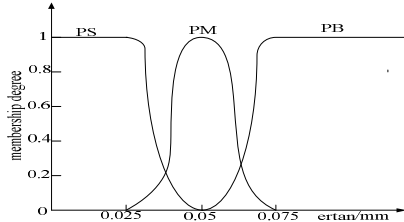


Fig. 6. Membership functions of ertan

If the error ery is small, it is needed to move to a forward point and estimate.

If the error ery is middle, fitting point may be move forward.

If the error ery is large, fitting point can not move forward and should go back.

When the output is moving forward, it shows that this arc can approximate the original curve. And it moves to a forward point and carries on the computation determination again. Otherwise this curve returns a data point directly, then it is drawn with an arc or a line.

If the curve is expressed as a line, the third fuzzy inference is required. The size of ertan is chosen as input variables, and Language variables' domain is $[0, 0.05, +\infty]$. This reasoning process is similar to the second inference. Membership functions of output variables and ertan are shown in figure 4 and 6 respectively.

3.3 Defuzzification

Now, using center of gravity method arrives at a precise. The expressed formula is given as follow.

$$z_0 = \frac{\sum_{i=1}^n \mu(z_i) \cdot z_i}{\sum_{i=1}^n \mu(z_i)} \quad (6)$$

z_0 values are among $[0,1]$. When z_0 is close to 0, the result is sure; when z_0 is more close to 1, the result is more impossible. In accordance with the size and scope of z_0 values, the inference result is divided. In order to facilitate the calculation and obtain good results in the fitting NC graphics, the curve is identified as the arc or moving forward when $z_0 \leq 0.5$, or it is identified as the line or moving backward.

4 Analysis of Simulation Result

In this experiment, the contour of NC images is given in figure 7. According to coordinates of data points in the curve, arcs and lines are drawn constantly to represent the original curve based on fuzzy reasoning. Ultimately a complete image, shown in figure 8, would be expressed through arcs or lines. Here, the fitted curve which is constituted by the line or arc approaches the original contour approximately. In the case of high efficiency, the image is fitted with less number of line segments and arc segments. The fitted curve based on lines and arcs can obtain good effect through fuzzy inference.

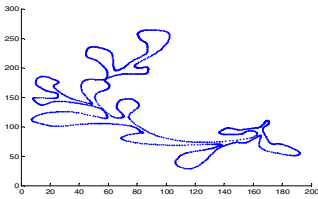


Fig. 7. Contour curves of NC graphics

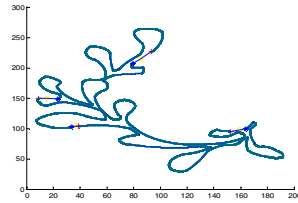


Fig. 8. The fitted curves through arcs and lines

5 Conclusion

In order to solve the question of fitting calculation for cutting path in NC, the curve fitting for numerical control is constructed based on fuzzy reasoning in this paper. In the curve fitting system, three fuzzy inferences are used to determine the state of curve fitting and the membership function based on lines and arcs. The result shows that the designed fuzzy inference system is reasonable, and contour curves can be fitted accurately with less number of line and arc segments. Compared with the traditional method, these techniques used in this paper improve the fitting performance, shorten the computing time and improve the fitting precision.

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Chain Effect and Control of Environmental Disaster Induced by Underground Mining

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Abstract. Mining usually causes great damages to natural environment. Generally speaking, continually occurring or chain effect among disasters is the embodiment between underground mining and environment damages. Extensive research suggests that the chain effect of disaster exists extensively. This paper introduces disaster chain theory into the research on mining engineering disaster to reveal the essence of environment disaster induced by mining activities. On the basis of the concept of mining disturbance hazard chain effect, the mathematical model of environment disaster chain induced by mining is established. Take Tongkeng Mine of Liuzhou China Tin Group Co., Ltd as an illustration, the chain effect drawing of environmental disaster induced by underground mining is charted. Furthermore, chain breaking methods of chamber blasting to cover collapsed crater and waste gas absorption by using alkaline were explained.

Keywords: chain effect, environmental disaster, mining influenced disaster-caused, chain breaking.

1 Introduction

In view of the system theory, a complete mining engineering system means a dynamic, hierarchical, stratified and recuperative open system. It is structured by a series of complicated subsystem interacting on each other and exchanging matter, energy and information with surroundings. The structure characteristic, style of the movement, dynamic environment and evolution process of subsystems have relatively stable zone and boundary, which is an important cause and criterion led to difference and relativity of background of mine disaster [1]. There have been many valuable achievements about the mechanism of mining disasters and its control measures, however, the study on mechanism of disasters based on its trait of continuity and relevance and the role of system integration is still insufficient. Because of the coupling interaction of different kinds of disaster, which will inevitably result in superimposing, transmitting, transforming or straggling of disaster happening and evolving, and further significant differences in the time and space [2]. Therefore, the single disaster mechanism research on underground mining disasters can't explain or solve many engineering problem.

The concept of disaster chain comes from the study on the relationship between earthquake hazard and its secondary hazard. In 1987, the famous Chinese seismologist Zengjian Guo put forward the concept of disaster chain and the classification for the first time. He opened up a new style in disaster research, which has become a hot research area in disaster science [3]. The backbone of this paper is to explore the chain effect and control of environmental disaster induced by underground mining according to the disaster chain theory.

2 Environmental Disaster Induced by Mining

2.1 Major Types of Disaster

The major types of disaster in the process of mining are strata movement, surface subsidence, rock burst, water inrush accident, waste rock, water and gas, slope landslide and debris flow. Fig.1 shows the negative effect of mining on the environment.



Fig. 1. Negative effect of mining on the environment

Characteristics of Disaster

- Multi-source and complexity of disaster-causing factors
- Difficult predictability of disaster occurrence
- Nonlinear nature of disaster
- Causality disaster analysis
- Potentiality and abruptness of disaster.

3 Definition and Connotation of Disaster Chain

3.1 Definition of Disaster Chain

In short, a succession of secondary disasters is induced after the occurrence of natural calamities. This phenomenon is called disaster continuous occurrence or disaster chain. We can also explain the disaster chain as original disasters induced in a succession of secondary disasters. Based on the analysis of definition of disaster chain, however, general characters from all types of disasters show as the starting point for the definition of disaster chain. It is mainly focus on characteristics of correlation, conditionality and interaction of disasters. In other words, the cognition of disaster must be taken into

account from the whole process of disaster and macroscopic disaster system. Cause, process and result of subsystem of disaster should be studied in coordination.

3.2 Extension of Disaster Chain

At present, most of the researches on disaster chain are limited to process of inoculation and induction of disaster. On the other hand, the study of disaster chain is focus on the significant nature disastrous, such as tsunami, fire and meteorological caused by earthquake. But there is as yet no forecast for disaster and system theory to actual application.

The secondary catastrophe chain theory was advanced by Professor Sheng-xie Xiao[2]. It was set in the general character of disaster on the basis of ecological pattern for revealing secondary catastrophe chain effect and law. The disaster relying on the carrier reflection and evolution was come up with for the first time. Disaster is divided into chain-styled phases by the degree and mechanism of the fragmentation force, putting forward chain--cutting disaster mitigation mode and prevent the disaster spread from the headstream, also forming the chain-styled theory of the disaster and the new academic system of application, which is the most systematic and comprehensive research on chain-styled disaster at present.

In recent years, the research on disaster vulnerability has fundamentally made people know that the comprehending of the mechanism of disaster formation must base on the understanding of resource development and utilization. A lot of hazard-formative factors have been left because of both unlimited and extensive resources development and unplanned coyoting. During mining disasters and accidents, particularly underground mining, they mainly are secondary disaster and derived disasters, which lead to the losses that are often inestimable. Therefore it is necessary to extend the concept of disaster chain and introduce it into research on mining engineering disaster, which is significant for revealing the essence of mining disaster-causing strengthening disaster prevention and mitigation.

3.3 The Proposal of the Concept of Mining Disturbance Hazard Chain Effect

Underground mining disasters are often due to anthropogenic disturbance, rarely underground flood by rain or disaster by earthquake, however, fundamentally we can know that the mining disaster will not exist if we human being never exploit mine resources, so we call it mining disturbance hazard, and a succession of or a series of secondary mining hazard induced by mining disturbance is described as mining disturbance hazard chain effect.

4 Chain Model of Environmental Disaster Induced by Mining

According to the definition of disaster [4], disaster results from the comprehensive effect including the hazard-formative environments on the earth surface, hazard-formative factors and hazard-affected bodies,

$$D = E \cap H \cap S. \quad (1)$$

Where H is the sufficient conditions of disaster, S is the necessary conditions of disaster damage, E is the background conditions affecting H and S . Any disasters of specific area are always decided by H , E and S .

Based on the above definition of disaster, we consider mining disasters as the outcome of comprehensive effect (H , E , S) too, but E is only applied to specific mining environment, and with regional characteristic, moreover, E is not only the above stated, but also the complicated hazard-formative environments in underground mining, such as artificial chamber, tunnel, stope, etc.

According to the reference [5], combining the characteristic of mining disaster the chain-styled relation structure of underground mining disaster divides into the hazard-formative environments $E(S(t))$, response status $S_{in}(SD(t))$, internal structure $RD(t)$ and destructive effort $HD(t)$. As shown in Fig. 2.

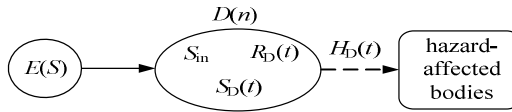


Fig. 2. Diagrammatic sketch of structural characteristic of mining disaster system

For each element $SG(n) \in S(n)$ of H_d , if and only if its state is the function of disaster chain environment E and the situation Sp_i ($i=1,2,\dots,k; k \geq 0$) of other elements $SGt(n) \in S(n)$, that is $Sp = \phi p(S, S_1, \dots, Sp_1, \dots, Sp_k)$, and the relation is as follows:

$$\begin{cases} \psi_1(S(t), R(t), R_{zd}(t)) = 0 \\ \psi_2(S(t), R_{zd}(t), S_z(t)) = 0 \\ \psi_3[S(t), R_{zd}(t), H_{zd}(t)] = 0 \end{cases} \quad (2)$$

Where H_d is called domination level. What's more, disaster chain $S(n)$ has a system structure $R_{zd}(t)$ of domination level H_d at the moment t in the environment E , and for any relation $R_{i,j}(t) \in R_{zd}(t)$, if the relation value is 0, $\theta_d=0$, it has:

$$R_{i,j}(t) = \phi_{i,j}(S(t)) \quad (i \geq 1, \quad j \leq n). \quad (3)$$

$$R(t) = \eta(S(t)) \quad (\theta_d = 0). \quad (4)$$

The above formulas (1) to (4) are structure model of disaster chain system.

4.1 Chain-Cutting Control of Environmental Disaster

Mitigating the disaster by cutting the disaster chain means blocking the disaster chain effect, firstly the source of disaster chain should be considered in the control process, and only the effective treatment of disaster source avoid both such disasters and secondary disasters. However, it is difficult to prevent most types of disasters completely by using the above method. Sometimes we need some help, such as specific tools and measures. As shown in Fig. 3 which is the hazard-formative chain effect of underground mining in Tongkeng mine [6].

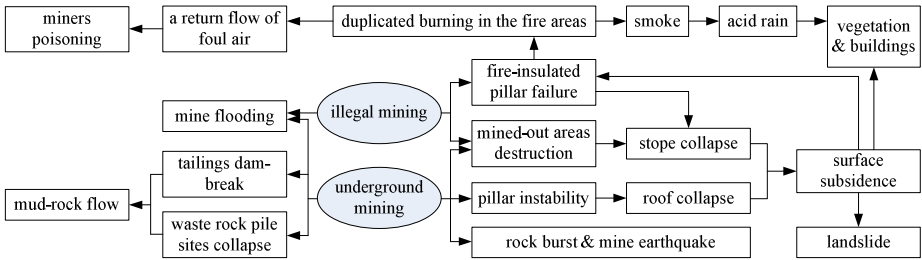


Fig. 3. The hazard-formative chain effect of underground mining in Tongkeng mine

Underground mining caused surface subsidence in Tongkeng mine of Dachang, Guangxi, and induced the spontaneous combustion of upper remaining sulfur-containing Deposit, which emitted a lot of SO_2 that would greatly threaten the local ecological environment. According to chain-cutting theory of disaster, both cover collapse pit with surface chamber blasting and alkaline absorption of waste gas were adopted to offer a comprehensive treatment.

4.2 Chain-Cutting Control of Covering the Collapse Pit

According to the condition of topography and topsoil, we make use of the falling rocks of mountain around collapse pit to fill it up by using tunnels construction and charging chamber to strengthen loose blasting or cast blasting, as shown in Fig. 4. Besides, we should take further densification measurements such as shotcrete cement so as to form well cover, which can cease the burning owing to oxygen-deficiency, thereby to achieve treatment result and chain-cutting control of covering the collapse pit.

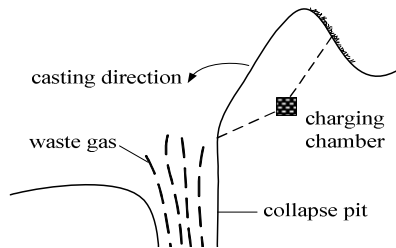
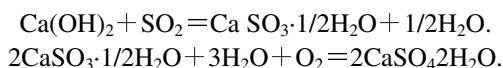


Fig. 4. Sketch map of cover with chamber blasting

4.3 Chain-Cutting Control of the Calcium Hydroxide Washing Law

When the above method does not work, the calcium hydroxide wet washing method will be used. Firstly, absorption reaction happens between vaporific limewater and surface SO_2 . Secondly, limewater also sank into the collapse pit to absorb waster gas. The reaction of limewater with SO_2 and O_2 includes two parts: absorption and oxidation. The main reaction equations are as follows:



From Fig. 5, by spraying vaporific lime water into the wellhead, there was a chemical reaction of the lime with the waste gas. The result of monitoring shows that the emission trend of major pollution SO_2 are basically controlled under 5.71 mg/m^3 , in order to reach the national emission standard, and achieve well treatment result.

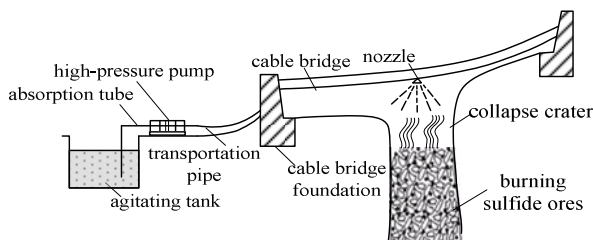


Fig. 5. Schematic diagram of alkaline absorption process of waste gas

5 Conclusions

The mining hazard-formative chain effect is the important characteristic of mining engineering disaster, and the application of chain-styled theory of disaster embodies a broad perspectives and systematicness in research on mining engineering disaster.

Mining natural accumulation chain is the sufficient conditions of disaster accident. It is inevitable to form the hazard-formative environments in the complicated condition, such as mined-out area, high stress, etc. what's more, frequently causing several kinds of secondary disaster, and even damaging the surface ecological environment.

With the view of mitigating the disaster by cutting the disaster chain, chain-culling control stops the source of disaster, putting forward the precaution measures to environmental disaster induced by mining, and also providing a valuable reference for engineering practice.

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Determination of the Original Probability of the Target Distributing Function for the Accidental Pollution Sources in a Drainage Area

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Abstract. Based on indoor experiment, the water quality model of non-persistent pollutants in paroxysmal pollution accidents of Yibin section of Yangtse River is established. Through fitting the diffusing concentration of improper pollution discharging and the actual monitoring value, the original probability of accidental pollution sources are obtained. And the original probability is modified by searching action, therefore the original probability is progressed to posteriori probability, which provided a scientific and objective method to determine the target distribution function of the search model of accidental pollution sources in a drainage area.

Keywords: original probability, posteriori probability, water quality model.

1 Introduction

In the search of accidental pollution sources in a drainage area, the determination of the original probability of the accidental pollution sources is a key problem to be solved [1,2,3,4,5]. The idea of optimal search is based on Bayes Theorem, however, the Bayes method has a big problem that there is a “prior information” before a sample is obtained, i.e., the original probability is subjective. Therefore, to accord the original target distributing function with the fact is a big challenge in the development and application of search theory [6,7,8,9,10]. This paper aimed at determining the original probability of the accidental pollution sources through establishing predicting model of pollutants, which provided a scientific and objective method to determine the target distribution function of the search model of accidental pollution sources in a drainage area.

2 The Establishment of the Water Quality Model in a Drainage Area

There already are many mature water quality model software internationally, however, these models require a lot of parameters and have a heavy workload of

analysis, which makes them hard to predicting the instantaneous pollution accidents. Therefore, to simulate the impact of pollutants on the water quality, the establishment of proper pollutant transformation model is necessary. As the water area involved with the searching of accidental pollution sources is big, the online monitoring of water quality is only set up in the entrance and exit of each political section, and the pollutants can be seen as even mixed up reaching the downstream monitoring cross section. Therefore, only the following factors are considered to study the portrait (the water flow direction) concentration changes: the upstream background input, the secondary river input of the section, the industrial pollution input of the section, the municipal waste water income of the section, the income of area sources of the section, the water quality output of the section.

Take the section between two pollution drains as an example, the starting point source A inputs Q_1 , the end point source B inputs Q_2 , the length of A to B is $L(\text{km})$, the area source input per section unit is $q(\text{kg}/\text{km}\cdot\text{d})$, then, the input of area sources in the whole section is $q\cdot L$, the upstream background input is Q_A , the output of B is Q_L , let Q_X be the output of any point X of the section. Suppose the decrement of section AB is D , then, the output of point B is:

$$Q_L = Q_1 + Q_A + qL - D. \quad (1)$$

Ignore the dispersion function, the following equation is obtained:

$$\frac{dQ}{dx} = I^* - K_c^* Q.$$

Integration along the X distance is:

$$Q_X = Q_0 e^{-K_c^* X} + \frac{I^*}{K_c^*} (1 - e^{-K_c^* X}). \quad (2)$$

According to the position of the side point sources, the river section is divided into several sub-sections L_1, L_2, L_3 , the output of each up-section equals to the input of the down-section, and add the point source charge to the beginning of the section, the output charge of each sub-section can be obtained. Suppose there are $n+1$ point sources in the studying section, and divide the section into n parts, thus, the output of controlling cross section in the end of the river section is:

$$Q_{Ln} = Q_A \exp(-K_c^* L) + \sum_i^n [Q_i \exp(-K_c^* \sum_j^n L_j)] + \frac{I^*}{K_c^*} [1 - \exp(-K_c^* L)]. \quad (3)$$

Therefore, the concentration Q of the controlling cross section is:

$$C_Q = Q_{Ln} / (86.4 \times W). \quad (4)$$

In (1) and (4) Q_X is the pollutant output of any cross section in point X along the river, kg/d; Q_{L_n} is the pollutant output of the controlling cross section(the end of the river section), kg/d; C_Q is the pollution concentration of the controlling cross section(the end of the river section) (mg/L); X is the distance between any point and the start cross section of the river section, km; K_c^* is the synthetically decay coefficient of the pollutants (1/km); L is the length of the controlling river section, km; L_j is the distance between point j and the controlling cross section, km; I^* is the pollutant input of disperse pollution sources in a river section unit, kg/(km · d); W is the flow of the river, m^3/s .

Equation (3) is the one-dimensional water quality model for steady flow, from which, the pollution charge of the end of the controlling river section (the controlling cross section) can be calculated if the following factors are already known, for example, the background input of upstream of a certain section, the pollution charge of each point source of the river section and the secondary river estuarine, and the length from the point source to the controlling cross section, the pollution charge of each river section unit, the decay rate of the pollutants, etc.

3 Determination of the Decay Coefficient

C_Q and I^* can be collected in the local environment protection department, therefore, the key problem is to determine the degradation coefficient K_c^* . According to the study along the Yibin section of Yangtse River, the pollution discharging industries mainly contains food, brewing, chemistry, chemical fiber, electrical & mechanical, paper-making, and the main pollutants is COD, therefore, the this section is chosen to analyze the COD parameter.

A. The determination principle of the degradation coefficient of chemical oxygen demand (COD). Chemical oxygen demand reflects the pollution of reducing substances, reducing substances refer to organics, nitrite, ferrite, sulfide, etc. The degradation of COD accords with first order reaction kinetics, which means:

$$\frac{dC_{COD}}{dt} = -K_c L_{COD}. \text{The integration of which is: } C_{COD} = C_{COD_0} \exp(-K_c t).$$

$$\text{Therefore } K_c = \frac{1}{t} \ln \left| \frac{C_{COD_0}}{C_{COD}} \right|. \quad (5)$$

$$\text{Conversion according to units is: } K_c^* = \frac{K_c}{u}. \quad (6)$$

In (5) and (6) t is reaction time, d; K_c is the synthetically degradation coefficient, 1/d; K_c^* is the synthetically degradation coefficient, 1/km; C_{COD} is the pollutant concentration in time t , mg/L; C_{COD_0} is the original concentration, mg/L.

B. Experimental study. Considering the difference between the experimental condition and the actual water environment, the degradation coefficient is modified as follows:

$$K_{Nriver} = K_{Nexperiment} \times 1.047^{T-T_0} + a \frac{U}{H} . \tag{7}$$

In (7) T is the actual river temperature, $^{\circ}C$; T_0 is the sample temperature, $^{\circ}C$; U is the average speed of the river flow, m/s; H is the average water depth, m; a is $0 \sim 0.6$, according to the river slope J .

As the water of Yibin section is very deep, the impact of flow rate and water depth changes can be ignored. Based on hydrological data, the temperature of water changes monthly, therefore, the decay rate of COD_{cr} in different periods can be calculated (Table 1).

Table 1. The degradation coefficient of COD_{cr} in different months in Yibin section

Period	Water temperature [$^{\circ}C$]	Slope, [m/km]	Actual water temperature [$^{\circ}C$]	The modified degradation coefficient, [d^{-1}]
drought period (11,12,1,2)	12.35	0.28	20.9	0.3833
normal-water period (3,4,5,10)	18.08			0.5041
high-water period (6,7,8,9)	23.63			0.6471

4 Testing of Water Quality Model

Put the modified simulation parameters into the derived COD model, the following equation is obtained:

$$\begin{aligned} C_{CODLn} &= 0.5561C_{CODA} + \sum_i^n [C_{CODi} \exp(-7.0442 \times 10^{-3} \sum_j^n L_j)] + \frac{I^*}{7.0442 \times 10^{-3}} (1 - 0.5561) \\ &= 0.5561C_{CODA} + 63.02I^* + \sum_i^n [C_{CODi} \exp(-7.0442 \times 10^{-3} \sum_j^n L_j)] . \end{aligned}$$

Therefore, the water quality model of COD in Yibin section of Yangtse River is:

$$\begin{aligned} C_{COD} &= C_{CODLn} / (86.4 \times W) = \\ &= \frac{0.5561 C_{CODA} + 63.02 I^* + \sum_i^n [C_{CODi} \exp(-7.0442 \times 10^{-3} \sum_j^n L_j)]}{86.4 \times W} . \end{aligned}$$

When calculating the average pollutants concentration of each pollution drain, the density of sewage is taken as 1000kg/m^3 . Also, in order to simplify the model, the pollution drains with the same distance to de downstream are combined into one drain when collecting the numbers of pollution drains. The specific statistics are as follows:

Table 2. Statistics of COD discharging value in Yibin section of Yangtse River

Distance between pollution drains and the downstream cross section, [km]	Numbers of pollution drains	COD discharging value, [t/a]	Sewage discharging value, [t/a]	Average discharging rate, [mg/L]
83.3	9	6828.75	10977461	0.6221
82.3	4	193.46	1964400	0.0985
81.3	2	441.44	2375279	0.1858
80.3	5	2103.2	3000000	0.7011
79.3	1	5405.40	7207200	0.7500
77	1	10702.00	13800000	0.7755
61	2	43.65	125766	0.3471
56.1	1	49.35	585000	0.0844
42.3	1	27.00	28000	0.9643
40.2	12	1974.52	5377383	0.3672
38	1	144.00	288000	0.5000
22.8	1	410.27	2051351	0.2000
19.6	1	1000.00	1500000	0.6667
5.5	2	256.90	881000	0.2916

The hydrological condition of Yibin section of Yangtse River in May 2009 is, $W=4530.45\text{ m}^3/\text{s}$, river width $B=355.8\text{m}$, flow rate $u=0.94\text{m/s}$, water depth $H=13.4\text{m}$. The monitoring value of two cross sections (Gua Gongshan and Jing Kou) is 11.74mg/L and 11.25mg/L respectively.

The total distance of Yibin section of Yangtse River is $L=83.3\text{km}$, and according to Zheng Binghui [11], the total area source pollution value in the stem of Yangtse River of upstream of The Three Gorges is $43.99 \times 10^4 \text{t/a}$, and the distance between Yibin and The Three Gorges estuarine is $L_1=842\text{km}$, therefore, the area source I^* of Yibin section of Yangtse River can be roughly calculated:

$$I^* = \frac{I}{L_1} = \frac{109.99 \times 10^7 / 365}{842} = 1179.26 \text{ kg } / (\text{km} \cdot \text{d}) \cdot$$

When testing the model, let $K_c^* = 7.0442 \times 10^{-3} / km$, and use the monitoring value of Gua Gongshan cross section as the initial COD_{cr} concentration, i.e. $C_{CODLn} = 11.74 \text{ mg/L}$, according to the pollution drain distribution in Table 4, the COD_{cr} model can be calculated as follows:

$$C_{CODLn} = C_{CODA} \exp(-K_c^* L) + \sum_i^n [C_{CODi} \exp(-K_c^* \sum_j^n L_j)] + \frac{I^*}{K_c^*} \times \frac{1}{86.4 \times W} [1 - \exp(-K_c^* L)]$$

With the above model, the COD_{cr} concentration of Jing Kou cross section in normal pollution discharging condition is 11.21 mg/L , compared to the monitoring value 11.25 mg/L , the error is only 0.36% , which is acceptable. Therefore, this model is very practical in actual application.

5 Conclusion

It can be seen through the water quality prediction model that the accidental pollution source can be determined through comparing the simulation value of a certain pollution index of each pollution drain and its actual monitoring value when pollution accidents takes place. As there might be several different values that would match the model, and the studied case only refers to that there is no treatment measure to the pollution and does not contain the situation that the pollutants are partly treated, therefore, the result achieved by water quality model is only a probability.

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Winning the Industrial Competitiveness with E-Commerce Adopting Component-Based Software Architecture

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Abstract. Over the years, several market mechanisms have sprung in electronic market space to tap new value creation opportunities. E-commerce B2B models are witnessing a move from traditionally being Brochure ware and Web Enablement of existing business process towards Business Model Reinvention (BMR). It begins with a new vision of the industry and winning business models. The key success variable to this achievement is Inter-enterprise Process Engineering. Component-based architecture provides the business benefits of rapid applications development for quick time to market, enterprise-wide consistency of business rules and quick response to changing business requirements. The paper begins with a brief description of the changing dynamics of business process in the BMR of e-commerce and then introduces the necessity of Inter-enterprise Process Engineering (IPE). We follow it up with a discussion on the component-based application architecture enabling BMR of e-commerce. Our observation establishes companies demand agile software in the face of accelerating business change. We have focused on the challenges in implementation of the same. . We conclude with the win-win situation of all players on successful implementation of Business Model Reinvention (BMR) of e-commerce.

Keywords: B2B, BMR, cybermediaries, IPE, MRO, EPS, virtual corporation, software components.

1 Introduction

The Internet is bringing profound change to the business world and has enabled a new way of conducting business. To compete in this emerging e-commerce scenario, companies need to change their business models, rethink the way they work and form new relationships with their trading partners and customers.

Attracted by the dramatic cost savings of electronic transactions and the opportunity to exploit new revenue channels, companies purchased stand-alone procurement packages to streamline purchasing and stand-alone storefront packages

to begin selling on the Web. As a result, e-Commerce applications are usually labeled as either "buy-side" or "sell-side," depending on whether the company hosting the application is buying or selling products or services. A third business model, the BMR, combines buy and sell-side functionality into one site and aggregates both buyers and sellers. These cybermediaries add value for the buyer by reducing the search space for appropriate suppliers, and for the seller by being found more easily by potential customers.

2 Concept of Business Model Reinvention (BMR)

Any two B2B e-commerce implementations, therefore, are as different as the businesses they support. However, there are four major categories into which B2B e-commerce applications can be roughly classified: vendor management, extended value/supply chain, I-market and customer care.

In the vendor management category, maintenance, repair and operations (MRO) procurement is the most common, business-to-business e-commerce application. MRO procurement is used to reduce costs in the purchasing of office supplies and other non-production materials needed by a business. As an example in the procurement category, in Steel authority of India Ltd Enterprise Procurement System (EPS) has been implemented and this has reduced a sustainable amount of processing cost & lead time. More over it has produced a high degree of transparency. Telcordia Technologies (formerly Bellcore) implemented an online MRO procurement system to reduce the \$135 processing cost per purchase order. In the first year alone, the company realized cost savings of \$6 million in this area.

Meanwhile, in the extended value/supply chain category, GE Aircraft Engines used its integrated logistics solution to reduce order cycle time by 15 to 30 days and reduced the cost of creating a purchase order from \$100 to \$5. To be successful, buy-side initiatives will have to deliver such breakthrough efficiencies and achieve dramatic cost reductions.

Online catalog sales are examples of B2B I-Markets. McKesson, a \$17 billion pharmaceutical wholesaler, has developed such a comprehensive customer care system on the Web that it has transformed itself from a drug distribution company to a value-added provider in the healthcare industry. To be successful, sell-side initiatives have to focus on revenue growth opportunities, holistic customer relationship management, and engineering consumer processes that delight the user and building communities-of-interest. In addition, sell-side initiatives may need to cater to both business-to-business and business-to-consumer markets simultaneously.

Most companies, of course, engage in both roles of buyer and seller, sometimes simultaneously in a single commerce transaction. Thus extending a company's existing business processes from the inside out must begin with a thorough analysis and understanding of customers', suppliers' and trading partners' requirements, and designing e-Commerce systems from the outside in.

Companies experienced with multiple e-Commerce applications have learned that they need a unified, incremental approach capable of supporting and sustaining multiple and continuously evolving e-Commerce initiatives -- they need strategies for e-Commerce integration.

Global 2000 companies have a tremendous asset base in their existing computer systems. These systems embody their unique business philosophy, policies, and processes. Smart companies will seek to adapt, not to obliterate, their legacy applications as they embrace e-Commerce initiatives. Much of the functionality needed to implement multiple and diverse e-Commerce applications is identical or similar and thus can be reused -- a key to e-Commerce integration. Core e-Commerce functionality includes user authentication and authorization, user profile management, workflow management, event notification, negotiation and collaboration, and data integration with enterprise data. These core e-Commerce components combining together resulted in the BMR of e-commerce. E-Commerce integration is the key to sustainable business strategy.

With experience as their teacher, forward-thinking companies riding the wave of e-commerce, have come to realize that B2B e-commerce is neither just a buy-side nor sell-side package. They have learned that if they extend their business processes across company boundaries and integrate them with their suppliers' and customers' business processes something totally new starts to happen. To them, e-commerce is an infrastructure for a whole new way of doing business and gaining competitive advantage.

3 Inter-enterprise Process Engineering (IPE)

The BMR of e-commerce involves Inter-enterprise Process Engineering (IPE). While Business Process Reengineering (BPR) was about streamlining business processes internal to the enterprise, IPE is about streamlining and automating business processes that unite an enterprise with its trading partners (customers, suppliers, distributors, and so on). ERP applications sought to streamline and link intra-company processes and systems. B2B e-commerce applications, on the other hand, streamline and automate inter-company processes.

Companies seek to achieve BMR are redesigning business processes so that they cross enterprise boundaries to eradicate duplicate processes, ineffective hand-offs and disconnects between and among enterprises. Virtual corporations are being created that have shared business goals, common planning, and performance management tools IPE is their competitive weapon for designing and implementing hyper-efficient business processes that are integrated in real-time and jointly owned by suppliers and customers. Cheaper, better, and faster takes on a whole new meaning in these 21st century corporations.

Inter-enterprise process engineering, however, does not result in an end state. It is an on-going process that enables virtual corporations to evolve in a continually changing business ecosystem. Organization form and function must be able to sense and respond to change. Agility is the byword of success – an agile business empowered by agile information systems. No longer can software development be on the critical path for organizational and process change. With change being the constant variable, a new software development paradigm – component-based development – is essential to building agile, virtual corporations.

3.1 Component-Based Application Architecture Enabling Third Wave of E-Commerce

Application Architecture. To achieve coherence and manage the complexity and change inherent in multiple e-Commerce applications, an overarching structure is needed, called application architecture which rationalizes, arranges and connects elements for a purpose. The role of architecture is to conceptualize the design in a form that developers and stakeholders can understand; to guide construction during the first development cycle, and in the future evolution of the system; and to enable management to structure the project and the organization itself around the architectural elements.

The results of good architecture will be a cost-effective use of legacy assets and commercially available components, and resilience to change. The structural elements along with their interfaces that comprise the system allow design tradeoffs based on cost and technological constraints. Buy or build decisions and incorporation of new technology can be determined for the structural elements rather than the overall architecture. Likewise, companies can upgrade their applications over time while maintaining integrity and interoperability with other enterprise applications.

Distributed object computing is now recognized as the way forward in building enterprise information architectures that can operate in advanced client/server, intranet and Internet environments. In essence, using objects to build information systems is like building a simulation with *business objects* representing the *people, places, things and events* that are found in the business setting or domain. Business objects reflect the real world and thus greatly enhance understanding and communication among systems developers and business people. And business objects reduce complexity because programmers do not need to know how an object works internally. They only need to know what the object is and the services it provides. Object technology, however, does have some downsides including a steep learning curve. Business objects, though they represent things in the real world, become unwieldy when they are combined and recombined in large-scale commercial applications. What is needed are ensembles of business objects that provide major chunks of application functionality (e.g. preprogrammed workflow, transaction processing and user event notification) that can be snapped together to create complete business applications.

Component-Based Software Development: This approach is embodied in the next step in the evolution beyond objects, software *components*. Components are self-contained packages of functionality that have clearly defined, open interfaces that offer high-level application services. Components can be distributed dynamically for reuse across multiple applications and heterogeneous computing platforms. The later characteristic is why Java^(TM) ("write once, run anywhere") has had such a dramatic impact on enterprise computing and component development, and why the eXtensible Markup Language (XML) is essential for developing a shared Internet file system.

A development style based on widget (short form of window object) is called the component based GUI development. Components take the best features of objects to a higher level of abstraction that is learned more easily by mainstream commercial software developers. Components must encapsulate useful, manageable and intuitive

solutions to real-world business problems. Components, then, must enable IT professionals to use object technology at meaningful and relevant levels of abstraction, while the system and service providers worry about the low-level object and system interactions.

A component-based application architecture provides the business benefits of rapid applications development for quick time to market, enterprise-wide consistency of business rules and quick response to changing business requirements. And because major software vendors are committed to component architecture, applications can mix and match best-of-breed solutions.

New de facto and open standards have emerged to make it possible to develop large-scale distributed computing systems with "plug and play" components -- the Object Management Group's CORBA 3 (CCM), Sun Microsystems's Enterprise JavaBeans, and Microsoft's COM+. Industrial strength server-side components are needed to deal with the complexity of the underlying information systems and distributed computing infrastructures. With components, solution developers can "plug into" standard preprogrammed services.

Today components are often thought of as being client-side technology, but the role of server-side component technology will be paramount as companies demand agile software in the face of accelerating business change.

The technology infrastructure consists of combinations of legacy applications that have been wrapped to appear and function as business objects, and services provided directly by a distributed object platform (persistence, transaction processing, event services and the like). Component-based development for e-Commerce applications is a process of assembly and refinement. The process begins with *cross-application components* that provide functionality common to most types of e-Commerce applications. Typical of such core components are user profile management, authentication, authorization, data management, workflow, negotiation, collaboration, and event notification. These cross-application components can be customized and extended to form *application-specific components*. For example, in a procurement application, a profiling component will contain attributes for identifying a user's role and buying power.

The final step in the component-based development process is the configuration of the components to incorporate the organization's unique business rules and user presentation and navigation. It is in this step that a company's competitive advantage is built on top of best-of-breed cross-application, application-specific and industry-specific components, and embedded in its e-Commerce applications.

4 Implementation Challenges

Task Ahead. In the globalized business scenario of the corporate world CEO and the boardroom are very much aware of the pressure from the competitors. They have no other alternative way but to step in the BMR of e-commerce to succeed or even to survive in that dynamic business world. As a result all the projects are to be top-driven. So, for the organizations emerged with the primary task of evaluating how the Third Wave of e-business will impact their industries and decide which strategies they should pursue in response. This crucial task can be subdivided into four steps:

- Understand dominant current trends
- knowing own industry and competitors
- Self-assessment & Execution of the strategy rapidly and iteratively

Challenges. Several key challenges in implementing third wave of e-commerce are:

- Integration of enterprise and legacy applications across enterprises: There are a host of enterprise and legacy applications that support a company's business, for example:
 - Enterprise Resource Planning (ERP), e.g. SAP
 - Supply chain Management (SCM), e.g. i2
 - Sales Force Automation (SFA), e.g. Siebel
 - Customer Relationship Management (CRM), e.g. Silknet, Siebel
- Responsiveness to changing business requirements: The integration nightmare described above is exacerbated by the fact that business relationships can, and do, change on a regular basis. For example, a supplier might decide to launch a new digital marketplace, requiring its customers to access its products through the marketplace instead of via electronic catalogs. Because such dynamic business interactions need to be supported by a dynamic B2B e-commerce platform, the B2B e-Commerce implementation must be rapidly adaptable.
- Implementation is expected in Internet Time: Unlike implementations of traditional client-server systems that take several years to complete and several months to upgrade, e-commerce platforms must morph dynamically as the business needs to evolve. Release cycles measure in weeks are expected and even necessary in order to compete.
- Lack of resources with required technical and process skills: There is an acute shortage of the skill sets required for implementing complex dynamic B2B applications. Technical expertise in new technologies are scarce commodities. Also, the processes required rapidly developing, host, operating, maintaining and evolving these dynamic B2B application platforms need to be significantly more dynamic than traditional software delivery approaches.

To summarize, implementing B2B e-commerce involves developing multiple e-commerce applications that are customized to the unique business requirements of the enterprise and integrating these applications with existing legacy/enterprise applications. In addition, these applications need to be delivered in the shortest possible time frame, keeping them adaptable and extensible to meet evolving business requirements.

Implementing B2B e-commerce is not an option – it is an imperative! Companies that ignore this imperative do so at the risk of their own peril. Enterprises must begin by defining their B2B e-commerce strategy, and act, by quickly implementing a small piece of the puzzle, followed by a series of rapid incremental releases. Wherever required, enterprises should get assistance from experts in the field and out-source whatever is not their core competency in the field of implementing e-Commerce, be it in the areas of strategy, or delivery (development, hosting and evolution).

5 Conclusion

Inter-enterprise connectivity could not be thought of earlier. The Internet makes it possible to do things that were never before possible. The Internet's distinguishing characteristic is ubiquity (existing or apparently existing everywhere at the same time), an attribute that can transform the very fabric of society and commerce. The Internet calls to us to reengineer not just our business, but to reengineer complete industries. It calls to us to extend our internal business processes to the world outside the corporation: customers, suppliers, and trading partners. And it turns the producer-consumer relationship upside down, placing the consumer in control. It calls to us to reengineer our corporation and shift the focus of business engineering from the inside, out.

The successful implementation of the business model reinvention of e-commerce will make it possible to have a win-win situation for all the players, industries and their CEOs, academicians, researchers, and IT industry and IT professionals.

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The Application of Frequency Domain and Time Domain Analysis on Vortex Flowmeter Signal Processing

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Abstract. The vortex flowmeter is widely used because of its many advantages. However, it is easily influenced by the noises caused by pipe vibrations and fluid turbulence. The digital processing methods can complement the drawbacks of the traditional methods. This paper adopted a frequency domain and time domain analysis method to the vortex flowmeter signal processing. In the paper, the basic principles of wavelet transformation and the signal processing based on the discrete wavelet transformation are given, the adjusting methods of center frequency of filter are studied, and the processing procedure and simulation result are carried out. A design method of the poly phase IIR filter banks is studied. The result shows that the wavelet transformation can reduce the noise effectively, and it's an effective method on vortex flowmeter signal processing.

Keywords: Mallat arithmetic, Filter Banks, Signal Processing, Vortex Flowmeter.

1 Introduction

Vortex flowmeter currently used more widely, but the traditional amplification, filtering and signal processing methods difficult to count the signal accurately which is with the noise. Wavelet transformation in the frequency domain and time domain is localized at the same time, which allow us to count the frequency distribution of a particular time. It can be used as a band-pass filter. It can decomposes the mixed-signal which has the various frequency component to the different band, and effectively used for the extraction of the harmonic and the measurement of its frequency. As wavelet transformation can break the signal into several different time resolving and frequency resolving, it can research the long-time low-frequency phenomenon and the short-time high-frequency phenomenon at the same transformation. Ideally, the vortex flowmeter's output signal is the sine signal, but the actually it mixes the noise. The signal processing of vortex flowmeter stresses on the higher frequency resolving which is on low-frequency and the higher time resolving which is on the high-frequency. Compares with the FIR filter, IIR has the good stop-band weaken, so we can obtain higher choose-frequency characteristic with lower exponent number, and need fewer memory cell. This article has studied IIR wavelet filter bank's realization.

2 Wavelet Transformation and the Mallat Arithmetic

The Concept Wavelet Transformation. The wavelet transformation means: $\psi(t)$ is a basic wavelet function, then makes it position τ , and then makes the inner product with the unanalyzed signal under the different size a :

$$WT_x(a, \tau) = \left\langle x(t), \frac{1}{\sqrt{a}} \psi\left(\frac{t-\tau}{a}\right) \right\rangle = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} x(t) \psi^*\left(\frac{t-\tau}{a}\right) dt \quad a > 0 \quad (1)$$

Where: $\psi_{a,\tau}(t) = \frac{1}{\sqrt{a}} \psi\left(\frac{t-\tau}{a}\right)$ is the wavelet function, which is formed from the mother wave function $\psi(t)$ after the plane-move and the expansion. The equivalent frequency range expression is:

$$WT_x(a, \tau) = \frac{\sqrt{a}}{2\pi} \int_{-\infty}^{+\infty} X(\omega) \psi^*(a\omega) e^{j\omega\tau} d\omega \quad (2)$$

Where: $X(\omega)$ and $\psi(\omega)$ are the Fourier transformation for $x(t)$, $\psi(t)$.

From formula (1), we know that wavelet transformation is the inner product for the signal and wavelet function. The essential of it is to decompose the signal to the frequency space W_a . From formula (2), we know that wavelet transformation equal as the band-pass filter, which means that wavelet transformation can be realized by the wavelet band-pass filter.

The Mallat Arithmetic. The Mallat algorithm is based on the multi-resolution analysis frame. It carries on the decomposition and restructuring to the discrete vortex signal. And it can separates the original signal form various frequency by the low-pass and bang-pass characteristic of wavelet transformation. Supposed that the discrete signal $\{f_k\}$ ($k = 1, 2, 3, \dots, N$) do the wavelet transformation on the limited space M as:

$$\begin{cases} c_k^0 = f_k \\ c_k^j = \sum_n c_n^{j-1} h_{n-2k} \\ d_k^j = \sum_n c_n^{j-1} g_{n-2k} \end{cases} \quad \begin{pmatrix} k = 1, 2, \dots, N \\ j = 1, 2, \dots, M/2^j \end{pmatrix} \quad (3)$$

Where h_n, g_n is the discrete filter's limited pulse response which is decided by the wavelet function. In the wavelet transformation fast algorithm, we often uses the tight collection orthogonal wavelet function, therefore the filter sequence n value is finite.

In actually, we look the signal $\{f_k\}$ which is collected at equal time interval as the original signal c_k^0 . From h_n, g_n and formula (3), we can get c_k^j and d_k^j . c_k^j is the changed approaching signal, which is equal to a low-pass filter effect on the $\{f_k\}$. The smaller size, the more high frequency components in the transformation signal. The larger size, the less high frequency components in it. d_k^j is the changed detail signal, which is equal to a band-pass filter effect on the $\{f_k\}$. So we can separate different frequencies

signal from the original signal using the low-pass and band-pass features of wavelet transformation. Fig.1 is the wavelet transformation of two series. We supposed H_j is the equal filter of d_k^j , and G_j is the equal filter of c_k^j .

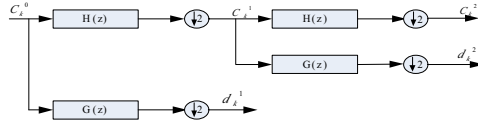


Fig. 1. The wavelet transformation of 2 series

Concept of the Filter Banks. We take the double channel filter banks as the example for discussion, and the structure is shown in Fig.2.

The frequency characteristic of $H_0(z)$ and $H_1(z)$ occupy the two frequency bands separately, which are $0 \sim \frac{\pi}{2}$ and $\frac{\pi}{2} \sim \pi$. The former corresponds the lower frequency band, the latter corresponds the higher frequency band. So, $x_0(n)$ is the lower frequency component of $x(n)$, and $x_1(n)$ is the higher component. We can obtain $\hat{x}(n)$ through the decomposition, processing and synthesis of signal $x(n)$. We hope $x(n) = \hat{x}(n)$, but it's impossible. If $\hat{x}(n) = cx(n - n_0)$, where c and n_0 are constant, that means $\hat{x}(n)$ is the pure delay signal of $x(n)$. We call $\hat{x}(n)$ is the perfect reconstruction of $x(n)$. The system's distortion mainly comes from mixes the repeat distortion, the scope and the phase distortion and the quantized error. The third type distortion has nothing to do with the filter, so we mainly discuss the first two types.

In the double channel filter bank, we hope that $H_0(z)$ 、 $H_1(z)$ can divide $x(n)$ into two signals which frequency spectrums are $0 \sim \frac{\pi}{2}$ and $\frac{\pi}{2} \sim \pi$. And the frequency spectrum doesn't overlap as far as possible. This requests $H_0(z)$ 、 $H_1(z)$ is conjugate mirror symmetry, also have the good band-pass and anti-passes performance.

As IIR filter has the good stop-band weaken, and we can obtain higher choose-frequency characteristic with lower exponent number, and need fewer memory cell, we use IIR filter for signal decomposition

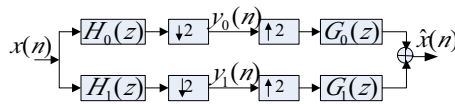


Fig. 2. Typical double channel filter banks

2.1 Design of the IIR Wavelet Filter Banks

We do the multi-phase decomposition from the filter system function and take the extraction of two filter banks as example.

$$H(z) = \sum_{k=-\infty}^{\infty} h(k)z^{-k} = (\dots + h(-2)z^2 + h(0) + h(2)z^{-2} + \dots) + z^{-1}(\dots + h(-1)z^2 + h(1) + h(3)z^{-2} + \dots) \quad (4)$$

$$= p_0(z^2) + z^{-1}p_1(z^2)$$

$$\text{Where: } p_0(z^2) = \sum_{l=-\infty}^{\infty} h(2l)z^{-2l}, \quad p_1(z^2) = \sum_{l=-\infty}^{\infty} h(2l+1)z^{-2l}.$$

We can see that the unit sampling response's coefficient is divided into even number item $h(2l)$ and odd number item $h(2l+1)$. This decomposition method is the dual decomposition. Dual multi-phase structure is shown in Fig. 3.

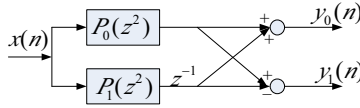


Fig. 3. Structure of dual multi-phase

Where $H_0(z) = p_0(z^2) + z^{-1}p_1(z^2)$, $H_1(z) = p_0(z^2) - z^{-1}p_1(z^2)$. Obviously, the length of $p_0(z)$, $p_1(z)$ is just the half of the $H_0(z)$, $H_1(z)$ therefore reduced the amount of calculation.

In the realization of the double channel multi-phase IIR filter banks, we use the all-pass filter to construct the IIR filter. Double channel filter bank need the high-pass filter and the low-pass filter are the conjugate mirror symmetry. Because the half-band-pass is the orthogonal mirror image filter, firstly we design the low-pass filter to the half-band-pass filter.

$$H(z) = 1 + z^{-1}T(z^2), \text{ where } T(z^2) \text{ is the all-pass filter, and } T(z^2) = \prod_{i=1}^L \frac{\alpha_i z^2 + 1}{z^2 + \alpha_i}.$$

decomposition $T(z^2)$ as $T(z^2) = E_{01}(z^2)/E_{00}(z^2)$, Where $E_{01}(z^2) = \prod_{i=1}^J \frac{\alpha_{1i} z^2 + 1}{z^2 + \alpha_{1i}}$,

$$E_{00}(z^2) = \prod_{i=1+j}^J \frac{\alpha_{0i} z^2 + 1}{z^2 + \alpha_{0i}}.$$

3 Simulation Result

Vortex flowmeter's output signal is magnified by the amplifier, and then processed by the analog filters, finally processed by the A/D. At last, it is processed by the signal processing system. Now, we use the pipe which diameter is 40mm, flow surface width is 11.2mm as example. The general fluid's frequency should not surpass 358HZ. We expand its scope to 500HZ. In the ideal situation the output signal should

be the sinusoidal signal. But actually, it will mix some certain and uncertain disturbance noise.

We supposed the signal as:

$$y(t) = 10 \sin(2\pi f_0 t + \varphi_0) + 3 \sin(2\pi f_1 t + \varphi_1) + 5 \sin(2\pi f_2 t + \varphi_2) + 0.2 \text{randn}(1, N) \quad (5)$$

Where f_0 is the frequency of vortex flowmeter's signal, f_1 and f_2 are the harmonic disturbances within the scope, which are high-frequency and low frequency. $\varphi_0, \varphi_1, \varphi_2$ are the initial phase. For facilitate, we supposed them as 0. $\text{randn}(1, N)$ is the random disturbances. From the simulation experiment, we see that when the decomposition series is 4, sampling point is 2048; we can get the basic accurate signal.

We use IIR filter bank to decomposition the signal, the result of all levels are shown in tab.1. Figure 4 shows the digital processing result of using the wavelet restructures. The experimental pipeline caliber is 40mm, the experiment result of the low speed fluid shows as follows.

Table 1. The result of all levels

level	1	2	3	4	5	6
true	5	0	0	0	3	0.1
IIR result	4.9808	0.3897	0.0356	0.0276	3.0012	0.0954
Db10 result	4.7356	1.6468	0.0353	0.2532	2.9364	0.3675

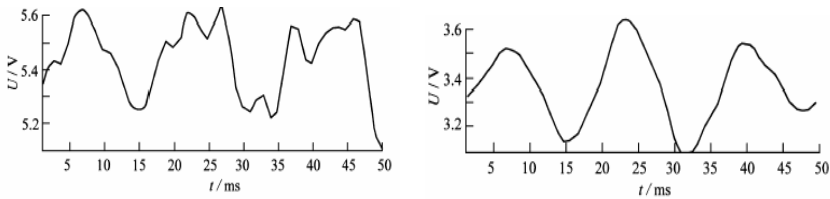


Fig. 4. Original signal and the restructure signal at the speed of 35.82m/s

4 Summary

This paper is only the achievement in lab in the current stage. From the analysis and the simulation we can see that the frequency domain and time domain analysis can filtrate the noises from the original signal effectively.

The wavelet transformation can do a bank of band-pass filter to realize the filter of vortex flowmeter. It can decomposition the signal and the noise to the different frequency bands effectively. In this paper, the IIR filter bank has good band elimination weaken, and the realization based on the multi-phase structure reduce the amount of calculation.

At the same time, wavelet transformation uses appropriate filter parameter for different sampling frequency, to facilitate the measurement of the greater-changed signal using sampling frequency .It improve the real-time of the system ,and is an effective method for the vortex flowmeter signal processing.

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The Relationship between College Students' Social Problem-Solving and Internet Addiction Tendency Based on Certain Intelligent Materials System

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Abstract. Since the origin of Internet researches from the end of 20 century, the relation between social problem-solving and Internet addiction tendency still need more exploration. According to the cognitive-behavior theory of Internet addiction, the negative problem solving tendency is an unadaptive cognitive factor and a sufficient condition of pathological Internet use. The purpose of this study is to exam the relation of college students' social problem-solving, social contact and Internet addiction tendency based on certain intelligent materials system.

Keywords: social problem solving, social anxiety, loneliness, internet addiction.

1 Introduction

From October 1997 to July 2008, a continuity of 22 publications of Statistical Report on Internet Development in China indicated that, adolescents and especially college students (18-24 year old), are the main users of the Internet. The Internet provides them convenient and efficient resources, on one hand, to help them learn and access information more effectively, keep in touch with the existing social relations and make new friends, but on the other hand, some college students could not adapt to this new life-style, leading to incontinent use of the Internet and lose the regular way of learning and living. In recent years, the researchers paid more attentions to the behavior of college students' Internet use. Although, some debates still exist on the definition of Internet addiction and pathological Internet use, without a consensus whether it's a new addiction or a symptom of other mental illness, researchers usually treat it as a pathological cognition and mental disorder with maladjustment and a number of behavioral and impulse control problems.

In Old Greece, Aristotle (1908/350 B.C.), a philosopher, considered that practical wisdom, idea and praxis are the hardest characters for individuals to achieve. All of those are related with the concept of the social problem-solving. However scientists didn't take seriously of social problem-solving until the middle of 20 century. In Problem Solving and Behavior Modification, D'Zurilla and Goldfried(1971) articulated that researchers should value the function of social problem-solving in

individuals' adaptation. Large researches of social problem-solving indicated that the deficiency of the ability in social problem-solving has close relation with maladjustment state (e.g., depression, anxiety) and individuals' problem behaviors (e.g., alcohol and drug abuse, self-injurious behavior). Since the origin of Internet researches from the end of 20 century, the relation between social problem-solving and Internet addiction tendency still need more exploration. According to the cognitive-behavior theory of Internet addiction, the negative problem solving tendency is an unadaptive cognitive factor and a sufficient condition of pathological Internet use. The purpose of this study is to exam the relation of college students' social problem-solving, social contact and Internet addiction tendency.

2 Method

2.1 Participants

Based on cluster sampling methods, Participants were 495 college students from 7 universities in Wuhan (255 males, 240 females; 138 freshmen, 137 sophomores, 172 juniors, 48 seniors). Average age is 20.10.

2.2 Measures

Social Problem-Solving Scale. Wang & Liu developed the revision of The Social Problem-Solving Inventory-Revised based on Chinese culture background. **Social Avoidance and Distressed Scale.** Revised ULS-8 **Aloneness Scale.**

Chinese Internet Addiction Scale. The scales all had satisfactory reliability and validity.

3 Results

3.1 General Discussion of College Students' Social Problem-Solving

The investigation of college students' social problem-solving showed that there was no significant interaction effect of gender, major or grade on social problem-solving. Further analysis revealed significant gender difference on negative problem-solving orientation, with higher scores of females than males, which shows females tend to use more negative problem-solving orientation. Such results may in line with the entire social and cultural background. Even the modern society promotes the quality between men and women, the view that men are superior to women still exists along history and with certain powerful influence. Male is regarded as the stronger in social life with higher ability to solve problems. So they can look at situations in a more positive way. But females gain less praise than males, leading to more negative problem-solving orientation when solving problems.

Moreover, the study also found significant grade difference in avoidant problem-solving style, which freshman's scores were significant lower than the other three grades, indicating that sophomore, junior and senior students tend to use more avoidant problem-solving strategies than freshman. And this study did not find any

other significant interaction effect of gender, grade and major on other dimensions of social problem-solving. Furthermore, both the birthplace of participants and whether they were the only child in family had no significant difference in social problem-solving, indicating that social problem-solving depends more on personal factors, and has little relationship with birthplace and whether the only child or not. And what are the fundamental influential factors of social problem-solving of college students still needs more research.

3.2 College Students' Internet Addiction Tendency

The exploration of college students' Internet addiction tendency in this study showed that there was no gender, major or grade interaction effect on Internet addiction tendency. But, grade difference was found on total scores and each dimension of Internet addiction tendency. Independent t-test showed that there was significant gender difference in Internet addiction tendency and each factor ($t=3.90$, $df=492$, $p<.01$; $t_1=2.42$, $df=493$, $p<.05$; $t_2=2.45$, $df=493$, $p<.05$; Unequal Variances: $t_3=4.51$, $df=490.61$, $p<.01$; $t_4=4.52$, $df=490.85$, $p<.01$). So, on total and each factor's scores, males are significantly higher than females. To further exam grade difference in Internet addiction tendency, make one-way ANOVA on Internet addiction tendency and four factors. Significant difference was found ($F=13.43$; $F_1=14.33$; $F_2=9.17$; $F_3=10.76$; $F_4=8.48$; $df_1=3$, $df_2=491$, $p<0.01$). Post Hoc Test revealed that, freshman's tendency scores were significantly lower than other three grades, and senior's tendency scores were significantly higher than other three grades, and no difference between sophomores and juniors.

The existing literatures do not demonstrate there is significant grade difference in college students' Internet addiction tendency, but some studies found such grade difference. Our result is inconsistent with Li's results, which showed as the age increase, lower tendency was found. And what is partly consistent with Ma's results is that, senior's tendency was significantly higher than freshman and sophomore. In addition, Shapiro pointed that there was age difference existing with adolescents' Internet addiction, with a slow increase during 11-17 years old, and a quick decrease during 17-18 years old, but again, increased to a higher stage during 18-20 years old, and decreased again after 22 years old. The average ages of four grades are 18.88, 20.06, 20.65 and 21.76, which are between 18 and 20 years old, representing a rise phase proposed by Shapiro. Thus, the results of this study are in line with Shapiro's. We infer that sample ages may be on account of the existing inconsistency. Future studies can combine both grades and ages to investigate college students' Internet addiction tendency, not only grade difference.

There was gender difference on Internet addiction tendency. Males were with higher scores than females. Males are more addicted than females on Internet, which can be concluded in many literatures. Li considered that such gender differences are partly results of physiological difference, personality and traditional social culture. Besides, in our study, there was no significant difference on major, birthplace or whether the only child in family on total scores or each factor, which are inconsistent with prior researches.

3.3 The Relationship between Social Problem-Solving and Internet Addiction Tendency

Results showed that, there was significant correlation between factors, and also the factor and total scores of Internet addiction tendency. Significant negative correlation was found between positive problem-solving orientation, rational problem-solving style and total scores, each factor of Internet addiction tendency. Using Internet addiction total scores and its factor scores as dependent variables and each factor scores of social problem-solving as independent variables, make regression analysis. Stepwise regression analysis showed that, rational problem-solving style and negative problem-solving orientation could significantly predict compulsive internet use and internet addiction abstinence reaction, tolerance of internet addiction, interpersonal and health issues and Internet addiction tendency. And, avoidant problem-solving style and impulse-careless problem-solving style could significantly predict time management issues. It was important that avoidant problem-solving style was a powerful predictive variable for Internet addiction tendency. Regression analysis revealed that individuals' social problem-solving could significantly predict Internet addiction tendency. And avoidant problem-solving style was the most powerful predictor variable, together with negative problem-solving orientation. Both of them could significantly predict impulse-careless problem-solving style, compulsive internet use and internet addiction abstinence reaction, interpersonal and health issues and Internet addiction tendency. And avoidant problem-solving style could significantly predict time management issue.

It was found that, the more positively and rationally when individuals solved social problems, the more healthily they were when using the Internet. On the contrary, the more individuals tend to be negative, avoidant and impulsive to solve problems in life, the more Internet addiction tendency could be found on them. Similar results could also be found in social problem-solving and behavior maladjustment, such as alcohol and drug intake, alcohol toxication, abnormal gambling. From another view, Internet addiction is a kind of avoidant and negative way to confront the problems in life. And individuals who use positive and rational way could handle the problems themselves, resulting less Internet addiction tendency.

Davis (2001) proposed cognitive-behavior model, in which he believed that maladjustment adaption was the sufficient condition of PIU, individual's cognitive symptom could aggravate Internet addiction tendency, and susceptibility was the necessary conditions of pathological Internet use. From the results in this study, on one hand, social problem-solving, as a cognitive-affective process could be a sufficient condition as of abnormal Internet use, on the other hand, it could induce depression, anxiety or other negative emotions, as a kind of susceptibility factor, to be a necessary condition of pathological Internet use.

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A Brief Construction on Innovative e-Learning System Based on Intelligent Materials

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Abstract. This research is focused on the factors of effective e-learning system. Policy, quality, creativity and technology are discussed with the perceptiveness of service science to build up the integrated e-learning system. Interdisciplinary perspective of service science helps to create the value of the innovative e-learning system. Documents analysis and focus group were conducted to get the results. Conclusions are to follow the glimmers of service science to find out the direction for the e-learning integrated system of next generation education.

Keywords: e-learning, quality, creativity, technology, service science.

1 Introduction

E-Learning has potential of supporting divergent education and may be used in future to change the pedagogy of passive education toward active and innovative education [1]. Peterson [2] indicates that, under the impact of rising cost, coupled with the possibilities unleashed by technological innovation, schooling may be transformed through virtual learning. The result could be a personalized, customized system of education in which families have greater choice and control over their children's education than at any time. "E-learning", which in itself is an innovation, promises to acquire even greater importance and becomes key element of education with the development of information technology and the needs of different learning styles. It will be important going forward to conceptualize e-learning systems that are likely to create the most pressure for improvements in quality, and to carefully assess their results [3].

Service science is an abbreviation of service science, management and engineering (SSME), which integrates interdisciplinary aiming to study the service phenomena occurred in human society, and develop service systems for better society. It needs not only the collaboration of different disciplines, but also the government, academia, and enterprises to work together for the purpose of service innovation. The perceptiveness of service science is essential for building an effective e-learning system, which is evaluated by the criteria of policy, quality, creativity and technology. The interdisciplinary approach of service science to the design and implementation of

e-learning system could help specific arrangements of people and technologies take actions that provide value for learners.

2 Effectiveness Factors on e-Learning

Brown, Anderson and Murray [4] identified a discernible pattern to the development of e-learning policy. The first stage occurs as governments act to make e-learning possible, the second as they work to integrate e-learning into the education system, effectively, to mainstream e-learning. In the third stage, a transformative role for e-learning is seen, with changes to views of learning and to the nature and operation of the tertiary institutions and the tertiary system. Nowadays, it goes future beyond these stages because of the needs of quality assurance, the creativity development for innovation, and the inevitable of technology supports.

3 Policy in Taiwan, the UK and Singapore

Taiwan has initiated national program for e-learning since 2003: Taiwan e-Learning and Digital Archives Program (TELDAP). The national program involves thirteen government agencies. The first phase of TELDAP last from 2003 to 2007 and the Taiwan National Science Council has continued the second phase, the promotion phase (2008-2012). There are seven operational programs in TELDAP, including "e-learning for everyone", "narrowing the digital divide", "mobile learning devices", "internet-based industrial park for e-learning", "advanced e-learning technology R&D", "fundamental research on learning and cognition in e-learning", and "policy guidance and manpower cultivation" [5]. The results that the national program has accomplished include how the national program has helped enhance competitiveness of commerce; improved public welfare; and how the national program has stimulated the research outputs in both industry and academia [6].

In UK, the National Grid for Learning (NGfL) encompassed projects and initiatives seeking to improve the quantity of technology available in schools, enhance connectivity to the internet, promote information and communication Technologies (ICT) related training for the education workforce and to ensure that the curriculum encouraged the use of ICT to support teaching and learning. In 2003, six year after the initial consultation on the NGfL was the first significant attempt made to assemble a coherent strategy to lend direction to the host of projects and initiatives already underway and only eight years into the decade of "transformation" did an explicit policy document emerge encompassing the strategy of e-learning in schools. "Harnessing Technology: Transforming Learning and Children's Service" emerged in 2005 as the only explicit policy document from central government encompassing e-learning strategy within the wider educational priorities of the UK [7].

The ministry of education in Singapore is constantly working to enrich and transform the learning environments of students and to equip them with the critical competencies to succeed in a knowledge economy. A key thrust is the integration of information and communication technology (ICT) into lessons to enhance students' learning. Additional funding and resources enable schools to seed innovative teaching

methods. A group of “future schools” are partnering industry players to use state-of-the-art technology to pilot new teaching and learning experiences. E-learning encompasses learning enhanced and delivered by ICT. ICT for delivering learning is very similar to ICT for e-commerce or e-business. E-learning may imply self-study, instructor-led events or small group collaboration. In Singapore, the first generation of e-learning systems included only authoring tools. The second generation included classroom management systems, along with lesson content management systems. Together, they came to be known as Learning Management Systems. Third generation systems introduced real time virtual classrooms [8].

4 Quality Assurance of e-Learning System

The Report of the Swedish National Agency for Higher Education (NAHE) suggested that the same criteria for quality should be applicable to e-learning as it is to traditional campus-based education. Many countries today have both Government agencies and organizations devoted to quality assurance of higher education, as well as other bodies with the specific task of promoting distance learning/e-learning [9]. The accreditation, audit and assurance process of e-learning should be integrated in the national framework and not be evaluated separately. College and university provide a variety of good quality courses online gain a competitive advantage over those that do not [3].

It is important to acknowledge that quality of a learning process is not something that is delivered to a learner by an e-learning provider but rather constitutes a process of co-production between the learner and the learning-environment [10]. The acceptance of e-learning by the market is dependent on the quality of the related products, services and tools. A harmonized conception of e-learning quality is a prerequisite for a properly functioning market in e-learning products and services and for their overall quality to continually improve. The standard harmonizes the international conception of e-learning quality by creating a coherent inventory of the diverse processes which affect the attainment and preservation of e-learning quality. These processes embrace all e-learning application scenarios, such as content and tool creation, service provision, learning and education, monitoring and evaluation, and lifecycle stages from continuous needs analysis to ongoing optimization [11].

5 Creativity Design on e-Learning

One of the educational objectives is to foster learner’s creativity for the advance of personal capability and the development of industrial innovation. The interaction between people’s thoughts and a socio-cultural context is another fundamental in e-learning system [12]. For the creativity content in e-learning system, Taiwan e-learning quality certification center of TELDAP states that the “Creativity” section is optional for e-learning system and the results will also be included to the score of evaluation. To encourage the “creativity” in the e-learning system, the submitter of e-learning system should highlight their creative examples from the lecture contents, learning guide, instructional design, instructional media, and other sections. [13].

6 Technology on e-Learning

The potential of technological innovation to provide a solution to the educational supply problem has been recognized and many governments have invested heavily in promoting ICT as a tool to lever educational output [14]. The 2009 European Year of Creativity and Innovation focuses on the role of ICT in enhancing cross-cutting skills such as creativity and entrepreneurship, and pushes forward innovation in education and training. The ICT clusters, representing various Member States under the Education and Training 2010 program, provides an open forum for debate and peer learning. The common conclusion is that ICT need to be seen as a key tool for the modernization and improvement of all aspects of education and training [15]. For example, Zamenopoulos and Alexiou [16] concentrate in an e-learning system that can exhibit and support creative behavior using knowledge learning through distributed human-machine interaction. Many educators have embraced Web 2.0 as a key element of e-learning and the use of Web 2.0 applications and technologies is developing a considerable role in developing creativity [17]. Brindasu and Beju [18] introduced the concept of e-creative design, which referred to the use of methods and techniques of modify for internet application for stimulating the individual and group creativity in a design session using the computer network. However, much of the debate associated with applying ICT in schools has focused on the types of technology to be used, the degree of access to technology and the manner in which it can be integrated into current organizational frameworks [7].

7 Methodology

This project examines a range of existing models and literature on e-learning within the context of service science. The approach taken is a thematic one focusing on the relationship between the factors of effective e-learning system and the interdisciplinary of service science in which integrated model of e-learning system could be built (Fig. 1). This research involved developing a validated template to support a documents analysis of e-learning system in Taiwan.

To add validity and depth to the findings, a number of experienced e-learning professionals in the field were invited to focus group to discuss research topic. This helped to triangulate the outcomes of the document analysis. The validation process of using experts added significantly to the value of the final results. The contextual understandings and complexities of e-learning system of which we make aware by all documents and professionals ensure a more comprehensive and nuanced collection of literature.

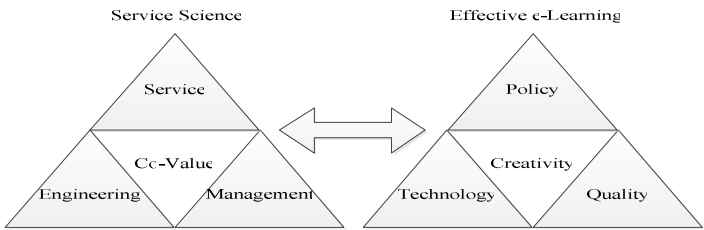


Fig. 1. Mapping of Service Science and Effective e-Learning

8 Results

E-learning makes globalization of educational quality an achievable reality. Countries like Taiwan, the UK and Singapore have been devoted a lot of resources in digital learning. Scholars, scientists, and business cooperated together to achieve a lot of facilities and content of e-learning products under the policy of digital learning. By applying the concept of service science, management and engineering, the effectiveness factors of e-learning were enhanced by technology, quality and creativity. Currently, Taiwan has advantages in the IT and Communication industries. It has also laid down a solid foundation for its policy of TELDAP. Taiwan has more opportunity to become a leader for the operation of boundaryless e-learning resources.

Calls for radical innovation and the development of new approaches to learning made possible by service science on digital technologies have occurred alongside a tight standards and target driven agenda. This agenda was based on increasingly centrally defined models of “good practice”, accountability system and scrutiny not only through the publishing of data on school examination output but on internal and external scrutiny of teaching via e-learning. Service science provides clear evidence that top-down approaches to technological innovation in the field of education can lead to an enhancement of current practice in the classroom and making administration of existing school systems more efficient. Tracing the history of education, we can find where we are and where we should go. Follow the glimmers of service science, we could find out the direction to devote ourselves to the next step for our next generation on e-learning.

9 Conclusions

Service Science, Management, and Engineering (SSME) is basically the realization that knowledge creation (science), knowledge application in a well-specified, cost-effective instance (engineering), and ongoing knowledge application to create and capture value as part of a business model or value proposition (management) are intimately linked in a meta-service-system value chain. The outlines of a “Moore’s Law of Service System Investment” can start to be seen. The purposes of e-learning, such as educational training, cost effective and boundaryless, could be achieved by the perceptive of service science. The most general form of the core question is how to apply the application of service science to create the most new value or innovation on e-learning. The specific question can take many forms ranging from seeking to understand the learning curves associated with service systems versus manufactured product systems or the optimal ratio of investment in new knowledge creation versus knowledge application. Virtual learning is already unavoidable in our education system. What we have been involved in e-learning will make a change to an interdisciplinary educational system. The principle of service science, which emphasis on the collaboration of different entities, disciplinarians could be a way to construct an integrated effective e-learning system.

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Nutrients Dosage Control in Biological Treatment of Whitewater Reuse

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Abstract. Nutrients, like nitrogen and phosphorous, are deficient in whitewater compared to what is required in order to fully degrade. So N and P are added to the whitewater biological treatment system to achieve efficient reduction, at the same time, we must ensure the effluent of the treatment be has a low nutrients concentration. Nutrients dosage control is a main problem in the whitewater treatment of whitewater reuse. We often use the strategy of maintaining BOD:N:P ration in a certain degree with the influent flow. By establish the mathematical model, we can look into the process of the biological treatment system, so as to adjust the BOD:N:P ration.

Keywords: whitewater reuse, biological treatment, nutrients dosing.

1 Introduction

Pulp and paper mills are industries that use a lot of water in theirs process. So there are problems associated with theirs reduction in fresh water consumption in the paper mills and they start to appear at a certain degree of closure [1]. But this may followed by a series of problems. The produced paper and the whitewater, which is the process water from the paper machine, could start to smell badly, along with corrosion and slime production [2]. The major part of these problems is caused by the growth of microorganisms in the whitewater system, these organisms nourish on the organic compounds, which accumulate in the whitewater as a result of the increased closure [3].

One solution to overcome these problems is to treat the whitewater in an in-mill biological treatment plant [4]. The benefit of the method is its removal of the dissolved organic compounds in the whitewater. The efficiency of a biological treatment process is among other things a function of the concentration of microorganisms in the reactor. In order to have an efficient and thereby a small reactor the concentration of microorganisms should be high. Nutrients, like nitrogen and phosphorus, have to be added to the biological treatment plant in order to achieve efficient reduction [5]. At the same time, the concentration of nutrients in the effluent should be low, otherwise the growth in the whitewater system could be promoted and the situation worsened, thus the controlling of the nutrient dosage represents a cost reduction opportunity as well as an opportunity to reduce the final effluent nutrient concentrations. Which are significant in the biological treatment of whitewater reuse.

2 Nutrients Requirements

Many wastewater, such as wastewater from pulp and paper, have a too low natural concentration of nutrients compared to what is required in order to fully degrade the organic compounds. Therefore nutrients are added during the treatment in order to have an efficient process. Biological treatment with limiting amounts of nutrients is an area that is not well investigated. Research on industrial wastewater has mostly been done with a surplus of nutrients and where the focus has been on the degradability of the organic compounds. The fate and transformation of nutrients have been investigated in the research of the process nitrification, denitrification and biological phosphorus removal, which mainly occur in municipal wastewater treatment plants.

The ultimate goal of a bacterial cell is to reproduce itself. Therefore the bacteria is increasing its size and multiplying its components so it can be divided into two identical daughter cells. In the cell several different organic and inorganic molecules can be found. Most of the cell by weight is made up of protein followed by genetic material ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). The rest of the cell is a mixture of inorganic molecules.

The elements that these different molecules are made up from can be divided into two different groups, Macronutrients and micronutrients. The Macronutrients such as N and P, are essential for the aerobic as well as anaerobic bacterial conversion processes. The nitrogen requirement for the anaerobic treatment of an industrial wastewater is only a small fraction of the amount for aerobic processes. The phosphorus requirement is approximately 20% of the nitrogen requirement [6]. There are a few different easily assimilable forms of these nutrient that can easily be added to the process, notably urea and ammonium hydroxide for nitrogen; phosphoric acid for phosphorus. In general, the required quantity of N respectively P can be calculated from the following ratio and depends on the waste water characteristics and the organic load.

3 Nutrients Dosage Control Strategy

The challenge is to achieve efficient treatment while maintaining low nutrient concentrations in the effluent. This is difficult since the concentrations should be very low, near the detection limits for on-line instructions.

In whitewater biological treatment plant, methods of dosage control can be far from ideal, leading occasionally to inefficient plant operation, occurrence of unnecessary costs and in some cases decreasing water quality. However, the development of control strategies has been increased in recent years mainly due to tightened environmental requirements and decreasing water consumption in pulp and paper mills. The possible purpose or results desired include the minimization of effluent concentrations organic pollutions and nutrients or the minimizations of nutrient dosage quantities, whilst maintaining stable process operation and efficient BOD removal.

There are several different strategies such as constant dosing, proportional to flow, maintain BOD5:N:P ration to a certain degree [7], nutrient residual, respire-metric-based

control. Along these strategies, maintain BOD5:N:P ration to a certain degree, is often used in actual biological treatment plant.

It is usually stated that the ratio of BOD:N:P in the wastewater to be treated should be approximately 350:5:1 for aerobic treatment. But this ration is often oppugned. For pulp and paper wastewater treatment using Active Sludge Treatment (AST) technology, BOD:N:P ratios have been reported for stable plant operation from 100:3.5:0.6 to lower limits suggested for BOD:N of 100:2.5 to 100:4.5 ,and BOD: P of 100:0.4 to 100:0.6. Zero supplemental phosphorus was added to a pulp paper mill effluent with successful stable AST operation, and zero nutrient addition has been implemented successfully for pulp and paper ASB operations, which is due to sufficient nutrient internal recycling.

Bashaar Y. also found that the ratio is lower than what is usually reported in the literature for pulp and paper mill wastewater. This suggests that both nitrogen and phosphorous have to be added to the wastewater for effective biological treatment. He thought that different wastewaters have different biomass yields, and the efficiency of COD removal should be taken into account.

So the essential of nutrients control consist in two aspects: the first one is to decide what BOD:N:P ratio should be used and the second is how to maintain this ratio.

4 The Biological Treatment Control System

4.1 Architecture of the Control System

The main framework of the whole control system consists of three parts, namely, an operation management part, a process control part and a field equipment part; however, a PROFIBUS-DP net is employed in a communication part. The architecture of the system is shown as Fig.1.

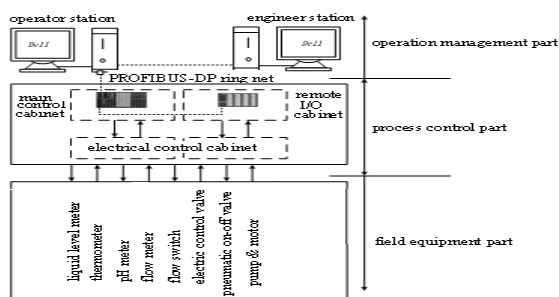


Fig. 1. Architecture of the control system

The operation management station, the PLC and the communication system in the control system of the whole wastewater treatment system are detailed as follows:

1) The operation management station is composed of two high-performance PCs, one is an engineer station, the other is an operator station and they are equipped with a CP5611 communication card. SIEMENSE STEP7 V5.2 SP1 is adopted as

programming software, and SIEMENSE WinCC V6.0 is employed as monitoring configuration software; with the standard software and networks, process diagnosis, process monitoring and control and information management of the whole plant can be realized.

2) The process control part: the main control cabinet adopts SIEMENS PLC S7-414-2DP PLC, AI/AO, DI/DO modules and ET200 remote modules; I/O modules are used for collecting the signals of field analog variables and digital variables. The control layer, which is the most important layer in the system and forms the second level, is changed with the overall control of the process.

3) The communication system: PROFIBUS-DP cables are adopted for connecting the engineer station with the operator station at the operation management level as well as the process control level with the operation management, one end of the cable is connected to the DP interface of CPU412-2DP, while the other end is connected to the CP5611 communication card on the host computer of the operator station; the communication rate of the CPU412-2DP network is set to be 1.5Mbps.

4.2 Description of the Nutrients Control System

In biological treatment system of whitewater reuse, we add nutrient is to achieve a high efficiency. Are the nutrients we added are too enough or too low? How to judge it? If we can establish a mathematical model, then maybe we can find some disciplinarians.

The microbial growth is usually described by a monod equation in mathematical models such as ASM1. In the question (1).

$$\mu = \mu_{\max} \cdot \frac{S_s}{K_s + S_s} \quad (1)$$

In the question, $\mu_{\max}$ is the specific growth rate, S_s is the substrate concentration, and K_s is the half saturation constant. With this expression the specific growth rate is only limited by the substrate. When a process with limiting amounts of nutrients is going to be modeled this has to be included in the model. If the limitations on the growth, due to low concentrations of nutrients, are described in the same way as the substrate, the expression for the growth rate would then be changed as equation (2).

$$\mu = \mu_{\max} \cdot \frac{S_s}{K_s + S_s} \cdot \frac{S_{NH}}{K_{NH} + S_{NH}} \cdot \frac{S_p}{K_p + S_p} \quad (2)$$

In the equation, the effects from ammonia nitrogen S_{NH} and phosphorus S_p are included. With the nutrients affects added, the model then can simulate the biological treatment system reasonable. And from the simulation, we can find some hints on the nutrients addition.

$$\frac{S_{NH}}{K_{NH} + S_{NH}} \quad (3)$$

$$\frac{S_p}{K_p + S_p} \quad (4)$$

For example, the ammonia nitrogen saturation functions (3) and phosphorus saturation function(4) as calculated using the monod equation for the biological treatment system, can be used as a reference to indicates whether each nutrient is present in sufficient quantities (function approaches 1) or is deficient relative to the requirements of the microorganisms modeled (function approaches zero). The comparison of the ammonia and the phosphorus saturation function for each pseudo-steady state indicates which nutrient is relatively deficient. If the operators find one of the nutrients is deficient, they can increase the relevant nutrient ration. Monitoring the relative values of these saturation functions on a regular basis could be very useful of for plant operators in order to determine which of the two supplemental nutrients is in short supply for the biomass to complete efficient BOD removal.

5 Results and Discussion

The overall goal of the biological processes is to reduce the easy degradable components in the whitewater, in order to solve some of the different problems that caused by closure of the whitewater system. In order to reduce the size of the reactors, the biological processes should be operated as efficiently as possible. And the biological treatment system should produce an effluent suitable for recycling.

The challenge in the biological treatment system is the control of nutrients; normally it is only nitrogen and phosphorus that are limiting the process since they are required in larger amounts. Ration control is often used which can be based on a BOD:N:P mass ration, translates to control of nutrients dosing flow rate in proportion to the measured BOD load in the whitewater be treated.

In the nutrients adding control process, mathematical model can be used to predict an imminent nutrient deficient state prior to the exhibition of symptoms such as low nutrient residuals. This would be an extremely useful tool for plant operators to monitor on a regular basis.

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The Traits of Biorthogonal Quarternary Small Function Wraps According to Quantity Matrix Dilation

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Abstract. In this note, the notion of a sort of vector-valued quarternary wavelet wraps with quantity dilation matrix is introduced. A new method for designing a kind of biorthogonal vector-valued wavelet wraps in vector-valued quarternary function space is developed and their biorthogonality property is studied by virtue of iterative method and time-frequency analysis method, and operator theory. Two biorthogonality formulas concerning these wavelet packets are presented. Moreover, it is shown how to gain new Riesz bases of space $L^2(R^n)^v$ from these wavelet wraps.

Keywords: Fourier coefficients, biorthogonality formuluss, vector-valued wavelet wraps, wavelet transform, tight frame superposition, Riesz bases, matrix dilation.

1 Introduction

Multiwavelets can simultaneously possess many desired properties such as short support, orthogonality, symmetry, and vanishing moments, which a single wavelet cannot possess simultaneously. Tight frames generalize orthonormal systems. They preserve the unitary property or the relevant analysis and synthesis operator. Already multiwavelets have led to exciting applications in image processing [1] signal analysis [2], and fractals [3] and so on. In the signal denosing method, wavelet analysis is a new analytical tool which develops on the basis of the Fourier analysis. The location and multiscale resolution function simultaneously contained in time domain and frequency domain. Vector-valued wavelets are a class of special multiwavelets. Chen [4] introduced the notion of orthogonal vector-valued wavelets [5]. Every frame (or Bessel sequence) determines an analysis operator, the range of which is important for a number of applications. Prefiltering is usually required for discrete multiwavelet transforms [6] but not necessary for discrete vector-valued transforms. Wavelet packets, owing to their nice characteristics, have been widely applied to signal processing [7], code theory, image compression, solving integral equation and so on. Yang [5] constructed a-scale orthogonal multiwavelet packets which were more flexible in applications. Shen [6] introduced multivariate orthogonal wavelets which may be used in a wider field. The goal of this paper is to give the definition and the construction of biorthogonal small function wraps and construct several new Riesz bases of space $L^2(R^n)^v$.

2 Preliminaries on Vector-Valued Function Space

We start from some notations. Set $Z_+ = \{0\} \cup N$, $u, v \in N$ and $u, v \geq 2$, $Z'' = \{(s_1, s_2, \dots, s_u) : s_r \in Z, r = 1, 2, \dots, u\}$, $Z'_+ = \{(s_1, s_2, \dots, s_u) : s_r \in Z_+, r = 1, 2, \dots, u\}$. Suppose that D is an $u \times u$ matrix whose all entries are integers and all eigenvalues are large than one in modulus. The absolute value of the determinant of matrix D is denoted by d , i.e., $|\det(D)| = d$. There exist a elements $\rho_0, \rho_1, \dots, \rho_{d-1}$ in Z'_+ by algebra theory such that $Z'' = \bigcup_{\rho \in \Gamma_0} (\rho + DZ'')$; $(\rho_1 + DZ'') \cap (\rho_2 + DZ'') = \emptyset$, where $\Gamma_0 = \{\rho_0, \rho_1, \dots, \rho_{d-1}\}$ denotes the set of all different representative elements in the quotient group $Z''/(DZ'')$ and ρ_1, ρ_2 denote two arbitrary distinct elements in Γ_0 . Set $\rho_0 = \underline{0}$, where $\underline{0}$ is the null of Z'_+ . Let $\Gamma = \Gamma_0 - \{\underline{0}\}$ and Γ, Γ_0 be two index sets. By $L^2(R'')^v$, we denote the aggregate of all vector-valued functions $\tilde{\lambda}(x)$, i.e., $L^2(R'')^v := \{\tilde{\lambda}(x) = (\lambda_1(x), \lambda_2(x), \dots, \lambda_v(x))^T : \lambda_l(x) \in L^2(R''), l = 1, 2, \dots, v\}$, where T means the transpose of a vector. Video images and digital films are examples of vector-valued functions where $\lambda_l(x)$ in the above $\tilde{\lambda}(x)$, denotes the pixel on the l th column at the point x . For $\tilde{\lambda}(x) \in L^2(R'')^v$, $\|\tilde{h}\|_2$ means the norm of vector-valued function $\tilde{h}(x)$, i.e., $\|\tilde{h}\|_2 = (\sum_{l=1}^v \int_{R''} |h_l(x)|^2 dx)^{1/2}$.

In the below $*$ means the transpose and the complex conjugate. And integration of is defined to be

$$\int_{R''} \tilde{h}(x) dx := \left(\int_{R''} h_1(x) dx, \int_{R''} h_2(x) dx, \dots, \int_{R''} h_v(x) dx \right)^T.$$

The Fourier transform of $\tilde{h}(x)$, is defined as $\hat{\tilde{h}}(\gamma) := \int_{R''} \tilde{h}(x) \cdot e^{-ix \cdot \gamma} dx$, where $x \cdot \gamma$ denotes the inner product of real vectors x and γ . For $\tilde{\lambda}, \tilde{h} \in L^2(R'')^v$, their symbol inner product is defined by

$$[\tilde{\lambda}(\cdot), \tilde{h}(\cdot)] := \int_{R''} \tilde{\lambda}(x) \tilde{h}(x)^* dx. \quad (1)$$

As usual, by $L^2(R'')$ we denote the linear space of all (complex-valued) square integrable functions on R'' . The space $L^2(R'')$ is a Hilbert space with the inner product given by

$$[g, \varphi] := \int_{R''} g(x) \overline{\varphi(x)} dx, \quad g, \varphi \in L^2(R'').$$

For $\lambda > 0$, we denote by $H^\lambda(R^4)$ the sobolev space of all functions $h(x) \in H^\lambda(R^4)$ such that

$$\int_{R''} |\hat{h}(\gamma)| (1 + \|\gamma\|^{2\lambda}) d\gamma < +\infty.$$

The space $H^\lambda(R^4)$ is a Hilbert space equipped with the inner product given by

$$[h, \varphi]_{L^2(R^u)} := \frac{1}{(2\pi)^4} \int_{R^u} \hat{h}(\gamma) \overline{\hat{\varphi}(\gamma)} (1 + |\gamma|^{2\lambda}) d\gamma, \quad h, \varphi \in L^2(R^u).$$

Definition 1. A pair of vector-valued functions $\tilde{\lambda}(x), \tilde{\lambda}(x) \in L^2(R^u)^v$ are called biorthogonal ones, if their translations satisfy the following relation:

$$[\tilde{\lambda}(\cdot), \tilde{\lambda}(\cdot - k)] = \delta_{0,k} I_v, \quad k \in Z^u, \quad (2)$$

A vector-valued multiresolution analysis of the space $L^2(R^u)^v$ is a nested sequence of closed subspaces $\{Y_\ell\}_{\ell \in Z}$ such that (i) $Y_\ell \subset Y_{\ell+1}, \forall \ell \in Z$; (ii) $\bigcap_{\ell \in Z} Y_\ell = \{0\}$ and $\bigcup_{\ell \in Z} Y_\ell$ is dense in $L^2(R^u)^v$, where 0 denotes an zero vector of space R^v ; (iii) $\tilde{h}(x) \in Y_\ell \Leftrightarrow \tilde{h}(Dx) \in Y_{\ell+1}, \forall \ell \in Z$; (iv) there exists $\Phi(x) \in Y_0$, called a vector-valued scaling function, such that its translates $\{\Phi_n(x) := \Phi(x - n), n \in Z^u\}$ forms a Riesz basis of subspace Y_0 . Since $\Phi(x) \in Y_0 \subset Y_1$, by Definition 3 and (4) there exists a finitely supported sequence of constant $v \times v$ matrix $\{P_n\}_{n \in Z^u} \in \ell^2(Z^u)^{v \times v}$ such that

$$\Phi(x) = \sum_{n \in Z^u} P_n \Phi(Dx - n). \quad (3)$$

Equation (4) is called a refinement equation. Define

$$\mathcal{P}(\gamma) = \frac{1}{d} \sum_{n \in Z^u} P_n \cdot \exp\{-in \cdot \gamma\}, \quad \gamma \in R^u. \quad (4)$$

where $\mathcal{P}(\gamma)$, which is a $2\pi Z^u$ periodic function, is called a symbol of $\Phi(x)$. Thus, (4) becomes

$$\widehat{\Phi}(D\gamma) = \mathcal{P}(\gamma) \widehat{\Phi}(\gamma), \quad \gamma \in R^u. \quad (5)$$

Let $X_j, j \in Z$ be the direct complementary subspace of Y_j in Y_{j+1} . Assume there exist $d-1$ functions $G_\mu(x) \in L^2(R^u)^v, \mu \in \Gamma$ such that their translates and dilations form a Riesz basis of X_j , i.e.,

$$X_j = \overline{\text{span}\{G_\mu(D^j \cdot -k) : k \in Z^u, \mu \in \Gamma\}}, \quad j \in Z. \quad (6)$$

Since $G_\mu(x) \in X_0 \subset Y_1, \mu \in \Gamma$, there exist $d-1$ sequences of constant $v \times v$ matrix $\{B_n^{(\mu)}\}_{n \in Z^u}$ s. t.

$$G_\mu(x) = \sum_{k \in Z^u} B_k^{(\mu)} \Phi(Dx - k), \quad \mu \in \Gamma. \quad (7)$$

By implementing the Fourier transform for the both sides of (9), we have

$$\widehat{G}_\mu(D\gamma) = \mathcal{B}^{(\mu)}(\gamma)\widehat{\Phi}(\gamma), \quad \gamma \in R^u, \quad \mu \in \Gamma. \quad (8)$$

$$d\mathcal{B}^{(\lambda)}(\gamma) = \sum_{k \in Z^u} B_k^{(\lambda)} \cdot \exp\{-ik \cdot \gamma\}, \quad \lambda \in \Gamma. \quad (9)$$

If $\Phi(x), \widetilde{\Phi}(x) \in L^2(R^u)^\vee$ are a pair of biorthogonal vector-valued scaling functions, then

$$[\Phi(\cdot), \widetilde{\Phi}(\cdot - n)] = \delta_{0,n} I_\nu, \quad n \in Z^u. \quad (10)$$

We say that $G_\mu(x), \widetilde{G}_\mu(x) \in L^2(R^u)^\vee$, $\mu \in \Gamma$ are pairs of biorthogonal vector-valued wavelets associated with a pair of biorthogonal vector-valued scaling functions $\Phi(x)$ and $\widetilde{\Phi}(x)$, if the family $\{\Psi_\mu(x - n), n \in Z^u, \mu \in \Gamma\}$ is a Riesz basis of subspace X_0 , and

$$[\Phi(\cdot), \widetilde{G}_\mu(\cdot - n)] = 0, \quad \mu \in \Gamma, \quad n \in Z^u. \quad (11)$$

$$[\widetilde{\Phi}(\cdot), G_\mu(\cdot - k)] = 0, \quad \mu \in \Gamma, \quad k \in Z^u. \quad (12)$$

3 The Characters of Vector-Valued Wavelet Packets

Denoting by $F_0(x) = \Phi(x)$, $\widetilde{F}_0(x) = \widetilde{\Phi}(x)$, $Q_k^{(0)} = P_k$, $Q_k^{(\lambda)} = B_k^{(\lambda)}$, $\widetilde{Q}_k^{(0)} = \widetilde{P}_k$, $\widetilde{Q}_k^{(\lambda)} = \widetilde{B}_k^{(\lambda)}$, $\lambda \in \Gamma$, $k \in Z^u$, order $D = 14I_\nu$, $u = 4$. For any $\alpha \in Z_+^4$ and the given vector-valued biorthogonal scaling functions $F_0(x)$ and $\widetilde{F}_0(x)$, iteratively define, respectively,

$$F_\alpha(x) = F_{14\sigma+\mu}(x) = \sum_{n \in Z^4} Q_n^{(\mu)} F_\sigma(14x - n), \quad (13)$$

$$\widetilde{F}_\alpha(x) = \widetilde{F}_{14\sigma+\mu}(x) = \sum_{n \in Z^4} \widetilde{Q}_n^{(\mu)} \widetilde{F}_\sigma(14x - n), \quad (14)$$

where $\mu \in \Gamma_0$, $\sigma \in Z_+^4$ is the unique element such that $\alpha = 14\sigma + \mu$, $\mu \in \Gamma_0$ holds.

Lemma 1[4]. Let $F(x), \widetilde{F}(x) \in L^2(R^4, C^\nu)$. Then they are biorthogonal if and only if

$$\sum_{k \in Z^4} \widehat{F}(\gamma + 2k\pi) \widehat{\widetilde{F}}(\gamma + 2k\pi)^* = I_\nu. \quad (15)$$

Definition 3. We say that two families of vector-valued functions $\{F_{14\sigma+\mu}(x), \sigma \in Z_+^4, \mu \in \Gamma_0\}$ and $\{\widetilde{F}_{14\sigma+\mu}(x), \sigma \in Z_+^4, \mu \in \Gamma_0\}$ are quarternary small function wraps with respect to a pair of biorthogonal vector-valued scaling

functions $F_{\underline{0}}(x)$ and $\widetilde{F}_{\underline{0}}(x)$, respectively, where $F_{14\sigma+\mu}(x)$ and $\widetilde{F}_{14\sigma+\mu}(x)$ are given by (13) and (14), respectively.

Applying the Fourier transform for the both sides of (18) and (19) yields, respectively,

$$\widehat{F}_{14\sigma+\mu}(\gamma) = Q^{(\mu)}(\gamma/14) \widehat{F}_{\sigma}(\gamma/14), \quad \mu \in \Gamma_0, \quad (16)$$

$$\widehat{\widetilde{F}}_{14\sigma+\mu}(\gamma) = \widetilde{Q}^{(\mu)}(\gamma/14) \widehat{\widetilde{F}}_{\sigma}(\gamma/14), \quad \mu \in \Gamma_0. \quad (17)$$

Lemma 2[6]. Suppose $\{F_{\alpha}(x), \alpha \in Z_+^4\}$ and $\{\widetilde{F}_{\alpha}(x), \alpha \in Z_+^4\}$ are wavelet packets with respect to a pair of biorthogonal vector-valued functions $F_{\underline{0}}(x)$ and $\widetilde{F}_{\underline{0}}(x)$. Then, for $\alpha \in Z_+^4$, we have

$$[F_{\alpha}(\cdot), \widetilde{F}_{\alpha}(\cdot - k)] = \delta_{\underline{0},k} I_v, \quad k \in Z^4. \quad (18)$$

Theorem 1[7]. Assume that $\{F_{\beta}(x), \beta \in Z_+^4\}$ and $\{\widetilde{F}_{\beta}(x), \beta \in Z_+^4\}$ are quarternary small function wraps with respect to a pair of biorthogonal vector-valued functions $F_{\underline{0}}(x)$ and $\widetilde{F}_{\underline{0}}(x)$, Then

$$[F_{4\beta+\mu}(\cdot), \widetilde{F}_{4\beta+\nu}(\cdot - k)] = \delta_{\underline{0},k} \delta_{\mu,\nu} I_v, \quad k \in Z^4. \quad (19)$$

Theorem 2. If $\{F_{\beta}(x), \beta \in Z_+^4\}$ and $\{\widetilde{F}_{\beta}(x), \beta \in Z_+^4\}$ are quarternary small function wraps according to biorthogonal vector-valued scaling functions $F_{\underline{0}}(x)$ and $\widetilde{F}_{\underline{0}}(x)$, then for any $\alpha, \sigma \in Z_+^4$, we have

$$[F_{\alpha}(\cdot), \widetilde{F}_{\sigma}(\cdot - k)] = \delta_{\alpha,\sigma} \delta_{\underline{0},k} I_v, \quad k \in Z^4. \quad (20)$$

Proof. When $\alpha = \sigma$, (26) follows by Lemma 3. as $\alpha \neq \sigma$ and $\alpha, \sigma \in \Gamma_0$, it follows from Theorem 1 that (20) holds, too. Assuming that α is not equal to β , as well as at least one of $\{\alpha, \sigma\}$ doesn't belong to Γ_0 , we rewrite α, σ as $\alpha = 4\alpha_1 + \rho_1$, $\sigma = 4\sigma_1 + \mu_1$, where $\rho_1, \mu_1 \in \Gamma_0$.

Case 1. If $\alpha_1 = \sigma_1$, then $\rho_1 \neq \mu_1$. (20) follows by (18), (19) and Lemma 1 and Lemma 2, i.e.,

$$\begin{aligned} [F_{\alpha}(\cdot), \widetilde{F}_{\sigma}(\cdot - k)] &= \frac{1}{(2\pi)^4} \int_{R^4} \widehat{F}_{14\alpha_1+\rho_1}(\gamma) \widehat{\widetilde{F}}_{14\sigma_1+\mu_1}(\gamma)^* \cdot \exp\{ik \cdot \gamma\} d\gamma \\ &= \frac{1}{(2\pi)^4} \int_{[0,28\pi]^4} Q^{(\rho_1)}(\gamma/4) \left\{ \sum_{u \in Z^4} \widehat{F}_{\alpha_1}(\gamma/4 + 2u\pi) \right. \\ &\quad \cdot \widehat{\widetilde{F}}_{\alpha_1}(\gamma/4 + 2u\pi)^* \} \widetilde{Q}^{(\mu_1)}(\gamma/4)^* \cdot e^{ik \cdot \gamma} d\gamma \end{aligned}$$

$$\begin{aligned}
&= \frac{1}{(2\pi)^4} \int_{[0, 28\pi]^4} \mathcal{Q}^{(\rho_1)}(\gamma/4) \tilde{\mathcal{Q}}^{(\mu_1)}(\gamma/4)^* \cdot e^{ik \cdot \gamma} d\gamma \\
&= \frac{1}{(2\pi)^4} \int_{[0, 2\pi]^4} \delta_{\rho_1, \mu_1} I_v \cdot \exp\{ik \cdot \gamma\} d\gamma = O.
\end{aligned}$$

Case 2. If $\alpha_1 \neq \sigma_1$, order $\alpha_1 = 14\alpha_2 + \rho_2$, $\sigma_1 = 14\sigma_2 + \mu_2$, where $\alpha_2, \sigma_2 \in Z_+^4$, and $\rho_2, \mu_2 \in \Gamma_0$. Thus, after taking finite steps (denoted by κ), we obtain $\alpha_\kappa \in \Gamma_0$, and $\rho_\kappa, \mu_\kappa \in \Gamma_0$. If $\alpha_\kappa = \sigma_\kappa$, then $\rho_\kappa \neq \mu_\kappa$. Similar to the Case 1, (20) follows. If $\alpha_\kappa \neq \sigma_\kappa$, then it gets from (10)-(12), we obtain

$$\begin{aligned}
&16\pi^4 [F_\alpha(\cdot), \tilde{F}_\sigma(\cdot - k)] = \int_{R^4} \hat{F}_\alpha(\gamma) \hat{F}_{\sigma_1}(\gamma)^* \cdot e^{ik \cdot \gamma} d\gamma = \dots\dots\dots \\
&= \int_{[0, 2 \cdot (14)^\kappa \pi]^4} \left\{ \prod_{l=1}^\kappa \mathcal{Q}^{(\rho_l)}(\gamma/14^l) \right\} \left\{ \sum_{u \in Z^4} \hat{F}_{\alpha_\kappa}(\gamma/14^l + 2u\pi) \right. \\
&\quad \left. \cdot \hat{F}_{\sigma_\kappa}(\gamma/14^l + 2u\pi)^* \right\} \left\{ \prod_{l=1}^\kappa \tilde{\mathcal{Q}}^{(\mu_l)}(\gamma/14^l) \right\}^* \cdot e^{ik \cdot \gamma} d\gamma \\
&= \int_{([0, 2 \cdot (14)^\kappa \pi]^4)} \left\{ \prod_{l=1}^\kappa \mathcal{Q}^{(\rho_l)}(\gamma/14^l) \right\} \cdot O \cdot \left\{ \prod_{l=1}^\kappa \tilde{\mathcal{Q}}^{(\mu_l)}(\gamma/14^l) \right\}^* \cdot \exp\{-ik \cdot \gamma\} d\gamma = O.
\end{aligned}$$

Therefore, for any $\alpha, \sigma \in Z_+^4$, result (26) is established.

4 Conclusion

Three biorthogonality formulas of vector-valued quaternary wavelet wraps are established. The direct decomposition of space $L^2(R^u)^v$ is proposed by constructing subspaces of the wavelet wraps.

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The Characters of Multiscale Pseudoframes of Subspace According to Binary Filter Functions

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Abstract. The notion of a generalized multiresolution structure and the concept of subspace bivariate affine pseudoframes are introduced. The pyramid decomposition scheme of a generalized multiresolution structure(BGMRS) is established, which is generalization of Mallat's pyramid algorithm. A necessary and sufficient condition for the existence of the pyramid decomposition scheme of space $L^2(R^2)$ is established. The rise of frame theory in applied mathematics is due to the flexibility and redundancy of frames. The structured frames are much easier to construct than structured orthonormal bases. Moreover, affine binary multiscale pseudoframe expansions of $L^2(R^2)$ are designed by virtue of the pyramid decomposition scheme.

Keywords: Oblique frames, multiscale pseudoframes, approximate function, convolution formula, bounded variation function, bivariate, parameterization, Fourier Transfer.

1 Introduction

Recently, wavelet tight frames have attracted more and more attention, just because they have nice time-frequency localization property, shift-invariances, and more design freedom. Wavelet tight frames have been widely used in denoising and image processing. What was needed was a localized time-frequency representation which has this information encoded in it. Chui and He [1] mainly constructed In 1946, D. Gabor [1] filled this gap and formulated a fundamental approach to signal decomposition in terms of elementary signals. Gabor's approach quickly become a paradigm for the spectral analysis associated with time-frequency methods. The frame theory has been one of powerful tools for researching into wavelets. In 1952, Duffin and Schaeffer [2] introduced the notion of frames for a separable Hilbert space. Later, Daubechies, Grossmann, Meyer, Benedetto, Ron revived the study of frames in [3], and since then, frames have become the focus of active research, both in theory and in applications, such as signal processing, image processing and sampling theory. Every frame(or Bessel sequence) determines an analysis operator, the range of which is important for a number of applications. The notion of Frame multiresolution analysis as described by [5] generalizes the notion of multiresolution analysis by allowing

non-exact affine frames. The rise of frame theory in applied mathematics is due to the flexibility and redundancy of frames, where robustness, error tolerance and noise suppression play a vital role [4,8]. The concept of frame multiresolution analysis (FMRA) as described in [8] generalizes the notion of MRA by allowing non-exact affine frames. It is well known that the majority of information is multidimensional information. Thus, it is significant generalize the concept of multivariate wavelet packets to the case of multiple vector-valued multivariate wavelets. Inspired by [2] and [5], we introduce the notion of an 2-band generalized multiresolution structure(GMS) of $L^2(R^2)$, which has a pyramid decomposition scheme. It also lead to new constructions of affine frames of $L^2(R^2)$.

The frame operator $\mathbf{F} : H \rightarrow H$, which is associated with a frame $\{\Upsilon_t\}_{t \in \Lambda}$, is defined to be

$$\mathbf{F} \varphi = \sum_{t \in \Lambda} \langle \varphi, \Upsilon_t \rangle \Upsilon_t, \quad \varphi \in H, \quad (1)$$

A family $\{y_t : t \in \Lambda\} \subseteq H$ is a frame for H if there exist two positive constants L_1, L_2 such that

$$\forall h \in H, \quad L_1 \|h\|_2^2 \leq \sum_{t \in \Lambda} |\langle h, y_t \rangle|^2 \leq L_2 \|h\|_2^2, \quad (2)$$

where H be a separable Hilbert space and Λ be an index set. Obviously, $\{\Upsilon_t\}_{t \in \Lambda}$ is a frame for H with lower frame bound L_1 and upper frame bound L_2 if and only if $\mathbf{F}$ is well defined and $L_1 I \leq \mathbf{F} \leq L_2 I$, where I denotes the identity operator on H . Let $\{y_t\}_{t \in \Lambda}$ be a frame for Hilbert space H with lower frame bound L_1 and upper bound L_2 . Then its frame operator $\mathbf{F}$ is invertible and $(L_1)^{-1} I \leq \mathbf{F}^{-1} \leq (L_2)^{-1} I$, that is to say, $\mathbf{F}^{-1}$ is also a frame operator. A sequence $\{y_t : t \in \Lambda\} \subseteq H$ is called a Bessel sequence if (only) the upper inequality of (2) holds. Supposing that only for all $h \in X \subset H$, the upper inequality of (2) holds, the sequence $\{y_t : t \in \Lambda\} \subseteq H$ is a Bessel sequence with respect to (w.r.t.) H . If the family $\{y_t\}$ is a frame, there exist a dual frame $\{y_t^*\}$ such that

$$\forall h \in U, \quad h = \sum_t \langle h, y_t \rangle y_t^* = \sum_t \langle h, y_t^* \rangle y_t. \quad (3)$$

Definition 1. A Bessel sequence $\{y_t : t \in \Lambda\} \subset H$ is a Plancherel frame for subspace $U \subset H$, if for all $u \in U$, it follows that $u = \sum_{t \in \Lambda} \langle u, y_t \rangle y_t$.

The Fourier transform of an integrable function $\Gamma(x) \in L^1(R^2) \cap L^2(R^2)$ is defined by

$$\mathcal{F}\Gamma(\omega) = \hat{\Gamma}(\omega) = \int_{R^2} \Gamma(x) e^{-2\pi i x \omega} dx, \quad \omega \in R^2, \quad (4)$$

which, as usual, can be naturally extended to functions in $L^2(R^2)$. For a sequence $c = \{c(v)\}_{v \in Z^2}$, $\in \ell^2(Z^2)$, we define its discrete-time Fourier transform as the function in $L^2(0,1)^2$ by

$$\mathcal{F}c(\omega) = C(\omega) = \sum_{v \in Z^2} c(v) e^{-2\pi i x \omega} dx, \quad (5)$$

Note that the discrete-time Fourier transform is 1-periodic. Let $T_k \Upsilon(x)$ stand for integer translates of a function $\Upsilon(x) \in L^2(R^2)$, i.e., $T_k \Upsilon(x) = \Upsilon(x - k)$, where $k \in Z^2$, and $\Upsilon_{n,k}(x) = a^n \Upsilon(a^n x - k)$, where $2 \leq a \in Z$ is a constant. Let $V_0 = \overline{\text{span}}\{T_v \Upsilon : v \in Z^2, \Upsilon(x) \in L^2(R^2)\}$ be a closed subspace of space $L^2(R^2)$.

Assume that $\mathcal{H}(\omega) := \sum_{v \in Z^2} |\hat{h}(\omega + v)|^2 \in L^\infty[0,1]^2$. In [5], the sequence $\{T_v \hat{h}(x)\}_v$ is a frame for V_0 if and only if there exist positive constants C_1 and C_2 such that

$$C_1 \leq H(\omega) \leq C_2, \text{ a.e., } \omega \in [0,1]^2 \setminus \mathbb{N} = \{\omega \in [0,1]^2 : H(\omega) = 0\}. \quad (6)$$

2 The Notion of Binary Generalized Multiresolution Structure

In the following, we consider the case of generators, which yield affine pseudoframes of integer grid translates for subspaces of $L^2(R^2)$. Let $\{T_v \hat{\lambda}(x)\}$ and $\{T_v \tilde{\lambda}(x)\}$ ($v \in Z^2$) be two sequences $L^2(R^2)$. Let Ω be a closed subspace of $L^2(R^2)$. We say that $\{T_v \hat{\lambda}(x)\}$ forms a pseudoframe for the subspace Ω with respect to (w.r.t.) $\{T_v \tilde{\lambda}(x)\}$ ($v \in Z^2$) if

$$\forall \Upsilon(x) \in \Omega, \quad \Upsilon(x) = \sum_{v \in Z^2} \langle \Upsilon, T_v \hat{\lambda} \rangle T_v \tilde{\lambda}(x). \quad (7)$$

It is important to note that $\hat{\lambda}$ and $\tilde{\lambda}$ need not be contained in Ω . Consequently, the positions of $T_v \hat{\lambda}$ and $T_v \tilde{\lambda}$ are not generally commutable [5], i.e., there exists

$\Gamma(x) \in \Omega$ such that

$$\sum_{v \in \mathbb{Z}^2} \langle \Gamma, T_v \tilde{\lambda} \rangle T_v \tilde{\lambda}(x) \neq \sum_{v \in \mathbb{Z}^2} \langle \Gamma, T_v \tilde{\lambda} \rangle T_v \lambda(x) = \Gamma(x). \quad (8)$$

Proposition 1[6]. Let $\tilde{\lambda}(x) \in L^2(R^2)$ satisfy $|\hat{\tilde{\lambda}}|$ a.e. on a connected neighbourhood of 0 in $[-\frac{1}{2}, \frac{1}{2}]^2$, and $|\hat{\tilde{\lambda}}| = 0$ a.e. otherwise. Define

$\Delta \equiv \{\omega \in R^2 : |\hat{\tilde{\lambda}}(\omega)| \geq C > 0\}$, and $V_0 = PW_\Delta = \{\phi \in L^2(R^2) : \text{supp}(\hat{\phi}) \subseteq \Delta\}$. Then for $\tilde{\lambda} \in L^2(R^2)$, $\{T_v \tilde{\lambda}, v \in \mathbb{Z}^2\}$ is an affine pseudoframe for V_0 with respect to $\{T_v \tilde{\lambda}, v \in \mathbb{Z}^2\}$ if and only if

$$\overline{\hat{\tilde{\lambda}}(\omega)} \hat{\tilde{\lambda}}(\omega) \chi_\Delta(\omega) = \chi_\Delta(\omega) \quad \text{a.e.}, \quad (9)$$

where χ_Δ is the characteristic function on Δ . Moreover, if $\tilde{\lambda}(\omega)$ is the above conditions then $\{T_v \tilde{\lambda}, v \in \mathbb{Z}^2\}$ and $\{T_v \tilde{\lambda}, v \in \mathbb{Z}^2\}$ are a pair of commutative affine pseudoframes for V_0 , i.e., $\forall h \in V_0$,

$$h(x) = \sum_{k \in \mathbb{Z}^2} \langle h, T_k \tilde{\lambda} \rangle T_k \tilde{\lambda}(x) = \sum_{k \in \mathbb{Z}^2} \langle h, T_k \tilde{\lambda} \rangle T_k \tilde{\lambda}(x). \quad (10)$$

The filter banks associated with a GMS are presented as follows. Define filter functions $B_0(\omega)$ and $\tilde{B}_0(\omega)$ by $B_0(\omega) = \sum_{v \in \mathbb{Z}} b_0(v) e^{-2\pi i \omega v}$ and $\tilde{B}_0(\omega) = \sum_{v \in \mathbb{Z}} \tilde{b}_0(v) e^{-2\pi i \omega v}$ of the two sequences $d_0 = \{d_0(v)\}$ and $\tilde{d}_0 = \{\tilde{d}_0(v)\}$, respectively, wherever the sum is defined. Let $\{d_0(v)\}$ be such that $B_0(0) = a$ and $B_0(\omega) \neq 0$ in a neighborhood of 0. Assume also that $|B_0(\omega)| \leq a$. Then there exists a refinable function $\tilde{\lambda}(x) \in L^2(R^2)$ (see ref.[8]) such that

$$\tilde{\lambda}(x) = a \sum_{v \in \mathbb{Z}^2} d_0(v) \tilde{\lambda}(ax - v), \quad \text{in } L^2(R^2) \quad (11)$$

$$\tilde{\tilde{\lambda}}(x) = a \sum_{v \in \mathbb{Z}^2} \tilde{d}_0(v) \tilde{\tilde{\lambda}}(ax - v), \quad \text{in } L^2(R^2). \quad (12)$$

Construction of Affine Frames for $L^2(R^2)$

Definition 2. Let $\{V_n, \tilde{\lambda}(x), \tilde{\tilde{\lambda}}(x)\}$ be a given BGMS, and let $Y_l(x)$ and $\tilde{Y}_l(x)$ ($l \in I$) be $a-1$ band-pass functions in $L^2(R^2)$. We say $\{T_v \tilde{\lambda}(x), T_v \tilde{Y}_l(x), l \in I\}$ forms an affine pseudoframe for V_1 with respect to $\{T_v \tilde{\tilde{\lambda}}(x), T_v \tilde{\tilde{Y}}_l(x), l \in I\}$, if

$$\forall \Phi \in V_1, \quad \Phi = \sum_{v \in \mathbb{Z}^2} \langle \Phi, T_v \tilde{\lambda} \rangle T_v \tilde{\lambda} + \sum_{l \in I} \sum_{v \in \mathbb{Z}^2} \langle \Phi, T_v \tilde{\gamma}_l \rangle T_v \tilde{\gamma}_l, \quad (13)$$

where $I = \{1, 2, \dots, a-1\}$. Let $\chi_\Delta(\omega)$ be the characteristic function of the interval Λ defined in Proposition 1. We shall use the following 1-periodic function. $\Gamma_\Delta(\omega) \equiv \sum_k \chi_\Delta(\omega + k)$. Accordingly, $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, l \in I\}$ is called a dual affine pseudoframe to $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, l \in I\}$ in the sense of (13). To characterize the condition for which $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, l \in I\}$ forms an affine pseudoframe for V_1 with respect to $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, l \in I\}$, we begin with developing the wavelet equations associated with band-pass functions $\gamma_l (l \in 1, 2)$ and $\tilde{\gamma}_l (l \in I)$ based on a GMS, namely,

$$\gamma_l(x) = a \sum_{v \in \mathbb{Z}^2} b_l \tilde{\lambda}(ax - v), \quad l \in I \text{ in } L^2(\mathbb{R}^2) \quad (14)$$

$$\tilde{\gamma}_l(x) = a \sum_{v \in \mathbb{Z}^2} \tilde{b}_l \tilde{\lambda}(ax - v), \quad l \in I \text{ in } L^2(\mathbb{R}^2). \quad (15)$$

Theorem 1[8]. Let Δ be the bandwidth of the subspace V_0 defined in Proposition 1. $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, v \in \mathbb{Z}, l \in I\}$ forms an affine pseudoframe for V_1 with respect to $\{T_v \tilde{\lambda}, T_v \tilde{\gamma}_l, l \in I\}$ if and only if there exist D_0 and $D_l, (l \in I)$ in $L^2([0, 1]^2)$ such that

$$\sum_{l=0}^{a-1} D_l(\omega + \sigma/a) \overline{\tilde{B}_l(\omega + \sigma/a)} \Gamma_\Delta(\omega) = 3\Gamma_\Delta(\omega), \quad \sigma \in I. \quad (16)$$

Definition 3. Let $\{V_\ell, f, \tilde{f}\}$ be a given GMS. We say that the GMS has a pyramid decomposition scheme if there are band-pass functions $\gamma_l, \tilde{\gamma}_l \in L^2(\mathbb{R}^2), l \in I$ such that

$$\begin{aligned} \forall \Phi(x) \in L^2(\mathbb{R}), \\ \sum_{v \in \mathbb{Z}} \langle \Phi, \tilde{f}_{1,va} \rangle f_{1,va} = \sum_{v \in \mathbb{Z}} \langle \Phi, T_{va} \tilde{f} \rangle T_{va} f + \sum_{l \in I} \sum_{v \in \mathbb{Z}} \langle \Phi, T_{va} \tilde{\gamma}_l \rangle T_{va} \gamma_l. \end{aligned} \quad (17)$$

Theorem 2[6]. Let $\{V_n, f, \tilde{f}\}$ be a given GMS. Assume that integer translates of each $f, \tilde{f}, \gamma_l, \tilde{\gamma}_l$ are all Bessel seq. in $L^2(\mathbb{R}^2)$, denoting $\underline{H}(\omega) = \sum_{v \in \mathbb{Z}^2} |f(\omega + v)|^2$. Then (17) holds if and only if

$$\sum_{l=0}^{a-1} B_l(\omega + \sigma/a) \overline{\tilde{B}_l(\omega + \sigma/a)} \underline{H}(\omega) = a \underline{H}(\omega), \quad \sigma \in I., \text{ a.e.} \quad (18)$$

Corollary 1. Let $\{V_n, f, \tilde{f}\}$ be a given GMS. Assume that functions $f, \tilde{f}, \Upsilon_l$ and $\tilde{\Upsilon}_l, l \in L$ in space $L^2(R^2)$ are such that (26) holds. Then for any integers n and s with $n < s$, we have

$$\forall \Phi(x) \in V_s, \quad \Phi(x) = \sum_v \langle \Phi, \tilde{f}_{n,v} \rangle f_{n,v}(x) + \sum_{l \in L} \sum_{\sigma=n}^{s-1} \sum_v \langle \Phi, \tilde{\Upsilon}_{l:\sigma,v} \rangle \Upsilon_{l:\sigma,v}(x). \quad (19)$$

Corollary 2. Let $\tilde{\lambda}(x), \tilde{\lambda}(x), \Upsilon_l(x), \tilde{\Upsilon}_l(x), l \in L$ are functions in $L^2(R^2)$. Assume that conditions in Theorem 2 are satisfied. Then, for all functions $\Phi(x) \in L^2(R^2)$, and any integer σ ,

$$\sum_v \langle \Phi, \tilde{\lambda}_{\sigma,v} \rangle \tilde{\lambda}_{\sigma,v} = \sum_{l=1}^{a-1} \sum_{n=-\infty}^{\sigma-1} \sum_{v \in Z^2} \langle \Phi, \tilde{\Upsilon}_{l:n,v} \rangle \Upsilon_{l:n,v} \quad \text{in } L^2(R^2) \quad (20)$$

$$\forall \Phi \in L^2(R). \quad \Phi = \sum_{l=1}^{a-1} \sum_{n=-\infty}^{\infty} \sum_{v \in Z^2} \langle \Phi, \tilde{\Upsilon}_{l:n,v} \rangle \Upsilon_{l:n,v} \quad \text{in } L^2(R^2) \quad (21)$$

So, if $\{\Upsilon_{l:n,v}\}_{v \in Z^2}$ and $\{\tilde{\Upsilon}_{l:n,v}\}_{v \in Z^2}$ are Bessel sequences, then they are a pair of affine frames.

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The Research of Security Technology in the Internet of Things

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Abstract. A security hierarchy structure of Internet of Things (IOT) was proposed, which is consisted of a sensation layer, a network layer and an application layer. From the three different layers, the security issues faced with the IOT and then the security requirements of it were analyzed. Through combining the security technologies of Internet, sensor networks and other mature security technologies, we can develop some appropriate defensive measures to ensure the security of the IOT, including the security of sensor nodes, privacy protection, intrusion detection, authentication and access control, thus achieving its safe, reliable and efficient operation.

Keywords: Internet of things, security technology, hierarchy structure, defensive measures.

0 Introduction

"The concept of Internet of things (IOT)" is the concept of a network based on "the concept of Internet", which extends and expands the client to any objects and makes the exchange of information and communication between the objects [1]. Therefore, the definition of the IOT is that it is a network that the radio frequency identification (RFID), infrared sensors, global positioning systems, laser scanners and other information sensing equipments, as agreed in the protocols and any objects connected to the Internet, exchange information and communicate with each other to realize the intelligent identification, location, tracking, monitoring and management of the objects. Accordingly, the key technologies of the IOT include RFID, infrared sensors, global positioning systems, sensor network technology, cloud computing and so on, which is widely used in intelligent transportation, environmental protection, government, public safety, safe home, industrial monitoring, environmental monitoring, personal health, enemy situation detecting and other fields.

It is clear that the IOT ("Internet of Things") covers all the things in the world, and is the combination of heterogeneous multi-networks. The IOT has the same security issues with the sensor network and Internet, and for some of its special nature, its research work is mainly focused on security in the process of its development. This paper discusses the security requirements and possible attacks in the IOT, and then

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presents the corresponding defensive measures, which are helpful to analyze and solve the security problems existing in the IOT.

1 Security Hierarchy Structure

The core structure of the IOT can be divided into three layers: sensation layer, network layer, and application layer. The sensation layer is mainly to identify the object and collect all kinds of information, such as smart cards, RFID electronic tags, sensor networks and so on; the network layer is responsible to transmit and process information obtained from the sensation layer, such as computers of the three networks convergence, Internet, wireless network and so on; the application layer is responsible for the analysis of information processing, control decision, so as to achieve its intelligent application and cover all the things in the world. The security hierarchy structure of the IOT is shown in Fig.1. It shows that different security technologies can be adopted in different layers.

Because the sensation layer is extremely vulnerable to suffer security attacks, it mainly uses attack detection and intrusion response techniques to resist illegal attacks effectively; the network layer mainly aims at security technologies of the network environment, such as wireless network security, secure routing and so on, to realize safe network interconnection; the application layer ensures the security of application system through user authentication and access control [2].

application layer security	Authentication, access control, security audit, etc.
network layer security	Wireless network security, secure routing, firewall, content analysis, etc.
sensation layer security	Attack detection, intrusion response, cryptography, virus control, etc.

Fig. 1. Security hierarchy structure of the IOT

2 Security Requirements

The IOT is the new system that virtual network interacts with the real world, taking sensor networks and the Internet as the core technology, as well as its ubiquitous data-aware features and wireless transmission of information, making the IOT to meet security requirements of the sensor network and Internet, while satisfying the security requirements for its own characteristics to ensure its safe and reliable operation.

2.1 Data Confidentiality

Data confidentiality is the most important network security requirement, and is still the primary issue to be resolved in the IOT. This requires data confidentiality in the transmission process.

2.1.1 Guarantee the Sensitive Sensation Information Not Be Leaked

The information privacy is the direct manifestation of the IOT information confidentiality, and the sensitive data from network cannot be leaked to unauthorized users.

2.1.2 Guarantee the Sensitive Protocol Information Not Be Leaked

In the network, the sensitive sensation information needs to be protected in the communication transmission, and the interactive sensitive information also cannot be revealed in the communication protocol.

2.2 Data Integrity

In the communication process, data integrity can ensure that the data which receiver receives has not been tampered or replaced by the attacker during the transmission. Data confidentiality cannot guarantee that the data not be tampered, intercepted or interfered by a malicious attacker in the information transmission process. Then, we need data integrity to ensure that data not be changed during the transmission. We can use message authentication code to achieve data integrity [3].

2.3 Data Freshness

Data freshness refers that the data is the latest data in the recent time, which is passed from senders to receivers. The main purpose to ensure data freshness is to prevent relay attacks.

2.4 Availability

The security solutions of the IOT provide a variety of services that can be used by authorized users, and can effectively prevent the illegal attacker from attempting to interrupt the service of the IOT. Availability requires the IOT work at a pre-set to provide access to information services for the system's legitimate users, but the attacker can make the IOT be at a part or completely paralyzed through forging and signal interference and other things.

2.5 Authentication

Node authentication or data source authentication is very important in many applications of the IOT. In the IOT, an attacker easily injects messages to the network, while the receiver can only be convinced that message is sent from the correct node through the data source authentication. The source authentication requests the sender's identity authentication and message authentication, meaning that any network data packet can find the source through the authentication and trace, and is undeniable. Authentication can ensure the accuracy of the transmission data and messages.

2.6 Extensibility

The IOT has a great number of nodes and wide distribution, while environmental conditions, malicious attacks or changes of tasks may affect the configuration of the IOT. Meanwhile, the nodes which often join or exit cause the network topology to change unceasingly. Therefore, its extensibility displays in the number of nodes, network coverage, life cycle, time delay, sensation precision, whose limit can be extended, and security solution scheme must provide security mechanisms and algorithms that support this extensibility to make the network maintain good working condition.

3 Possible Attacks

The IOT is vulnerable to various attacks like the other traditional networks, and there are a lot of special security issues in it. Some attacks may be encountered at all layers of the IOT are introduced in the following.

3.1 Local Security of Sensation Nodes

It uses a large amount of sensor nodes to replace people to complete complex, dangerous and mechanical work in the IOT, so most of these nodes are arranged in unattended environment, then an attacker can easily access to these devices, thus creates damage or illegal manipulation to these devices or the sensor nodes, even replaces machine's software and hardware through local operation [4].

3.2 Denial of Service Attacks

The sensation layer of the IOT uses the sensor network, then any attack which can weaken or destroy the normal work of sensor network will damage the whole of the IOT, and there is a large number of nodes which exist in groups, so the massive node's data transmission demand will cause network congestion and result in denial of service attacks, when the data transmit. The DoS attacks to sensor network include exhaustion, collision, neglect and greed, flooding attacks and so on, any kind of which directly affect the availability of the IOT.

3.3 The Sybil Attack

The IOT is a heterogeneous multi-network, so it is vulnerable to the Sybil attack. In the Sybil attack, the single node taking on multiple false identities appears in the front of other nodes through forging identity or stealing legitimate node identity, making it easier to become a node in the routing path to attract the data stream to improve probability that the target data stream passes through these nodes. The Sybil attack has strong destructiveness to the network.

3.4 Malicious Data Attacks

Malicious data attacks is through sending malicious data to some program or application to produce the unexpected result attack, which provide access to the target

system privileges for the attackers. Data-driven attacks divide into the buffer overflow attack, the format string attack, the input validation attack, the synchronized crack attack, the trust crack attack and so on, and it is very easy to implement the buffer overflow attack to the convergent node in the sensor network.

3.5 Malicious Code Attacks

There are infinitely many entrances in the wireless network environment and the sensor network environment for vicious procedures. Once invaded successfully, and then it becomes very easy to spread through network. Its transmissibility, concealment, destruction, etc. compared to the TCP/IP network, is more difficult to prevent, like worm malicious code, which has no parasitic file by itself, and it will be difficult to detect and eliminate such malicious codes in such an environment.

3.6 Application Layer Security

The application layer of the IOT is faced with all security issues existing in the TCP/IP network, meanwhile, because the data format is diverse which IOT collects from sensation layer, the data from a variety of sensation nodes is massive, and it is the multi-source heterogeneous data, and then bring the network security issues which will be more complicated.

4 Defensive Measures

The security issues in the IOT which proposed in view of above, the following will give some corresponding defensive measures to ensure the IOT to achieve safe operation.

4.1 Encryption Mechanism

Data encryption can ensure data not to be obtained its sensitive information by the attacker in the transmission process, and can prevent the attacker from eavesdropping and interference, which requires a valid key exchange and management schemes, but as a result of its own restrictions of sensation node, key management scheme must be easily deployed and suits the characteristics of limited resources for sensation node, and ensure that the security of the entire network will not be destroyed when some nodes are manipulated. Implementations in key management, we can use symmetric key cryptography and asymmetric key cryptography. The typical solutions based on symmetric key management are DES, RC5, SPINS protocol, pre-distribution scheme based on the key pool, key space random key pre-distribution scheme and so on. Compared with asymmetric key cryptography, computational complexity of symmetric key cryptography is lower, but there is deficiency in the key exchange and management, especially under the IOT environment, there are some problems to achieve integration of key management system with other networks. Therefore, asymmetric encryption technology is also commonly used in the key management, and then common methods are RSA algorithm and elliptic curve cryptography (ECC) and so on. Compared to RSA algorithm, elliptic curve cryptography (ECC) has small

key length, high safety performance, and the entire time-consuming of digital signature is small, so its value is higher.

4.2 Secure Routing

In the sensation layer and network layer of the IOT, many routing protocols are vulnerable, so we need a secure routing algorithm to resist attacks and enhance network security. In wireless sensor networks, common methods to resist routing attacks are:

(1) Using security routing algorithm TRANS protocol. TRANS is a security mechanism based on geographic routing protocol to isolate malicious nodes and build trust routing to provide an architecture taking the location as the center for wireless sensor networks.

(2) Adding Intrusion Tolerant Strategy in routing to improve the security of the IOT.

(3) Using multi-path routing selective method against selective forwarding attacks. Using multi-path routing selection that allows nodes to dynamically choose next hop point of a packet, and can further reduce the plan that intruders control the data stream, and then provide protection [5].

4.3 Authentication Mechanism

Authentication of the IOT mainly includes identity authentication and message authentication. Authentication mechanism is that the data communication receiver can confirm the true identity of the data sender, and whether the data has been tampered in the transmission process. From the IOT architecture, authentication mechanism of the sensation and network layers are very necessary.

4.4 Access Control

Access control has been given a new meaning under the IOT environment, in the TCP/IP network, which mainly gives “the human” access authorization turning into the machine authorization, restrictedly distributes and interacts sharing data, and will become more complex between machines. In the context of the IOT, access control mechanisms based on the role that applies in the traditional network become less flexible to control resources of the sensation layer, showing the limitation of its application.

5 Conclusions

After presenting a security hierarchy structure of the IOT, we discussed its security requirements which are different from that of the traditional networks, and then analyzed the possible security threats faced with it. For the security issues faced with the IOT, we combined the security technologies of Internet, sensor networks and other more mature security technologies to give some appropriate defensive measures. This can help to form a comprehensive and efficient security system and satisfy the

security requirements of the sensation layer, network layer and application layer of the IOT.

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Novel Algorithms to Restrain Deviation When Synthesizing Adjustable Frequency Signal Using DDS

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Abstract. Direct digital synthesis technology (DDS) is applied widely in synthesizing adjustable frequency signal since it has characteristics such as high frequency resolution, fast frequency switching and continuous phase frequency and so on. According to the working principle of DDS, it is very important to calculate the frequency control word. Because there are shortcomings of large computation, low efficiency of frequency setting, more storage space occupied or significant cumulative errors of frequency setting when calculating frequency control word with usual methods, three novel algorithms for calculating frequency control word are developed in this paper. These new methods do not need large computation and more space and simultaneously, they can decrease the error greatly, which play an important role in improving the frequency setting speed and precision of signal generator.

Keywords: DDS, Frequency Control Word, Adjustable Frequency, Signal Source, Algorithm.

1 Introduction

With the development of science and technology, common waveform generator with single performance has become increasingly unable to meet the actual demand. Frequency synthesis technology is a very good method when realizing diverse waveform generators with complex performance. There are direct digital frequency synthesis (DDS), indirect frequency synthesis and direct analog frequency synthesis technology in frequency synthesis technology. In March, 1971, firstly raised by American researchers J.Tierney, C.M.Rader and B.Gold, DDS is a new all digital frequency synthesis way to synthesize directly waveform needed from phase concept. Compared to the traditional frequency synthesis technology, DDS has characteristics of high frequency resolution, fast frequency switching, continuous phase frequency, low phase noise, easy extensions and integration and easy implementation of diverse modulation of the output signal. Since DDS technology meets many requirements of modern electronic systems, it has wide applications [1-3].

2 DDS Working Principle and Characteristics

DDS Working Principle. The theory basis of direct digital synthesis is Nyquist sampling theorem[4]. According to the theorem, for continuous sine wave signal of a

cycle, we can sample it with equal phase intervals. Then discrete sequence of phase magnitude of a periodic sinusoidal signal shown in Fig.1(a) can be obtained. The magnitude is quantized and coded with bits. So, continuous sine wave signal of a cycle can be converted to a discrete binary sequence shown in Fig.1(b). All these binary bits are stored into a read-only memory and the address of each memory unit is the phase sample address. The content of each memory unit is the quantification of the amplitude of the sine wave. The process for the reverse process is that the amplitude values in memory unit are extracted in light of phase sample address, converted by D/A converter, filtered by low-pass filter and returned to the original analog sine wave signals. In terms of Nyquist sampling theorem, in this reverse process, it can be restored to its original waveform as long as more than two binary magnitude values are taken at the equal phase interval.

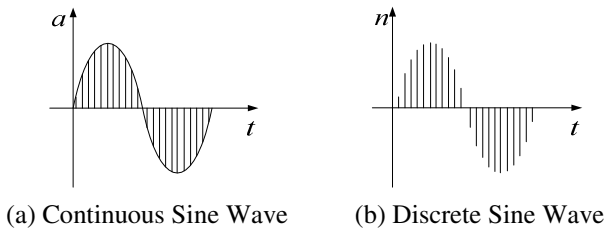


Fig. 1. Continuous and Discrete Sine Wave

DDS is the realization of the above reverse process. DDS circuit consists of clock, phase increment register, phase accumulator, waveform memory, D/A converter and low-pass filter [5-7]. The diagram of working principle of DDS is shown as Fig.2. Under the reference clock with certain frequency, the output frequency can be changed by changing the phase interval represented by each reference clock pulse (that is, frequency control word, M , shown in Fig.2.) The waveform memory usually is a read-only memory which is used to store the coded quantization value of arbitrary waveform amplitude and it can be waveform. The working process is as following. When the clock pulse arrives, the frequency control word will be added to the data stored in phase accumulator. And the output of phase accumulator is used as an addressing address of waveform memory after it is latched and the contents of this address unit is the amplitude of a waveform synthesis point. The amplitude value is converted by D/A converter and filtered by low-pass filter, and then the analog signal which meet requirement is obtained [8-10].

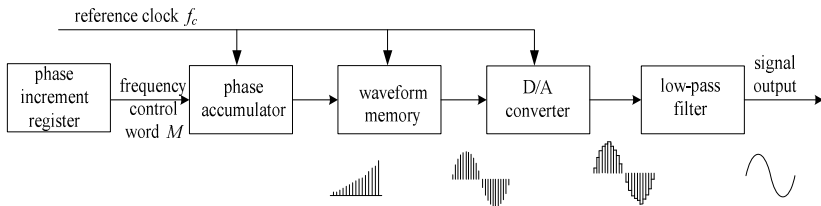


Fig. 2. The Diagram of Working Principle of DDS

If the reference clock frequency is f_c and the phase accumulator bit is N , the output frequency of DDS is $f_{out} = M \times f_c / 2^N$. Here, M is the frequency control word and its value is preset by the external control circuit. When the frequency of reference clock, f_c , and the number of phase accumulator bit, N , is certain, the output frequency, f_{out} , is decided by M [11]. So, the frequency control word M is $M = 2^N \times f_{out} / f_c$. When M is equal to 1, the lowest frequency of signal synthesized is $f_{out} = f_c / 2^N$ which is the frequency resolution of DDS. The highest output frequency is determined by Nyquist sampling theorem and it is $f_c / 2$ [12].

3 The Usual Algorithms of Calculating Frequency Control Word

When the reference clock frequency f_c is equal to 2fHz, the bit of phase accumulator is N , and the range of frequency output is $a\text{Hz} \sim f\text{Hz}$ and frequency resolution is $t\text{Hz}$, the calculation of frequency control word M is analyzed. Under the above condition, there are $(f-a)/t+1$ optional frequency output which are $a\text{Hz}, (a+t)\text{Hz}, (a+2t)\text{Hz}, \dots, (f-t)\text{Hz}, f\text{Hz}$. Taking $a=0.1\text{Hz}, f=1\text{MHz}, t=0.1\text{Hz}$ as an example, the range of frequency output is from 0.1Hz to 1MHz, which are 0.1Hz, 0.2Hz, ..., 999.9998KHz, 999.9999KHz, 1MHz and the total frequency point is about ten million. Here the least frequency also should be the integral times of frequency resolution t .

One of the Usual Algorithms to Compute the Frequency Control Word. At first, the value of frequency control word M written to phase increment register corresponding to $(f-a)/t+1$ frequencies is calculated by hand calculation. And $(f-a)/t+1$ numbers which are represented with N bits are stored into system memory. After the frequency setting value is accepted by the signal generator, the value chased down from $(f-a)/t+1$ numbers is written to phase increment register.

The advantage of this method is high setting frequency accuracy which can be up to frequency resolution of DDS chip $f_c / 2^N$. However, when the system is designed, the amount of data needed to compute is large, speed frequency setting is low and storage space required is more.

Another Usual Algorithm to Compute the Frequency Control Word. With above formula, the frequency control words are calculated by programming. At first, the frequency control word M_1 corresponding to $f_{out} = t\text{Hz}$ is computed, and then M_1 is truncated and M_1' is gotten. Then under a certain frequency, the value $M = B \times M_1'$ is written into the frequency register, where $B (=1, 2, 3, \dots)$ is the quotient of a certain frequency divided by $t\text{Hz}$ since t is the frequency resolution.

This algorithm has the advantages such as simple programming, small hand calculation working and little storage space. But there are accumulating error of setting frequency. With the frequency increasing, the absolute error of frequency Δ is increasing too and its value is $\Delta = (M_1 - M_1') \times B / M_1 \text{ Hz}$. For example, if $f_c = 2\text{MHz}$, $N = 28$, $t = 0.1\text{Hz}$ and the output frequency is 1KHz, the absolute error is about 31Hz. Such a large error in the instrument calibration applications is not allowed.

4 A New Algorithm to Compute the Frequency Control Word

The First New Algorithm to Compute the Frequency Control Word. To solve the problem of above methods, a new algorithm to compute the frequency control word is put forward. Under the circumstance of no reducing the setting speed of frequency, a lot of storage space is saved and the absolute error of setting frequency is decreased clearly with the new algorithm.

At first, we will calculate the values of frequency control word M truncated corresponding to the output frequency $M1\{t, 2t, \dots, 9t\text{Hz}\}, M2\{10t, 20t, \dots, 90t\text{Hz}\}, \dots, Mi\{10^{i-1} \times t, 10^{i-1} \times 2t, \dots, 10^{i-1} \times 9t\text{Hz}\}, \dots, Mq\{10^{q-1} \times t, 10^{q-1} \times 2t, \dots, 10^{q-1} \times 9t\}$ and write them into the phase increment register. Here, $q = \lceil \log_{10}^{f/t} \rceil$. And then all the values will be saved into q arrays such as $M1, M2, \dots, Mi, \dots, Mq$. We can get the value of frequency control word M corresponding to $x\text{Hz}$ frequency from three steps. Step1: calculate the multiple of x to t : $B=x/t$. Then the maximum of B is f/t (f is the largest output frequency). Step2: display B with an expression as $B=n_1+n_2 \times 10+n_3 \times 10^2+\dots+n_p \times 10^{i-1}+\dots+n_p \times 10^{p-1}$, $0 \leq n_i \leq 9$, $1 \leq i < p$, $n_p \neq 0$. Step3: When the setting frequency is $x\text{Hz}$, we can extract the value $M1[n_1]$ from $M1$, $M2[n_2]$ from $M2, \dots, Mi[n_i]$ from Mi , $\dots$, and $Mp[n_p]$ from Mp and then add all these value, which means that $M= M1[n_1]+ M2[n_2]+M3[n_3]+\dots Mi[n_i]+\dots Mp[n_p]$. Here, when $ni=0$, there is no data extracted from Mi .

Since each array is calculated by hands, the maximum error is 0.5 when getting each array values of frequency control word M truncated corresponding to setting frequency. At this time, the corresponding error is $\Delta \leq 0.5 \times f_c / 2^N = 0.5t/M_1 \text{ Hz}$. Therefore, the maximum absolute error of this algorithm is $q \times \Delta = 0.5 \times t \times q / M_1 \text{ Hz}$.

Summing up the above, we can get the advantages of this new algorithm as following. (1) The data stored into memory is small. There are only q groups, which means $9 \times q$ n -bit binary numbers. (2) The speed of frequency setting is much faster since the value is retrieved from only q groups instead of from $(f-a)/t+1$ numbers. (3) Since each array is calculated by hands, the maximum error is 0.5 when getting each array values of frequency control word M truncated corresponding to setting frequency. At this time, the corresponding error is $\Delta \leq 0.5 \times f_c / 2^N = 0.5t/M_1 \text{ Hz}$. Therefore, the maximum absolute error of this algorithm is $q \times \Delta = 0.5 \times t \times q / M_1 \text{ Hz}$.

The Second New Algorithm to Compute the Frequency Control Word. In order to reduce the absolute error of frequency phase, q array, $\Delta 1 \sim \Delta q$, can be used to store the rounding part of $M1 \sim Mq$ data. Then, we can extract the value $\Delta 1[n_1]$ from $\Delta 1$, $\Delta 2[n_2]$ from $\Delta 2, \dots, \Delta i[n_i]$ from Δi , $\dots$, and $\Delta p[n_p]$ from Δp and then add all these value, which means that $\Delta = \Delta 1[n_1] + \Delta 2[n_2] + \Delta 3[n_3] + \dots \Delta i[n_i] + \dots \Delta p[n_p]$. Then the result is rounded and is added to the result of step3, which is the data needed to write to the phase increment register.

Taking $a=0.1\text{Hz}$, $f=1\text{MHz}$, $t=0.1\text{Hz}$ as an example, when the setting output frequency x equals to 7893.4Hz , we can get the value of frequency control word M according to four steps. Step1: calculate the multiple of x to t : $B=x/t=7893.4/0.1=78934$. Step2: display B with an expression as $B=4+3 \times 10+9 \times 10^2+8 \times 10^3+7 \times 10^4$. Step3: extract the value $M1[4]$ from $M1$, $M2[3]$

from M2, M3[9] from M3, M4[8] from M4 and M5[7] from M7 and then add all these value. We can get that $M = M1[4] + M2[3] + M3[9] + M4[8] + M5[7]$. Step4: We can extract the value $\Delta 5[7]$ from $\Delta 5$, $\Delta 4[8]$ from $\Delta 4$, $\Delta 3[9]$ from $\Delta 3$, $\Delta 2[3]$ from $\Delta 2$ and $\Delta 1[4]$ from $\Delta 1$, and then add all these value, which means that $\Delta = \Delta 1[4] + \Delta 2[3] + \Delta 3[9] + \Delta 4[8] + \Delta 5[7]$. Then the result is rounded and is added to the result of step3. The sum is the frequency control word M which is needed to write to the phase increment register.

After the above processing, the accumulating error can be reduced further.

The Third New Algorithm to Compute the Frequency Control Word. There is also another algorithm to reduce the absolute deviation when computing the frequency control word M . At first, we will calculate the values of frequency control word M truncated corresponding to the output frequency $M1\{t, 2t, \dots, 9t\text{Hz}\}$, $M2\{10t, 20t, \dots, 90t\text{Hz}\}$, $M3\{100t, 200t, \dots, 900t\text{Hz}\}$, ..., $Mi\{10^{i-1} \times t, 10^{i-1} \times 2t, \dots, 10^{i-1} \times 9t\text{Hz}\}$, ..., $Mq\{10^{q-1} \times t, 10^{q-1} \times 2t, \dots, 10^{q-1} \times 9t\}$. And then the first $q-1$ groups data are multiplied by 10 and then stored into $q-1$ arrays such as $M1, M2, \dots, Mi, \dots, Mq-1$. The last group data is stored into the q th array Mq . We can get the value of frequency control word M corresponding to $x\text{Hz}$ frequency from four steps. Step1: calculate the multiple of x to t : $B = x/t$. Then the maximum of B is f/t (f is the largest output frequency). Step2: display B with an expression as $B = n_1 + n_2 \times 10 + n_3 \times 10^2 + \dots + n_i \times 10^{i-1} + \dots + n_p \times 10^{p-1}$, $0 \leq n_i \leq 9$, $1 \leq i < p$, $n_p \neq 0$. Step3: If $p-1 = q$, we can extract the value $M1[n_1]$ from $M1$, $M2[n_2]$ from $M2$, ..., $Mi[n_i]$ from Mi , ..., and $Mp[n_p]$ from Mp and then denote M as $M = (M1[n_1] + M2[n_2] + M3[n_3] + \dots + Mi[n_i] + \dots + Mp-1[n_{p-1}]) / 10 + Mp[n_p]$ when the setting frequency is $m\text{Hz}$. Here, when $n_i = 0$, there is no data extracted from Mi . And if $p-1 < q$, we can extract the value $M1[n_1]$ from $M1$, $M2[n_2]$ from $M2$, ..., $Mi[n_i]$ from Mi , ..., and $Mp[n_p]$ from Mp and then denote M as $M = (M1[n_1] + M2[n_2] + M3[n_3] + \dots + Mi[n_i] + \dots + Mp[n_p]) / 10$ when the setting frequency is $x\text{Hz}$. Here, when $n_i = 0$, there is no data extracted from Mi .

The advantages are that the absolute deviation can be decreased to $0.5f_c/2^N\text{Hz}$ or $\leq 2 \times 0.5f_c/2^N$ when the setting frequency range is from a to $f/10$ or from $f/10 \sim f$.

5 Conclusions

Direct digital synthesis technology is widely applied in various fields because of characteristics of high stability, wide frequency band and so on. According to the working principle of DDS, to address the disadvantages of large computation, low efficiency of frequency setting, more storage space occupied or significant cumulative errors of frequency setting when calculating frequency control word with usual methods, three new algorithms of calculating frequency control word are developed in this paper. These new algorithms do not need large computation and more space and simultaneously, error can be decreased greatly and the frequency setting speed and precision are improved clearly too. The algorithms can be employed in synthesizing adjustable frequency signal generators when adopting DDS technology.

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Flexible Collaborative Learning Model in E-Learning with Personalized Teaching Materials

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Abstract. Personalized learning system can provide better service for learners in e-learning. The flexible collaborative learning model is proposed with personalized teaching materials, learning strategies and grouping according to learner characteristics. The formal description of learner model is given, flexible collaborative learning model is designed, and the algorithm of flexible collaborative grouping and flexible collaborative strategies is generated.

Keywords: e-learning, teaching materials, learner model, flexible collaborative learning model.

1 Introduction

With the rapid development of information technology, the personalized learning system is already a hotspot in e-learning and intelligent education. One of e-learning's aims is how to provide better personalized service and teaching materials for learners. If learners learn with the same model, it can not satisfy the learner with his personalized need. But if the learner model makes initial estimations of the new learner's knowledge level and his personalized characteristics before his study, the problem of personalized need will be solved. So the research of learner model is the primary problem in e-learning.

At present, several generic e-learning norms such as the AGR (AICC Guidelines and Recommendations), SCORM (The Sharable Content Object Reference Model) and IMS (Instructional Management Systems) are committed to solve the two major issues of learning resources sharing and interoperability, and have achieved satisfactory results. [1]. In terms of learner model, typically included vector model, overlay model and fault model.[2] In vector model, Learner's knowledge was modeled in a vector consisted of concepts or topics or subjects. Each element in the vector shows the degree which learner gains knowledge about those concepts, topics or subjects.[3] In overlay model. Learner's knowledge is the subset of expertise's knowledge. Each element in overlay model is the number which presents learner's knowledge level. [4] Fault model can contain learner's errors and the reasons of the errors. [5] The drawback of vector model overlay model and fault model is that it can not describe the lack of learner's knowledge. Then, it is poor that the research results of

collaborative learning model according to the learner characteristics. So the flexible collaborative model is proposed for the learner's personalized learning in e-learning.

The paper is organized as follow: In section 2 Definition of Learner Model is introduced. In section 3 details about the flexible collaborative Learning Model included the algorithm of flexible collaborative grouping and mining flexible collaborative Strategies is presented. Finally, the summary is proposed.

2 Formal Description of Learner Model

A learner model is defined as “a representation of the learning system's beliefs about the learner”. Accord to the analysis results of learner model in flexible learning system, It include Learner Profile, Knowledge Level, Cognitive Ability, Learning Style and Learner Motivation. They respectively defined as follows:

Learner model := { Learner Profile, Knowledge Level, Cognitive Ability, Learning Style, Learner Motivation }

Learner Profile. Learner profile provides learners the basic characteristics in order to distinguish the different learners and their professional background. Learner Profile is defined as follows:

Learner Profile := { StuNo, Name, Gender, Age, Nation, Major, Email }

Learner Profile information is static information, in the whole learning process will not change.

Knowledge Level. Before learners begin to learn, the system offers a pre-test paper according to the teaching materials which can evaluate the learner's present knowledge level. The result of pre-test is the grade of learner's knowledge level. The Knowledge Level is defined as follows:

Knowledge Level := { 1 low level, 2 medium leves, 3 high levels }

Learner's knowledge level is dynamic, so the set of the learner in different knowledge level is divided into three levels: low, medium, and high, respectively represented with 1, 2 and 3.

Cognitive Ability. In accordance with Bloom's “Taxonomy of educational objective” theory in this system. Every learner's cognitive ability corresponds to a vector which has six dimensions:

Cognitive Ability := { Know, Understand, Apply, Analyze, Synthesize, Evaluate }

Learning Style. Learning styles are various approaches of learning. They involve educating methods, particular to an individual that are presumed to allow that individual to learn best. It is defined as follows:

Learning Styles := { active vs. reflective, sensing vs. intuitive, visual vs. verbal, sequential vs. global. }

Learner Motivation. Keller (1979, 1983) has developed a four-factor theory to explain motivation. The four-factor is attention (A), relevance (R), confidence (C), and satisfaction (S). It is defined as follows:

Learner Motivation := { Attention, Relevance, Confidence, Satisfaction }

Attention := { 0 Additional support/Low attention, 1 a bit additional support/in attention ,

2 No additional support/Higher attention }

Relevance := { 0 Additional support/Low relevance, 1 a bit additional support/in relevance ,

2 No additional support/Higher relevance }

Confidence: = { 0 Additional support/Low confidence, 1 a bit additional support/in confidence , 2 No additional support/Higher confidence }

Satisfaction := { 0 Additional support/Low satisfaction, 1 a bit additional support/in satisfaction , 2 No additional support/Higher satisfaction }

3 Flexible Collaborative Learning Model

According to the learner's learning needs, learning ability and learning style, the system actively adjusts the teaching materials, learning strategy and learning paths making the teaching materials suited to the learner's ability, and the provided guidance suited to the learning strategies. The flexible collaborative learning model is shown in Figure 1.

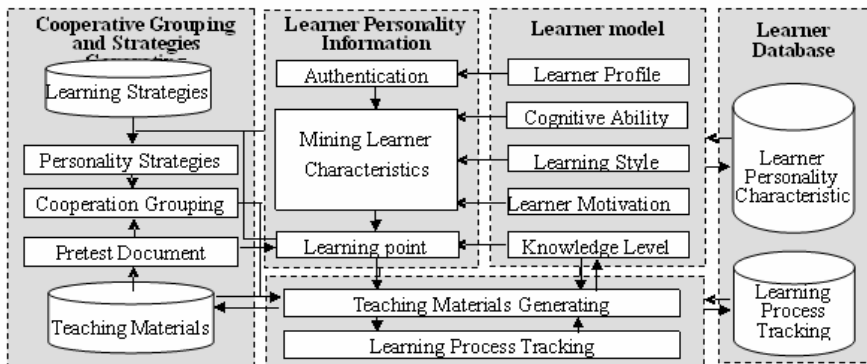


Fig. 1. Flexible Collaborative Learning Model

Learners actively interact with flexible learning system, constantly obtain, analyze and feedback information, so as to construct their knowledge. By the flexible learning system recording of the learning process, learners can timely control and adjust their own learning process to achieve optimized learning objectives suitable to them. The flexible learning system is intelligent. Intelligence is the basic guarantee for the

system to realize self-adaptation. It enables the system make comprehensive and scenically diagnose of the learner's actual level and psychological conditions, present suited teaching materials and learning support according to the presetting and learning process tracking.

Algorithm of Flexible Collaborative Grouping. In e-learning, the number of the learners with the same learning objectives is very numerous, in order to speed up the group, The function of random () is to randomly grouped for learners, so that the number of learners is equal within every groups, and then every groups use the greedy algorithm to group again.

The A represents the array of learners. A [i] represents the learner i. N is the total number of learners in every groups, and $T_{\max}$ is the maximum number in the next grouping. The algorithm is as follows: (1) Creating an empty group, the learner A [1] is joined the group. (2)The learner A [2] as initiation, then, from the existence of a group of learners' last start has been added to determine whether to join the learners and their conditions: a similar level of knowledge and cognitive ability, and complementary learning styles: ① If the conditions are satisfied, judge the number of the learner will join is less than $T_{\max}$, If less than, the learner is to join the group. If more than, the group saved, and then be removed from the group sequence. The learner will compared with the other learner of the last to join in the next group, then judge the conditions and the group is less than, so as to determine whether the learner access to the group, if the learners still can not access to the group, Others groups will be judged .if such a group does not exist, create a new group, the group placed there after all and the learners into the new group.②If the conditions are not satisfied, according to the order,judged the relationship with the learner joined at last in the 2,3 ..., M (M <N) groups, taking the ① or ②algorithm according to the condition. (3) Return to (2), until all learners are in group.

Algorithm of Mining Flexible Collaborative Strategies. Collaborative Learning Strategies := { Competition, debate, collaborative, problem solving, partnerships, designs, role playing}.In this paper, the algorithm of the learning strategies is identified as following :(1) With learner characteristics, learning strategies will be determined whether it is appropriate with teaching materials. If it is, the strategy will be stored in the array: mode [].(2) In the learning strategies u_i in teaching materials, do the following:(a) With the characteristics of teaching materials, the role P_q ($q=1,2,\dots,m$) is obtained in the learning strategies($q = 1,2, \dots m$).(b) According to the role P_q , calculate the coupling degree B, witch each of the learners l_i ($i = 1, 2 \dots T_{\max}$)in the group and the role p_q , then the learner with the minimum coupling degree B is selected.(c) If the learner obtain the same minimum B on different roles, The Random () function would be used to choose a role for the learner.(d) For the role that the learner give up, the learner with the second small coupling degree will is selected. If the different roles in the same learner make the second small coupling degree, the method in (c) will be used. Then successively cycles (d), until a learner has only one role so far. (e) The sum B' of coupling degrees B in all roles with all learners is

obtained. (3) Compare with every B' in every learning strategies, if M is the minimum under the strategies, the contents of learning strategies with M .

4 Summary

The flexible collaborative learning model is proposed with personalized teaching materials, learning strategies and grouping according to personality characteristics. According to the formal description of learner model in flexible learning system, then especially analyze the building of flexible collaborative model, and the algorithm of flexible collaborative grouping, flexible collaborative strategies, learning model and teaching materials are proposed.

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Selection of Suppliers in Fuzzy Environment with Stock-Out Allowed and Its Heuristic Algorithm for Solution

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Abstract. On the premise of time restriction and allowable stock-out, fuzzy parameters of suppliers' supply capacity and demand capacity of manufacturers are considered, and a satisfactory selection scheme of suppliers is discussed in this study for the determination of the suppliers involved and the quantity of their materials in order to minimize the total cost. A fuzzy planning model of single material demand is proposed concerning this issue, and fuzzy supply quantity and fuzzy demand quantity are converted to mean area used in heuristic algorithm for solution.

Keywords: vendor selection, fuzzy parameter, mean area, heuristic algorithm.

1 Introduction

Supplier management is a very significant issue in supply chain decision-making, and the evaluation and selection of suppliers is an integral part of supplier management. The development of modern enterprises results in the complexity of supply-demand relationship between enterprises and material suppliers. Due to demand disparity at different time during the production cycle of a specific product, a single supplier is unable to satisfy all the material demand during the entire production cycle, thus the need for corporation with other suppliers is required. Dickson was among the first researchers on this topic whose influence is the greatest [1], followed by a series of researches conducted by a large number of experts on supply chain management. By summarizing all these research methods, qualitative method, quantitative method and the combined method of them are most frequently used, such as factor analysis method, analytical hierarchy process (AHP) method and optimization method. In Reference [2] and [3], time restriction is taken into account, but only on the premise of non-allowable stock-out, and the selection of suppliers with minimum inventory cost and the smallest number of suppliers is discussed; in Reference [4], the selection of suppliers with minimum inventory cost under time restriction is investigated. However, all these literatures focus on the issue of selection of suppliers in definite environment. However, many uncertain factors exist in real life. In order to obtain maximum profit, enterprises have to make decisions in an uncertain environment. The development of modern operational research method tends to process fuzzy and

uncertain information, and the commonly-used methods for uncertain information processing include fuzzy mathematics [5-7], stochastic mathematics and interval mathematics. In this study, the vendor selection problem under uncertain environment with time restriction and stock-out allowed is discussed.

2 Problem Description and Modeling

Secondary supply chain consisting of n suppliers and one manufacturer, the demand quantity of manufacturer B for a specific material at T_j moment is a fuzzy parameter $\tilde{y}_j$ ($j = 1, 2, \dots, h$). Supposing that n suppliers are $A_1, A_2, \dots, A_n$, and the material quantity provided by supplier A_i at t_i moment (t_i is the promised moment of A_i) to manufacturer B is the fuzzy parameter $\tilde{X}_i$ ($i = 1, 2, \dots, n$); the unit price of material provided by supplier A_i is p_i ($i = 1, 2, \dots, n$); the distance between supplier A_i and manufacture B is d_i ($i = 1, 2, \dots, n$); freight of unit mileage for unit material from supplier A_i to manufacturer B is q_i ($i = 1, 2, \dots, n$); manufacturer B has warehouse for the storage of materials provided by suppliers, and storage cost of unit material within unit time interval is r (for single material, storage cost is considered to be identical); when supplier A_i provides material to manufacturer B , the order cost paid by manufacturer to supplier is γ_i ($i = 1, 2, \dots, n$). When stock-out takes place, stock-out loss will occur to manufacturer B , c is set as unit stock-out cost.

In order to establish the mathematical model concerning this issue, 0—1 variable z_i is introduced, with the following implication: if supplier A_i is selected, 1 is adopted; otherwise, 0. Due to allowable stock-out, the total cost at this time includes transportation cost, purchase cost, order cost and inventory cost, as well as stock-out cost. Actual supply quantity of supplier A_i is set as x_i , then $0 \leq x_i \leq \tilde{X}_i$, $x_i = 0$ means that supplier A_i is not selected to be a participator in the supply.

It can be easily known that the transportation cost at this time is $\sum_{i=1}^n q_i d_i x_i$;

purchase cost is $\sum_{i=1}^n p_i x_i$; order cost is $\sum_{i=1}^n z_i \gamma_i$; inventory cost with non-allowable

stock-out is $r(\sum_{j=1}^h \tilde{y}_j T_j - \sum_{i=1}^n x_i t_i)$ [2].

Considering the probability of stock-out, the demand quantity of manufacturer B at T_j moment can't be completely satisfied. Due to occurrence of

stock-out, inventory cost is zero. The total inventory cost upon the occurrence of stock-out is $r(\sum_{j=1}^h y_j T_j - \sum_{i=1}^n x_i t_i)$, where y_j represents manufacturer B 's demand

quantity satisfied at T_j moment, and $y_j = \min \left\{ \tilde{y}_j, \sum_{k \in \{i | t_i \leq T_j, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k - \sum_{k=1}^{j-1} y_k \right\}$.

For stock-out cost, since time restriction is to be considered, the situation at T_j moment should be discussed first. To determine whether stock-out occurs at T_j moment, all that needs to do is to compare the demand quantity of manufacturer B at T_j moment with the material quantity that is able to be supplied by suppliers at T_j moment and before T_j moment. Apparently, when the material quantity that can be supplied by suppliers at this moment is smaller than the demand quantity of manufacturers, then, stock-out occurs. Accordingly, stock-out cost at T_j moment can be expressed as follows:

$$c \left[\tilde{y}_j - \sum_{k \in \{i | t_i \leq T_j, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k + \min \left\{ \sum_{k \in \{i | t_i \leq T_{j-1}, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k, \sum_{k=1}^{j-1} y_k \right\} \right]^+.$$

Where $\max[x]^+ = \max\{0, x\}$, and total stock-out cost can be obtained by adding up the stock-out cost at each moment together;

$$c \left\{ \sum_{j=1}^h \left[\tilde{y}_j - \sum_{k \in \{i | t_i \leq T_j, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k + \min \left\{ \sum_{k \in \{i | t_i \leq T_{j-1}, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k, \sum_{k=1}^{j-1} y_k \right\} \right]^+ \right\}.$$

Then, the mathematical model with minimum total cost is obtained as follows:

$$\begin{aligned} \text{Min } \tilde{f} = & \sum_{i=1}^n q_i d_i x_i + \sum_{i=1}^n p_i x_i + \sum_{i=1}^n z_i \gamma_i + r \left(\sum_{j=1}^h y_j T_j - \sum_{i=1}^n x_i t_i \right) \\ & + c \left\{ \sum_{j=1}^h \left[\tilde{y}_j - \sum_{k \in \{i | t_i \leq T_j, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k + \min \left\{ \sum_{k \in \{i | t_i \leq T_{j-1}, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k, \sum_{k=1}^{j-1} y_k \right\} \right]^+ \right\} \end{aligned} \quad (1)$$

$$\text{s.t. } y_j = \min \left\{ \tilde{y}_j, \sum_{k \in \{i | t_i \leq T_j, i \in \{1, 2, \dots, n\}\}} \tilde{X}_k - \sum_{k=1}^{j-1} y_k \right\}. \quad (2)$$

$$\sum_{i=1}^n x_i = \sum_{j=1}^h y_j. \quad (3)$$

$$x_i \leq z_i x_i \quad i = 1, 2, \dots, n. \quad (4)$$

$$z_i \in \{0,1\} \quad i = 1, 2, \dots, n. \quad (5)$$

$$0 \leq x_i \leq \tilde{X}_i \quad i = 1, 2, \dots, n. \quad (6)$$

$$0 \leq y_j \leq \tilde{y}_j \quad j = 1, 2, \dots, h. \quad (7)$$

This is 0-1 combined fuzzy planning model with fuzzy objective and fuzzy restriction.

3 Model Solution

Due to the existence of fuzzy parameters, then objective function (1) and constraint condition (2), (3), (6) and (7) is without definite significance. In order to specify the implication of fuzzy figures, reasonable conversion is conducted on the basis of the achievement of Dubois and Prade [5,6].

Supposing that $\tilde{A}$ is LR trapezoidal fuzzy number, $\tilde{A} = (a_l, a_u, c, d)_{LR}$, and its membership function is as follows:

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x - a_l + c}{c}, & x \in [a_l - c, a_l] \\ 1, & x \in [a_l, a_u] \\ \frac{a_u + d - x}{d}, & x \in [a_u, a_u + d] \\ 0, & \text{others} \end{cases}.$$

Then, for $\forall \alpha \in (0, 1]$, according the definition of α -level cut of $\tilde{A}$, the following can be obtained:

$$\tilde{A}_\alpha = \{x \mid \mu_{\tilde{A}}(x) \geq \alpha\} = [a_l - (1 - \alpha)c, a_u + (1 - \alpha)d].$$

In this study, mean area measurement method is adopted to measure the values of two fuzzy numbers.

For arbitrary $\alpha \in [0, 1]$, set $\tilde{A}_\alpha = [\tilde{A}_l(\alpha), \tilde{A}_r(\alpha)]$, note $m(\tilde{A}_\alpha) = (\tilde{A}_l(\alpha) + \tilde{A}_r(\alpha))/2$. Apparently, $m(\tilde{A}_\alpha)$ is the average value of α -level cut $\tilde{A}_\alpha$, e.g. the midpoint of closed interval $[\tilde{A}_l(\alpha), \tilde{A}_r(\alpha)]$.

According to literature [7], we name $s(\tilde{A}) = \int_0^1 m(\tilde{A}_\alpha) d\alpha$ is the mean area of $\tilde{A}$, and when comparing the values of fuzzy numbers $\tilde{A}$ and $\tilde{B}$, if $s(\tilde{A}) > s(\tilde{B})$, then $\tilde{A} > \tilde{B}$; if $s(\tilde{A}) < s(\tilde{B})$, then $\tilde{A} < \tilde{B}$; if $s(\tilde{A}) = s(\tilde{B})$, then $\tilde{A} = \tilde{B}$.

It can be easily known that for trapezoidal fuzzy number $\tilde{A} = (a_l, a_u, c, d)_{LR}$, then

$$s(\tilde{A}) = \frac{1}{4}(2a_l + 2a_u - c + d).$$

Thus, fuzzy supply quantity of suppliers and fuzzy demand quantity of manufacturers are converted to mean area. On this basis, solutions are obtained by designing heuristic algorithm.

Definition. Name the set of suppliers at promised moment not larger than T_i as $\{A_1, A_2, \dots, A_k\}$, then name set $\Theta = \{(A_1 : s(\tilde{X}_1)), (A_2 : s(\tilde{X}_2)), \dots, (A_k : s(\tilde{X}_k))\}$ as the supply set at T_i moment. Name set $\Phi = \{(A_1, s(\tilde{x}_1)), (A_2, s(\tilde{x}_2)), \dots, (A_k, s(\tilde{x}_k))\}$ as the valid supply set corresponding to Θ at T_i moment, where $s(\tilde{x}_g) > 0 (g=1, 2, \dots, k)$ is the remaining valid supply quantity of A_g after the determination of the supply quantity at $T_1 \sim T_{i-1}$ moment. Name I as the subscript set of supply points in Φ .

For instance, $I = \{1, 2, \dots, k\}$ according to the above definition.

Since when stock-out occurs at a specific moment T_j , then all the suppliers with the supply capacity at and before T_j moment will be selected as the participator in the supply, with all the supply quantity used up and zero stock-out cost at this moment. When stock-out does not occur at T_j moment, then the selection of suppliers and supply quantity is conducted according to the principle in which minimum cost incurred by manufacturers is achieved. Thus, the solution algorithm is given as follows:

Step1 $j = 1, \varphi^* = \emptyset$

Step2 (1) supply set $\Theta = \{(A_1 : s(\tilde{X}_1)), (A_2 : s(\tilde{X}_2)), \dots, (A_k : s(\tilde{X}_k))\}$ generated at T_j moment

(2) valid supply set $\Phi = \{(A_1, s(\tilde{x}_1)), (A_2, s(\tilde{x}_2)), \dots, (A_k, s(\tilde{x}_k))\}$ generated at T_j moment

If $\sum_{i=1}^k s(\tilde{x}_i) \geq s(\tilde{y}_j)$, then it can be calculated that

$M_i = q_i d_i + p_i + r(T_s - t_i) + \gamma_i (i \in I)$, and the minimum within $M_i (i \in I)$ is set as M_l , e.g. $M_l = \min_{i \in I} \{M_i\}$. Then, supplier A_l is

selected, and $z_l = 1$;

If $s(\tilde{x}_l) < s(\tilde{y}_j)$, then the supply quantity of supplier A_l is $s(\tilde{x}_l)$, $\varphi^* = \varphi^* \cup \{(A_l, s(\tilde{x}_l))\}$, $s(\tilde{y}_j) = s(\tilde{y}_j) - s(\tilde{x}_l)$, $y_j = y_j + s(\tilde{x}_l)$, followed by (2) in step 2;

If $s(\tilde{x}_i) \geq s(\tilde{y}_j)$, then the supply quantity of supplier A_i is $s(\tilde{y}_j)$,

$\varphi^* = \varphi^* \cup \{(A_i, s(\tilde{y}_j))\}$, $y_j = y_j + s(\tilde{y}_j)$, $j = j + 1$, followed by step3;

If

$$\sum_{i=1}^k s(\tilde{x}_i) < s(\tilde{y}_j), \text{ then } \varphi^* = \varphi^* \cup \Phi, y_j = \sum_{i=1}^k s(\tilde{x}_i), z_i = 1 (i \in I),$$

$j = j + 1$, followed by step3;

Step3 If $j > h$, followed by step4; otherwise $y_s = 0$, followed step2

Step4 All the supply quantities of the same suppliers are added up in φ^* .

This algorithm is quasi-polynomial time algorithm, by which a satisfactory solution can be easily obtained in practice.

4 Conclusion

The issue of supplier selection in which stock-out is allowed has been further studied. Fuzzy planning model concerning this issue is given. By taking the characteristics of this issue into consideration, fuzzy supply quantity and fuzzy demand quantity are converted to mean area, and a corresponding heuristic algorithm has been designed for solution, thus providing theoretical basis for the selection of suppliers.

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Noisy Speech Enhancement Using a Novel a Priori SNR Estimation

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Abstract. In view of the problem of a priori SNR estimation in speech enhancement, a novel algorithm is proposed in this paper. Through adding momentum term, the presented algorithm maintains the advantages of indirect decision algorithm in effectiveness, and improves the tracking speed of instantaneous SNR with the elimination of musical noise. Simulation results demonstrate that the algorithm possesses good performance in many kinds of noise conditions.

Keywords: speech enhancement, DD, Wiener filtering, priori SNR, noise reduction.

1 Introduction

Voice is the most direct and convenient means of information exchange. But in real life, the speech signal will be inevitably influenced from the surrounding environment or the media, which make the enhancing speech convey the inaccurate features and information from original speech. Therefore, speech enhancement techniques must be used to reduce noise for improving the quality of voice communications. Nowadays, with the maturity of digital signal processing theory and the development of computer technology, a number of speech enhancement algorithms have been proposed, and the representative speech enhancement algorithms include: spectral subtraction, Wiener filtering algorithm, KLT algorithm, minimum mean square error algorithm [1-4]. Most of the speech enhancement algorithms have their own different gain factors, the gain factors can generally be expressed as a function of a priori SNR and a posteriori SNR[5-7]. The posteriori SNR can be obtained by noisy speech component and a known noise speech component, so the accuracy of the estimated a priori SNR will determine the performance of speech enhancement systems. Currently, as the decision directed (DD) method proposed by Ephraim and Malah can effectively eliminate the residual musical noise, the method is most commonly used. But, the DD method will lead to the time delay of a frame length in tracking changes of speech signal.

In this paper, based on the DD method, a new a priori SNR estimation algorithm is proposed by adding momentum term. The proposed algorithm maintains the advantages of indirect decision algorithm in effectiveness and simpleness and improves tracking speed of the instantaneous signal to noise ratio. And it can further

improve the SNR and suppress the generation of musical noise. Without loss of generality, in order to compare capacity of the two methods, the proposed algorithm and DD algorithm are applied to Wiener filter to achieve the enhancing performance of noisy speech. The simulation results show that speech enhancement technology based on this proposed algorithm has better effect to eliminate background noise, but also further reduce the speech distortion.

2 Wiener Filter and the DD Algorithm

Let the noisy speech signal, clean speech signal and noise signal be denoted by $y(t)$, $s(t)$ and $n(t)$, respectively. And the noisy speech signal will be expressed as

$$y(t) = s(t) + n(t) \quad (1)$$

Taking the FFT to the observed signal gives

$$Y(m, k) = S(m, k) + N(m, k) \quad (2)$$

where $Y(m, k)$, $S(m, k)$, $N(m, k)$ represent the short-time spectral component of $y(t)$, $s(t)$ and $n(t)$, respectively. And m is the frame index, k is the frequency bin index. If the voice signal $\tilde{S}(m, k)$ is recovered from the noisy speech signal $Y(m, k)$, we need find a linear filter $H(m, k)$, which makes the estimated speech signal $\tilde{S}(m, k)$ meet

$$\tilde{S}(m, k) = H(m, k) * Y(m, k) \quad (3)$$

Let the error signal generated from the clean speech and its estimated value is^[8]

$$\begin{aligned} e(m, k) &= \tilde{S}(m, k) - S(m, k) \\ &= [H(m, k) - 1] * S(m, k) + H(m, k) * N(m, k) \end{aligned} \quad (4)$$

where $[H(m, k) - 1] * S(m, k)$ is the speech distortion caused by the spectral weighting that can be minimized if the spectral weighting $H(m, k) = 1$. $H(m, k) * N(m, k)$ describes the residual noise that can be minimized using $H(m, k) = 0$. As the clean speech signal and noise signal are not related, we have

$$\begin{aligned} e^2(m, k) &= \{(H(m, k) - 1) * S(m, k) + H(m, k) * N(m, k)\}^2 \\ &= (H(m, k) - 1)^2 * S^2(m, k) + H^2(m, k) * N^2(m, k) \\ &\quad + 2 * H(m, k) * (H(m, k) - 1) * N(m, k) * S(m, k) \\ &= (H(m, k) - 1)^2 * S^2(m, k) + H^2(m, k) * N^2(m, k) \end{aligned} \quad (5)$$

The Wiener filter can be obtained by minimizing the square error signal as

$$H(m, k) = \frac{\xi(m, k)}{\xi(m, k) + 1} \quad (6)$$

where $\xi(m, k)$ represents the a priori SNR, which can be computed as

$$\xi(m, k) = \frac{E[S^2(m, k)]}{\lambda(m, k)} \quad (7)$$

where $\lambda(m, k) = E[N^2(m, k)]$ is the variance of the noise. For the above priori SNR, the Decision-Directed method proposed by the Ephraim and Malah is used[9]

$$\xi(m, k) = a \cdot \frac{|\tilde{S}(m-1, k)|^2}{\lambda(m, k)} + (1-a) \cdot \max\{\gamma(m, k) - 1, 0\} \quad (8)$$

where $\gamma(m, k)$ represents a posteriori SNR, it can be computed as

$\gamma(m, k) = \frac{|Y(m, k)|^2}{\lambda(m, k)}$, a is the weighting coefficient, and $\tilde{S}(m-1, k)$ is the estimated speech spectrum at previous frame. So the estimated speech spectrum of the clean speech is

$$\tilde{S}(m, k) = H(m, k) * Y(m, k) = \frac{\xi(m, k)}{\xi(m, k) + 1} * Y(m, k) \quad (9)$$

Taking the IFFT to the estimated speech spectrum gives

$$\tilde{s}(m, k) = \text{IFFT}[\tilde{S}(m, k)] \quad (10)$$

3 The Modified Algorithm Based on Momentum Term

For the DD algorithm in (8), it can effectively eliminate the residual musical noise. But this method will lead to the time delay of a frame length in tracking changes of speech signal, which will result in much echo in enhanced speech signal and affect the overall performance of speech enhancement system. In this paper, a new method is proposed based on momentum term, it maintains some advantages of indirect decision algorithm and can reduce the time delay of a frame length in tracking changes of speech signal.

The improved method for the a priori SNR estimation is expressed as

$$\xi(m, k) = a \cdot \frac{|\tilde{S}(m-1, k)|^2}{\lambda(m, k)} + \beta[\xi(m, k-1) - \xi(m, k-2)] + (1-a) \cdot \max\{\gamma(m, k) - 1, 0\} \quad (11)$$

where $[\xi(m, k-1) - \xi(m, k-2)]$ represents momentum term, which is usually used in adaptive filtering theory to improve the algorithm's tracking speed, and in this paper, we transplant it in the a priori SNR estimation method to reduce the time delay of DD algorithm. β is the momentum parameter.

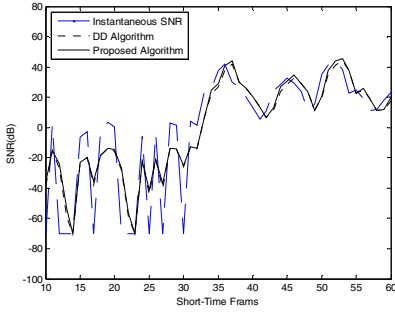


Fig. 1. SNR evolution over short-time frames, parameter $a=0.98$, $\beta=0.9998$.

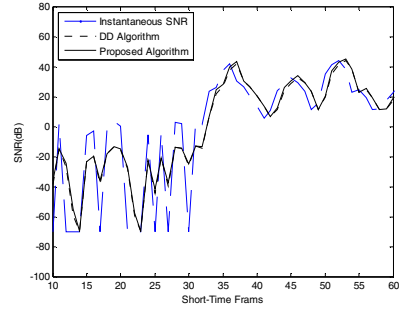


Fig. 2. SNR evolution over short-time frames, parameter $a=0.98$, $\beta=0.7$.

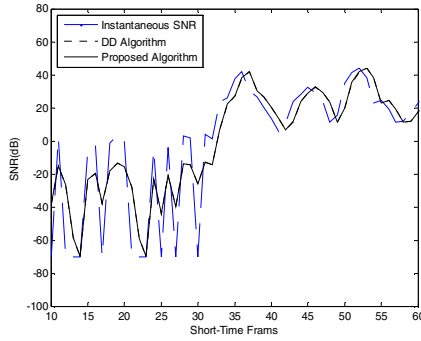


Fig. 3. SNR evolution over short-time frames, parameter $a=0.98$, $\beta=0.1$.

Figure 1, 2 and 3 show the performance of the DD algorithm and the proposed algorithm corresponding parameter $\beta=0.998$, $\beta=0.7$ and $\beta=0.1$. We consider the case that the clean speech is corrupted by additive destroyerengine noise with the SNR=20 dB. The dash-dotted curve represents the instantaneous SNR. The dotted curve and the real curve represent the a priori SNR evolution of the DD algorithm and the proposed algorithm, respectively. As can be seen from the three figures, the improved algorithm has relatively a smaller fluctuation than the DD algorithm in the silent phase, which is help to eliminate the musical noise. And the proposed algorithm improves tracking speed of the instantaneous SNR and further increases the signal to noise ratio of the enhanced speech signal in the sound stage, which will reduce echo and have a more effective removal of background noise. Based on the above improved situation, the behavior of figure 1 is most prominent. That is, for parameter $\beta=0.998$, it will be most conducive to the improvement of the system, so the following simulation is chosen in parameter $\beta=0.998$ case.

4 Experimental Results

Notice that in the following experiment, without loss of generality, we have chosen the Wiener filter to compare performance from the speech spectrogram, segmental SNR and LSD. The sampling frequency is 8kHz in the speech signal and noise signal. Six kinds of noises included white noise, buccaneer noise, pink noise, destroyerengine noise, factory noise, destroyerops noise are added to the clean speech signal at 0, 5, 10 dB, respectively. And the frame length N is 256 and frame overlap is 128 points.

In order to compare the performance of the DD algorithm with that of the proposed algorithm, the parameters in (8) and (11) are set as follows, $\alpha=0.98$, $\beta=0.9998$.

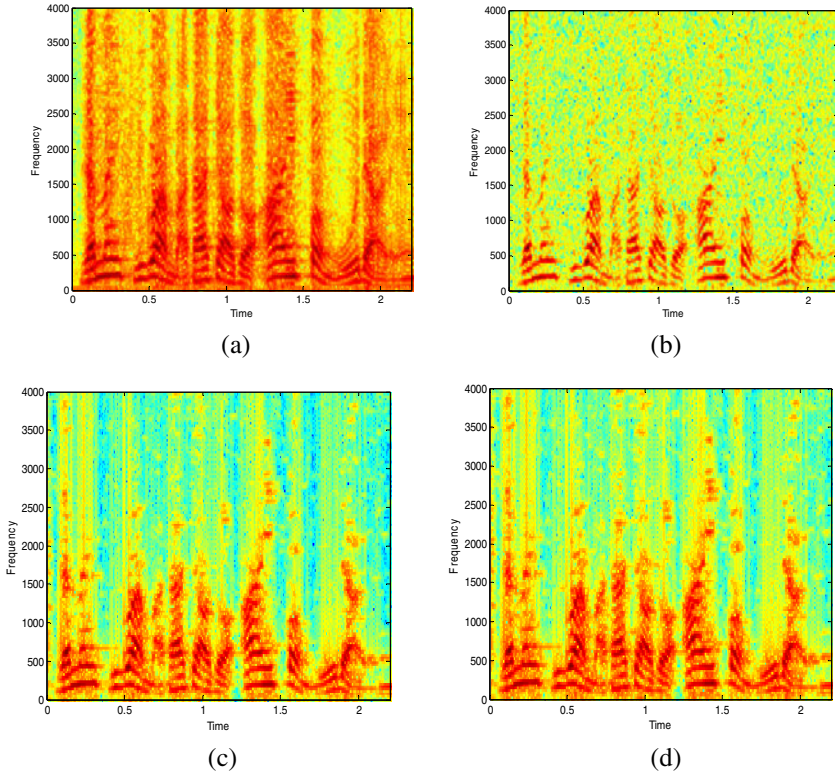


Fig. 4. Spectrogram of two algorithms corrupted by additive white noise (SNR=10dB)

Figure 4 show that the speech signal is respectively corrupted by additive white noise at 10dB. (a)~(d) represent clean speech signal, noisy speech signal, enhanced speech signal using DD algorithm and enhanced speech signal using improved algorithm. The simulation results show that our proposed approaches have better noise reduction capability, while keeping more of the speech signals energy remained unchanged than the DD method.

Table 1. Comparison of Segmental SNR between DD and the proposed algorithm

Noise type	Input SNR	Segmental SNR (dB)	
		DD algorithm	proposed algorithm
White	0 dB	4.6276	4.9109
	5 dB	6.5124	6.7544
	10 dB	8.9520	9.1751
Pink	0 dB	3.9805	4.2613
	5 dB	5.7196	5.9926
	10 dB	8.3642	8.6245
Buccaneer2	0 dB	4.5258	4.7287
	5 dB	6.5310	6.7399
	10 dB	8.6618	8.8568
Destroyerengine	0 dB	4.1767	4.4539
	5 dB	5.9512	6.1797
	10 dB	8.3122	8.5346

Table 2. Comparison of LSD between DD and the proposed algorithm

Noise type	Input SNR	LSD (dB)	
		DD algorithm	proposed algorithm
White	0 dB	24.3908	23.6630
	5 dB	20.7490	20.1449
	10 dB	16.6711	16.0641
Pink	0 dB	21.7397	20.6441
	5 dB	17.5225	16.6120
	10 dB	12.6601	11.8704
Buccaneer2	0 dB	22.6437	21.7774
	5 dB	18.6355	17.7893
	10 dB	14.4734	13.8192
Destroyerengine	0 dB	15.5588	14.3832
	5 dB	10.9008	10.1249
	10 dB	6.9852	6.5254

Table 1 presents the input SNR of noisy speech and the corresponding average segmental SNR obtained using DD algorithm and improved algorithm. The segmental SNR measure takes into account both residual noise level and speech degradation, it can be computed during speech activity course, as follows:

$$SNR_{seg} = \frac{1}{M} \sum_{k=0}^M 10 \log \sum_{n=m_k}^{m_k+N-1} \frac{s^2(n)}{[s(n) - \tilde{s}(n)]^2} \quad (12)$$

where M is the number of frames, N is the length of each frame and m_k is the end point of each speech frame.

From the comparison table of average segmental SNR, the enhanced speech signal using the proposed algorithm has a higher average segmental SNR, which shows that the proposed algorithm has a good superiority of denoising capability and the analytical results accord to the result in the above SNR evolution curve.

Table 2 describes the input SNR of noisy speech and the corresponding LSD obtained using DD algorithm and proposed algorithm. It can be seen from table 2, the LSD of the proposed algorithm are general small. Because the LSD reflects the proximity between the clean speech signal and its estimated value. So the improved speech enhancement system makes speech signal have a smaller distortion.

In a word, we can see from the curve of SNR estimation, spectrogram, Segment SNR and LSD that the modified algorithm can possess a more denoising capability, retain more speech element and keep the minimum speech distortion.

5 Conclusion

In this paper, based on momentum term technique, we propose a novel a priori SNR estimation algorithm for noisy speech enhancement. The presented method improves the estimation of the a priori SNR using the DD approach and has the ability to improve to track the change with the speech signal, so the reverberation effect characteristic of the DD approach is reduced. The simulation results validate the above analysis.

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A Distributed Cross-Realm Identification Scheme Based on Hyperchaos System

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Abstract. Aiming at the existing the system closed limitations in centralized authentication, was proposed a distributed cross-realm authentication anonymously mechanism suit for network parallel. And systematically analyzed the security system, based on 3d generalized Hénon mapping and Rijndael algorithm, designed and implemented hyperchaotic data encryption. Made the system has credibility, safety, efficiency, etc.

Keywords: distributed, identity authentication, hyperchaos, encryption.

1 Introduction

The core of identity authentication based on Trusted Computing Platform, it is: TPM (Trusted Platform Module) - the user who is able to prove him has a legitimate TPM also not expose himself specific is which TPM to the authentication, in order to prevent the Platform user behavior is tracking. At present, trusted computing group releases the identity authentication protocols including the Privacy Certificate Authorities in TPMv1.1 and Direct Anonymous Attestation in TPM v1.2.

In PCA scheme, the authenticity of TPM responded for verifying and proof by PCA, and every time TPM shows different AIK (Attestation Identity Key), thus TPM is able to prove himself is a true TPM to identity authentication person, while not expose himself concrete which TPM, thereby it is in the realization of the Identity authentication also guarantee the anonymity [1]. However, because of PCA relying on the trusted third party excessively, no applicable business model, and it can form bottleneck of influencing authentication efficiency easily, so that makes it difficult to used in the practical system.

DAA solutions use DAA certificate to replace the original AIK certificate, only need to apply for one time and can be repeated use, to a certain extent, ensure that the system of efficiency, at the same time guarantee the trusted platform anonymous [2]. In DAA scheme, DAA issuer is one releasing DAA signed authoritative institutions, each different TPM settings their own DAA awarded person, thus formed a relatively independent credible domain, different credible domain have different DAA awarded person, in different credible domain, participants will credit different DAA awarded person, caused DAA scheme only is suitable for single credible domain, when validation speakers in different fields and trusted computing platforms need interact, due to verify speakers and trusted computing platform credited different DAA issuer, who will not be for normal direct anonymous authorization. At the same time because

DAA solutions use zero knowledge proof, achieving complexity is larger, the anonymity, time consuming, they all exist problems and DAA scheme is primarily oriented toward small range, boundaries defining network environment.

Literature [3] for DAA mechanism puts forward a centralized cross-realm authentication protocol. Among them the trusted third party Arbitration Center of Certificate (CAC) validates for authenticity of DAA certificates issued by the AIK Certificate aroused by different manufacturers and TCP integrity verification, the verification results is authoritative, it is absolute credible third party in cross-realm authentication framework. The scheme solves limitations of DAA scheme only suitable for single credible domain, but for rely on the trusted third party too much.

This paper based on the characteristics of current network applications, and for authentication security requirements, presents a distributed cross-realm authentication scheme, discards the anonymous centralized single-point cross-realm authentication, the user can freely choose the authentication arbitration center, avoid distrust with the closed system. And analyze systematically the safety of distributed cross-realm anonymous authentication mechanism, design and realize hyperchaos data encryption based on 3d generalized Hénon mapping and Rijndael algorithm. Perfecting the system reliability and safety.

2 Distributed Cross-Realm Anonymous Authentication Solutions

Basic Structure. If the trusted computing platform TCPa of credible domain Doa apply service to Internet service Provider (ISP) of credible domain Dob, while the ISP and TPM of TCP belong to different credible domain, which is shown proved TCPa and validated ISP belong to different credible domain, right now the ISP verifies the authenticity and completeness of TCP assisted by DCAC.

Authentication Implementation Process Analysis. As figure 1 shows the authentication framework.

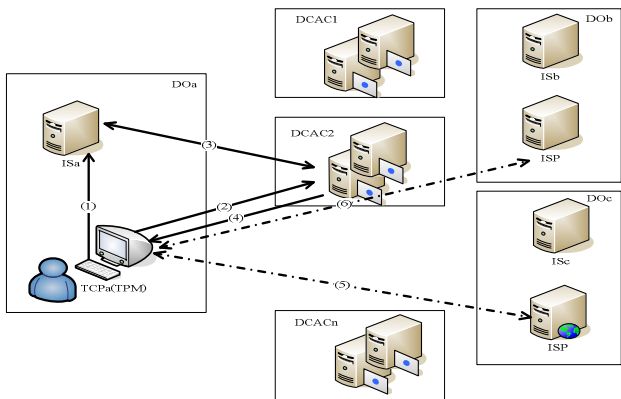


Fig. 1. Distributed cross-realm authentication framework

1. TCPa firstly get through the DAA authentication of credible domain DAA certificates issuer ISA, namely to obtain the certificate issued by the AIK.
2. After TCPa get local AIK certificates, it can choose any Internet credible third party to distributed certification arbitration center DCAC. In figure 1, it is DCAC2, and send cross-realm certificate request.
3. DCAC2 get through news interaction validation trusted computing platform TCPa's authenticity and integrity with DAA issuer ISA of TCPa location domain, TCPa use the local AIK certificate and its own integrity metrics to DCAC2 prove the identity.
4. DCAC2 issue cross-realm authentication certificate to TCPa which is with legal AIK certificates and platform complete.
5. TCPa proves its authenticity identity and platform integrity in cross-realm authentication certificate to the ISP of credible domain DOB anonymously. With ISP launched the corresponding service request and service response.
6. When TCPa again apply service request to other credible domain such as the ISP of DOc, they don't need to make conduct another certification request, directly use DCAC2 issued cross-realm authentication certificate, makes the system efficiency can be further embodiment.

At the same time each DCAC can simultaneous process multiple TCP cross-realm authentication application, satisfy characteristics about distributed network parallel, high-performance and computer collaborative working, cross-realm authentication certificate issued by once, multiple applications, make TCP, TPM metrics load decreases in communication process, verification has diminished, improve efficiency, and prevent authentication DCAC become system bottlenecks. Trusted computing platform take AIK certificate and integrity measure information to "push" in the way of cross-realm authentication DCAC, according to platform's request from trusted computing, DCAC issued cross-realm authentication certificate to with legally AIK certificate and unspoiled platform integrity trusted computing platform. As in figure 1 shows, after trusted computing platform TCPa obtain cross-realm authentication certificates, in the effective authorized time, TCPa can hold the certificate apply cross-realm service to ISP of other any credible domain, ISP verify the legality of cross-realm authentication certificate, complete the verification of TCPa's authenticity and integrity.

3 Security System of Distributed Cross-Realm Authentication Structure

After TCP get through authentication of DCAC, between TCP and DCAC, between TCP and ISP of target domains, are establish trust relations, so safety is the primary factor to consider.

Security Architecture. In order to ensure the safe of authentication data, we formulate a site safely shared identity information standard, which cuts and expands for security statement markup language SAML, makes it apply to the secure transmission for common individual user information format among Internet sites.

In order to guarantee the safety of network communication, the sites of communication use HTTP protocol, when users log on to a website that supports distributed single point authentication, they may put input user name and password to a fraud webpage, and authentication system routing to Internet to ask for confirmation id to the site, the identification process relies on the network address mapping DNS system, therefore must participate in every distributed single point identity authentication website using transport layer security protocol (TLS), in order to avoid the replay of the attack.

For transmission news, use by SSL protocol (Secure Socket Layer), to protect information transmission confidentiality and integrity. At the same time set effective time scope for news, avoiding information be replayed.

This authentication mechanism uses Rijndael algorithm as the data encryption algorithm for encrypting data, Rijndael is basic cryptographic algorithms used in advanced encryption standard (AES). Rijndael is a block cipher with variable grouping length and variable key length. The packet length and key length all can independently set to 32 bit arbitrary multiples, minimum of 128 bits, a maximum of 256 bits. Making it more robust and reliable than 56 DES.

Combining hyperchaos Hénon mapping and Rijndael algorithm, the son keys provided directly by hyperchaos sequence password instead of making a key expand, then in each son key there is no connection between, there is not repeated use of keys, key exhaustively attack unable to its work, safety will increase greatly.

Design and Implementation of Encryption Scheme. 3d generalized Hénon mapping is one of often used chaos mapping when people to study hyperchaos system applied in data encryption. Due to it have two positive Lyapunov indexes, so also called hyperchaos Henon mapping.

It consists of a set of difference equation

$$\begin{cases} x_{n+1} = a - y_n^2 - bz_n \\ y_{n+1} = x_n \\ z_{n+1} = y_n \end{cases} \quad (1)$$

Literature[4,5] is obtained that when $1.54 < a < 2$, $0 < |b| < 1$, system is in hyperchaos state, when Hénon mapping is in parameters a from 1.98 tends to 2, b from -0.005 tends to 0 and from 0.0084 tending to zero, namely from 3 lines $b = -0.42a + 0.84$, $b = 0.25a - 0.5$ and $a = 1.98$ have surrounded the delta region, its randomness is best.

When $a = 1.65$, $b = 0.15$, hyperchaos Hénon mapping of the two positive biggest Lyapunov exponent value they are 0.689 and 0.693 respectively.

First, make sure initial parameters of hyperchaos Hénon mapping: (a, b, x_0, y_0, z_0) , for convenient calculation, mapping can be rewritten to:

$$x_{n+a} = a - x_{n+1}^2 - bx_n \quad (2)$$

Iterative generating hyperchaos sequence eliminated N times before the data, from $N + 1$ times began as the first value of hyperchaos sequence, got the using of real-valued sequence $\{x_i\}_{i=1}^{i=\infty}$. Adopt the whole numerical sequence method generating

digital sequence: according to certain rules will real-valued sequences $\{x_i\}_{i=1}^{i=\infty}$ into the whole numerical sequence $\{z_i\}_{i=1}^{i=\infty}$, namely the key sequence K.

In Literature [6] extracted integer sequence from hyperchaos Hénon mapping with single precision 16-bit floating-point calculations, to take one dimension of data, each iteration time get a 16-bit floating-point, abandon the integer part, namely take 15 place decimal fraction, from this 15 place choosing any three, there were 2730 kinds. Choose any four and five... Until 15, can get decimal number are: 3.55×10^{12} .

From each real-valued extract 8 bit keys, and get a decimal number which can be directly to 256 take mould, also can choose from any two by add, multiply operation, and get the result to 256 take modules, there are 1.26×10^{25} kinds.

The integer numerical sequence has very good randomness properties extracted from these kinds on experiment, and together with the initial parameters of hyperchaos Hénon mapping are as seed key, and each encryption will replace seed key. If each group with 52 16bit son encryption $(k_{52(i-1)+1}, k_{52(i-1)+2}, \dots, k_{52i})$ encrypting 64 bit of the expressly, need keys total of $16 \times 52 = 832$ bit, so the length of generated sequence K should not be less than the $832 \div 64 = 13$ times of expressly. Each iteration generating 8 bit keys, so every two integer value can form a son key, Creating a group key needs iteration 104 times.

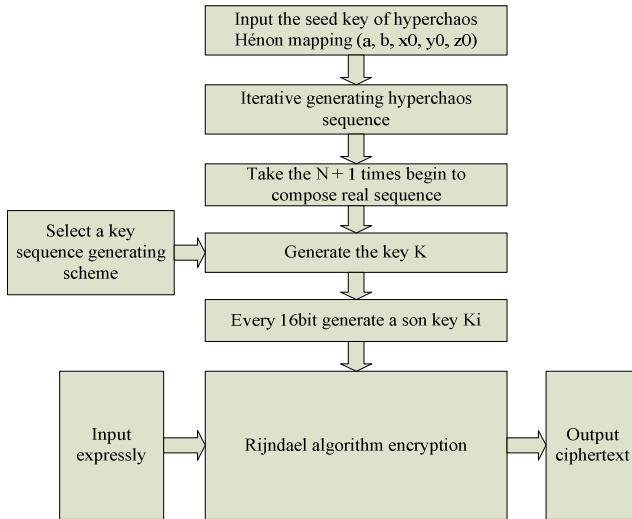


Fig. 2. Rijndael data encryption principle diagram based on chaotic Hénon mapping

Encryption process shows in figure 2, decryption process is similar with encryption process, only make each encryption key k_i generating the corresponding decryption son key u_i is OK.

4 Conclusion

This paper aims at limitation of traditional centralized certification, puts forward a suitable distributed cross-realm authentication mechanism for the current network environment. This mechanism improves absolute trusted third party information closure, and adopt a distributed certificate arbitration center, by the users' choice. And on the basis of this authentication mechanism, researches and designs a kind of taking chaotic sequence password as son key used data encryption scheme of block ciphers algorithm, makes the chaos system excellent characteristics apply to block cipher. Further assures the safety of network authentication, realizes cross-realm directly anonymous authentication process of trusted computing platform.

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An Signal Denoising Method Based on Modified Wavelet Threshold Filtering for Ocean Depth

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Abstract. Due to ocean environmental noises, the technique for seafloor topography surveying may not availably distinguish true seafloor topography information from noisy echo-sounding signal. Based on Neyman-Pearson criterion and singularity detecting technology through wavelet transform, an optimal wavelet threshold filtering algorithm (OWTF) was proposed to denoise the echo-sounding signal. Echo-sounding data experimental result shows that compared with the traditional approach, OWTF algorithm may mitigate the errors in conventional filtering method, while enhance the utilization ratio of depth information.

Keywords: Ocean depth, Wavelet threshold filtering, Signal denoising.

1 Introduction

Obtaining underwater topography information by echo-sounder plays an important role in hydrographic survey, ocean exploration, and other underwater environmental engineering. During ocean measure, the echo-sounder's data is affected by environment noises, e.g., tide, float grass, fishes, air bubble, etc. The contaminated signal denoising is crucial for extracting and analyzing the useful information in practical ocean engineering. Conventionally, to eliminate wave influence, surveyors drag the depth points of echo-sounding curve to smooth noises in PC screen by man-machine interactive smoothing (MMIS). However, it is difficult to discriminate which factor is main contribution to seafloor curve between seabed topography and ocean environment noises. When ocean wave influence is rough and seabed topography status is unknown (see Fig.1), smoothing echo-sounding curve to denoise by MMIS may cause seabed topography distorting [1].

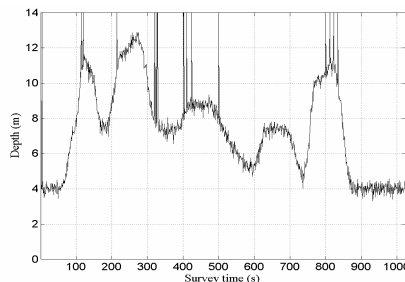


Fig. 1. Echo-sounding signal recorded by SDH-13D apparatus.

Based on Neyman-Pearson criterion and singularity detecting technology by wavelet transform (WT), an optimal wavelet threshold filtering method (OWTF) is presented to maximize the probability of detection for a given signal. At last, compared with MMIS, the results of the experiment by OWIF is given with ocean measure data sampled.

2 Wavelet Threshold Selection

In following, $s(n)$ is assumed to be a actual seafloor signal, which is affected by the ocean environment noises $w(n)$, and $w(n)$ is assumed to be an ergodic white Gaussian noise with the mean of zero and the covariance of σ_s^2 . Meanwhile, above signals are considered to be statistic independent to each other. Therefore, the echo-sounding signal is described as

$$r(n) = s(n) + w(n) \quad (n = 0, 1, \dots, N-1) \quad (1)$$

Taking a given threshold value, wavelet coefficients which are bigger than threshold are used to restore actual seafloor signal $s(n)$ by an inverse discrete wavelet transform (IDWT). Simultaneously, those wavelet coefficients which are less than threshold value is set to zero.

The hard-threshold filtering is defined as [2]

$$\begin{cases} d(j), & |d(j)| \geq l(j) \\ 0 & , |d(j)| < l(j) \end{cases} \quad (2)$$

where $d(j)$ is WT coefficient, and $l(j)$ is a threshold at scale j .

Meanwhile, the soft-threshold filtering is defined as

$$\begin{cases} \text{sign}(d(j)) \cdot (|d(j)| - l(j)), & |d(j)| \geq l(j) \\ 0 & , |d(j)| < l(j) \end{cases} \quad (3)$$

If set threshold value over high, the low wavelet coefficients of the signal $r(n)$ is restrained. Reconstructing original echo-sounding signal by IDWT with the surplus wavelet components will add the distortion of the original signal estimated value $s(n)$, and reduce the utilization ratio of measure information. Whereas, reducing the threshold value will also increase the distortion of the estimated signal, it may enhance noise disturbance. Therefore, to resolve the dilemma, an optimal wavelet threshold should be adaptively selected without experiential value.

Considering $r(n)$, $s(n)$, and $w(n)$ as wavelet decompose coefficients of the r_{jn} , s_{jn} , and w_{jn} at scale j , respectively. As to signal detection, original hypothesis H_0 and preparation selection hypothesis H_1 are adopted. Thus, the likelihood ratio $\Lambda(r_{jn})$ is determined as

$$\Lambda(r_{jn}) = \frac{p(r_{jn} / H_1)}{p(r_{jn} / H_0)} \quad (4)$$

According to detection theory, the false alarm probability is written as

$$p_e = \int_{l(j)}^{\infty} p(|r_{jn}|/H_0) dr_{jn} = 1 - \text{erf}\left(\frac{l(j)}{\sigma_w}\right) \quad (5)$$

where $\text{erf}(\cdot)$ is an error function.

Based on Neyman-Pearson criterion [3], while likelihood ration $\Lambda(r_{jn})$ exceeds certain threshold, the original hypothesis H_1 is accepted, otherwise, the hypothesis H_0 is adopted [4]. This detection criterion is formulated as

$$\left| r_{jn} \right| \begin{matrix} H_1 \\ > l(j) \\ H_0 \end{matrix} \quad (6)$$

Therefore, when $|r_{jn}| < l(j)$, select H_0 and make the corresponding wavelet coefficients r_{jn} equal zero, then restore seafloor signal $s(n)$ with the wavelet coefficients at surplus scales. Consequently, wavelet threshold $l(j)$ at scale j is obtained, viz., $l(j) = L\sigma_w$, where L is a threshold factor. When root mean square (RMS) achieves minimum value by changing L , an optimal wavelet threshold L_{opt} is determined. Meanwhile, above-mentioned process gives an optimal reconstructed signal $\bar{s}(n)$, too, which is written as

$$\bar{s}_{jn} = r_{jn} u(|r_{jn}| - L\sigma_w) \quad (7)$$

where $u(\cdot)$ is unit pulse function.

Meanwhile, RMS is obtained as follows

$$\text{RMS} = \text{sqr}\left(\frac{1}{N} \sum_{n=0}^{N-1} [s(n) - \bar{s}(n)]^2\right) \quad (8)$$

Nevertheless, to obtain L_{opt} , the original seafloor signal $s(n)$ must be known during calculating RMS according to Eq. 8. Though, it can be set in advance in simulation, virtually, the actual seafloor signal $s(n)$ is unknown in real applications. As the wave has cycle property to some extent, in addition, the seafloor topography signal $s(n)$ may be looked upon as a continuous differentiability function. Meanwhile, underwater obstructions, reefs, wrecks, etc., will bring sudden skip in the recorder paper of echo-sounding signal. Usually, these obstructions' signals are defined as transient signals, which are usually described with singularity. Singularity and irregular structure often carry the most important information in signals, which are particularly meaningful for recognition.

Further, singularity can be expressed as Lipschitz exponential a in mathematics [5]. As Fourier transform is lack of locality and it only can confirm the integer character of the function singularity points, which is difficult to determine the distribution status of singularity points in the space and frequency. By decomposing signals into elementary building blocks that are well localized both in space and frequency, WT can characterize local regularity of signals. The *Lipschitz* exponential

a of function $f(n) \in L^2(\mathbf{R})$ at point x_0 means that in a adjacent field of the point x_0 , $f(x)$ satisfies

$$|f(x) - f(x_0)| \leq M |x - x_0|^a \quad (9)$$

where M is constant.

Generally, the singularity of signal is larger than zero while the singularity of noise is less than zero [3, 5]. For the detection of the singularities and inflexion points of the signal, the maxima of WT modulus is employed [6]. The WT of function $f(x)$ is given by

$$W_{a,b}f(n) = f(n) * \frac{d\Omega(n/a)}{dn} \quad (10)$$

Further, if the wavelet function is a derivative of Gaussian, then the maxima belong to connex curves which are never broken from a scale to other [6]. Thus, signal singularities' detection is possible by using the wavelets. Additionally, the mean density of additive while Gaussian noise (AWGN) is presented [7].

$$d_s = \frac{1}{2^j \pi} \left(\frac{\|\psi^{(2)}\|}{\|\psi^{(1)}\|} \right) \quad (11)$$

where $\psi^{(1)}$ and $\psi^{(2)}$ are the first order derivative and the second order derivative of the function $\psi(n)$, respectively.

On basic of these discrimination conditions of Eq. 8, Eq. 10, and Eq. 11, the transient signal may be distinguished from the seabed echo-sounding record while AWGN be filtered out.

3 Experiment and Analysis

In this section, a group of sea experiment data (shown in Fig. 1) is employed by OWTF approach to compare with MMIS. In these data, besides dredging effect, the echo-sounding curve of the sea-route is contaminated by environment noises. These disadvantageous factors increase the difficulty to acquire the actual seafloor topography.

To accurately separate seafloor topography from the noisy record, firstly, MMIS is utilized to smooth noises, which gives topography curve shown by the dash-dot line in Fig. 2. Then, compared with conventional MMIS, OWTF method is used to denoise the signal in Fig. 1. During the denoising procedure, four scale wavelet transform is employed to decompose this signal. $L_{opt}=1.49$ and $RMS=0.17$ m. The seabed topography signal is obtained, which depicted by the solid line. Meanwhile, the absolute different value of above two methods is drawn by the dotted line.

Fig. 2 illustrates that (1) the seabed topography information can be attained by above methods. However, OWTF may effectively eliminate the experience error in the traditional MMIS method, and reduce the handwork workload. (2) As depicted in

Fig. 1 is dredged seafloor, which has some transient signal components. Unfortunately, these components are smoothed out by MMIS (see Fig. 2). While by OWTF, these signals are restored. In transient point the different value of two methods is even more than 1.12 m. Thus, OWTF may enhance the utilization ratio of depth information and improve the reliability of the seafloor.

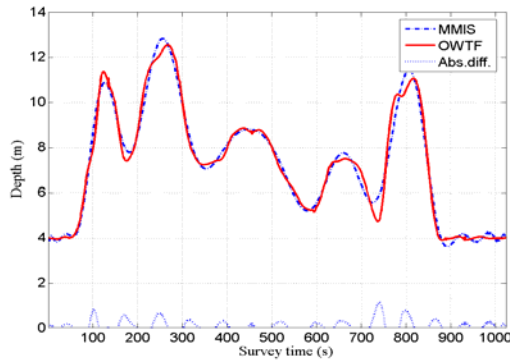


Fig. 2. The seafloor topography curves by MMIS & OWTF as well as their absolute different value.

4 Summary

OWTF method can effectively separate seafloor topography from echo-sounding polluted by environment noises, and all reconstructing error of OWTF technology satisfy the requirement of claiming utmost error. This technology improves utilization ratio of the echo-sounding signal and decreases false alarm probability. To some extent, it has the capability of detecting underwater obstruction. Besides, OWTF approach may reduce the experience error of MMIS approach.

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Research on Design of Signal Acquisition Card in Bridge Health Monitoring System Based on Certain Intelligent Materials Design of Signal

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Abstract. Bridge Health Monitoring System has always been one of the hot spots. Signal acquisition card as a part of bridge health monitoring system, play a decisive role. The accuracy of data collection is the basis of analysis bridge health. Only we capture accurate information of the bridge's state, can we determine whether there is a problem with the bridge state. Principle designing acquisition card is simple and feasible, accurate and effective. Data acquisition Related to the sensor, signal front-end processing, single chip set, etc. In this paper, we design Data acquisition card to apply bridge health monitoring system in the existing technology. And it can effectively capture the signal of the bridge.

Keywords: signal acquisition, ADC, microcontroller, isolation circuitry.

1 Introduction

In recent years, the bridge accidents happen frequently. Bridge health problems have become the focus of attention. In the bridge operation, due to frequent load, or even overloading and even natural disasters, traffic accidents and other man-made attack will cause damage and partial destruction of the bridge. In order to ensure the safe operation of the existing bridge and the possible extension of its safety use, testing should assess the existing bridge, and should be conducted regularly. The so-called detection and evaluation[1], that is, on the existing bridge and the components of the overall minutes to inspect, understand, inspection, testing, after a checkup of analysis, sometimes need to backed up by relevant test cases to their disease, injury, disease and injury causes, there is a carrying capacity, functionality and the ability to identify normal operation and other operations, give a clear conclusion; the same time, measures should be taken and the proposed maintenance and reinforcement of the proposal, together with the owners for decision-making.

Bridge Health Monitoring System [2, 3] is a multidisciplinary combination of technologies. It involves sensor technology, signal acquisition, microcontroller

technology. There is also computer software, usually including: the operating system environment (such as DOS, WINDOWS, UNIX) and application procedures. Bridge Health Monitoring System's model is generally as follows.

That we can see from the bridge health monitoring system model, the signal acquisition card plays an important role. Reasonable signal acquisition card can accurately capture the signal of the health bridge status and come out of the accurate information from host computer.

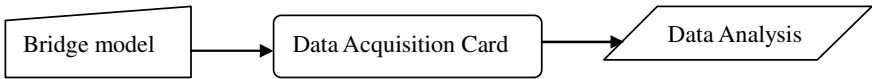


Fig. 1. Bridge Health Monitoring System Model

2 Signal Acquisition Card

Data acquisition card receives analog signals coming from the sensors. The design process of data acquisition card is shown as follow.

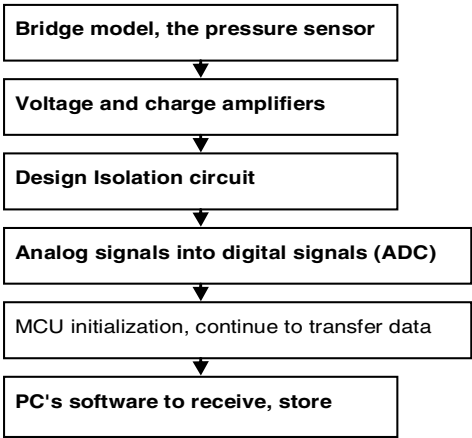


Fig. 2. Signal Acquisition Card

Pressure Sensor. Design of signal acquisition cards, we have to mention the pressure sensor. Pressure sensor is sensors that converted the pressure to electrical signal and output electrical signal. Pressure sensors generally compose of sensitive components and the elastic sensitive elements (or strain gauge). The role of flexible sensor that measured pressure in the area and converted to a displacement or strain, and then by the displacement sensor or strain gauge and the pressure is converted to electrical signals as a certain relationship. Sometimes the function of two components is one. Pressure sensors are widely used in various industrial, such as automation

environment, involving water utilities, rail transportation, smart buildings, ships, machine tools, plumbing and other industries.

Piezoelectric sensors based on piezoelectric effect of certain electronic media and made the basis. In the external force, the surface can produce dielectric charge, the size of the charge correspondence the size of pressure. And by this principle it will be able to convert the pressure to the charge and we collected them. Piezoelectric sensor has response frequency bandwidth, high sensitivity, signal to noise ratio, simple structure, reliable, light weight, and so on. Thus, in mechanical engineering, biomedical, oil exploration, bridge inspection, logging, electro-acoustics and many other technical fields to obtain a wide range of applications.

In bridge detection, the optimal sensor placement is a very important issue. In the detection process, it is unrealistic to arrange each sensor in the every bridge position, and this will lead to the complexity of data redundancy. So it is a hot spot to arrangement so few sensors as possible as we can in place and get the full signal. There have been many people in this area in depth research, and given the many ways model. In recent years, method based genetic algorithm has been very good development.

Voltage amplifier. Voltage amplifier is connected to the leads of the piezoelectric element after the cable amplifier. Its function is the high output impedance of the piezoelectric element into a low impedance. And piezoelectric effect of a weak voltage signal amplification. Figure 3 shows the equivalent circuit of a voltage amplifier.

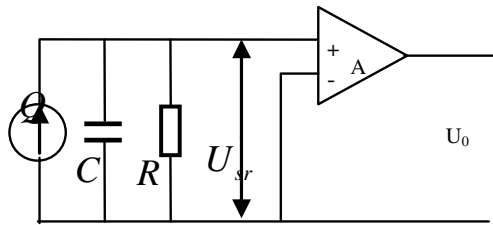


Fig. 3. Basic circuit Voltage amplifier

Charge Amplifier. Piezoelectric sensors to the mechanical input signal into electrical signals. However, the output signal must be done to apply the appropriate treatment. Therefore, appropriate follow-up of piezoelectric sensors and hardware to transfer the circuit was very important.

Mentioned above can be used as a charge amplifier or voltage amplifier pre-conversion circuits. However, in practice, as a pre-transformation using the voltage amplifier circuit makes the output not only with the charge, but also the distribution and connection cables and other related parameters such as capacitance. Therefore, the interchangeability of the system is not good. Charge amplifier can be used to solve the problem.

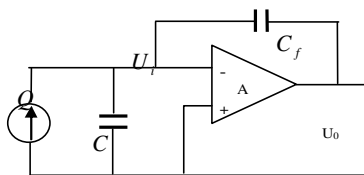


Fig. 4. Basic circuit charge amplifier

The main function of the charge amplifier has two. The first, it can amplify weak voltage signals from the sensor output charge signal. The second, it can transfer high impedance output of the sensor into a low-impedance output.

ADC. AD7708 [5, 6] is a multi-channel 16-bit Σ - Δ ADC. It supports 4 or 5-channel true differential input and 8 or 10-channel pseudo differential inputs. The chip allows simultaneous switching of two signals, thereby enhancing the multiplexing application throughput. The chip also includes switch current sources, low power switch and a temperature sensor. The ADC at 3V power supply, in the normal way, the power current is 2mA; in the standby mode power consumption current is less than 10 μ A. AD7708 suitable for wide dynamic range and low-frequency applications, low cost, low power consumption and performance of a complete analog front-end solutions, and the sensor's output signal to analog to digital conversion directly, without signal conditioning. Input channel can be programmed to 8 ranges from 20mV to 2.56V; input signal can be set to buffered mode, the buffer mode to eliminate the impact of a large source impedance and noise through an RC filter to filter and attenuation of RFI; All have direct access to the input signal without the need for other aspects of the conditioning signal amplification to make it more suitable for wide dynamic range and low frequency signal measurement, such as temperature, stress, pressure sensors and other signals. Thanks to the concrete application of this new type of ADC, including medical equipment, industrial process control, portable instrumentation, pressure sensors, smart transmitters, weighing, temperature measurement and data acquisition equipment. Therefore in the actual application, the rational design of the isolation circuit has an important application.

Isolation circuit design before AD7708 front[7]. Isolation circuit design primarily for two considerations: first, the protection of the circuit under test and the test circuit, so they can not be measured by the test circuit or circuit failure of the whole system work. Second, reduce the environmental impact of noise on the testing circuit. After the class for the protection equipment to ensure the validity of measurement results, the test circuit and measured the electrical circuit must be strictly isolated, isolation circuit should have high accuracy. Circuit cost and size have to meet the project needs.

Mega64 Microcontroller. Serial protocol is 38400b, 8 data bits, 1 stop bit, even parity.

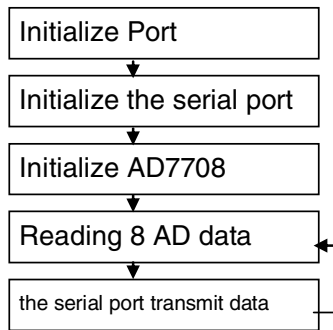


Fig. 5. Mega64 SCM settings

PC to accept data. Data acquisition card sends data to the PC through the serial port and store. Staff can analyze and process the collected data, and make decision corresponding to results.

3 Conclusion

Bridge Health Monitoring System is a complex process. Data acquisition card as a key module of the system plays a decisive role. This data acquisition card is available in a simple design principle, and we design the data acquisition card in details. Experiments prove that it is available.

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Low Illumination Image Denoising Research and Its Real-Time Implement

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Abstract. According to the requirement of real-time image processing and the variety of noise, a hybrid filter algorithm is presented in this paper, and then the color image real-time denoising is realized on FPGA. An improved median filter algorithm which combines the number of roots with the comparison of ranks is presented upon the conditional median filter algorithm. Based on the local threshold, the hybrid algorithm which combine improved median filter with weighted mean filter judges the noise type, and then uses different denoising method. At last, the algorithms are finally fulfilled in the real-time image acquisition system. The results show that the hybrid filter algorithm satisfies the real-time requirement and have higher visual effect.

Keywords: color image, real-time denoising, FPGA.

1 Introduction

Noise is inevitably introduced to reduce image quality during the image generation, collection and transmission. It is necessary to reduce noise in order to further treatment. With the development of the computer industry, a variety of image filtering software which is already quite mature such as: Photoshop, Matlab, etc. Image processing algorithm is simple but large computation, software realization can't satisfy the requirement about real-time and flexibility, and the hardware implementation based on embedded chips is devised.

With the quick development of microelectronics and technique, field-programmable gate array design (FPGA) [1] is used more and more with programmability, low cost, high density and high reliability. FPGA is the key device in the real-time acquisition system in this article. The functions such as ddr2 controller, different color spaces conversion, hybrid filtering are realized on it.

We use the algorithm which combines the improved median filter algorithm with mean filter algorithm, and the whole project based on FPGA is introduced. We designed primary modules with verilog HDL and emulated with software ISE10.1 of Xilinx Inc. At last, the algorithm is finally fulfilled in the color image real-time acquisition system which is based on FPGA.

2 System Structure

The image acquisition system as show in Fig. 1. The image acquisition device is mt9d111, and the image data which format is yuv422 is read into ddr2 after processed

by FPGA. The image must be de-noising before display because of a lot of noise is introduced for low illumination. According to the physical properties, the most sensitive information of vision is image brightness changes. The brightness information which for hybrid filter is separated from the image data that read out from ddr2. After that, combine brightness information with other chromatist information, then sent image data into display device after color space transformation (yuv turn rgb), image enhancement, image magnification, etc.

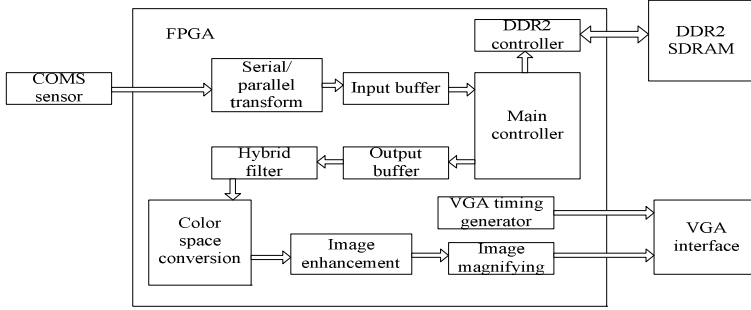


Fig. 1. System Structure Diagram

3 Design of Hybrid Filter Algorithm

Analysis and Improvement of Median Filter Algorithm. The median filter algorithm [2] performs well in the reduction of noise and the improvement of signal-to-noise ratio, is nonlinear Filtering Algorithm. The main idea is to use the median pixel, the neighborhood of the pixel gray level to sort by, instead of the original pixel as output value. $f(x,y)$ and $g(x,y)$ are input data and output data separately, S is the window template. The median filter algorithm formula as show in (1).

$$g(x, y) = \text{media}\{ f(x-i, y-j) \} ; (i, j) \in S \quad (1)$$

Traditional median filter implementation process is as follows: first select a $n \times n$ window (n is Usually Odd number) and then the window moves along the image data. After moving, we sort the image pixels in the window in order to replace the pixel value of the window center using the middle value in the window. Window moving needs many comparison operations. For example of the 3×3 window, we need $9 \times (9-1)/2 = 36$ times comparison operations. Consequently, although conventional median filter is quite simple, it is computationally expensive. So when we implement it on FPGA, it needs to use up abundant peripherals and the speed is slow [3].

Based on the foundation number and ranks comparison, the median filter algorithm is easy to realize on hardware. Assuming the set of digital image pixels is $\{ X_{ij}; i, j \in S \}$, we observe the top position of all data from s cross window and compare the number of 1 and 0. The filter output is obviously belonging to the collection of more number. It can be divide into three situation: (1) all 0 or all 1; (2) one for 0, four for 1

or one for 1, four for 0; (3)three for 1, two for 0 or three for 0, two for 1. According to third situation, it compares three times for median value; to first situation, it compared three times for median value; to second situation, it compares six times for median value; to first situation, combine with ranks comparison, it compares nine times for median value.

The ranks comparison of s cross window as show in Fig 2.

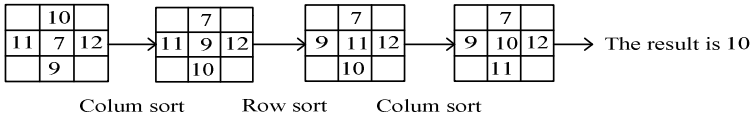


Fig. 2. Ranks Comparison Diagram

The algorithm reduces the number of comparisons to six times to find median value. It reduces the complexity of the original algorithm and improves the processing seed significantly and easy to fulfill in the real-time image pre-processing system.

Mean Filter Algorithm. The main idea of mean filter algorithm [4] which is also called neighborhood average method as show in (2) is to use average gray value of a few neighborhood pixels instead of each pixel.

$$g(x, y) = 1/M \times \sum f(i, j) \quad ; (i, j) \in S \quad (2)$$

$f(x, y)$ and $g(x, y)$ are input data and output data separately; M is the total of pixel in it. S is the window template which can be a cross, a square, a circular and so on. The cross window not only ensure the information of point and line but also keep the image details. The mean filter algorithm contain average and weighted filter algorithm, the same weighted mean algorithm that not make full use of pixel correlation and location information is certain blindness. Therefore this article adopts the weighted mean algorithm.

De-nosing Algorithm Selection. Impulse noise and gaussian noise pixels can be separated by local threshold and then applied different de-noising method. We assume the pixel value of image point (i, j) is $x(i, j)$, the traditional output is $m(i, j)$. We can obtain the value of $l(i, j)$ from the definition formula $l(i, j) = |x(i, j) - m(i, j)|$.

The image points $p_1(i, j)$ and $p_2(i, j)$, are close to $x(i, j)$ in the neighborhood. We define $a = |p_1(i, j) - x(i, j)|$, $b = |p_2(i, j) - x(i, j)|$, $v(i, j) = (a + b) / 2$. The de-noising rules as follows:

- If $l(i, j) \geq t_1$ and $v(i, j) \geq t_2$, median filter algorithm is used;
- If $l(i, j) \geq t_1$ and $v(i, j) < t_2$, mean filter algorithm is used;
- If $l(i, j) < t_1$, mean filter algorithm is used.

According to the MAD algorithm [5], we define the local threshold $t_1 = 2 \times \sigma$, σ is Gaussian standard deviation, the definition formula is $\sigma = 2 \times M_k$. $M_k = \text{median} \{ |x_i - m_k| \}$, m_k is the median value in the neighborhood. The local threshold t_2 , usually an integer

between 6 and 10, is mainly for fine image texture, such as only one pixel wide lines, circles, triangles and so on. In this article t_2 is 10. To determine the pixel points $p_1(i, j)$ and $p_2(i, j)$, we first take the absolute value of subtraction between the other four pixel value and $x(i, j)$ in the neighborhood, then find out two smallest, is a and b.

4 Hardware Implementation of Hybrid Filter

Structure Design of Hybrid Filter. In this paper, we design and implement a 3×3 cross window in real time hybrid filter based on the component XC3S400A, Spartan3A and Spartan3AN, Xilinx. The image data is must by hybrid filter when read into FPGA from DDR2. First is the generation of window which contain 9 data, then get the median value by improved median algorithm. We determine the noise type on the basis of median value, and then determine the output under the control of counting module. Fig. 3 shows the hybrid filter structure diagram.

Window Module. Image data transmits adopting data stream way, one data in one clock, in the hardware. The key in the window module [6] is how to realize acquisition 9 pixels at the same time in one clock cycle. How to storage first two lines is the key factor. In the article, FIFO generating in ISE10.1 IP core is used to cache first two lines image data, so it can ensure that three data arrive simultaneously. In order to removal the data simultaneously, the obtained data is delayed by register. Fig. 4 shows the window generation diagram.

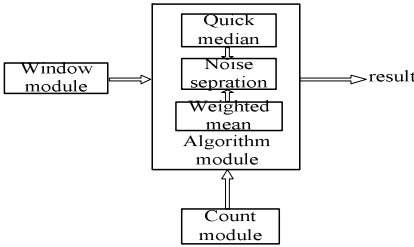


Fig. 3. Hybrid Filter Structure Diagram

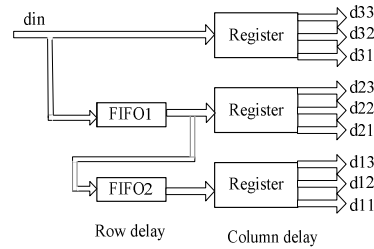


Fig. 4. Window Generation Diagram

Counting Module. Median filter can not implement correctly the midship line and midship column in every line in an image needing the count module [7] to control the filter. Set the output to zero when the window moving to the edge. We can ensure whether the image reach the edge or not and thus control the edge.

Algorithm Module. The algorithm combined median with mean is explained in third section. After generating the cross window module and renovating the five data, we can get the mean value quickly with the algorithm mentioned in this article. Fig. 5 shows the simulation diagram. Noise separation is based on the median output. Fig. 6 shows the noise separation simulation diagram.

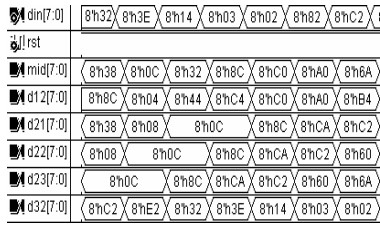


Fig. 5. Window Simulation Diagram

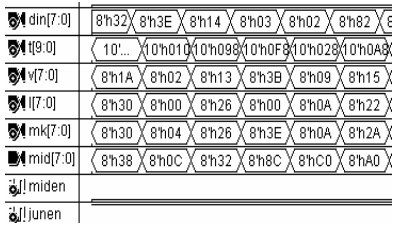


Fig. 6. Noise Separation Simulation Diagram

After judging the noise type, the values of miden and junen determine whether the output is weighted mean or median. Row-column ri and lj determine to reset the output. Fig. 7 shows the globe simulation diagram.

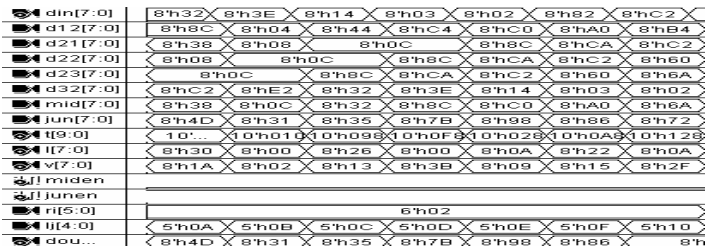


Fig. 7. Globe Simulation Diagram

5 Result Analysis

Under the same condition, we contrast the real-time performance between the traditional median algorithm and the improved median algorithm. The clock frequency of FPGA is 50Mhz. Table 1 shows the result.

Table 1. Real-time Performance Comparison

Filter algorithm	Clock frequency	Processing time
Traditional median	50[MHz]	1.24[ms]
improved median	50[MHz]	0.52[ms]

Under the same condition, we contrast the image before and after the filter algorithms which contain the mean filter algorithm, the median filter algorithm and the hybrid filter algorithm based on image acquisition system. Fig. 8 shows the comparison diagram.

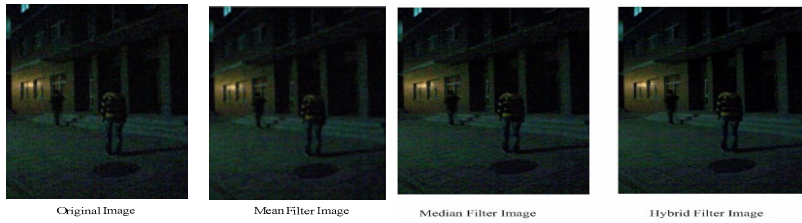


Fig. 8. Comparison Diagram

Contrasting original and de-noising image, the image which use hybrid filter algorithm has higher visual effect.

The collected four images are put into Matlab, count the PSNR [8] separately in the yuv color space. Table 2 shows the result.

Table 2. PSNR Comparison

Filter algorithm	PSNR
mean filter	28.721
median filter	29.857
hybrid filter	31.041

6 Conclusion

The hybrid filter algorithm which is proposed in this article can effectively remove the noise. The algorithm make full use of the parallel features of FPGA .It not only improve the processing speed significantly but also satisfies the real-time requirement and has ideal de-noising effect. Due to the programmable features of FPGA, the hybrid filter algorithm has high value in many applications, such as real-time monitoring, video booth and so on.

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Study of Environmental Impact Parameters on National Days in Typical Traffic Streets of Shanghai Based on Modified Grey Cluster Method

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Abstract. Many environmental parameters can impact the ambient air quality. Some ones are usually lack of data. Grey system method can be applied for such uncertainty analysis. This paper utilized a width gray cluster analysis model for assessing the impact of key environmental parameters on ambient air quality. Several sites in Shanghai are studied on base of the new model. The results show that PM10 may be the main component with significant impact on ambient air quality in the road with fewer crowds in Shanghai. Case study also demonstrates that the grey cluster analysis model can be applied well for assessing the impact of key environmental parameters on ambient air quality.

Keywords: Grey cluster method, Ambient Air quality, Typical Traffic Street, Shanghai.

1 Introduction

Assessment on ambient air quality in the road belongs to a complex control system with multi-objectives and multi-layers. Many contaminants may impact on ambient air quality. For the complexity of environmental phenomenon and lack of data of the contaminants, recent researches are focus on those uncertainty questions with many methods. The grey system may be a satisfied method [1]-[4]. Deng firstly introduced the grey model which is a truly multidisciplinary and generic theory that deals with systems that are characterized by poor information and/or for which information is lacking [5]-[7].

Meng introduces the weighted value to obtain related degree during applying the method of grey related degree analysis to assess ambient air quality [8]. Fan forecasted a variation trend of the ambient air quality through remnant difference correction GM(1,1) model with grey system. Their results were quite in agreement with the observations with relative errors from 0.4% to 7.7% [9]. Lee compared three forecasting models based on the mean absolute percentage errors of their accuracy from the grey model in forecasting air pollution in a traffic tunnel. They found that

the modified grey model was simple and efficient [10]. This paper tries to use a modified grey cluster analysis method to assess the impact of key environmental parameters on ambient air quality.

2 Methods and Materials

Traditional grey cluster model. The grey cluster function can be defined as $F_{jk}(x)$ as follows.

$$F_{jk}(x) = \begin{cases} a_{jk}X & X \in [0, \lambda_{jk}(2)] \\ F_{jk}(s) & X \in [\lambda_{jk}(2), \infty] \\ (k=1, F_{jk}(s)=1) \end{cases} \quad (1)$$

$$F_{jk}(x) = \begin{cases} a_{jk}X & X \in [\lambda_{jk}(1), \lambda_{jk}(2)] \\ -a_{jk}[X - \lambda_{jk}(2)] + F_{jk}(s) & X \in [\lambda_{jk}(2), \lambda_{jk}(3)] \end{cases}, k=1, 2, \dots, m-1 \quad (2)$$

$$F_{jk}(x) = \begin{cases} F_{jk}(s) & X \in [-\infty, \lambda_{jk}(2)] \\ -a_{jk}[X - \lambda_{jk}(2)] + F_{jk}(s) & X \in [\lambda_{jk}(2), \lambda_{jk}(3)] \end{cases}, k=m \quad (3)$$

where X is the value for the analyzed air contaminant with the sequence number of j ($j=1, 2, \dots, n$); $F_{jk}(x)$ is defined as the value of the corresponding grey cluster function for X . Here, j ($j=1, 2, \dots, n$) is the sequence number of the analyzed air contaminant, and k ($k=1, 2, \dots, m$) is the assessing level. In all above equations, $\lambda_{jk}(2)$ is named for the standard value in k level. $[\lambda_{jk}(1), \lambda_{jk}(3)]$ is the fuzzy range with the central value of $\lambda_{jk}(2)$. $F_{jk}(s)$ is defined as the value of the corresponding grey cluster function to $\lambda_{jk}(2)$. a_{jk} is the slope of the function.

Modified grey cluster model. The new grey cluster model has changed the grey cluster function and can be shown as:

$$F_{jk}(x) = \begin{cases} 1 & X \in [0, \lambda_{jk}] \\ 1 - (X - \lambda_{jk}) / (\lambda_{jk+1} - \lambda_{jk}) & X \in [\lambda_{jk}, \lambda_{jk+1}] \\ (k=1) \end{cases} \quad (5)$$

$$F_{jk}(x) = \begin{cases} (X - \lambda_{jk-1}) / (\lambda_{jk} - \lambda_{jk-1}) \\ \quad X \in [\lambda_{jk-1}, \lambda_{jk}] \\ 1 \quad X \in [\lambda_{jk}, \lambda_{jk+1}] \\ 1 - (X - \lambda_{jk+1}) / (\lambda_{jk+2} - \lambda_{jk+1}) \\ \quad X \in [\lambda_{jk+1}, \lambda_{jk+2}] \end{cases}, k=1, 2, \dots, m-1 \quad (6)$$

$$F_{jk}(x) = \begin{cases} (X - \lambda_{jk-1}) / (\lambda_{jk} - \lambda_{jk-1}) \\ \quad X \in [\lambda_{jk-1}, \lambda_{jk}] \\ 1 \quad X \in [\lambda_{jk}, \infty] \end{cases}, k=m \quad (7)$$

where λ_{jk} is the standard value in k level for new grey cluster model.

Grey cluster vector. After the new grey cluster function being decided, the grey cluster coefficient μ_{jk} can be defined as Eq. 8.

$$\mu_{jk} = \frac{1}{n} \sum_{j=1}^n F_{jk}(s) \quad (8)$$

Ambient air quality level. The standard for defining ambient air quality levels has been stipulated by CNIS in 1996 [11]. Those limits can be transferred to the grey level and illustrated in Table 1.

Table 1. Limits values of ambient air parameters in china

Level	SO ₂ (mg/m ³)	NO _x (mg/m ³)	CO (PPM)	PM10 (mg/m ³)
I	0.02	0.05	4	0.08
II	0.06	0.05	4	0.20
III	0.10	0.10	4	0.30
IV	>0.10	>0.10	>6	>0.30

3 Case Study

The new grey model is used to assess the ambient air quality in streets in National day in Shanghai.

Four ambient air parameters had been investigated in the three sites of the typical traffic streets. The tested ambient air parameters are sulfur dioxide, nitrogen oxides, carbon monoxide and particulate matter with equivalent diameter of 10 micron.

As Fig. 1, the tested sites are two sites in Xinhua Road with fewer crowds and cars and one site in Yan'an Road with much crowds and cars. All samples were monitored on an eight-hour basis and in holiday of National Day from Oct. 1st to 3rd in 2010, which was less influenced by rainy climate.



Fig. 1. The tested sites

Particulate matters and gaseous pollutants were in unit of mg/m^3 or PPM. TSI 8520 DUSTTRAK Aerosol Monitor, TSI 8554 Q-TRAK IAQ Monitor and SwemaAir300 digital hygrothermograph were used to measure their level. The average logged results are shown as Table 2.

Table 2. Original data of ambient air parameters in shanghai

Sites	SO ₂ (mg/m ³)	NO _x (mg/m ³)	CO (PPM)	PM10 (mg/m ³)
S1	0.009	0.020	0.142	0.234
S2	0.010	0.026	0.152	0.296
S3	0.012	0.030	0.157	0.386

The value of the grey cluster function can be calculated by Eq. 5 to Eq. 7 and shown in Table 3.

Table 3. The value of the grey cluster function

Level	SO ₂	NO _x	CO	PM10
I	0.122	0.306	0.408	0.326
II	0.197	0.246	0.328	0.230
III	0.249	0.233	0.259	0.259
IV	0.251	0.261	0.244	0.244

Moreover, the grey cluster coefficient can be gotten by Eq. 8 and shown in Table 4.

Table 4. The grey cluster coefficient

Sites	I	II	III	IV	RESULTS
S1	0.836	0.034	0.221	0	Level I
S2	0.824	0.098	0.140	0.112	Level I
S3	0	0.767	0.062	0.314	Level II

4 Discussion

Obviously, Table 4 demonstrates that two sites in Xinhua Road had ambient air quality of level I and the rest site in Yan'an Road was in level II.

Traditional grey method considers the grey character of the whole system and can analysis the contribution to comprehensive pollution by each ambient air parameter. This method has the advantage of deducible convenience. However, the resolving power of traditional grey method is so low that the results may be unreasonable. As far as using traditional grey cluster, the results in Table 4 will be changed as that the ambient air quality of all sites are level I. As a fact, site 3 had a high concentration of PM10. The modified grey model explains the above results with the new model.

5 Conclusion

The results show that PM10 may be the main component with significant impact on ambient air quality in the road with fewer crowds and cars in Shanghai. However, the CO may be the main component in the road with much crowds and cars.

New grey cluster method has applied the fuzzy methodology into the grey system, which is to consider the fuzzy and randomness of the goal. This can improve the sensitivity of the assessment method. The results show a good agreement with the real ambient air quality. It can be concluded that the new grey cluster method may be a reasonable improvement for the traditional grey method.

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A Way for Real-Time Rendering Algorithm of Visual Endoscopy Scene Based on GPU

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Abstract. This paper is about a new real-time rendering algorithm of visual endoscopy scene based on GPU parallel computing technology. Without decreasing the display precision of three-D image, this algorithm uses ray casting algorithm to reduce the amount of collected data of graphic hardware memory and applies GPU high-level parallel computing and the multiple data stream processing capacity in generating the ray and rendering fragment which are the most sophisticated parts of volume rendering. As for CT data of $512 \times 512 \times 355$, in addition to ensuring the clear display of the image this algorithm can make the rendering speed faster than 40 fps.

Keywords: Visual Endoscopy, Ray Casting, Volume Rendering, GPU.

Introduction

With its non-invasive quality, repeatability and other obvious advantages, visual endoscopy has been studied and applied widely. At present, visual endoscopy has been applied to many clinical trials and various medical diagnoses, mainly focusing on those organs with a cavity structure, such as the colon, the trachea and the blood vessel. With the further development of medical three-D visualization, the conflict between the volume rendering speed and the user's requirement for real-time interactive processing is getting tenser. Programming based on PC graphics hardwares have been more and more common with the wide spread of PC Programmable graphics hardwares and the common use of Compute Unified Device Architecture(CUDA).

1 The Basis of Programmable Hardware and the Traditional Ray Casting

Since the basic work of three-D graphics is traditionally performed by CPU, graphics card is only in charge of frame buffer. In 2003, GPU was first used for common parallel computing, and it was in the same year that it entered the mainstream of parallel computing. The three-D graphics computation is highly speeded up by the particular parallelism and high dense computation of GPU, less data communication between GPU and CPU and other advantages[1-3].

CUDA is a new architecture of software and hardware . We can regard GPU as a device for parallel data computing, then CUDA is in charge of distributing and

managing the processed computation[4], CUDA can directly invoke the computing resources of GPU.

The main idea of Ray Casting[5-7] is to simulate the process in which the projection of natural ray of light on an object is partly absorbed or occluded by some semitransparent object and an image is formed on the other side of projected object. As is shown in Fig.1, ray ds casts on point a , and transmits between point a and b , then leaves the object at point b . When the ray is transmitting in the object, the ray is influenced consecutively. This process can't be accurately materialized in the algorithm. In practice, we resample the consecutive ray as many discrete points and classify these discrete points by mapping the volume data to colors. Thus, the results will be integrated from front to back or from back to front to simulate the process in which ray goes through an object.

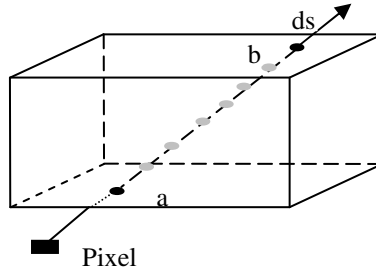


Fig. 1. Theory of Ray Casting

2 Ray Casting Algorithm Based on GPU

2.1 Transparency Composing

Transparency naturally means the ability of penetrating an object. When a ray goes through an object, the wavelength ratio will change. If it goes through more than one object, the changes will accumulate. Therefore, rendering of a transparent object is basically the blending of the color of a transparent object and that of the object behind it. The blending formula is shown as follow:

$$c_0 = a_s c_s + (1 - a_s) c_d \quad (1)$$

In this formula, a_s represents the transparency of a transparent object, c_s is the original color, c_d is the original color of the target object, and c_0 is the result color value obtained by observing the target object through the transparent object.

In ray casting algorithm, the transparency is ordered while the ray going through volume texture. Thus, the process of ray going through volume texture can be regarded as the sample synthesizing procedure. When we synthesize the sample from front to back, the synthesizing formula can be :

$$\begin{aligned}
C_i^\Delta &= (1 - A_{i-1}^\Delta)C_i + C_{i-1}^\Delta \\
A_i^\Delta &= (1 - A_{i-1}^\Delta)A_i + A_{i-1}^\Delta
\end{aligned} \tag{2}$$

C_i and A_i stand for the result color value and opacity gained from collecting the sample in the volume texture, and they are actually the data in voxel. C_i^Δ and A_i^Δ are the accumulated color value and opacity.

2.2 The Sampling Process along the Ray

As is shown in Fig.2, providing that the ray projects on the cube from point F, and leaves from point L, the supposed crossing distance is m . After the ray projects onto the cube from point F, the sampling process begins when the crossing distance is $n(n < m)$. Therefore, we have a formula(3):

$$T = T_s + d \times \Delta t \tag{3}$$

In this formula, T_s represents the volume texture coordination of the projected point in the cube's surface, and d is the projecting direction. Whereas, Δt stands for the interval of sampling which will increase with n increasing. T is the final coordination of sampled texture. We can find the voxel data in the volume texture through the obtained coordination of sampled texture. The sampling process of a ray will not stop until $n > m$ or the transparency adds up to over 1.

3 Realization of Algorithm

Based on the above theory, as well as the limitation of the storage space of graphics hardwares, a relatively larger amount of data can not be all loaded to the display memory at a time. In our algorithm, a rendering technology based on the division of field of view will only render the voxel within the field of view. The fundamental principle of this algorithm is that we first map the three-D volume data to world coordinate system, then divide the data into visible and invisible according to the field of view. Render the visible data in the current frame, and the basic steps are followings:

- 1) Generate the ray: generate the starting point and direction for the original ray.
- 2) Traverse the scene: organize the scene, search for the model surface primitives which need ray-intersecting with the spatial dissection structure of the ray information in the visible field.

3) Finish model intersection: detect the intersecting point and compute the intersection between the ray and the surface primitives.

4) Render and derive the ray: compute the lighting with the phone lighting model, then add the result to the related pixel in the frame buffer. If the rays intersect, generate the according inflected light or refracted light with the information of intersecting point. When it is necessary, the shadow will be generated to test the ray.

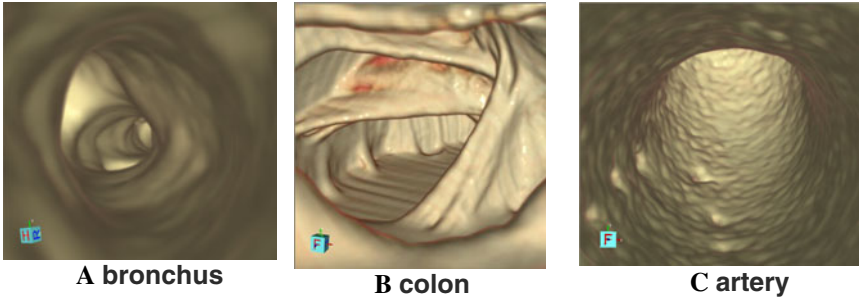


Fig. 2. Experimental Results

4 Result and Conclusion

In this paper, the algorithm is improved with VC++6.0 and OpenGL. The computation of GPU is achieved by CUDA, and the test is carried out on three kinds of datasets. The configuration of the machine is Intel Core 2 Duo E6300 CPU 2GB memory, GeForce GTX 570 display card, 1280MB display memory, and Windows XP SP3 system. The result is shown in Fig.2 and Table 1.

Table 1. Speed Comparison between Traditional Algorithms and Present Algorithm(unit: fps)

experimental data	Chest CT (bronchus)	Belly CT (colon)	Chest CT (artery)
resolution ratio	512×512×217	512×512×252	512×512×355
traditional algorithm	9.8	6.4	3.5
proposed algorithm	50.8	43.7	42.0

In Table 1, the rendering speed has been obviously lifted after the improvement, and there are two reasons for that. One is that there are a large amount of visible data in bronchus, colon and blood vessel and in this algorithm we filter those visible data. The other one is that we apply GPU parallel computing from generating the ray to rendering fragment.

Without decreasing the display precision of three-D image, we successfully reduce the number of voxels in the computation of ray projecting. By applying GPU high-level parallel computing and the multiple data stream processing capacity in generating the ray and rendering fragment which are the most sophisticated parts of

volume rendering, pre-processing time is reduced, and the rendering speed of scene is lifted dramatically, which surely meet the need of large volume data rendering.

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FPGA Implementation of a Novel Type DDS Based on CORDIC Algorithm

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Abstract. A novel digital frequency synthesizer (DDS) is introduced using CORDIC algorithm module instead of ROM look-up table module in the paper. Application of CORDIC algorithm module can greatly reduce the amount of storage and cancel the amount of storage to improve data accuracy and improve the DDS frequency resolution limits. An increasing zero-iteration of the CORDIC algorithm module is applied on a novel type DDS through the Altera FPGA chip using VerilogHDL programming. The simulation and verification results show the feasibility of this approach. This new method has simple circuit structure and high frequency resolution, suitable for VLSI inheritance compare with the old type DDS.

Keywords: CORDIC, DDS, FPGA, pipeline, VLSI.

1 Introduction

Direct digital frequency synthesizer (Direct Digital Synthesizer, DDS) technology was first put forward by American scholar Tierney[1]. Compared with the other frequency synthesizer, it has many advantages including high resolution, fast frequency conversion speed, phase continuous, and low phase noise. These advantages make the DDS is widely used in digital signal as the signal generator source. It has the arbitrary waveform output capability, and is easy to implement VLSI inheritance and digital modulation. CORDIC algorithm [2, 3] implementation in hardware is used in the adder and shift device before, because this feature will greatly reduce the FPGA resources, and then meet the requirements of the designer [4].

An implementation processes of novel type DDS based on CORDIC algorithms is proposed, which the circuit is simple and easy to realization. VerilogHDL code is written, simulated, verified, and downloaded to the Altera Cyclone II EP2C8Q208C8. The novel method can accurately output sine and cosine waves and can satisfy the requirements of high speed, high accuracy, high resolution, and real-time computing. Compared to the traditional DDS, the novel type DDS based on CORDIC algorithm has lower resource consumption and greatly improved performance and speed.

2 The Principle and Structure of DDS

2.1 The Principle of DDS

Direct digital synthesis (DDS) technology is a departure from the concept of phase; it is one frequency synthesis technology that direct synthesizes required waveforms. DDS is based on a fixed-frequency precision clock as reference clock source, through digital signal processing technology to produce a frequency and phase adjustable output. Therefore, DDS is an extension of the theory of digital signal processing and hardware implementation of signal synthesis problem in digital signal. In the actual DDS, the equation of DDS frequency can be written as

$$f_0 = \frac{K}{2^N} f_c \quad (1)$$

DDS can be achieved by two transformations. Firstly, Clock frequency f_c produce quantitative phase sequence from the variable K . The process is usually implemented by an N-bit phase accumulator with which its clock is f_c , as shown in Fig. 1. Then the corresponding discrete amplitude of sinusoidal signal is generated from quantified discrete phase sequence. This process can be completed by the mapping waveform of ROM. The detailed process can be shown in Fig. 2. The cosine signals of frequency f_0 can be obtained from the digital waveform transformed through the conversion module (A/D) and a low pass filter (LPF).

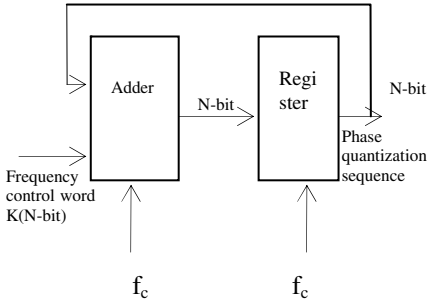


Fig. 1. The schematic diagram of traditional DDS phase accumulator.

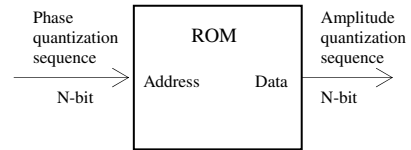


Fig. 2. Traditional DDS phase – amplitude conversion schematic diagram.

Variable K is called the phase increment or frequency control word. When N is large enough, DDS can has very small frequency interval. The output frequency of DDS can be varied from the frequency control word K .

2.2 The Structure of DDS

DDS's structure includes digital part (the phase accumulator and ROM waveform look-up table) and analog part (low pass filter (LPF) and D/A converter), as shown in Fig. 3, where K is the frequency control word, f_c is the clock frequency, N is the phase

accumulator word length, and D is the word length of ROM data bit and D/A conversion bit. Phase accumulator make incremental with steps K under the control of f_c . N -bit binary code is addressed to the ROM as the output of ROM address, after ROM output amplitude of the code $S(n)$. Then it is converted to analog signals through D/A module and then output data flow by the LPF.

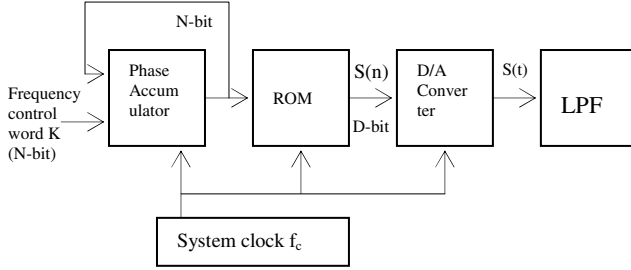


Fig. 3. The basic structure of DDS.

3 A Novel DDS Using CORDIC Algorithm

3.1 CORDIC Algorithm

Coordinate Rotation Digital Computer (CORDIC) algorithm is mainly used for trigonometric, logarithmic, and exponential function calculation. It can be divided into circular mode and vector mode [5]. The sine and cosine signals that generated by DDS are mainly circular pattern. The vector $V_2(x_2, y_2)$ can be derived from the initial vector $V_1(x_1, y_1)$ and rotated angle θ .

$$x_2 = (x_1 - y_1 \tan \theta) \cdot \cos \theta \quad \text{and} \quad y_2 = (y_1 + x_1 \tan \theta) \cdot \cos \theta \quad (2)$$

After a series of conversion, the expressions can be simplified as

$$x_{i+1} = x_i - \delta_i \cdot y_i \cdot 2^{-i} \quad \text{and} \quad y_{i+1} = y_i + \delta_i \cdot x_i \cdot 2^{-i} \quad (3)$$

Above expressions are only additions, subtraction and shift operations. The results can be obtained after n time's iterations using Eq. 3. Letting $x_0 = K_{+1}$, $y_0 = 0$, iteration results are given

$$x_n = \cos z_0, \quad y_n = \sin z_0, \quad z_n \rightarrow 0 \quad (4)$$

As the angle value is set as z_0 , iteration results x_n and y_n are the trigonometric values.

Where positive or negative of δ_i can be determined by z_i in equation $z_{i+1} = z_i - \delta_i \cdot \arctan(2^{-i})$. It is agreed that δ_i on behalf of the vector rotation, -1 represents a clockwise rotation and +1 represents counterclockwise rotation.

$$\delta_i = \begin{cases} 1 & z_i \geq 0 \\ -1 & z_i \leq 0 \end{cases} \quad (5)$$

3.2 A Novel DDS Using CORDIC Algorithm

The traditional phase amplitude converter is basically a look-up table structure. In order to achieve higher frequency resolution and the spectrum degree, frequency control word generally has the larger value. If the frequency control word set to 48-bit, the ROM resources should be consumed and it is impossible in reality to implement. Compared with the traditional DDS which based on look-up table, the novel type DDS based on CORDIC algorithm only needs to change the phase-amplitude converter module, as well as the phase accumulator module does not need to change.

Phase accumulator design. Like the traditional phase accumulator, the frequency control word K and the cumulative output phase data register are added under each clock pulse by adder, and then send the results to register's input port, as shown in Fig. 1. Register feedback phase data which generated in the previous clock to the input of the adder, in order to add frequency control word by adder in the next clock.

Phase accumulator is constituted by the adder and register, using pipeline design. Because the input frequency control word is 48-bit, six grades of pipeline is chosen and each grade is an 8-bit look-ahead adder as a result of look-ahead to reduce the carry delay. After first input frequency control word, accumulated results are output after six cycles. Then adder will output data after every one clock cycle.

Phase-amplitude converter design. In the traditional DDS, N -bit of the waveform memory ROM is equivalent to $0 \sim 360^\circ$ of the sine signal values into a sequence of 2^N samples. When the waveform memory ROM are D data bits, the magnitudes of 2^N samples are stored in the ROM as D -bit binary value. The ROM can output corresponding phase of the sinusoidal according to different address. Phase - amplitude transformation principle is shown in Fig. 2.

Compared to the traditional DDS, CORDIC algorithm is used to implement phase - amplitude converter. CORDIC algorithm can cover the angle range is $[-99.88^\circ, 99.88^\circ]$ [6]. In order to achieve to all angles cover in $[-180^\circ, 180^\circ]$, A novel design using two-grade zero-iteration[7] is adopted to implement phase-amplitude converter in this paper. The scope of the angle will expand 45° after each additional zero-iteration. Therefore, the angle can cover to all angle ranges $[-180^\circ, 180^\circ]$ after the two-grade zero-iteration. At the same time, the two-grade abnormal mode correction factor can also be increased as $(1/\sqrt{2})(1/\sqrt{2})=1/2$, using the two-grade zero-iteration [8, 9]. The abnormal mode coefficients can be calculated by four adders and a move right of two-bit device. The pipeline architecture is adopted in the core CORDIC algorithm to achieve [10], as shown in Fig. 4.

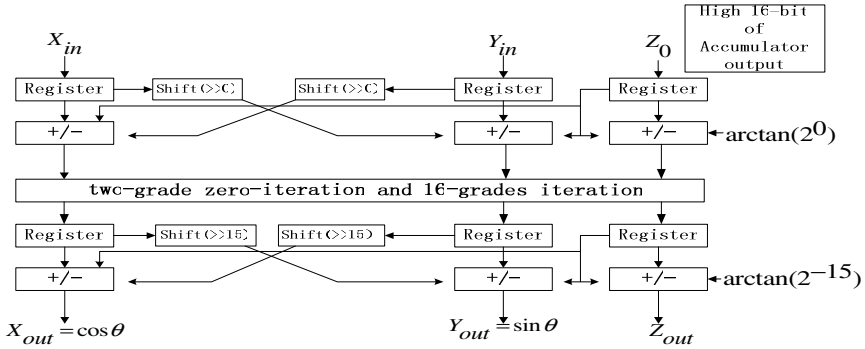


Fig. 4. 18-grades of pipeline structure diagram in CORDIC algorithm.

4 FPGA Implementation and Simulation

The width of 48-bit frequency control word is chosen in the CORDIC algorithm. The output of phase accumulator's high 16-bit is intercepted as the input z_0 of phase-amplitude converter. The pipeline structure is adopted in the phase-amplitude converter, as shown in Fig. 4. Because two grades of zero-iteration are increased, a total of iterations are 18 grades, where the shift sequence is 0, 0, 0, 1, 2, ..., 15. Therefore, the phase-amplitude converter only has shift device, adder and register. After 18 grades of iterations, the desired results can be output from $x_{17} = \cos z_0$ and $y_{17} = \sin z_0$.

VerilogHDL is used to the whole RTL programming. Quartus II 9.1 software is applied on the simulation, placement and routing, and time analysis. Then the data is downloaded to the Altera Cyclone II series EP2C8Q208C8 FPGA chip to verification, and synthesized circuit used simplicity's professional synthesis software simplify pro 9.6.2. Digital part of the DDS only need 916LEs, the frequency can be achieved more than 110MHz.

5 Conclusion

A novel type DDS using CORDIC algorithm module instead of ROM look-up table module is presented in this paper. The novel type of DDS has some good features, such as low consumption of resources, high speed, and easy to implementation, can be observed from the simulation results and synthesized circuit. The novel DDS has a high frequency resolution and can produce sine and cosine two signals. Only adders, shift device and registers are applied according to the derived CORDIC algorithm formula in the novel DDS. Because each pipeline unit has similar structure after the composition of pipeline, it is very suitable for VLSI implementation. When adopting FPGA to implement DDS, the DDS based on CORDIC algorithm module could be a good method to solve the problem that ROM storage capacity bottlenecks bring many limitations to improve performance of DDS.

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Unsupervised Kernel Fuzzy Clustering Based on Differential Evolution Algorithm in Intelligent Materials System

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Abstract. In 2009, we proposed a clustering algorithm called the unsupervised kernel fuzzy clustering algorithm based on simulated annealing (UKFCSA) that generalized the conventional possibilistic clustering and can be run as an unsupervised clustering algorithm. In contrast to the conventional SA based possibilistic or kernel based possibilistic clustering, it has a relatively better performance in several aspects. However, UKFCSA is still a time consuming algorithm. In this paper, an efficient global optimization technique—differential evolution algorithm (DE) is introduced to optimize the clustering model. The contrast experiments with UKFCSA illustrate the effectiveness of the proposed algorithm.

Keywords: clustering, differential evolution algorithm, possibilistic c-means, kernel function.

1 Introduction

As an important tool, cluster analysis has been applied in many fields such as data mining, statistical data analysis, image segmentation and pattern recognition. Compared with the conventional hard clustering, fuzzy clustering has a better performance because of its generalization of the membership values [1, 2]. The most widely used fuzzy clustering algorithm is the fuzzy c-means clustering (FCM), which is proposed by Bezdek in 1981 [3]. An important improved vision of FCM is the possibilistic clustering algorithm (PCM), which is proposed by Krishnapuram and Keller in 1993 [4]. To overcome these problems, we proposed a clustering algorithm called the unsupervised kernel fuzzy clustering algorithm based on simulated annealing (UKFCSA) in 2009 [5]. UKFCSA performs the clustering by optimizing the proposed kernel possibilistic Xie-Beni index using the RJMCMC (Reversible Jump Markov Chain Monte Carlo) based simulated annealing algorithm (SA), which makes the number of clusters change in a given range and the optimal number of clusters and partitioning obtained automatically. In contrast to the conventional SA based possibilistic or kernel based possibilistic clustering, it has a relatively better performance in several aspects. Although UKFCSA

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has a relatively better performance in several aspects, it also suffers from the high computational complexity problem.

In this paper, an efficient global optimization technique—differential evolution algorithm (DE) is introduced to optimize the previously proposed clustering model of generalized kernel possibilistic clustering (GKPCM). The rest of this paper is organized as follows. First, GKPCM is briefly reviewed, and then the proposed algorithm is described in detail. Finally, the contrast experimental results are and our conclusions are given.

2 Unsupervised Kernel Fuzzy Clustering Based on Differential Evolution Algorithm

Generalized kernel possibilistic clustering. There are many modified vision of PCM [5,6] have been proposed in the literature that aimed to improve the performance of PCM according to its disadvantages, especially the coincident clusters problem. However, these algorithms also have or partly have the following three problems. (1) The algorithm must take a preliminary assumption on the cluster number, i.e., it can not run as an unsupervised clustering. (2) The optimization problem of the clustering model consists of several sub-optimization problems and each sub-optimization problem only depends on one cluster center, which results in the coincident cluster problems. (3) All the algorithms mentioned above including FCM, PCM and all of its variants adopt the alternative optimization method to minimize the objective function. However, the alternative optimization method sometimes may trap into local optimal values, which makes these algorithms tend to find incorrect clustering partitions. To overcome these problems, we proposed a clustering algorithm called the unsupervised kernel fuzzy clustering algorithm based on simulated annealing (UKFCSA) in 2009 [5]. The clustering model of UKFCSA is called the generalized kernel possibilistic clustering model, which can be described as follows.

Minimize

$$J(U, V) = \sum_{i=1}^c \sum_{j=1}^n u_{ij}^m D_{ij}^2 + \sum_{i=1}^c \eta_i \sum_{j=1}^n (1 - u_{ij})^m$$

subject to $v_i \in \Omega^{(i)}, 1 \leq i \leq c.$

where n is the total number of samples and c is the number of cluster ($1 < c < n$). The exponent $m > 1$ is the fuzzy factor, which is used to control fuzziness or amount of clusters overlap. $U = [u_{ij}]_{c \times n}$ is the fuzzy partition matrix of $c \times n$, u_{ij} is the value of the membership function of the j th sample belonging to the i th cluster.

Table 1. Computational efficiency of different algorithms

	Iter. times	time(second)	optimal value
UKFCSA	7588	17.9482	177.4918
proposed	270	5.3042	122.2980

$X = \{x_1, x_2, \dots, x_n\} \subset R^s$, s is the dimension of space. $V = [v_1, v_2, \dots, v_c]$ is the cluster center matrix of $c \times s$, where v_i is a cluster center. $D_{ij} = \|\Phi(x_j) - \Phi(v_i)\|$ is the distance from x_j to cluster center v_i in the feature space and $\Omega^{(i)}$ is a subset of R^s .

Differential evolution algorithm. The differential evolution algorithm (DE) is a random search-based heuristic global optimization method [6, 7]. Under certain conditions, it ensures the optimal solution by minimizing the cost function obtained in the probability sense. Practical applications have shown the efficiency of the differential evolution algorithm. There are 10 basic DE variants [13] in the literature that were proposed by Storn and Price. Here we use the vision of DE/rand/1/bin to optimize our clustering model. For population at the t th generation $\{Z^{(1)}(t), Z^{(2)}(t), \dots, Z^{(NP)}(t)\}$, where $Z^{(i)}(t)$ ($i = 1, 2, \dots, NP$) is a D -dimensional vector (also called individual or parameter vector), NP is the population size, three operation i.e., mutation, crossover and selection are conducted to generate the next generation of the population. In mutation and crossover, each individual will reproduce a new offspring individual $Z^{(i)'}(t)$. In selection, $Z^{(i)'}(t)$ is determined to replace $Z^{(i)}(t)$ or not, then the update is accomplished and the next population is generated. The individual that yields the least cost function is the optimal solution when DE is terminated.

3 Contrast Experimental Results

Experiments. We compared the proposed algorithm with UKFCSA to test its computational efficiency. The test data set is the well-known data of Iris data set, which is one of the most used real world benchmark data in machine learning [8]. It consists of 150 samples of three classes with four-dimension. Figure 1(a) depicts the iris data in its dimensions of sepal length, sepal width, and petal length. The initial centers for PCM obtained by FCM are reasonable, and close to the real cluster

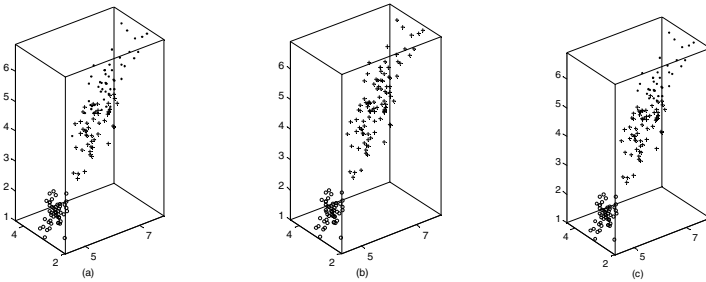


Fig. 1. Results on Iris data: (a) The original data set; (b) crisp partition of three clusters from PCM; (c) crisp partition of three clusters from UKFCSA and our algorithm;

center (class mean). In this case, PCM still generate two coincident clusters [see Fig. 1(b)], while both UKFCSA and the proposed algorithm have a acceptable performance [see Fig. 1(c)]. From table 1 we can see that our algorithm has fewer iteration times and less computational time than that of UKFCSA.

Conclusion. In this paper, we adopt the efficient global optimization method of the differential evolution algorithm to find the optimal partitions of the data set. The contrast experimental results show that the proposed algorithm inherits the merit of UKFCSA, in the meanwhile it converge faster and has a higher computation speed. Our future work is to study the relations between the cluster performance and the kernel function, so we can choose an appropriate type of kernel function and the parameters according to the prior information of the date set to be classified.

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Variations of Western Boundary of the Kuroshio in the East China Sea

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Abstract. Studying on the temporal and spatial variations of the western boundary of the Kuroshio in the East China Sea (KECS) will help to further understand the interaction between Kuroshio water and East China Sea shelf water. In this paper, the temperature-salinity (T-S) scatter diagram statistical analytic method was improved to analyze the western boundary of the KECS; the temporal and spatial variations of the western boundary were manifested by using the MATLAB computer program. The following main results have been obtained. (1) The western boundary shows varying degree of convexity to the continental shelf area or concavity to the Kuroshio in different locations. (2) From the entrance to the exit, it is mainly in the northeast of Taiwan and the southwest of Kyushu that the western boundary bulges to the shelf area greatly above 100m depth, compared with the middle of the KECS from 100m to 200m depth. (3) If the convexity to the shelf area is defined as peak and the concavity to the Kuroshio is defined as valley, the western boundary appears peak and valley alternately from the surface to 200m depth. Alternate peak and valley changes greatly in different seasons above 100m depth, but changes little from 100m to 200m depth. (4) The spatial variations of the western boundary in spring and autumn are more dramatic than that in winter and summer, for there are eight depth layers with peak or valley in spring and autumn from the surface to 200m depth, in contrast to seven in winter and summer. (5) From winter to autumn, in terms of the surface, latitudes reached by the western boundary in the middle of the KECS (125.5°E) and southwest of Kyushu (128.5°E) changes little, respectively around 28.0°N and 31.0°N; but changes greatly in the northeast of Taiwan (122.5°E), respectively 26.4°N, 25.8°N, 25.3°N and 26.3°N in four seasons.

Keywords: Sea hydrological-climate environment, East China Sea, Kuroshio, Water mass.

1 Introduction

The Kuroshio is a strong western boundary current along the North Pacific Ocean, with high temperature, high salinity, and high velocity. As an important part of the

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North Pacific subtropical circulation, the Kuroshio carries huge heat from low latitudes to mid-latitude regions, affecting the climate and environment in East Asia [1]. Along the outer edge of East China Sea shelf, the Kuroshio water interacts with the shelf water, as a result of the interaction, the energy and material exchange is the main reason for variations of coastal circulations, and also an important factor affecting the climate and environment in China [2]. In terms of water masses, there is always a boundary between Kuroshio water and other water masses essentially. Identifying the boundary of the Kuroshio is of crucial significance on further study of interaction between the Kuroshio and shelf water, energy and material exchange, the impact range and flow changes of the Kuroshio. As to the boundary (or width) of the Kuroshio, Guan [3] once took the part where the velocity $\geq 40\text{cm/s}$ as the width of Kuroshio; For the sake of plotting convenience, Sun [4] took the part where the velocity $\geq 1\text{Kn}$ (about 51.4cm/s) as the width of Kuroshio; According to the Argos satellite-tracked drifter data, combined with the submarine topography, Ren and others [5] took the approximate isobathes as the boundary of the Kuroshio. In addition, Zheng and Tan [6] determined the boundary of the Kuroshio with temperature gradient and salinity gradient when studying the ocean front. With the development of water mass analysis, many scholars applied different water mass analytic methods to analyze the water masses in the East China Sea (ECS), and gave the boundary of Kuroshio surface in winter and summer [7, 8]. Researches mentioned above laid the foundation for the further research of the boundary of the Kuroshio. However, because of the limitations of the navigational measurement data, the temporal and spatial variations of the Kuroshio boundary were not clear.

Seasonal and interannual climate changes have become an urgent need for the climate prediction, the role which oceans play in seasonal and interannual climate changes become the focus of marine science in recent years [9]. Based on the global ocean temperature and salinity database, improving the temperature-salinity (T-S) scatter diagram statistical analytic method, this paper attempts to analyze the temporal and spatial variations of the western boundary of the Kuroshio in the East China Sea (KECS).

2 Study Region

According to previous studies, the axis of the KECS is quite close to the 200m depth contour [10], combined with the circulation in the ECS [2], this paper's study region is defined to be the range of $25.5^{\circ} \sim 32.5^{\circ}\text{N}$, $122.5^{\circ} \sim 128.5^{\circ}\text{E}$ with the upper left corner and lower right corner of the area clipped (Fig. 1).

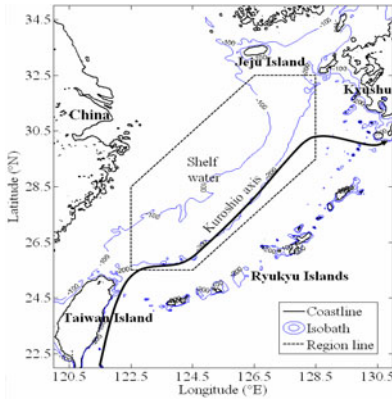


Fig. 1. Study region

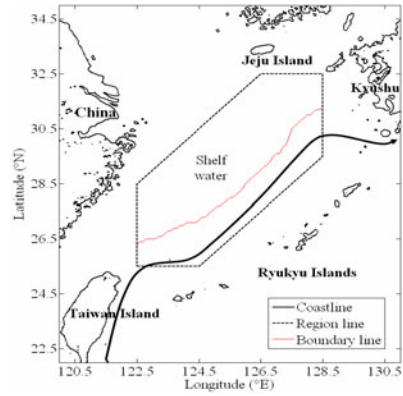


Fig. 3. Western boundary of the surface of the KECS in February

3 Data and Method

Data. The data comes from World Ocean Atlas 2009 (WOA09), which was released by the National Oceanographic Data Center (NODC) of National Oceanic and Atmospheric Administration (NOAA) in 2010. It is a set of objectively analyzed (1° grid) climatological fields of in situ temperature, salinity, dissolved oxygen and other parameters at for annual, seasonal, and monthly compositing periods for the World Ocean. In this study, the temperature and salinity data [11, 12] will be drawn out, its grid is $1^\circ \times 1^\circ \times$ standard depth levels.

Method. Temperature and salinity are the two most important parameters of seawater; the traditional water mass analysis was usually on the basis of T-S diagram. If a large number of data points in large-scale sea areas are mapped on the coordinate plane with temperature as ordinate and salinity as abscissa, the T-S scatter diagram can be got. According to the definition of water mass in terms of set theory — water mass is a set of similar water types [13] — this is corresponding directly to the relatively dense scatter set on the diagram. Obviously, on the diagram, the dense part is corresponding to the body of the water mass, while the sparse part is corresponding to the mixing zone between water masses [7]. If a logical line can be worked out in the mixing zone, then mapped on the topographic map, the boundary of the water mass will appear.

In this study, February, May, August and November are chosen as the representative months of winter, spring, summer and autumn, the MATLAB computer program is used to extract the data of $25.5^\circ \sim 32.5^\circ\text{N}$, $122.5^\circ \sim 128.5^\circ\text{E}$ range, standard depth levels — 0m, 10m, 20m, 30m, 50m, 75m, 100m, 125m, 150m and 200m — from the surface to 200m depth. Then the data is interpolated into $0.1^\circ \times 0.1^\circ$ grid.

Now the surface of the KECS in February is taken for example (Fig. 2), the axes are divided into equal intervals, then the T-S data points in each interval are counted, and the frequency curves of temperature and salinity were made respectively.

Obviously, the peaks of the curves are corresponding to the body of the water masses, while the valley is corresponding to the mixing zone between water masses. According to previous studies [8], there are two main water masses — Kuroshio water and shelf water — in this study region. There are two obvious peaks and a relative valley on the frequency curves of temperature and salinity, the two peaks are the Kuroshio water and shelf water; the valley is the mixing zone between them.

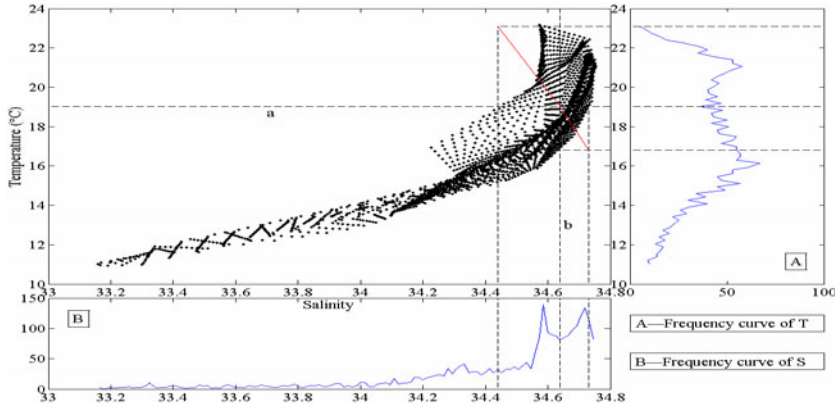


Fig. 2. T-S scatter diagram and T&S frequency curves of the surface of the KECS in February

Dashed a and b were made through the lowest points of temperature valley and salinity valley, so they divide the T-S scatter diagram into upper right, lower right, upper left and lower left four rectangular regions. Evidently, the T-S points in the upper right region with high temperature and salinity are the main body of Kuroshio water; in contrast, the T-S points in the lower left region with low temperature and salinity are the main body of shelf water. The lower right and upper left regions are the main mixing zone between the two water masses. Then a logical line needs to be worked out in mixing zone as the boundary of water mass. The approach is as follows.

First, define the actual rectangular regions in the lower right and upper left regions, and then make the diagonals of the actual rectangular regions, for the diagonals can divide the T-S points in the actual rectangular regions into two parts logically, so the diagonals divide all the T-S points in the diagram into two parts — Kuroshio water and shelf water. Last, map the diagonals on the topographic map, the western boundary of the surface of the KECS in February is got (Fig. 3).

With the same method, the western boundaries of the KECS of standard depth levels in February, May, August and November were got. It should be noted that, since the KECS flows close to the steepest slope below 200m depth, the 200m depth contour was defined as the western boundary of the KECS in the range of 122.5° ~ 127°E. On the basis of the boundaries, using the MATLAB computer program to interpolate and visualize, the western interfaces of the KECS in four representative months were worked out (Fig. 4).

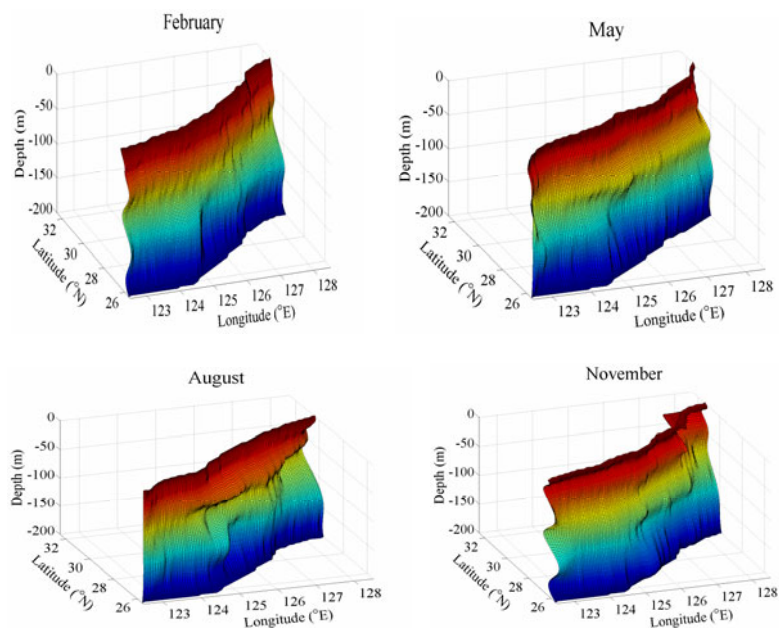


Fig. 4. Western interfaces of the KECS in four representative months

4 Results and Discussion

It is shown from the western interfaces of the KECS in four representative months that, the spatial variations of the western boundary of the KECS are large in different seasons, that is to say, the western boundary shows varying degree of convexity to the shelf area or concavity to the Kuroshio in different locations from the entrance — the northeast of Taiwan to the exit — the southwest of Kyushu and the surface to 200m depth. This is reflecting the interaction between the Kuroshio water and shelf water directly. From the entrance to the exit, there are two main areas — the northeast of Taiwan and the southwest of Kyushu — in which the western boundary bulges to the shelf area greatly above 100m depth, being consistent with the results that Yu has got from the Argos satellite-tracked drifter data, however, due to the submarine topography, it is in the middle of the KECS that the western boundary bulges to the shelf area greatly from 100m to 200m depth. For the sake of studying convenience, the convexity to the shelf area is defined as peak and the concavity to the Kuroshio is defined as valley, so the western boundary appears peak and valley alternately from the surface to 200m depth, Lu [8] has got the similar results when he studied the water masses in the ECS.

The variations of the western boundary of the KECS in winter, spring, summer and autumn were compared in the northeast of Taiwan (122.5°E), the middle of Kuroshio (125.5°E) and the southwest of Kyushu (128.5°E). From the Fig. 4, some results could be obtained as follows.

Overall, the spatial variations of the western boundary in spring and autumn are more dramatic than that in winter and summer, for there are eight depth layers with peak or valley in spring and autumn from the surface to 200m depth, in contrast to seven in winter and summer. As we know, spring and autumn are transitions between winter and summer, the temperature of the sea water is complex and unstable this time [14], so the interaction between water masses is relatively strong.

From winter to autumn, Alternate peak and valley changes greatly in different seasons above 100m depth, but changes little from 100m to 200m depth. The temperature and salinity of the sea water are affected by the weather conditions [14], and the sea water above 100m depth is influenced by the weather conditions more greatly than that from 100m to 200m depth. So, compared with the boundary from 100m to 200m depth, the boundary above 100m depth changes greatly.

From winter to autumn, in terms of the surface, latitudes reached by the western boundary in the middle of the KECS (125.5°E) and southwest of Kyushu (128.5°E) changes little, respectively around 28.0°N and 31.0°N; but changes greatly in the northeast of Taiwan (122.5°E), respectively 26.4°N, 25.8°N, 25.3°N and 26.3°N in four seasons. Due to the effects of seasonal changes of Taiwan Strait water, in the northeast of Taiwan, the western boundary of the KECS changes greatly. In winter, Taiwan Strait water is less while the Kuroshio water intrusion is significant; in spring, Taiwan Strait water increases gradually while the Kuroshio water intrusion declines; in summer, the Taiwan Strait water expands more greatly, this time the Kuroshio is stopped by the front, the intrusion is very slight; in autumn, the Taiwan Strait water starts to decrease while the Kuroshio water intrusion starts to increase [15].

5 Conclusions

This study validated the results of some previous researches, and got some new phenomena.

- The spatial variations of the western boundary of the KECS are large in different seasons. The western boundary shows varying degree of convexity to the shelf area or concavity to the Kuroshio in different locations from the entrance to the exit and the surface to 200m depth.
- From the entrance to the exit, it is mainly in the northeast of Taiwan and the southwest of Kyushu that the western boundary bulges to the shelf area greatly above 100m depth, compared with the middle of the KECS from 100m to 200m depth.
- The western boundary appears peak and valley alternately from the surface to 200m depth. Alternate peak and valley changes greatly in different seasons above 100m depth, but changes little from 100m to 200m depth.
- Overall, the spatial variations of the western boundary in spring and autumn are more dramatic than that in winter and summer, for there are eight depth layers with peak or valley in spring and autumn from the surface to 200m depth, in contrast to seven in winter and summer.

- From winter to autumn, in terms of the surface, latitudes reached by the western boundary in the middle of the KECS (125.5°E) and southwest of Kyushu (128.5°E) changes little, respectively around 28.0°N and 31.0°N; but changes greatly in the northeast of Taiwan (122.5°E), respectively 26.4°N, 25.8°N, 25.3°N and 26.3°N in four seasons.

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Reusable Pseudonym Privacy Protection in Pervasive Computing

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Abstract. Pervasive computing brings a lot of convenience to users and also carries serious privacy issues on them. A reusable pseudonym privacy protection for pervasive computing is presented. The pervasive computing systems will be divided into many autonomous regions, and each autonomous region uses the same pseudonym sets. Users will be randomly assigned a pseudonym within a region that it did not use currently in this region. The relationship between the user and a pseudonym are a complex relationship of many to many, and it is better to protect users' privacy. From the security analysis, the method is safe and feasible. In addition, the privacy protection method requires only a small burden for pseudonym management. Pseudonym of the selection process is completed by the authentication server. Therefore, the privacy protection program has little interference on the users.

Keywords: pervasive computing, pseudonym, privacy protection.

1 Introduction

Pervasive computing environment are composed of various terminals, such as sensors, cameras, radio frequency identification (RFID), global positioning system (GPS), mobile PC and mobile telephones. These devices will be everywhere and many are not visible (eg, sensors). In the pervasive computing environment, in order to better provide services to users, the environment need to collect and use some personal information, which apparently involves the user's private information. The invisibility of pervasive systems lets them very hardly know when, where and what equipments are to serve them, what personal information is collected and processed by these devices. In addition, because of the awareness ability of sensor networks in the pervasive computing environment, and the development of artificial intelligence and data mining technology, these make a lot of personal data more easily to be captured and analyzed. Therefore, a privacy protection program which is safe and small interference to the user has very important significance.

At present, some researches about privacy protection of pervasive computing mainly are the following several methods. First, privacy protection is based on policy methods which it restrictively control the user's sensitive information by defining some privacy policy [1-4]. Second, privacy protection is based on anonymous methods [5-7]. Anonymous hides the relations or connection between a user and his personal data.

Anonymity not only protects a user's identity, but also other users can not determine the user's identity with a subject or an operation. Because the user's behavior may be continuously monitored by cameras, sensors and other, it has been proved to be not a valid approach that simply hides the identity of the anonymous explicitly. In some cases, the user's true identity can be deduced by the attacker's background knowledge, such as the data to be sent to the service providers, the user's request, and publicly available data. Third, privacy protection is based on the pseudonym methods [8-10]. Pseudonyms are often used to hide the user's identity. A pseudonym is similar to the virtual identity of a user with many virtual identities to protect their true identity.

2 System Structure

Pervasive computing privacy protection program should reflect the feature that it disturbs slightly to the user and has a small amount of computing tasks. This paper mainly uses a repeatable pseudonyms method to protect user privacy. In pervasive computing system, if the user uses only global pseudonym, although doing so can easily solve the authentication and other security problems, it brings several very serious problems, such as a pseudonym system must be great, system can very easily track these users and the flow attack may occur, thus it result in a more serious privacy threats. To resolve the privacy protection, we use the idea of reservation IP address in Internet (these reservation IP address are 10.0.0.0-10.255.255.255, 172.16.0.0-172.31.255.255, and 192.168.0.0-192.168.255.255). Internet network address translation can allow different LAN to use the same reservation IP address. If Global pervasive computing environment is divided into many regions, each region can also use the same pseudonym set. In each region, users are randomly assigned a pseudonym to get the service, and the pseudonym is called back after the server is over by the region. Thus, in a region the same pseudonym may be used by different users, and in different time periods the same user may use different pseudonyms. Therefore, the relations between a user and a pseudonym are many to many. In whole pervasive computing these many-to-many relations become more complicated, and attackers are more difficult to find the mapping relations between users and pseudonyms.

Global pervasive computing environment in this paper is divided into many autonomous regions (AR), and all of autonomous regions are using the same pseudonym set S , as shown in figure 1. To avoid too many users in one region can not be assigned different pseudonyms, and to prevent the attack of birthday paradox, the number of pseudonyms must be more enough. We use the output value of SHA-512 algorithm as a pseudonym set S , that is, $S = H(\text{SHA-512})$. In an autonomous region, as long as the user exists, the autonomous regions on the one hand randomly select a pseudonym to the user, and on the other hand select a certain number of pseudonyms which do not correspond with any users. The purpose is to ensure that the number of pseudonyms reached a threshold value in the autonomous region.

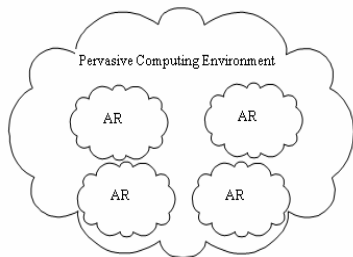


Fig. 1. The division of autonomous region (AR)

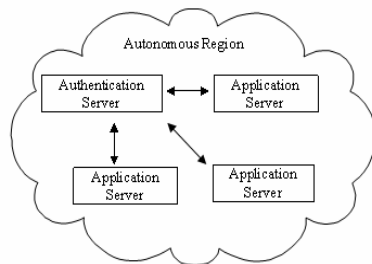


Fig. 2. The relationship between servers in an autonomous region

An autonomous region contains an authentication server and many application servers. Authentication server authenticates the users that access the region, while application servers are to provide some services in this region, as shown in Figure 2. In a region the authentication server and each application server have a share key K_n . K_n is the share key between authentication server and n th application server. When $n = 1$, namely K_1 , express the share key between authentication server and the 1st application server. The shared key uses to transmit secret data among authentication server and application servers.

3 Privacy Protection Process

There includes three types of entities in an autonomous region, they are the user (U), authentication server (AUS) and application server (APS). The user access process mainly involves in two phases. The first is the authentication process that authentication server authenticates the user; the second is the user uses a ticket that contains a pseudonym to access services. This paper focuses on the second stage, not to discuss the user authentication process.

There contains the same set of pseudonym $S = H$ (SHA-512) in any one autonomous region. The value of H (SHA-512) is 512 bits. It is a total of 2^{512} pseudonyms, enough against brute-force attack. Because of the pseudonyms space is quite big, it is impossible that the number of pseudonyms is not enough. The privacy protection process is as follows.

(1) $U \rightarrow AUS$ (service request), Users send service requests to the authentication server.

(2) $AUS \rightarrow U$ (authentication), Authentication server authenticates the user. If the authentication is passed, then it carries on the following process, otherwise it rejects the user's request.

(3) $AUS \rightarrow U$ (services list), Authentication server provide users with a list of services and the service code number, such as restaurants, hotels, printers, taxi and weather information and other services. These services correspond with the service code

(4) $U \rightarrow AUS(\text{service code } m)$, The user selects a service code m to transmit to the authentication server.

(5) $AUS \rightarrow U(\text{ticket})$, Authentication server generates a ticket back to the user.

$$\text{ticket} = E_{k_i}(\text{ID}_s, \text{ID}_i, m, N)$$

Where, K_i is the share key between authentication server and i th application server. ID_i is a pseudonym chosen randomly from the set of pseudonyms that it is not used at the present time in this region, $\text{ID}_s \in H(\text{SHA-512})$. ID_i is the identifier of the i th application server. m is a service code the user selected, and the service is provided by the i th application server. N is a nonce.

(6) $U \rightarrow APS(\text{ticket})$, The user uses ticket to access the i th application server.

(7) $APS \rightarrow U(\text{service})$, Application server will verify the authenticity of ticket, if the ticket is true, the i th application server will provide services to the user based on user selected service code.

4 Security Analysis

The privacy threat in this privacy protection process exists mainly in two places. The first is the conflict issues of pseudonym set. This paper has used the security hash function, and its output value is 512 bit, therefore the birthday paradox attack can not occur. The second is the ticket produced by the authentication server. The ticket mainly contains a pseudonym that it does not to be used in the autonomous region, namely chooses one from $H(\text{SHA-512})$. The ticket also contains the service code the user select and a nonce N . Ticket is encrypted by the share key K_i the authentication server and application server, and this ensures that the ticket contents are confidential. Owing to using the pseudonym in ticket, even if the application server can not know which users access the service. The nonce N can prevent replay attacks.

5 Conclusion

The same pseudonym set is used in different regions. Users will be randomly assigned a pseudonym within a region that it did not use currently in this region. Different users may use the same pseudonym in different time and in different place. Also, different users will use the same pseudonym in the same region. The relationship between the user and a pseudonym are a complex relationship of many to many. In addition, this way can effectively reduce the complexity of pseudonym management, and it has little interference on the users. It is a better way to protect users' privacy.

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Wasterwater Factories Solution on SCADA System

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Abstract. This paper introduces the composition and the working rule of SCADA system and elaborates on the design and specific implementation method of solution plan of SCADA system in sewage treatment works. Constructing a highly stable and reliable SCADA system may realize automatic management and control of sewage treatment process in order to avoid the waste of manpower and physical resources on the spot and also to increase the safety of workers.

Keywords: scada, solution, data, automatic.

1 Introduction

With quick development of economy, the household water consumption and industrial water consumption are continuously increasing. Simultaneously, the amount of both household wastewater and industrial wastewater increases as well. The wastewater may cause environment pollution and worsen the living conditions of mankind if not treated before discharging. Sewage treatment works may dispose sewage to get rid of large particles and some harmful substances. Then the disposed water can be reused in industry or greenery. Although the disposed water can't meet the standard of drinking, we can reduce the waste of tap water in some way and can recycle water resources.

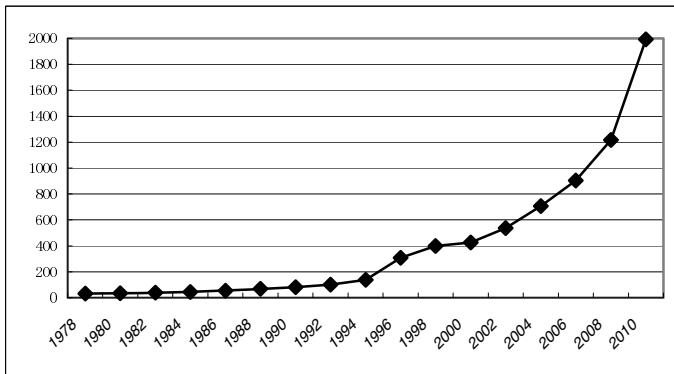


Fig. 1. Development of wasterwater factories

Sewage disposal has been major investment projects in many countries. Fig. 1 shows us the development of sewage treatment works in China. By the end of 2010, sewage treatment works in cities had been built up 1993, counties and some key towns, which can dispose more than 100 million

cubic meters per day. There are also 2360 sewage treatment projects being built, which may dispose 64 million cubic meters per day. China will temporarily become one of the fastest growing countries in the ability of disposing wastewater.

As the quick development of drainage undertaking, the number of sewage treatment works is growing dramatically. How to effectively manage the process of sewage disposal save resources and increase economic benefit has become a major problem.

2 SCADA System

SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA systems are used to monitor and control a plant or equipment in industries such as steel communications, water and waste control, energy, oil and gas refining and transportation [1]. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units and/or Programmable Logic Controllers, and the central host and the operator terminals [2, 3]. A SCADA system gathers information (such as where a leak on a pipeline has occurred), transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, such as determining if the leak is critical, and displaying the information in a logical and organized fashion. These systems can be relatively simple, such as one that monitors environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in an unclear power plant or the activity of a municipal water system [4-6]. Traditionally, SCADA systems have made use of the Public Switched Network for monitoring purposes. Today many systems are monitored using the infrastructure of the corporate Local Area Network/Wide Area Network. Wireless technologies are now being widely deployed for purposes of monitoring [7].

SCADA systems consist of:

- One or more field data interface devices, usually RTUs, or PLCs, which interface to field sensing devices and local control switchboxes and valve actuators.
- A communications system used to transfer data between field data interface devices and control units and the computers in the SCADA central host. The system can be radio, telephone, cable, satellite, etc., or any combination of these.
- A central host computer server or servers (sometimes called a SCADA Center, master station, or Master Terminal Unit (MTU)).
- A collection of standard and/or custom software systems used to provide the SCADA central host and operator terminal application, support the communications system, and monitor and control remotely located field data interface devices.

2.1 The Solution for Wastewater Factories

The structure of SCADA system solution for wastewater treatment plants is shown in Figure 2. The structure is a hierarchical structure, including management layer, data storage and data analysis layer, SCADA monitoring layer and field control layer. This

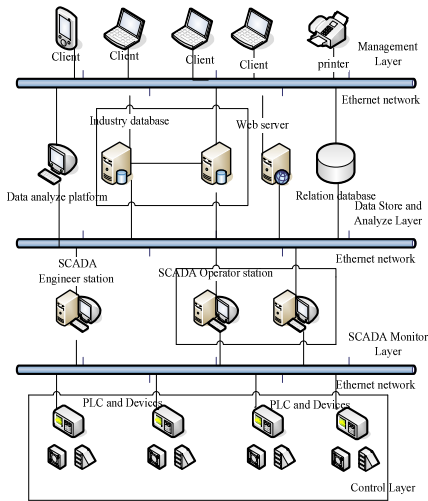


Fig. 2. Structure of sewage treatment system

hierarchical structure ensures the system flexibility and plasticity.

Key points of SCADA system for sewage treatment works includes: Make sure the central monitoring system can control equipment with high real-time, high accuracy and high reliability. There should be strict restrictions to equipment operation. Make sure to realize the gathering to most data on the spot. Make sure high stability of the system and integrity and accuracy of data. There should be various visual methods for data presentation such as dynamic graphics, tendency forms, report forms etc. There is a need to integrate the video information, real-time data and alarm messages into a screen to present.

Automatic system is a system that can be continuously improved and optimized. SCADA software should keep pace with the system's improvements. SCADA system should be compatible with various hardware from different manufacturers in order to upgrade the system, protect the initial investment of clients and provide convenience to choose equipment. Data storage should have high property to compress data to reach high resolution to mass data, to save data with high accuracy and to save disk space. Data retrieval should be fast and the system property should not be influenced if many clients visit data at the same time. Provide shortcut analysis tools to make operators complete data storage, data inquiry, data analysis and statistic computing. The stored historical data should satisfy the needs of equipment management, technological analysis, cost analysis, performance management etc.

On the spot of wastewater treatment, workers mainly handle equipment and technology maintenance. They have relatively little automation knowledge. So what they need is a set of SCADA system with stability, lifelike, convenience to operate, ability to diagnose and self-restore.

However, for the upper wastewater management staff and supervision departments need a set of software system which can convenience statistics, computing and analysis and also can flexibly generate data presentations such as report forms, curves etc.

Data Gathering with High Property and High Reliability. The solution adopts hot standby configuration of SCADA software operator station to ensure the reliability of system acquisition/control. Hot standby can make sure when host computer

malfunctions, the slave computer will take the place of host computer within one second to fulfill the functions of host computer.

In the solution, data acquisition software bears the technique of data block acquisition and it can resolve the “bottlenecks” in communication with large collection points and high efficiency to make acquisition property most optimized. At the same time, it bears the properties of malfunction diagnosis and on-line surveillance to convenience the debugging of system.

As for the automatic system of sewage treatment works, a project involves many types of hardware such as PLC, apparatus, frequency converter etc. The equipment which need control are as follows, wastewater lifting electric engine, gate, electric/pneumatic gate, thick/thin grill electric engine, blower etc. As the demand changes, the system may be reconstructed and expanded. So SCADA system puts forward a high requirement of compatibility to the hardware equipment. The software support adopted in the solution realizes quick and reliable communication with much hardware equipment at home and abroad. Through simple parameters set-up, hardware equipment communication can be realized.

Vivid Picture Effect and Seamless Integration of Video Information. The software adopted by the solution has a perfect interface presentation property of graphics and animation. It can integrate imitation animation and live video into a screen to show clients to make them clear about every equipment and technological flow.

The upper operation administration unit of sewage treatment works and operation monitoring unit need to obtain real-time data of sewage treatment works on the spot to supervise the real-time operation conditions. The software adopted in the solution provides abundant interfaces to convenience different clients to get data.

“Evidence” for Production, Operation and Management. SCADA system in sewage treatment works requires realizing all the information in production and operation to be historically recorded and also requires query to records through various methods. In response to the above requirements, the system adopts industrial database software to store historical data and realizes the redundancy of historical data through the method of disk array.

The historical data stored in SCADA system in large sewage treatment works can not only be applied to query of report curve of primitive historical data but bring the potential value of these historical data into full play. For example, through historical electricity consumption data and different electricity price, we can figure out when to carry out technological processing with large consumption of electricity can reduce electricity costs to the bottom. Different water qualities require different dosage of medicine. In the past, sewage treatment works would dose according to experience. With large amount of primitive data, we can calculate the accurate dosage of medicine to optimize water quality so that the cost of medicine can be reduced. Through computing and analysis platform of industrial database, this solution can easily realize the above analysis and form the most optimize design solution for operation and management.

Web System, Information Sharing Platform. As the continuous development of internet technique, mobile office has gradually developed into all walks of life. The administrators need to supervise the site situation and make decisions through various ways of approaching the net. The web publication function in the solution is designed

to meet this requirement. The system provides perfect security role management to make sure the safety of the system.

3 Summary

Through constructing SCADA system with high stability and reliability, wastewater disposal of sewage treatment works can realize automatic management and control to save manpower and physical resources and to increase the safety of the workers. We can seamlessly integrate on-the-spot video gathering information and alarm message can be demonstrated on SCADA screen by means of video and animation, which provides “double safety” to the system. The data gathered by SCADA system can be uploaded to the upper operation and administration unit and operation and supervision unit.

Building up a complete historical database and alarm event database, we can solve the problem of low automation in most sewage treatment works, the problem of operation safety and the problem of technological limitation of management to reduce the basis for malfunction analysis and retrospection. Finally, safe, reliable and economical operation in sewage treatment works can be achieved.

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M-Learning Interactive Design for Computer Core Course

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Abstract. On the basis of analyzing feasibility of m-learning in college computer core course, this paper designs an m-learning interactive knowledge network. Then it elaborates the interactive processes among the nodes of m-learning interactive network as well as explains the features of the interactive network. In detail, it designs the interactive contents and puts forward a typical example of m-learning interactive contents for college computer core course.

Keywords: m-learning, interactive network, interactive contents.

1 Introduction

As the rapid development of mobile computing, m-learning is more and more popular among college students. Combining with mobile computing, m-learning, which is based on digital learning, can make learners study anytime anywhere. M-learning will be an indispensable learning model in the future [1]. Then the key point under m-learning contexts is how to interact knowledge. This paper tries to introduce m-learning into college computer teaching and also probes the interactive problem among elements of learning community.

2 The Feasibility of Realizing M-Learning in Computer Core Course

College computer core course is a required course for all college students. It is an entrance course for computer knowledge. The purpose of the course is to make students grasp basic knowledge for computer software and hardware, effectively use windows 2000 and office software and grasp internet knowledge.

There exist current problems in this course:

- The number of students is large whereas the number of teachers is relatively small. Most colleges offer large classes for this course. This way of teaching can't arouse initiative and enthusiasm to study. Teachers also can't provide personal help to students.
- The basic knowledge among students remarkably differs. Some students have learned some about computer whereas some students have been proficient in using computers. So it is a big problem that how to make students of different levels grasps knowledge and skill that they desire.

In terms of the above situations, it is quite urgent to introduce m-learning into the teaching of college computer core course as a subsidiary teaching method. This teaching method is beyond the limitation of time and space. It will offer effective aid to all the teaching steps.

3 M-Learning Interactive Knowledge Network

Interaction is the spirit of m-learning and it is the key point to support m-learning [2]. M-learning knowledge network is constructed through creating knowledge, transferring processes and employing knowledge resources in order to realize value. Its main factors include people, resources and mutual relations. Under the situation of m-learning, clients are allowed to issue information, which makes clients knowledge sources as well as receiving points in knowledge network. So the knowledge resources conveyed among clients form a network. This network is made up of knowledge nodes and the relations among knowledge nodes which consist of relatively independent knowledge monomers, which are made up of knowledge elements or knowledge units such as independent concepts, things or laws etc [3]. However, the relations among knowledge nodes mainly display the accumulation of knowledge because of some relations among knowledge itself.

Under the circumstances of m-learning, interactive knowledge network is an open one. The forming and maintaining processes of knowledge network keep constant connection with the various resources of m-learning. After clients obtain knowledge resources from internet or various servers, they usually make further management and digestion to the knowledge. During the management, clients usually organize the knowledge nodes according to different types of relations to form interactive knowledge, as is shown in Fig. 1. In the interactive knowledge network, knowledge continuously flows from one knowledge node to others [4]. The double-headed arrows show us the activities of the knowledge in interactive knowledge network. Then the interactive knowledge network can realize knowledge sharing in m-learning.

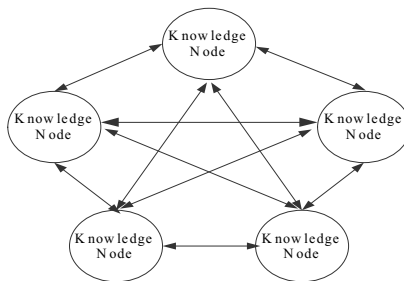


Fig. 1. Interactive knowledge network

Interactive knowledge network is cross-regional and international communication network. It may cover knowledge resources from different languages and different disciplines. In this network, every client has equal right to obtain knowledge and to choose knowledge. In the interactive knowledge network, the interaction is embodied not only in the knowledge flow among nodes but also in the links that help construct

knowledge network. The knowledge link refers to the relation from one knowledge node to the other. In a conventional information service model, knowledge links refer to the links among journals. However, in m-learning, knowledge links are embodied in hyperlinks through which knowledge nodes not only attract clients' attention but also direct clients' attention to other nodes. Its value is that a knowledge node through links may become the door of a relative topic.

We should say that knowledge links are the core of interactive information network. Through links people obtain knowledge, which more accords to the people's habit of obtaining information through association, is more accurate and direct and more approaches to clients' needs[5]. Macroscopically speaking, interactive knowledge network is a digital system of organizing and managing knowledge resources. Its innate structure and operation mechanism is various digital knowledge systems supported by digital technology which is the core of internet technology.

Under the situation of m-learning, interactive knowledge network bears the following three features. Firstly, it is dynamic. At first, knowledge nodes are dynamic. Macroscopically speaking, the form and development of interactive knowledge network is realized through adding and deleting knowledge nodes. The number of knowledge nodes and their structures are continuously changing. Microcosmically speaking, the contents of knowledge nodes are enlarged, extended or reorganized by clients, which makes the contents be integrated. While integrating knowledge, new knowledge will be created. Then, the knowledge links are dynamic [6]. Knowledge links are the glue of nodes. On one hand, while the number of knowledge nodes and their structures are changing, the relations among knowledge nodes are naturally changing. On the other hand, even though the number of knowledge nodes doesn't change, the contents may change, which makes the original contents links change. Secondly, interactive knowledge network bears the feature of sharing. In m-learning context, the providers of knowledge resources are clients of the whole internet, which makes the interactive knowledge network, become a super large and convenient knowledge center free of time and space. In this knowledge center, every client is not only the provider of knowledge but also the receiver of knowledge. Every client is also a participant who can share information resources with other clients. In interactive knowledge network, clients can freely issue information and at the same time clients with similar interest can absorb the information. They can also comment to communicate with other clients, as is shown in Fig. 2. Client A and client B issue information under the context of m-learning and at the same time they can share resources through communication. Client C absorbs the shared information of client A and B and then issues his/her information resource after processing back to the context of m-learning to share with other clients. It is through the actions of issuing, communicating, absorbing etc. that the knowledge resources in the network become rich, which realizes knowledge sharing.

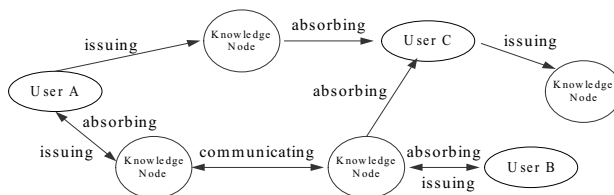


Fig. 2. Knowledge sharing in interactive knowledge network

Thirdly, interactive knowledge network bears the feature of value-adding. The interactive knowledge network is formed through the links among knowledge nodes. However, its meaning is quite beyond knowledge nodes themselves. On one hand, the creators of knowledge nodes can't show us the whole process of searching and accumulating knowledge. So while absorbing knowledge resources used by the creator in the creation process. The formation of interactive knowledge network provides the possibility to trace the source of knowledge. So while scanning a knowledge node, clients may obtain more relative resources through links. On the other hand, in the interactive knowledge network, some knowledge node may quickly trigger more hidden knowledge resources through linking with other nodes [7]. This is mainly because some conscious activities which are seldom displayed by clients. When these hidden conscious activities are issued on the internet, other clients can consciously reallocate them. The large quantities of relative hidden knowledge resources accumulated and traded off against each other. Then the creative thoughts may be aroused and at the same time new knowledge is formed [8].

4 M-Learning Interactive Design for Computer Core Course

The interactions in m-learning mainly include the interactions between teachers and students and mobile terminals, interactions between teachers and students and learning resources and interactions between and students. Interactive design should put emphasis on contents interaction design on the basis of analyzing features of the course, media forms and carrying capacity of mobile terminals.

The contents interaction of mobile terminals includes contents interaction based on short messages and the contents interaction based on scanning and linking. The contents interaction based on short messages is through predetermined orders to send and receive short messages [9]. This way of interaction applies to a large range of mobile terminals as long as the mobile terminals can send and receive shore messages. This way of interaction bears the feature of low cost.

The contents interaction based on scanning and linking is through WAP (Wireless Application Protocol) to realize the visiting control of resources of WAP server and web server. Mobile terminals use WML (Wireless Makeup Language) to realize the functions like scanning, data inputting, super link, text and graphic presentation etc. This way of interaction can satisfy diversified interactive needs such as scanning resources, downloading, demanding of various forms etc. However, it requires the mobile terminals to own WAP internet access.

While designing in detail, we can adapt interactive ways of scanning and linking to display various forms of contents of m-learning. For example, we can use the forms of texts, pictures, videos, audios, animations, and super links to display the course contents. As for the interaction of simple texts and instant contents, we can choose the interactive method based on short messages such as self-testing exercises based on texts etc.

5 Summary

Reasonable and effective m-learning course and learning model can satisfy learners the need to obtain interesting and practical information and services while learners are free when working, having fun or having a party. It can provide learners with excellent learning effect and convenience. At the same time, m-learning accords to the condition of unconscious attention in psychology. Learners are not easy to be tired [10]. So it is believed that there will be more and more learners who step into m-learning.

M-learning is the combination of mobile computing and digital learning. It is also the extension of digital learning technique. Simultaneously, m-learning makes some new techniques such as multimedia, context intelligence, hepatic interaction mobile devices etc. mingled with education and training fields. It also displays different features from those of e-learning and digital learning which are based on cable network and desktops. The essence of m-learning is the interaction of education and technology. M-learning will not only bring people new concept on learning but also promote a complete change of learning environment for the mankind.

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Modeling and Simulation of Water Fountain Control Software in Ptolemy II

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Abstract. There are two methods to design software model, object-oriented and component-oriented. Embedded system has the characteristics of real-time, hierarchy and heterogeneousness. Disadvantage of object-oriented method is so much functional coupling that system's characteristics cannot be described well. Component-oriented method can meet the system's characteristics well because of components independent from each other. We introduce actor-oriented Ptolemy II modeling method, using atomic actor and composite actor by tree structure to solve hierarchy of the system, and using different computation model interaction to solve real-time heterogeneity of the system. This paper describes the principle of small water fountain control software and compares the advantages and disadvantages between component-oriented Ptolemy II platform and object-oriented UML modeling. Water fountain control software is modeled in the form of different actor-oriented components and then simulates based on Ptolemy II platform. As a result, expected result is achieved.

Keywords: actor, Ptolemy II platform, realtime, hierarchy, heterogeneousness, water fountain.

1 Introduction

Embedded software system is becoming more and more complex, and then implementation becomes difficult. It is an urgent problem on how to improve the software's simplicity and reliability. Physical system's structural features can be described by the software model, which can provide better guidance for software development, then the software's development cycle and cost can be reduced[1]. There are two methods to build software model, object-oriented and component-oriented. Object-oriented approach[2] divides the system into different functional modules. Each functional module is abstracted as an object, and the association among objects can be realized by class hierarchy and function calls. System's important features such as continuity and synchronization are hidden behind the function call. This kind of way increases the coupling among objects. The structure of the system is used to be described by object-oriented language UML[3]. Component-oriented approach divides the system into different sub-functions, defined in different components, which is independent from each other and coupling is small. Embedded

system[4] has the characteristics of real time, hierarchy and heterogeneousness. Real-time means any incentives from the outside environment can be given a timely response by the computer. Hierarchy refers that the system has many subsystems and each subsystem is composed of other small subsystems. Heterogeneousness refers that each subsystem has different interaction modes[4]. Object-oriented method can not satisfy the above characteristics well. However, component-oriented method can achieve embedded system's modeling framework in a good way[4].

Ptolemy II[5] proposed an actor-oriented design method based on component-based modeling method. Embedded system can be divided into different actors according to their functions and then analyzes the actors's interaction mode. On Ptolemy II platform system's hierarchy can be solved by composite actor which contains several sub-actors. Heterogeneousness uses different models of computation(MOCs) to achieve.

2 Ptolemy II Modeling Methodology

The Ptolemy II[6] project is a modeling, simulation and design platform for embedded software designed by a research group at University of California, Berkeley. The Ptolemy II project designs components as different actors. Actor is a component in which the implementation method is encapsulated, by setting the ports and parameters, cooperating with the other actors to accomplish a specific function via the communication channel[6]. Atomic actor does not include any other sub-function actors. The needed sub-function actors are included by composite actor. Actor's ports and parameters will be set through visual window depending on the system's function, and then can visually see parameter configuration has what affects on the system. Parameter's values do not change when a model is executing. Channel passes data from one port to another to accomplish the interaction among actors[7]. Actors interact only with the channel which is connected to and not indirectly, thereby functional coupling is reduced[7]. Actor's domain polymorphism can be realized by freely combining with different MOCs. There are many actors in the actor-library, whose functions are basically fixed. Reuse of actors to model and simulate can reduce the modeling cycle. However, those actors can not meet the needs of all systems. Ptolemy II has a characteristic of open source code allowing the user to add new actor to the library. Actor-oriented modeling method provides greater assurance to achieve the correct architecture of the physical system.

Composite actor itself can be seen as an actor, and several sub-functions within it can be expressed by different sub-actors. The relationship between composite function and its sub-function is expressed by the conception of hierarchy. The structure of tree can express this characteristic well. Leaf node represents atomic actor and sub-tree node represents composite actor. External ports defined by composite actor are called hierarchical ports[8]. Introduction to composite actor can solve the system's hierarchy problem.

Embedded system is generally composed of sub-systems. Those sub-systems are often required to run in different environments, however, some modeling languages and tools can only describe certain aspects of the system and can not accurately describe the whole. There are many MOCs on Ptolemy II platform. MOC might give operational

rules for executing a model. These rules determine when actors perform internal computation and update internal state, how to perform external communication, and so on[8]. MOC can satisfy different running environments needed by sub-systems. There are many MOCs such as Discrete Event (DE) , Synchronous Dataflow (SDF) , Finite State Machines (FSM)and Continuous Time(CT)[9]. The emergence of different MOCs solve the problem of heterogeneousness. Upon the above description we can summarize modeling methodology on ptolemy II platform as follows.

- 1) Describe the function of the system and experimental principle.
- 2) Draw the system's architecture in the form of tree structure, and then the system's functions can be decomposed by layers .
- 3) Choose atomic actor upon the function, if the actor is not in the library, then design the new one.
- 4) Atomic actors will be combined into a composition actor upon the need, and then select an appropriate MOC according to interactive mode.
- 5) Change the important parameter to see simulation results changed in this way.

According to the above description, water fountain control software is modeled so that we have a deep understandability of actor-oriented modeling methodology on Ptolemy II platform, and then effective guidances are provided for complicated embedded system.

3 Modeling and Simulation

The principle of small water fountain control software is described as Figure1.

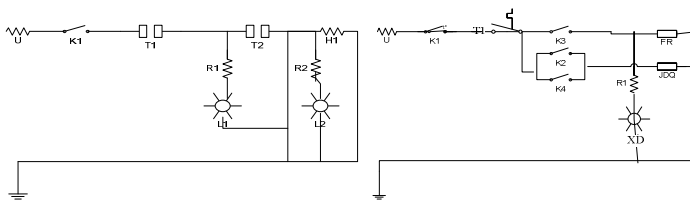


Fig. 1. Principle of water fountain control software[10].

Heat Insulation Circuit included U(fuse), K1(heat switch), T1(anti-dry temperature control), T2(heat thermostat), H1(heat tube), L1(keep warm lamp)and L2(heat lamp)[10]. Turn on the electricity, K1 closed, L1 went out, L2 lighted up, H1 heated up, when the temperature rose to 95℃, T2 automatically disconnected, H1 stopped heating, L2 went out, L1 lighted up[10]. When water temperature dropped to 85℃,T2 automatically closed, L1 went out, L2 lighted up, H1 heated up and time after time to maintain water temperature between 85℃—95℃[10]. Disinfection Circuit included K1(disinfection switch), T1(disinfection thermostat), K2(disinfection start button), XD(disinfection lamp), FR(heat tube), K3, K4 (normally open contacts) and JDQ(alternation relay)[10]. Turn on the electricity, XD lighted up, FR at this time

began to heat up, when temperature reached 120°C, T1 disconnected, JDQ released, K3, K4 disconnected, XD went out, FR stopped heating[10]. Disinfection is completed as the above description[10].

Object-oriented modeling language UML will abstract each water fountain's function to an object. Association between objects is realized through function calls, and then the whole system's modeling framework is formed, so functional coupling increases significantly. Ptolemy II platform will abstract each function to an actor which communicates only with actors connected to it, so the coupling is reduced. The change of state caused by temperature can not be displayed well through the system's modeling established by UML language. Ptolemy II platform can realize this well and the user also can change the system's configuration through window display according to their needs. However, modeling established by UML language can not do this.

The steps of modeling and simulation of water fountain control software on Ptolemy II platform are described as follows.

- <1> The top-level chooses SDF as a MOC because the interaction between actors belongs to data stream. The transition of lamp's state can be realized by FSM whose natural domain is FSM which can be omitted, then change it to a composition actor controlled by the upper director SDF in order to communicate with the other actor. Through SDF and FSM MOCs the heterogeneousness of the system can be resolved.
- <2> Heat Insulation Circuit. "H1" is abstracted to a composition actor "heater" to produce temperature source whose sub-actor is shown in Figure 4. Right click the actor to select "Customize-Ports" which can define the input port "rate" and the output port "temp". A composition actor "light" can realize lamp's state transition. "L2" and "L1" can be abstracted as the state of "heat up" and "keep warm". "maxtemp", "mintemp" and "initialtemp" separately represent the maximum temperature 95°C, the minimum temperature 85°C and the initial temperature 0°C. The transition of state can be realized by comparing with the parameters. The port "rate" outputs 0.5 when in the state of "heat up" and -0.5 when in "keep warm". The modeling of "light" can be seen in Figure 5. Atomic actor "temperature" and "status" separately represent temperature display and status display. Finally, communication can be realized by interlink between actors. Modeling of Heat Insulation Circuit is shown in Figure 3.
- <3> Disinfection Circuit: The methodology of modeling is the same as the above description. The state of disinfection lamp can be seen in Figure 6, and the port "rate" outputs 3 in the state of disinfection and outputs 0 when disinfection is finished.
- <4> According to the above description the levels of water fountain control software can be seen in Figure 2. The system's hierarchy can be clearly exhibited by the structure of tree. When the system's modeling is finished, click the button



to get the simulation results.

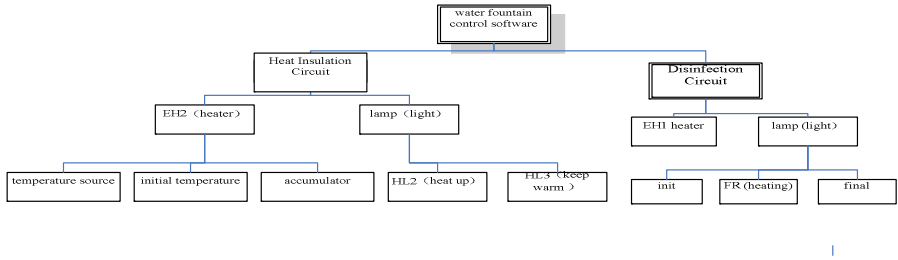


Fig. 2. Water fountain control software level diagram.

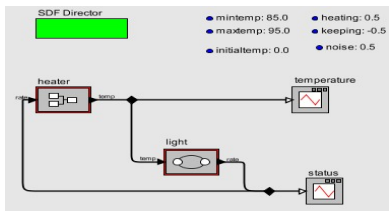


Fig. 3. Modeling of Heat Insulation Circuit.

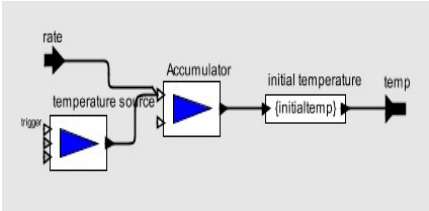


Fig. 4. Modeling of H1.

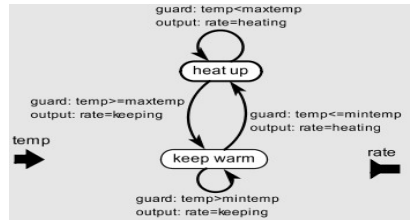


Fig. 5. State transition of L1,L2.

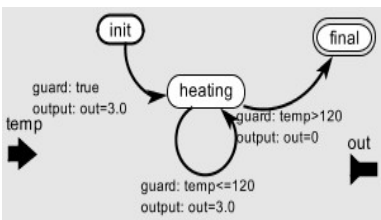


Fig. 6. State transition of disinfection lamp.

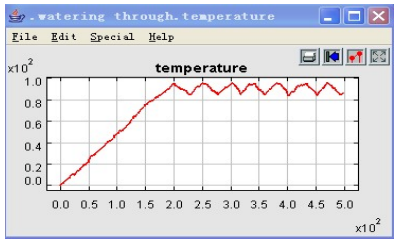


Fig. 7. H1's temperature.

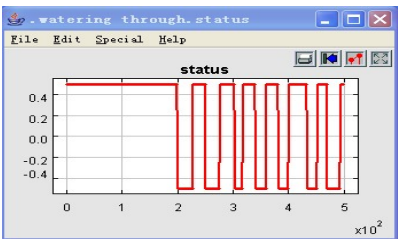


Fig. 8. State of L1,L2 lamp.

Figure 7 and Figure 8 show that the initial temperature of the Heat Insulation Circuit is 0°C. It's in the state of "heat up" when the temperature is less than the maximum temperature of 95°C, in "keep warm" when reaches to 95°C and in "heat up" when the temperature is less than 85°C. The state of the heating insulation circuit is repeatedly displayed.

4 Conclusion

Water fountain control software is modeled and achieved expected results on Ptolemy II platform based on actor-oriented modeling methodology. This method can be proved to be right and practical, so guidances for modeling framework of complex system can be provided, then the physical system's quality, reliability and productivity will also be improved.

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Space Vector Modulated Direct Torque Control for PMSM

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Abstract. It always exists that there are big ripples on flux linkage and electromagnet torque in traditional direct torque control (DTC) system. The implement of space vector modulation (SVM) was researched in-depth. The optimum combination of the fundamental voltage space vector was obtained according to the current expected voltage vector so as to compensate the error of stator flux linkage and electromagnet torque in precise. Inverter switch frequency is ensured constant by space voltage vector modulation at the same time. SVM direct torque control for permanent magnet synchronous motor (PMSM) was realized. Simulation results have shown that rapid torque response of DTC is still maintained, ripples on flux linkage and torque are dramatically reduced. The dynamic and static system performances are dramatically improved.

Keywords: Space vector modulation (SVM), Direct torque control (DTC), Permanent magnet synchronous motor (PMSM).

1 Introduction

Permanent magnet synchronous motor (PMSM) has been widely used on a variety of occasions with advantages of high power density and big starting torque and high efficiency. PMSM has become a hot research field of electricity transmission. Direct torque control (DTC) has quick response and good dynamic performance, and it has received extensive attention and made many achievements [1-4].

The output of hysteresis comparator for flux linkage and electromagnet torque can only be 0 or 1, thus, the results can not distinguish the size of error. In a sampling cycle, switching voltage vector selection table can only choose a relatively suitable voltage vector, in most cases, which can not compensate current flux linkage error and electromagnet torque error. Meanwhile, at a fixed sampling period, the inverter switch time can not be controlled under hysteresis comparator, which results in inconstant inverter switch frequency.

Voltage space vector modulation (SVM) DTC for PMSM is researched in-depth in the paper. The excellent dynamic performance of DTC is maintained, and the steady state performance is improved.

2 Basic Theory of PMSM DTC

The voltage equation of surface PMSM in $\alpha\beta$ axis is as following.

$$\begin{cases} u_{\alpha} = R_s i_{\alpha} + L_s \frac{di_{\alpha}}{dt} - \omega_r \psi_r \sin \theta_r \\ u_{\beta} = R_s i_{\beta} + L_s \frac{di_{\beta}}{dt} + \omega_r \psi_r \cos \theta_r \end{cases} \quad (1)$$

Where u_{α}, u_{β} are the $\alpha\beta$ axis components of stator voltage vector; i_{α}, i_{β} are the $\alpha\beta$ axis components of stator current vector; L_s is the stator inductance; R_s is the stator resistance; ψ_r is permanent magnet flux; ω_r is rotor speed; θ_r is rotor angle.

The torque equation of PMSM is as following.

$$T_e = p_n \left[\frac{\psi_r |\psi_s|}{L_d} \sin \delta_{sm} + \frac{L_d - L_q}{2L_d L_q} |\psi_s|^2 \sin 2\delta_{sm} \right] \quad (2)$$

Where δ_{sm} is load angle.

If the stator flux amplitude is maintained constant, electromagnet torque can be controlled by controlling load angle, which is the basic theory of DTC.

Fig. 1 shows the diagram of traditional DTC of PMSM. The estimated electromagnet torque value T_e is compared with the given electromagnet torque value T_e^* . The torque control signal ΔT is got by hysteresis comparator of torque. The estimated flux linkage value $|\psi_s|$ is compared with the given flux linkage value $|\psi_s^*|$. The flux linkage control signal $\Delta\psi$ is got by hysteresis comparator of flux linkage. Flux and torque control signals combined with the current position signal $S\psi$, according to switching voltage vector look-up table, the current relative optimal space voltage vector is determined to drive PMSM. The switching voltage vector look-up table is shown in Table 1.

Table 1. Switch Voltage Vector Look-Up Table

$\Delta\psi$	ΔT	①	②	③	④	⑤	⑥
1	1	U_{s2}	U_{s3}	U_{s4}	U_{s5}	U_{s6}	U_{s1}
	-1	U_{s6}	U_{s1}	U_{s2}	U_{s3}	U_{s4}	U_{s5}
-1	1	U_{s3}	U_{s4}	U_{s5}	U_{s6}	U_{s1}	U_{s2}
	-1	U_{s5}	U_{s6}	U_{s1}	U_{s2}	U_{s3}	U_{s4}

From Eq. 5, it can be seen that the relationship between electromagnet torque change and load angle change is linear. Thus, the PI torque controller can be used to establish the relationship between them.

α, β components of the reference stator flux linkage can be got by Eq. 6. According to the estimated stator flux linkage, the error of flux linkage is shown in Eq.7.

$$\begin{cases} \psi_{\alpha}^* = |\psi_s^*| \cos(\theta_s + \Delta\delta_{sm}) \\ \psi_{\beta}^* = |\psi_s^*| \sin(\theta_s + \Delta\delta_{sm}) \end{cases} \quad (6)$$

$$\begin{cases} d\psi_{\alpha} = \psi_{\alpha}^* - \psi_{\alpha} \\ d\psi_{\beta} = \psi_{\beta}^* - \psi_{\beta} \end{cases} \quad (7)$$

The expected voltage vector SVM needed is computed by Eq. 8.

$$\begin{cases} U_{\alpha} = R_s i_{\alpha} + d\psi_{\alpha} / T_s \\ U_{\beta} = R_s i_{\beta} + d\psi_{\beta} / T \end{cases} \quad (8)$$

Schematic diagram of SVM DTC system is shown in Fig. 3. Compared to traditional DTC system, hysteresis comparators of flux linkage and torque are replaced by PI torque controller and the reference flux linkage computation. Switch voltage vector look-up table is replaced by SVM technology.

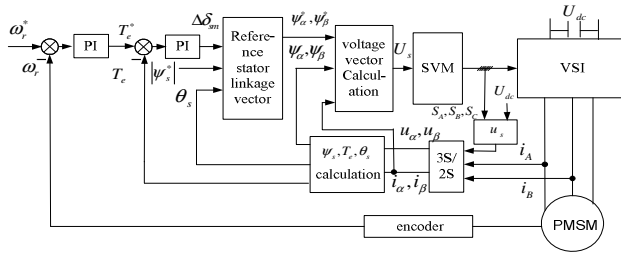


Fig. 3. Schematic diagram of SVM DTC system

5 Simulation Results

In order to verify the performance of SVM DTC for PMSM, simulation model is built using Matlab/Simulink to carry out simulation. The given speed is 1000r/min and load torque is 5N.m. Flux linkage and electromagnet torque waves is shown in Fig. 4 and Fig. 5 based on traditional DTC and SVM DTC respectively.

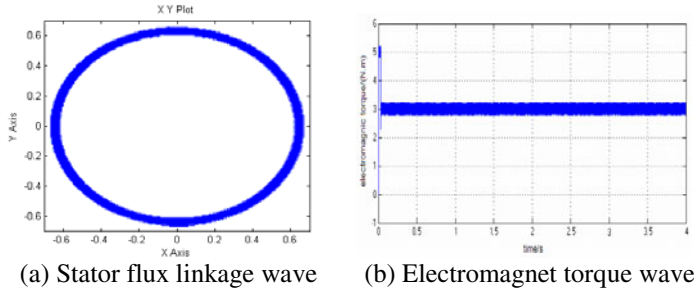


Fig. 4. Waves based on traditional DTC method

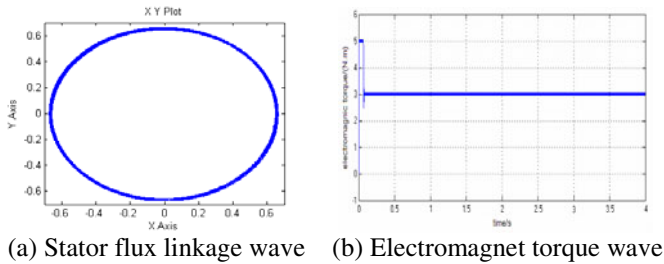


Fig. 5. Waves based on SVM DTC method

From Fig. 4 and Fig. 5, it can be seen that in the traditional DTC system, there is a big ripple on flux and torque and the waves are not smooth; the flux and torque ripple significantly become lower based on SVM DTC method due to SVM strategy. A precise compensation for flux and torque is achieved. The torque response based on SVM DTC is nearly the same as the traditional DTC method, which indicates the excellent performance of fast response is maintained under SVM DTC method.

6 Conclusion

In order to reduce big ripples of torque and flux in traditional DTC method, SVM DTC for PMSM is researched in the paper to compensate precisely for flux and torque. At the same time, inverter switching frequency is ensured constant. Simulation results have shown that the dynamic and static operating performances of DTC system are improved.

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Robust Model Predictive Control for Nonlinear Systems

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Abstract. On the basis of the fuzzy T-S (Takagi-Sugeno) model, we propose a robust model predictive control for a class of nonlinear systems with constraint inputs. The upper bound of predictive cost is derived; the constraints on stability and inputs are transformed into linear matrix inequalities (LMIs), which can be easily solved. Thus we adopt a parallel distributed compensation (PDC) controller in the scheme. Sufficient conditions of moving horizon optimization are derived based on LMIs and Lyapunov function, and consequently the stability of closed-loop systems is proved. The simulation results verify the effectiveness of the proposed method.

Keywords: Nonlinear Systems, Model Predictive Control, Constraint Inputs, Fuzzy Model.

1 Introduction

Many investigators have studied the nonlinear control with input saturation in recent years[1-4]. The application of a T-S fuzzy model to describe and model nonlinear system has attracted great attention in nonlinear control system design. Wang H.O. et al. provided the state feedback inputs of the fuzzy system, stability sufficient conditions of the closed system and the robustness [5, 6]. Ma X.J. and Sun Z.Q. proposed the feedback inputs based on the state observer and the sufficient conditions [7].

MPC (Model Predictive Control) is one of the most effective methods to solve the hard constrain problem[2-4]. With the rapid development of the computers, the MPC not only is applied in the process control, but also in the aviation and space fields[9,10]. According to the linear matrix inequalities, MPC offers good robustness, easy implementation, simple calculation, and is suitable for on-line application. We propose a nonlinear predictive control method on the basis of predictive fuzzy model and LMI constrains.

First, we build the nonlinear system model with fuzzy T-S model. The overall model of the system is achieved by fuzzy “blending” of these linear models through nonlinear fuzzy membership functions, so as to approach the original system accurately. Second, the parallel distributed compensator is designed with an infinite horizon predictive control, thus the optimization problem with input saturation is transformed to the problem of solving the LMI eigenvalue. Finally, the spacecraft

dynamic performance through the atmosphere is simulated, and the results validate the effectiveness of the method.

2 T-S Model of Nonlinear System

Consider the nonlinear discrete system with input saturation

$$\mathbf{x}(k+1) = \mathbf{f}(\mathbf{x}(k), \mathbf{u}(k)), \|\mathbf{u}(k)\|_2 \leq u_{\max}. \quad (1)$$

Where $\mathbf{f}(k)$ is the nonlinear function, $\mathbf{x} \in \mathbf{R}^n$ is the state vector, $\mathbf{u} \in \mathbf{R}^m$ is the input vector. $\|\cdot\|_2$ denotes the Euclidean norm of the vector. The nonlinear system above is described by fuzzy IF-THEN rules, which locally represent nonlinear input-output relation. R^i denotes the i -th rule of the fuzzy model.

$$\begin{aligned} R^i : & \text{IF } z_1(k) \text{ is } M_{i1} \text{ and } \dots \text{ and } z_n(k) \text{ is } M_{in}, \\ & \text{THEN } \mathbf{x}(k+1) = (\mathbf{A}_i + \Delta\mathbf{A}_i)\mathbf{x}(k) + (\mathbf{B}_i + \Delta\mathbf{B}_i)\mathbf{u}(k), \quad i = 1, 2, \dots, L. \end{aligned}$$

Where M_{ij} are the fuzzy sets, L is the number of IF-THEN rules.

$\mathbf{A}_i \in \mathbf{R}^{n \times n}$, $\mathbf{B}_i \in \mathbf{R}^{n \times m}$, $i = 1, 2, \dots, L$. $z_1, z_2, \dots, z_n$ are some measurable system variables. Every function of the fuzzy model denotes a “subsystem”. Here, the parametric uncertainty terms are introduced into the T-S model for approaching the original system. The uncertainty terms satisfy the condition: $[\Delta\mathbf{A}_i \quad \Delta\mathbf{B}_i] = \mathbf{D}\theta(k)[\mathbf{E}_{i1} \quad \mathbf{E}_{i2}]$, $\theta^T(k)\theta(k) \leq \mathbf{I}$. Where $\mathbf{D}$, $\mathbf{E}_{i1}$, $\mathbf{E}_{i2}$ are real, constant matrices of the corresponding dimensions, indicating the uncertainty of the system.

A singleton fuzzifier, product inference engine and center-average defuzzifier are employed to obtain the global fuzzy state equation

$$\begin{aligned} \mathbf{x}(k+1) &= \frac{\sum_{i=1}^L w_i(z(k)) [(\mathbf{A}_i + \Delta\mathbf{A}_i)\mathbf{x}(k) + (\mathbf{B}_i + \Delta\mathbf{B}_i)\mathbf{u}(k)]}{\sum_{i=1}^L w_i(z(k))} \\ &= \sum_{i=1}^L \lambda_i(z(k)) [(\mathbf{A}_i + \mathbf{D}\theta(k)\mathbf{E}_{i1})\mathbf{x}(k) + (\mathbf{B}_i + \mathbf{D}\theta(k)\mathbf{E}_{i2})\mathbf{u}(k)] \\ &= (\mathbf{A} + \mathbf{D}\theta(k)\mathbf{E}_1)\mathbf{x}(k) + (\mathbf{B} + \mathbf{D}\theta(k)\mathbf{E}_2)\mathbf{u}(k) \\ &= \mathbf{A}(k)\mathbf{x}(k) + \mathbf{B}(k)\mathbf{u}(k) \end{aligned} \quad (2)$$

$$\mathbf{A} = \sum_{i=1}^L \lambda_i(z(k))\mathbf{A}_i, \quad \mathbf{B} = \sum_{i=1}^L \lambda_i(z(k))\mathbf{B}_i, \quad \mathbf{E}_1 = \sum_{i=1}^L \lambda_i(z(k))\mathbf{E}_{i1}, \quad \mathbf{E}_2 = \sum_{i=1}^L \lambda_i(z(k))\mathbf{E}_{i2}.$$

Where $\mathbf{z}(k) = [z_1(k) \dots z_n(k)]^T$, and $M_{ij}(z_j(k))$ is the grade of membership of

$$M_{ij}, \quad w_i(\mathbf{z}(k)) = \prod_{j=1}^n M_{ij}(z_j(k)). \quad \text{Therefore}$$

$$\begin{cases} \sum_{i=1}^L w_i(z(k)) > 0 \\ w_i(z(k)) \geq 0 \end{cases}, \lambda_i(.) = \frac{w_i(.)}{\sum_{i=1}^L w_i(.)}, 1 \geq \lambda_i(.) \geq 0, \sum_{i=1}^L \lambda_i(.) = 1. \quad (3)$$

For the fuzzy system 2 (Eq. 2), a fuzzy controller is designed by using parallel distributing compensation (PDC) theory.

$$\begin{aligned} \text{Controller } U^i: & \text{ IF } z_1(k) \text{ is } \mu_{i1} \text{ and } \dots \text{ and } z_n(k) \text{ is } \mu_{in}, \\ & \text{ THEN } \mathbf{u}(k) = \mathbf{F}_i \mathbf{x}(k), \quad i = 1, 2, \dots, L. \end{aligned}$$

The global fuzzy controller of the system is

$$\mathbf{u} = \sum_{i=1}^L \lambda_i \mathbf{F}_i \mathbf{x}(k). \quad (4)$$

Because of involving hard and other constrains in every step of receding optimization, MPC is the efficient method for input constraints[2-4]. The Min-Max method is proposed for the uncertain fuzzy system 2 (Eq. 2). By solving Eq. 5 at time k , we obtain $\mathbf{u}(k+i|k)$, apply present $\mathbf{u}(k|k)$ to the object, and repeat the optimization solution at the next sampling point based on the new initial states $\mathbf{x}(k+1)$.

$$\begin{aligned} & \min_{u(k+i|k), i=0,1,\dots,m-1} \max_{[A(k+i), B(k+i)] | i \geq 0} J_{\infty}(k) \\ & \text{s.t. } \|\mathbf{u}(k+i|k)\|_2 \leq u_{\max} \end{aligned} \quad (5)$$

$$J_{\infty}(k) = \sum_{i=0}^{\infty} [\mathbf{x}^T(k+i|k) \mathbf{Q}_1 \mathbf{x}(k+i|k) + \mathbf{u}^T(k+i|k) \mathbf{R} \mathbf{u}(k+i|k)], \mathbf{Q}_1 = \mathbf{Q}_1^T > 0, \mathbf{R} = \mathbf{R}^T \geq 0.$$

Where $[A(k+i), B(k+i)]$ is the i -th predictive model at time k . $\mathbf{x}(k+i|k)$ denotes the predictive state at time $k+i$ based on $\mathbf{x}(k)$, and $\mathbf{u}(k+i|k)$ is predictive control of i -th step at time k . $\mathbf{Q}_1, \mathbf{R}$ are weighting matrices of the state and the input for the performance criteria respectively.

Since the magnitude amount of calculation, it is difficult to solve the equation directly. The feedback MPC is introduced here; an optimization problem with input constraint is equivalent to solving the generalized eigenvalue problem with LMI constraint.

Lemma 1[11]. Suppose that $\mathbf{A}, \mathbf{D}, \mathbf{E}, \theta$ are appropriate dimension positive definite matrices, and $\|\theta\| \leq 1$, for any matrix $\mathbf{P} = \mathbf{P}^T > 0$ and constant $\varepsilon > 0$, let $\mathbf{P} - \varepsilon \mathbf{D} \mathbf{D}^T > 0$, we have

$$(\mathbf{A} + \mathbf{D} \theta \mathbf{E})^T \mathbf{P}^{-1} (\mathbf{A} + \mathbf{D} \theta \mathbf{E}) \leq \mathbf{A}^T (\mathbf{P} - \varepsilon \mathbf{D} \mathbf{D}^T)^{-1} \mathbf{A} + \frac{1}{\varepsilon} \mathbf{E}^T \mathbf{E}.$$

3 Main Result

Theorem 1. Let $\mathbf{x}(k|k)$ be the state of the nonlinear system measured at the sampling time k , the state feedback control to the system is

$$\mathbf{u}(k+i|k) = \sum_{j=1}^L \lambda_j \mathbf{F}_j \mathbf{x}(k+i|k), \quad \mathbf{F}_j = \mathbf{Y}_j \mathbf{Q}^{-1}, \quad j=1,2,\dots,L.$$

The loop system is asymptotic stability, if there exist variable $\gamma > 0$, $\mathbf{Q} > 0$, $\Lambda > 0$, $\mathbf{Y}_j (j=1,2,\dots,L)$ satisfying the optimization problem of LMI constraint.

$$\min_{\gamma, \mathbf{Q}, \Lambda, \mathbf{Y}_j (j=1,\dots,L)} \gamma \quad (6)$$

$$\text{s.t.} \begin{bmatrix} 1 & \mathbf{x}^T(k|k) \\ \mathbf{x}(k|k) & \mathbf{Q} \end{bmatrix} \geq 0 \quad (7)$$

$$\begin{bmatrix} u_{\max}^2 \mathbf{I} & \mathbf{Y}_j \\ (\mathbf{Y}_j)^T & \mathbf{Q} \end{bmatrix} \geq 0, \quad j=1,2,\dots,L \quad (8)$$

$$\begin{bmatrix} \mathbf{Q} & \mathbf{Y}^T \mathbf{R}^{1/2} & \mathbf{Q} \mathbf{Q}_i^{1/2} & (\mathbf{Q} \mathbf{A}_i^T + \mathbf{Y}_i^T \mathbf{B}_i^T) & (\mathbf{Q} \mathbf{E}_{i1}^T + \mathbf{Y}_i^T \mathbf{E}_{i2}^T) \\ \mathbf{R}^{1/2} \mathbf{Y} & \gamma \mathbf{I} & 0 & 0 & 0 \\ \mathbf{Q}_i^{1/2} \mathbf{Q} & 0 & \gamma \mathbf{I} & 0 & 0 \\ (\mathbf{A}_i \mathbf{Q} + \mathbf{B}_i \mathbf{Y}_i) & 0 & 0 & \mathbf{Q} - \Lambda \mathbf{D} \mathbf{D}^T & 0 \\ (\mathbf{E}_{i1} \mathbf{Q} + \mathbf{E}_{i2} \mathbf{Y}_i) & 0 & 0 & 0 & \Lambda \mathbf{I} \end{bmatrix} \geq 0 \quad (9)$$

$$\begin{bmatrix} \mathbf{Q} & \frac{1}{2}(\mathbf{Y}_i + \mathbf{Y}_j)^T \mathbf{R}^{1/2} & \mathbf{Q} \mathbf{Q}_i^{1/2} & \frac{1}{2}(\mathbf{Q} \mathbf{A}_i^T + \mathbf{Y}_i^T \mathbf{B}_i^T + \mathbf{Q} \mathbf{A}_j^T + \mathbf{Y}_j^T \mathbf{B}_j^T) & \frac{1}{2}(\mathbf{Q} \mathbf{E}_{i1}^T + \mathbf{Y}_i^T \mathbf{E}_{i2}^T + \mathbf{Q} \mathbf{E}_{j1}^T + \mathbf{Y}_j^T \mathbf{E}_{j2}^T) \\ \frac{1}{2} \mathbf{R}^{1/2} (\mathbf{Y}_i + \mathbf{Y}_j) & \gamma \mathbf{I} & 0 & 0 & 0 \\ \mathbf{Q}_i^{1/2} \mathbf{Q} & 0 & \gamma \mathbf{I} & 0 & 0 \\ \frac{1}{2}(\mathbf{A}_i \mathbf{Q} + \mathbf{B}_i \mathbf{Y}_i + \mathbf{A}_j \mathbf{Q} + \mathbf{B}_j \mathbf{Y}_j) & 0 & 0 & \mathbf{Q} - \Lambda \mathbf{D} \mathbf{D}^T & 0 \\ \frac{1}{2}(\mathbf{E}_{i1} \mathbf{Q} + \mathbf{E}_{i2} \mathbf{Y}_i + \mathbf{E}_{j1} \mathbf{Q} + \mathbf{E}_{j2} \mathbf{Y}_j) & 0 & 0 & 0 & \Lambda \mathbf{I} \end{bmatrix} \geq 0, \quad j < i, i=1,2,\dots,L \quad (10)$$

Proof. Consider a discrete Lyapunov function $V(\mathbf{x}(k)) = \mathbf{x}^T(k) \mathbf{P}(k) \mathbf{x}(k)$, $\mathbf{P}(k) = \mathbf{P}^T(k) > 0$, $\mathbf{x}(k|k) = \mathbf{x}(k)$. Let $V(\mathbf{x}(k))$ is the upper bound of $J_\infty(k)$. The follow inequality is required to satisfy so as to confirm the upper bound exists.

$$V(\mathbf{x}(k+i+1|k)) - V(\mathbf{x}(k+i|k)) \leq -[\mathbf{x}^T(k+i|k) \mathbf{Q}_i \mathbf{x}(k+i|k) + \mathbf{u}^T(k+i|k) \mathbf{R} \mathbf{u}(k+i|k)]. \quad (11)$$

When the system is asymptotic stability, $\mathbf{x}(\infty|k) = 0$. And then $V(\mathbf{x}(\infty|k)) = 0$. Superimpose the inequality 11 from $i=0$ to $i=\infty$, we obtain

$\max_{[A(k+i), B(k+i)]} J_{\infty}(k) \leq V(\mathbf{x}(k|k))$. As a result, the optimization problem is equivalent to minimizing the $V(\mathbf{x}(k|k))$. It then follow that

$$\min_{[A(k+i), B(k+i)]} \max J_{\infty}(k) \leq \min V(\mathbf{x}(k|k)) \leq \min \gamma,$$

$$\mathbf{x}^T(k|k) \gamma^{-1} \mathbf{P} \mathbf{x}(k|k) \leq 1.$$

Let $\mathbf{Q} = \gamma \mathbf{P}^{-1}(k) > 0$, inequality 7 can be gained with Schur complement. Design the infinite horizon predictive control as PDC controller.

$$\mathbf{u}(k+i|k) = \mathbf{F} \mathbf{x}(k+i|k) = \sum_{i=1}^L \lambda_i \mathbf{F}_i \mathbf{x}(k+i|k).$$

Substituting Eq. 2 into inequality 11, we obtain

$$\mathbf{x}^T(k)(\mathbf{A} + \mathbf{B}\mathbf{F} + \Delta\mathbf{A} + \Delta\mathbf{B}\mathbf{F})^T \mathbf{P}(k)(\mathbf{A} + \mathbf{B}\mathbf{F} + \Delta\mathbf{A} + \Delta\mathbf{B}\mathbf{F}) - \mathbf{P}(k) + \mathbf{Q}_1 + \mathbf{F}^T \mathbf{R} \mathbf{F} \mathbf{x}(k) \leq 0.$$

And it is equivalent to the follow one

$$(\mathbf{A} + \mathbf{B}\mathbf{F} + \mathbf{D}\theta(k)(\mathbf{E}_1 + \mathbf{E}_2 \mathbf{F}))^T \mathbf{P}(k)(\mathbf{A} + \mathbf{B}\mathbf{F} + \mathbf{D}\theta(k)(\mathbf{E}_1 + \mathbf{E}_2 \mathbf{F})) - \mathbf{P}(k) + \mathbf{Q}_1 + \mathbf{F}^T \mathbf{R} \mathbf{F} \leq 0.$$

Applying Lemma 1, we have

$$(\mathbf{A} + \mathbf{B}\mathbf{F})^T (\mathbf{P}^{-1}(k) - \varepsilon \mathbf{D} \mathbf{D}^T)^{-1} (\mathbf{A} + \mathbf{B}\mathbf{F}) + \frac{1}{\varepsilon} (\mathbf{E}_1 + \mathbf{E}_2 \mathbf{F})^T (\mathbf{E}_1 + \mathbf{E}_2 \mathbf{F}) - \mathbf{P}(k) + \mathbf{Q}_1 + \mathbf{F}^T \mathbf{R} \mathbf{F} \leq 0, \varepsilon > 0,$$

The both side of the inequality are postmultiplied by $\mathbf{Q}$, let $\gamma \varepsilon = \Lambda > 0$, $\mathbf{F} = \mathbf{Y} \mathbf{Q}^{-1}$, according to Schur complement, we obtain

$$\begin{bmatrix} \mathbf{Q} & \mathbf{Y}^T \mathbf{R}^{1/2} & \mathbf{Q} \mathbf{Q}_1^{1/2} & (\mathbf{Q} \mathbf{A}^T + \mathbf{Y}^T \mathbf{B}^T) & (\mathbf{Q} \mathbf{E}_1^T + \mathbf{Y}^T \mathbf{E}_2^T) \\ \mathbf{R}^{1/2} \mathbf{Y} & \gamma \mathbf{I} & 0 & 0 & 0 \\ \mathbf{Q}_1^{1/2} \mathbf{Q} & 0 & \gamma \mathbf{I} & 0 & 0 \\ (\mathbf{A} \mathbf{Q} + \mathbf{B} \mathbf{Y}) & 0 & 0 & \mathbf{Q} - \Lambda \mathbf{D} \mathbf{D}^T & 0 \\ (\mathbf{E}_1 \mathbf{Q} + \mathbf{E}_2 \mathbf{Y}) & 0 & 0 & 0 & \Lambda \mathbf{I} \end{bmatrix} \geq 0.$$

The inequality is affine to $\mathbf{A}_i, \mathbf{B}_i, \mathbf{E}_{i1}, \mathbf{E}_{i2}$, $\mathbf{Y} = \sum_{i=1}^L \lambda_i \mathbf{Y}_i$. According to Schur

complement and Ref.12, two LMIs are expressed as inequality 9 and inequality 10. And then, feasibility of the predictive, that is input constraint, is taken account of.

$\mathbf{x}^T(k|k) \mathbf{Q}^{-1} \mathbf{x}(k|k) \leq 1$ is constant set of the system 2 (Eq. 2). From the inequality 11, we have

$$\mathbf{x}^T(k+i|k) \mathbf{Q}^{-1} \mathbf{x}(k+i|k) \leq 1, \quad i \geq 1,$$

$$\mathbf{u}(k+i|k) = \mathbf{F} \mathbf{x}(k+i|k) \quad \mathbf{u}(k+i|k) = \mathbf{F} \mathbf{x}(k+i|k),$$

$$\|\mathbf{u}(k+i|k)\|_2 \leq u_{\max},$$

$$\max_{i \geq 0} \|u(i|k)\|_2^2 = \max_{i \geq 0} \|YQ^{-1}x(i|k)\|_2^2 \leq \lambda_{\max}(Q^{-1/2}Y^TYQ^{-1/2}) \leq u_{\max}^2.$$

With Schur complement, the input constraint can transform to
$$\begin{bmatrix} u_{\max}^2 \mathbf{I} & Y \\ (Y)^T & Q \end{bmatrix} \geq 0,$$

and be equivalent to
$$\begin{bmatrix} u_{\max}^2 \mathbf{I} & Y_j \\ (Y_j)^T & Q \end{bmatrix} > 0, j = 1, 2, \dots, L.$$

4 Simulation

When an aircraft is flying through the atmosphere, the symmetry dynamic characteristics is described as balancing and swing-up of an inverted pendulum on a cart.

$$\begin{aligned} \dot{x}_1 &= x_2 \\ \dot{x}_2 &= \frac{g \sin x_1 - amlx_2^2 \sin(2x_1)/2 - au \cos x_1}{4l/3 - aml \cos^2 x_1}. \end{aligned}$$

Where $g = 9.8\text{m/s}^2$ is the acceleration of gravity. $a = 1/(M + m)$ is the mass of the cart, and m is the mass of the pendulum. $l = 0.3\text{m}$ is the length of the pendulum, x_1, x_2 denote the angle of the pendulum from the vertical and the angular velocity respectively. u is the force applied to the cart. A fuzzy controller is designed with the fuzzy dynamic model.

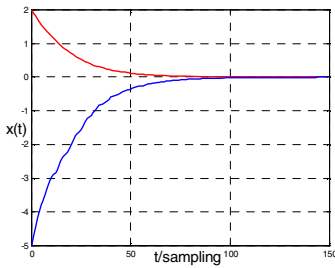


Fig. 1. States trajectories

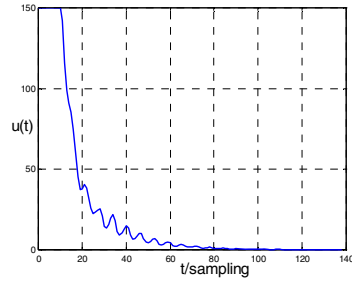


Fig. 2. Thrust u

When the constraint of the input is $|u| \leq 150\text{N}$, and sampling period is $T = 0.02\text{s}$, the initial state are $[2, -5]$, $Q_1 = \text{diag}\{1, 1\}$, $R = 1$, the original nonlinear system is simulated. The state trajectories are shown in Fig.1. As shown in Fig.2, the input control curve satisfies the input constraint.

5 Conclusion

On the basis of the T-S fuzzy model, the nonlinear system is described, and parametric uncertainty terms are introduced into the T-S model. The parallel distributed compensator (PDC) is designed with an infinite horizon predictive control, thus the optimization problem with input constraint is transformed into the constraint LMI problem. The simulation of the aircraft dynamic characters through the atmosphere testifies the method validity.

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The Factors Affecting Relationship between COD and TOC of Typical Papermaking Wastewater

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Abstract. The factors affecting correlation between COD and TOC of wastewater in a typical paper mill which polluted river water seriously had been studied. Most organic components of papermaking wastewater can be oxidized absolutely by COD tests. Volatility of organic components influenced correlation between COD and TOC of papermaking wastewater by contrasting experimental and theoretical COD values and experimental and theoretical TOC values respectively. Molecular formulas of organic components also can affect the relationship between COD and TOC of papermaking wastewater via regression analysis of the correlation between COD and TOC of typical organic matters which represented main organic components in papermaking wastewater.

Keywords: Papermaking wastewater, COD, TOC, Factors.

1 Introduction

Chemical oxygen demand (COD) is widely used for determining the strength of organic pollution. However, COD can not reflect the degree of industrial wastewater precisely owing to the impacts of types and concentration of oxidants, reaction temperature and time, the acidity of reaction solution and catalyst etc [1,2]. The procedure of the test is intricate, which always brings secondary effluents [3]. Relatively, total organic carbon (TOC) can reflect the strength of organic pollution accurately because its method contains many advantages, such as its short time-consuming process, fast and accurate results, stability and reliability etc [4]. Theoretically, there is a correlation between COD and TOC [2]. Actually, many scholars have found significant correlation between COD and TOC of industrial effluent, specific classes of organic chemicals and surface water [5,6,7]. The correlations between these indicators are weak in some natural water [8]. Baker, J.R analyzed correlation between COD and theoretical COD of variable organic matters. The result showed that many factors possibly affect the differences between measured COD and theoretical COD [9]. However, researches on the factors of the correlation between COD and TOC are seldom.

Accordingly, the objective of this research was to find out factors that may influence the relationship between COD and TOC of typical papermaking wastewater by affect the determination of these indicators. To do this, effects of paper mill on environment had been demonstrated. Organic components of paper mill and river water were analyzed. The result offered theoretical basis to the substitution of TOC for COD.

2 Research Method

Water sampling and component analysis. Water samples of a paper mill beside Kaishantun section of the Tumen River were collected. In Kaishantun section, river water samples upstream the paper mill and river water samples downstream the mill were collected. Microporous membranes (0.45 μ m) were used to filter suspended particles in samples before component analysis.

Analysis of organic components of water sample of river downstream the mill, oxidized water sample of papermaking wastewater by COD test and blank water sample which were oxidized by COD test were realized via liquid-liquid extraction-gas chromatography mass spectrometry (LLE-GCMS). Wastewater sample were analyzed via the method of LLE-GCMS and purge and trap-gas chromatography mass spectrometry (P&T-GCMS). Qualitative and quantitative analysis were based on peak heights, peak areas and retention time of organic components.

Determination of COD and TOC. Potassium dichromate method (GB/T11914-1989) was applied to determine COD of papermaking wastewater, dissolved organic matters which represent mainly organic components in paper waste and the water samples of the Tumen River. TOC of these samples were measured by combustion oxidation - non-dispersive infrared absorption method (HJ/T71-2001).

Regression analysis. Regression analysis was achieved taking advantage of least squares. The results were examined by correlation test. T test was used to examine significant difference between intercepts and 0.

3 Results and Discussion

Internal relations between papermaking wastewater and surface water. The types and quantities of organic components which came from papermaking wastewater and river water downstream the mill were analyzed and counted respectively. All components which could be identified were classified. The mass ratio of each type of organic component in paper waste and river water downstream the mill was calculated. The results were located in table 1.

Table 1. Types and mass ratios of major organic components in papermaking wastewater and river water downstream the mill

Types of organic components	Papermaking wastewater	The Tumen River	Types of organic components	Papermaking wastewater	The Tumen River
Cyclic alcohol	2.77%	0.380%	Phenol	20.7%	12.1%
Aromatic alcohol	3.57%	—	Carboxylic acid	5.54%	—
Ether	1.43%	0.330%	Aromatic acid	1.34%	—
Fatty acid ester	24.9%	21.9%	Aliphatic aldehyde	1.07%	1.06%
Aromatic acid ester	1.42%	0.620%	Aromatic aldehyde	4.71%	1.09%
Lactone	3.13%	0.514%	Alicyclic hydrocarbon	0.846%	0.429%
Aromatic-aliphatic ketone	13.0%	25.8%	Aromatic	1.55%	2.14%
Aromatic ketone	1.38%	5.71%	n-Alkane	1.32%	14.1%
Alicyclic ketone	1.97%	2.02%	PAH	0.452%	0.897%
Sulfur compound	0.73%	0.809%	Heterocyclic class	3.41%	2.03%
Olefin	1.05%	—	Silane	0.339%	6.56%

Table 1 showed that major types of organic components in papermaking wastewater also have high proportions in river, such as aromatic-aliphatic ketone, fatty acid ester and phenol. And main types of organic components in papermaking wastewater presented in river water downstream the mill. However, some types of organic components which had high proportions of quality in river had low quality in papermaking wastewater, such as silane, n-alkane. Otherwise, the contents of the same types of organic components in papermaking wastewater and the Tumen River were different, such as aromatic-aliphatic ketone. These organic components perhaps did not derive from paper mill. River water possible contained these organic components or analogues before flowing through the paper mill. Besides, the contents and concentration of organic compounds of wastewater might change via the effects of volatility, dilution and diffusion of river water, adsorption of solid phase in river. Thus, the sources of organic components in river had been analyzed. 56 organic components in river were same as that in paper mill. In addition, peak area of these 56 organic components is 74.9% of the area of sum of all the peaks approximately. River COD value was 6 [mg/l] before the river flow through this paper mill. However, COD of filtered river water downstream the mill was 67[mg/l]. All these evidences can suggest that major organic components in Kaishantun section of the Tumen River derived from this paper mill. That is so say, this paper mill can present those paper mills that polluted the environments severely.

The impact of properties of organic components on the correlation between COD and TOC. Papermaking wastewater had been oxidized by COD test after the dilution. The types and quantities of organic components of papermaking wastewater and blank water sample were analyzed by LLE-GCMS. Total ion current (TIC) of papermaking wastewater and blank water samples were shown in fig.1 and fig.2 respectively.

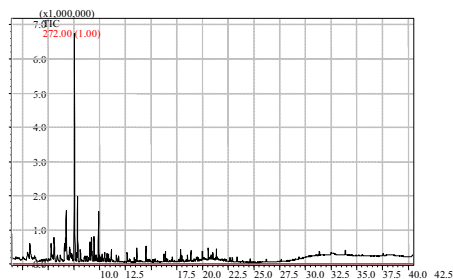


Fig. 1. TIC of papermaking wastewater

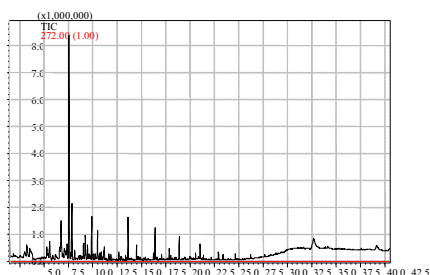


Fig. 2. TIC of blank water sample

The results showed that the types of components in two samples were same. Peak heights and areas of the components in two samples were almost matched. The result implies that almost all the organic components in papermaking wastewater can be oxidized absolutely by COD test. In waste water, mass ratios of organic components were added up which had been identified by both LLE-GCMS and P&T-GCMS. Average contents of all elements were obtained basis on statistics of mass ratios of all organic components and the quantities of carbon, hydrogen and oxygen in these organic matters. Theoretical COD/TOC was 3.27. Measured COD/TOC was 2.77. The following factors possible contribute to difference between measured COD/TOC and theoretical COD/TOC. First, names of some organic components were difficult to identify. The loss of illegible organic compounds possible affects the result of the calculation. Second, measurement error may influence the values. Finally, LLE-GCMS is suitable to analyze the samples that contain variable different organic matters, yet P&T-GCMS has a higher sensitivity to volatile organic compounds. Thus, the compounds obtained by two methods are not absolutely same. The properties of the methods possible made some organic matters omitted from the result of calculation. Volatility of organic components possibly also made impact on the measurement because some organic matters detected by P&T-GCMS were not found by LLE-GCMS. The impact of volatility on COD and TOC had been examined. Some organic matters were selected to represent main organic components in papermaking wastewater. Solutions of selected matters were prepared in concentration gradients. Both COD and TOC values were measured. The result indicated that measured COD and TOC of ethyl acetate, acetone, benzyl alcohol and benzene were lower than theoretical COD. Selected organic matters can be oxidized absolutely by TOC test. Thus, volatility of organic probably makes impact on the measurement of COD and TOC of selected matters.

The impact of major organic compounds in papermaking wastewater on the correlation between COD and TOC. 84 common organic components were detected by both LLE-GCMS and P&T-GCMS. Some organic matters were selected to represent main organic components in these components. Solutions of selected matters were prepared in concentration gradients. Both COD and TOC values were measured. Tests of significance of intercepts had been calculated by t test. When significance level (α) was 0.01, regression equation of correlation between COD and TOC, correlation coefficient (r), degrees of freedom (f), simplified linear equations were shown in table 2.

Table 2 reflected that COD and TOC of all selected organic matters had linear correlation at the 99% confidence level. There were not significant differences between intercepts and 0. The result also showed that linear equations among organic components are different. This means that types and quantities of elements of organic components probably affect COD and TOC in the solution. Supposed that all organic matters in table 2 were used to prepare a fictitious solution, the proportions of preparation were same as the mass ratios of papermaking wastewater's organic compounds which were represented by them. Mass ratios were adjusted to keep the sum of all the mass ratios 1. The ratios of COD to TOC of this simulant solution were calculated according to simplified equations. The result was 2.81. Comparing to measured ratio of COD to COD, the value of simulant solution can reflect correlation between COD and TOC of papermaking wastewater. Therefore, types and quantities of elements of organic components in papermaking wastewater are able to affect the relationship between COD and TOC of papermaking wastewater.

Table 2. Correlation between COD and TOC of aqueous organic solutions

Types of components	Selected components	f	r	t	$t_{\alpha/2(n-2)}$	Simplified Linear equation
Fatty acid ester	Ethyl acetate	4	0.9994	0.4131	4.605	COD= 2.200TOC
Lactone	Acetone	4	0.9953	2.275	4.605	COD=2.591TOC
aromatic-aliphatic ketone	Acetophenon	1	0.9997	11.12	63.66	COD= 3.041TOC
Aliphatic ketones	Acetone	4	0.9952	1.334	4.605	COD= 3.532TOC
Phenol	Phenol	4	0.9986	0.2164	4.605	COD= 2.953TOC
Carboxylic acid	Acetic acid	2	0.9987	1.790	9.925	COD= 2.675TOC
Alicyclic ketones	Cyclohexanone	2	0.9960	5.435	9.925	COD=3.982TOC
Aromatic alcohol	Benzyl alcohol	3	0.9698	0.03960	5.841	COD= 3.540TOC

4 Conclusion

Organic compounds in paper mills can affect the quality of river water. COD and TOC of river water were relative to papermaking wastewater. Volatility of organic compounds influences the measurement of COD and TOC. COD and TOC of papermaking wastewater are probable affected by the types and quantities of organic compounds in papermaking wastewater.

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An Equilibrium Algorithm to Simulate the Structure of Land Use Changes

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Abstract. The computer-based CGELUC model is constructed based on CGE theory. The CGELUC model constructs a mechanism-based model to analyze dynamic laws of evolving land use structure at regional scales. Structural change and pattern succession in land systems undoubtedly leads to changes in the suitability and quality of different kinds of land types. In this paper we introduce the CGELUC model including framework, model composition, and the modules, can be used to simulate principles of regional land use structural changes due to constraints and influences at the policy level. The model can also conduct relevant research pertaining to land use such as simulations, predictions, assessments and analyses.

Keywords: Equilibrium algorithm, CGELUC, CGE, Land use.

1 Model Features

CGELUC models vary in complexity and size, their scope can be as large as the world or as small as a town. The model complexity is mainly described by studying the number and behavior of objects in the economic system. For example, a description of government expenditure based on a budget is far simpler than actual government consumption behavior. In addition, government consumption behavior is also constrained by the development of the whole economy, institutional reform and advancement of social welfare in the practical operation of the economy. The size of the model is based on the “small country hypothesis” whether the economy involved is world-wide or in a town.

One developing trend in the CGELUC model is to make the model more delicate and complex, including finer divisions of the model’s sectors, wider classifications of consumers and non-recursive dynamics of the model. The other trend is to make the model more suited for analysis of economic and structural changes in regional land use by combining more practical characteristics of the economy. These include accounting for imperfect competition, technological progress and institutional factors endogenous in the model. The Computable General Equilibrium of Land Use Change (CGELUC) model uses the framework of the Computable General Equilibrium (CGE) to analyze the factors that influence regional land use types. The CGELUC

model retains three main features of the traditional CGE model: (i) the number of commodities and factors and the relative prices are decided by the endogenous model; (ii) the model can calculate the numerical solution of the prices of commodities and factor prices when they are entirely removed; (iii) the CGELUC model as a multi-economic, multi-numeric market model that simulates optimized behavior based on relevant information [1].

2 Model Compositions

The CGELUC model differs from empirical statistical models because it is a mechanistic model based on microeconomic theory and can effectively reflect mechanisms in structural changes in regional land use [2].

2.1 Thematic Quantitative Analysis

The CGELUC model describes the relationship between land desertification, changes in water area and expansion of developed area and the factors that influence quantitative analysis. The dynamics of land system change, desertification and changes in water area, grassland excluding pasture grassland and forest excluding economic forest are mainly influenced by natural processes [3]. The developed areas are significantly influenced by population, economic aggregation and technical progress, generally change directionally and are highly suitable for simulation and estimation with econometric methods.

2.2 Production Behavior

The CGELUC model characterizes production behavior with a quantitative description of the supply of products related to regional land use conversion and includes two types of equations: descriptive production equations and producer optimization equations. The common forms of descriptive production equations include the Cobb-Douglas function, constant elasticity of substitution (CES) function and two-tier or multi-tier nested CES function. The quantitative relationship between the production factor inputs, intermediate inputs and outputs can be described with these equations. Different production functions are generally chosen according to different research purposes for practical applications. The aim of the producer optimization equation or profit maximization equation is to define producer behavior, determine producer demand for various factors by making marginal returns of factors equal to their corresponding marginal productivity and describe how producers pursue minimum costs or maximum profits under constraint of the production function.

2.3 Land Use Conversion

In the CGELUC model, land use conversion requires investments of capital, labor, land and intermediate inputs, which are considered to be production behavior. Two types of equations characterize land use conversion: descriptive production equations and producer optimization equations. The descriptive production equations include the Cobb-Douglas function, the CES function and the two-tier or multi-tier nested

CES function, which are used to describe the quantitative relationship between production factor inputs, intermediate inputs and outputs [4]. Different land use conversion functions are generally chosen based on different research purposes and study areas. The land use conversion optimization equation aims to determine demands of producers for various factors by making marginal returns of various factors equal to their corresponding marginal conversion rates.

2.4 Consumption Behavior

The CGELUC model characterizes consumption behavior mainly with descriptive equations and demands for relevant products of regional land use conversion, which includes the descriptive production equation and the consumer optimization equation. The descriptive production equation is mainly used to describe the constraint on consumers' budgets.

2.5 Government Behavior

Policy behavior such as government revenue, interest rates and subsidies is added to the model equation system only as exogenous variables in the CGELUC model. Government behavior in the CGELUC model is not limited to formulating relevant policies; more importantly, the government also acts as a consumer in the CGELUC model.

2.6 Foreign Trade

The CGELUC model involves foreign trade as an important component to more accurately describe the system. The CGELUC model uses the small country assumption. This assumption helps to describe the issues conveniently, but the complexity of the equation caused by involvement of foreign trade still cannot be avoided.

2.7 Market Equilibrium

Equilibrium is the core of the CGELUC model and mainly includes market equilibrium and the balance between income and expenditures. Product market equilibrium requires that the total supply of products equals the total demand for products [5]. Capital market equilibrium means that total investment equals total savings. Factor market equilibrium mainly refers to equilibrium between supply and demand of labor and land market equilibrium. Residents' income and expenditure equilibrium means that residents spend all income. The government budget equilibrium is a generalized equilibrium. If government expenditures do not equal income, then a fiscal deficit will be added to government revenue as a variable so that the disequilibrium of the government budget can be expressed with a set of equations.

2.8 Macroscopic Closure

The different variables under various equilibrium conditions in the CGELUC model provide an important way to study the actual state of disequilibrium. However, it is unrealistic to assume that the market, income and expenditures of various departments can simultaneously balance; only a conditional equilibrium can be achieved. The

macroscopic closure theory of the CGELUC model makes trade-offs between labor market, government budget and investment-saving equilibriums and optimal conditions for production.

3 Modules of the CGELUC Model

Quantitative analysis module includes the areas of developed regions, unused land, water, grassland with indirect economic value such as ungrazed or commonwealth grassland and forest with indirect economic value such as ecological commonwealth forest are simulated with the macroscopic econometric model.

Production of final products is calculated from the following formula:

$$Z_c(t) = \min_{d,l} \left\{ \frac{X_{d,c}(t)}{ax_{d,c}(t)}, \frac{LK_{l,c}(t)}{al_{l,c}(t)}, \frac{Y_c(t)}{ay_c(t)} \right\} \quad (1)$$

where $Z_c(t)$ represents the amount of final products produced in the t th year; $X_{d,c}(t)$ signifies the amount of the intermediate product d consumed in the production process of the final product c ; $ax_{d,c}(t)$ stands for the consumption coefficient of the intermediate product d in the production process of the final product c ; $LK_{l,c}(t)$ represents the amount of the l th type of land consumed in the production process of the product c ; $al_{l,c}(t)$ is the consumption coefficient of the l types of land in the production process of the final product c ; $Y_c(t)$ signifies the amount of intermediate products consumed in the production process of the final product c ; $ay_c(t)$ represents the consumption coefficient of the intermediate products in the production process of the final product c .

Land use conversion module which includes Land use conversion, using the following formula:

$$DL_{zl}(t) = \min \left\{ \frac{XL_{c,zl}(t)}{axl_{c,zl}(t)}, \sum_l FL_{l,zl}(t), \frac{YL_{zl}(t)}{ayl_{zl}(t)} \right\} \quad (2)$$

where $DL_{zl}(t)$ is the amount of the z lth newly-increased land in the t th year; $XL_{c,zl}(t)$ stands for the amount of intermediate input c consumed in the z l land use conversion process; $axl_{c,zl}(t)$ is the consumption coefficient of the intermediate input c in the z l land use conversion process; $FL_{l,zl}(t)$ is the area of the l th land input into the z l land use conversion process; $YL_{zl}(t)$ represents the quantity of intermediate products consumed in the z l land use conversion process; $ayl_{zl}(t)$ stands for the consumption coefficients of the intermediate products in the z l land use conversion process.

Equilibrium closure module includes Product market equilibrium, which is calculated from the following formula:

$$Q_c(t) = Xp_c(t) + Xg_c(t) + Xv_c(t) + Xc_c(t), \quad (3)$$

$$Pq_c(t) = Pd_c(t), \quad (4)$$

$$Pq_c(t) = (1 + \tau_c(t))Ps_c(t). \quad (5)$$

where $Q_c(t)$ is the number of integrated products sold at home in the t th year; $Xp_c(t)$ is the quantity of product c demanded by household consumption; $Xg_c(t)$ is the quantity of product c purchased by the government; $Xv_c(t)$ is the quantity of product c demanded by investment; $Xc_c(t)$ is the total demand of the intermediate input for the product c ; $Pq_c(t)$ represents the price of the integrated product c sold at home; $Pd_c(t)$ is the domestic selling price of the domestic product c ; $\tau_c(t)$ is the indirect tax rate of the product c ; $Ps_c(t)$ represents the domestic price of supply of the domestic product c .

4 Concluding Remarks

The computer-based CGELUC model is constructed based on CGE theory. The CGELUC model is divided into two parts when simulating structural changes in regional land use, including a thematic quantitative analysis section and an equilibrium analysis section of regional land area supply and demand. The structure of regional land use is influenced by socioeconomic factors, including industrial structure, trade environment, economic policies and institutional arrangements, and these multi-dimensional factors should be taken into consideration by different departments as part of an open, balanced economic system. This model can be used to simulate principles of regional land use structural changes due to constraints and influences at the policy level. The model can also conduct relevant research pertaining to land use such as simulations, predictions, assessments and analyses.

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Research on Computer-Based Simulation for the Dynamics of Land System

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Abstract. The Dynamics of Land System (DLS) model is a collection of programs that simulates pattern changes of land uses by conducting scenario analysis of the area of land use change. The Dynamic Land System (DLS) model provides an important way to predict scenarios for future land productivity. The DLS model is a powerful tool for simulating the dynamics of land use changes, which is theoretically based on restrictions of the distribution of land use types. In this paper, we introduce the main function modules, model inference, model estimation, and model test.

Keywords: Simulation, Function modules, Model inference, DLS.

1 Introduction

The land system is an open, complex system consisting of two subsystems, the geographic environment and human activities, inside which are certain structures and functions. At the core of simulated land use pattern changes are interactions among the natural environment, human society and area of land use change. The Dynamics of Land System (DLS) model is a collection of programs that simulates pattern changes of land uses by conducting scenario analysis of the area of land use change. The DLS model fully considers the links between related models of nature, ecology and economy. It also extracts decision-making reference information used in land use planning, environmental planning and management of natural resources by designing different scenarios of changing regional land use area [1,2].

2 The DLS Model

The DLS model effectively simulates spatial-temporal pattern changes of land uses. Regarding data integration, the DLS model represents various land use types in a grid data format, which spatially expresses characteristics of the distribution of regional land use types with high spatial resolution [3]. It takes information from the basic grid unit as observed data and realizes the spatial-temporal simulation of the pattern changes of land uses at the pixel level.

2.1 Function Modules of the DLS Model

The DLS model is based on quantitative analysis of land use pattern changes at the pixel level, interactions among driving factors and spatial-temporal distribution of land use pattern change. Mechanism analysis of the DLS model aims to estimate the statistical relationship between the pattern changes of land uses and its driving factors. Driving factors behind land use pattern can be analyzed with the explanatory linear model of land use pattern (ELMLUP) and explanatory nonlinear model of land use pattern (ENMLUP) built at the pixel level. The two models can be used to research restrictions on the distribution of land use types at the pixel level with different backgrounds and goals, and they can be used flexibly to reveal in-depth driving mechanisms of pattern changes of land uses at the pixel level [4].

2.2 Model Inference

(i) Spatial autocorrelation

The quantitative relationship between $\hat{Q}_i^{kt}$ and $\hat{X}_i^t$ is developed through the following multiple linear regression model:

$$\hat{Q}_i^{kt} = a_0^k + a^k \hat{X}_i^t. \quad (1)$$

where $a^k = (a_1^k, a_2^k, \dots, a_L^k)$ is the coefficient matrix of $\hat{X}_i^t$, and a_0^k is a constant term. Regarding grid i at time t , the result $reg(\hat{Q}_i^{kt})$ estimated by the model is naturally employed to reflect the average proportion of area of land use type k under natural and socioeconomic conditions $\hat{X}_i^t$.

Apparently, $reg(\hat{Q}_i^{kt})$ does not equate with deviation of the actual observed value $real(\hat{Q}_i^{kt})$. If the demanding area of land use type k changes in the demanding module, the relative stability of land use pattern will be broken. Therefore, we can hypothesize that a certain relationship exists between the land pattern change and the value difference between $reg(\hat{Q}_i^{kt})$ and $real(\hat{Q}_i^{kt})$; when estimated value, $reg(\hat{Q}_i^{kt})$, is smaller than the observed value, $real(\hat{Q}_i^{kt})$, the area proportion of land use type k will increase; when estimated value, $reg(\hat{Q}_i^{kt})$, is larger than the observed value, $real(\hat{Q}_i^{kt})$, the area proportion of land use type k will decrease.

When the demanding module of the ELMLUP requires the area proportion of land use type k to change to $DEMAND^{k(t+1)}$ at time $t+1$ in grid i , the area proportion of land use type k will vary:

$$\hat{Q}_i^{k(t+1)} = real(\hat{Q}_i^{kt}) + [reg(\hat{Q}_i^{kt}) - real(\hat{Q}_i^{kt})] \cdot F_i. \quad (2)$$

where $\hat{Q}_i^{k(t+1)}$ is the area proportion of land use type k in grid i at time $t+1$; F_i is the changing coefficient of the area of the land use type regulated by the general demanding equation:

$$DEMAND^{k(t+1)} = \sum_{i=1}^n \{real(\hat{Q}_i^{kt}) + [reg(\hat{Q}_i^{kt}) - real(\hat{Q}_i^{kt})] \cdot F_i\}. \quad (3)$$

An iteration adjustment is then needed until the proportion of the area of the land use type k increases to $DEMAND^{k(t+1)}$.

Conversely, if the demanding area of land uses type decreases, the trends for the changes of the land uses types will be dissimilar.

(ii) ELMLUP

In the same way, the quantitative relationship between $\hat{Q}_i^{kt}$ and $\hat{X}_i^t$ is developed through the following regression equation:

$$Q_i^{kt} = b_0^k + b^k X_i^t. \quad (4)$$

where $b^k = (b_1^k, b_2^k, \dots, b_L^k)$ is the regression coefficient matrix of X_i^t , and b_0^k is a constant term; $reg(\hat{Q}_i^{kt})$ is the area proportion of land use type k at time t , estimated by the multiple linear regression model; $real(\hat{Q}_i^{kt})$ is the actual observed value of the area proportion of land use type k at time t .

$$Q_i^{k(t+1)} = real(Q_i^{kt}) + [reg(Q_i^{kt}) - real(Q_i^{kt})] \cdot F_i' \cdot R_i^{kt}. \quad (5)$$

where the definition of F' is similar to that of F_i ; R_i^{kt} is the influence function that stands for the influence of the spatial autocorrelation factors on grid i that change with Q_i^{kt} . If the change in area of land use type k in grids near grid i is frequent, there will be correspondingly great changes in Q_i^{kt} and R_i^{kt} due to spatial autocorrelation.

By contrast, if land use type k in grids near grid i are relatively steady, the change in Q_i^{kt} would be correspondingly little. This is the explanatory model for land use pattern in linear form, or the ELMLUP, which considers the effect of spatial autocorrelation.

2.3 Model Estimation

In this paper, we introduce one of the most commonly used methods, the least squares method. The least squares method produces a line that has the minimum sum of the deviations squared (least square error) from a given set of data [5]. For the two multiple linear regression functions in the ELMLUP, the minimum sums of the deviations squared are respectively defined by the following two equations:

$$\hat{Q}(a_0^k, a^k) = \sum_{i=1}^n [\text{real}(\hat{Q}_i^{kt}) - \text{reg}(\hat{Q}_i^{kt})]^2 = \sum_{i=1}^n [\text{real}(\hat{Q}_i^{kt}) - (a_0^k + a^k \hat{X}_i^t)]^2, \quad (6)$$

$$Q(b_0^k, b^k) = \sum_{i=1}^n [\text{real}(Q_i^{kt}) - \text{reg}(Q_i^{kt})]^2 = \sum_{i=1}^n [\text{real}(Q_i^{kt}) - (b_0^k + b^k \hat{X}_i^t)]^2, \quad (7)$$

2.4 Model Test

It is still unknown whether linear relationships exist between the change of land use pattern and natural and socioeconomic factors after the regression coefficient of the multiple linear functions is obtained in the ELMLUP. Therefore, a significance test is needed for the estimated multiple linear regression function. Here, we introduce the approach of using variance analysis to test the significance of the regression function. In this approach, the total variance is decomposed into two parts:

$$\sum_{i=1}^n (Q_i^{kt} - \bar{Q}^{kt})^2 = \sum_{i=1}^n [Q_i^{kt} - \text{reg}(Q_i^{kt})]^2 + \sum_{i=1}^n [\text{reg}(Q_i^{kt}) - \bar{Q}^{kt}]^2 = ESS + MSS, \quad (8)$$

where $\bar{Q}^{kt}$ is the average of Q_i^{kt} ; ESS is the sum of variance of regression function; MSS is the sum of variances of the errors. Then, a new statistic is defined as follows:

$$F = \frac{MSS/f}{ESS/g} = \frac{MMS}{EMS}, \quad (9)$$

where statistic F has a distribution of $F(f, g)$, and f and g are the degrees of freedom of the regression function and error, respectively.

By calculating statistic F and the significance probability, we can judge the significance of the multiple regression function. If the value of the significance probability is relatively small, or smaller than the significance level (for instance 0.01), we can conclude that the regression function accurately simulates the relationships between land use patterns and their driving factors.

3 Concluding Remarks

The Dynamic Land System (DLS) model provides an important way to predict scenarios for future land productivity. When combined with associated models, the DLS can analyze trends in land productivity under various hypotheses and provide decision-making information support for land use planning and land resource management. The DLS model is a powerful tool for simulating the dynamics of land use changes. It is robust for simulating land use pattern changes in terms of both the expression of mechanisms and simulation effects. The DLS model also has improved the scientific and rational nature of predicted and estimated results.

DLS is a software tool developed based on the DLS model for the dynamic simulation of the land use pattern changes. It can measure the influence of driving

factors that are closely associated with changes in the land use pattern, including natural conditions, socioeconomic factors and even land use management policies. It can simulate the spatial-temporal process of pattern changes of land uses and export maps of pattern changes of land uses with high spatial and temporal resolution by setting conversion rules of land use types and designing change scenarios.

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Estimation System for Land Productivity

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Abstract. The land resource is a multifunctional natural resource, which is in continuously growing demand under a background of rapid population growth and economic development. Land is involved in production activities and is traded in the factor market as a commodity. Alternatively, land uses change with changing human activities. It is necessary to estimate the effects of land system change to maximize the use of the land. In this paper, we describes the processes, parameters needed and operation of the estimation model, which will improve the ability of readers to use this model and provide a foundation for its wide application.

Keywords: Land productivity, Parameter configuration, ESLP.

1 Introduction

Land productivity generally refers to the overall productivity related to various combinations of the natural characteristics of the land and socioeconomic factors. Land productivity is determined by radiation, heat, water and soil, the biological characteristics of the crop, and input levels and management. The sustainable exploration and use of land resources are crucial to all levels of governments and land users, and the protection of land resources is related to current and future benefits for humans. The Estimation System for Land Productivity (ESLP) is a collection of several applications, including land suitability assessment, and the evaluation of land productivity, and some advanced applications which use the stock of land resources as fundamental input information.

2 Features of the ESLP

The Estimation System for Land Productivity (ESLP) is a collection of several applications, including land suitability assessment, and the evaluation of land productivity, and some advanced applications which use the stock of land resources as fundamental input information [1]. The core modules of the ESLP include the estimation of the cumulative amount of land resources, the determination of land use types and land use intensity, the demands of crop growth on climatic resources such

as effective radiation, temperature and rainfall, and the assessment of land suitability which includes the maximum potential crop yield and limiting factors of crop production.

3 Parameters

The growing period for crops, influenced by seasons, is one of the important parameters in the ESLP. As a comprehensive indicator of changes to the agro-ecological conditions, the growing period is defined as the period from the time when moisture and temperature conditions are suitable for crop growth until the crops mature [2,3,4]. The thermal zone is one of the important parameters in agro-ecological zoning. It indicates the total heat available during the growing period which can usually be represented by the heat available for the crop during each day of the growing period. The soil property information is the basis of soil mapping. Soil types are classified as different soil genus or soil species. Soil properties are influenced by the soil quality, land management and even the habits of the planted crops. The land resource stock is characterized by the combined status of land use types, and constitutes the basis of agro-ecological zoning. The climate parameters under different scenarios are useful to simulate and predict the spatial-temporal changes in land productivity under different scenarios, which can be extended with climate parameters. An effective way to increase productivity is to raise the input levels, which can include the financial investment by governments, collectives or individual farmers in fixed and current assets [5]. The ESLP can estimate and simulate changes in land productivity for different input levels.

4 Operation of the Estimation Model

The land productivity estimation contains eight operational steps. The first four operations mainly include the preparation of the parameters: temperature interpolation, identifying the length of the growing period (LGP), and determining the radiation surface and effective radiation. The final four operations are the determination of potential thermal productivity, potential climate productivity, potential land productivity and potential agricultural productivity.

There are many methods for the spatial interpolation of temperature, and the distance weighting method is used to spatially interpolate climate data in the ESLP. The specific steps in spatial interpolation are described below.

(i) Calculate the order and distances from the four closest weather sites to each grid point. Assume that meteorological station S_i has the same attributes (abscissa (meter) x , ordinate (meter) y , annual precipitation line (millimeter) preline), as grid point G , then the square of the distance from grid points to the four sites is as follows:

$$d_i^2 = (S_i.x - G.x)^2 + (S_i.y - G.y)^2. \quad (1)$$

- (ii) Calculate the weighting of each site on the grid points.
- (iii) Calculate the temperature. The temperature data is adjusted to the temperature as follows:

$$S_i.T^* = S_i.T + r \times S_i.elv / 100.0. \quad (2)$$

where S_i is the meteorological station i ; T^* is the adjusted temperature (including the maximum, minimum and average daily temperatures); T is the original data; elv is the altitude (meter). The temperature of the grid point at sea level is then calculated by the following formula:

$$G.T^* = \frac{\sum_{i=1}^4 (W_i \times S_i.T^*)}{\sum_{i=1}^4 W_i}, \quad (3)$$

Finally, the temperature at the actual elevation is determined by:

$$G.T = G.T^* - r \times G.elv / 100.0. \quad (4)$$

The LGP identification module is used to determine the length of the growing period. The input parameters include the workspace, the estimated number of years and the output paths for the LGP identification results. Temperature is the basis for the determination of the LGP. The ESLP uses the spatially interpolated temperature grid data to determine the initial and final ten-day periods with the average temperature above 5°C for each year and consequently determines the LGP for crops.

The radiation data preparation module transforms the radiation data from text data to spatial grid data. The input parameters include the workplace, input path for site-based radiation observation data, estimated year, and the storage path of output data.

The effective radiation estimation module is used to determine the effective radiation during the LGP for crops based on the radiation data and the LGP for crops. The input parameters include the LGP for crops, estimated years, output path for effective radiation data and input path for radiation data. The parameters of this module are all sourced from the estimation results of preceding modules.

The potential thermal productivity module estimates the maximum potential productivity of crops under certain temperature and light conditions. The parameters required for this module include the input path for temperature data, estimated years, input paths for the effective radiation data and land-use data, and the output path for the potential thermal productivity. The temperature and effective radiation data are from the estimation results described above. The land use data is sourced from remote sensing image data, with operator-computer interactions to extract land use information.

The potential climate productivity module estimates how restrictions in precipitation affect the potential productivity. The input parameters include the elevation, effective radiation, average, maximum and minimum temperatures, wind speed at 2 m above ground level, average relative humidity, precipitation and the k_c coefficient. The elevation data is obtained with the following steps. First, a topographic map is scanned and saved as a raster data image. Geographic Information

System (GIS) based software is then used to digitize the map, and a contour layer is extracted with the contour and point elevation feature information (mainly peak elevations). Finally, the contour layer is used as the source file and interpolated to get an elevation map in GRID format with the use of the Kriging interpolation software tool. The climate data, such as effective radiation and precipitation, is obtained from ground-based observations at meteorological stations, with the original data stored in ASCII format and then interpolated into GRID format.

The potential land productivity module estimates the controlling effects of soil characteristics on potential productivity. There are numerous parameters in this module, including 12 parameters related to three main aspects, the site conditions, soil properties and soil nutrients. The site condition parameters include the slope and aspect, which can be obtained by estimation from the elevation data using GIS application software. Soil property parameters include soil texture, pH, and topsoil depth. For the pH and topsoil depth, soil survey data can be used. The soil survey data is text data, which uses points as the statistical unit and can be interpolated into grid data with the Kriging interpolation method. The soil nutrient data includes soil organic matter, total nitrogen, total phosphorus, total potassium, available nitrogen, available phosphorus and potassium, all of which are also obtained from the soil survey data. The soil texture needs to be further classified based on the soil texture classification standard after interpolation. Soil texture is a soil physical property, which generally refers to the composition of mineral grains of different diameters in the soil. Soil texture is closely related to soil aeration, fertilizer retention, water holding capacity and ease of cultivation. Soil texture is an important property for identifying appropriate soil use, management and improvement, and therefore it is a vital factor for land productivity.

The land productivity module aims to estimate the land productivity at different management and input levels. The required parameters include the input level, contribution coefficients of investment in agricultural science, technology and management, estimated years, input paths for potential land productivity, and output paths of land productivity. The agricultural investment and management level data includes the agricultural population, total power of farm machinery, fertilizer use, plastic film use, investment in agricultural infrastructure construction, and agriculture funding input, all of which are usually at a regional scale. The agricultural population data is disaggregated in a different way from other data. Models are then established to find the population living in 1 km² grids of different land use types in the county. The models are generally in the following form:

$$P_i = \sum_{j=1}^n a_j x_j = B_j. \quad (5)$$

where P_i is the total population in the district i ; a_j is the demographic distribution coefficient for the j th land use type in this district (person/km²); x_j is the area of the j th land use type in this district (km²); n is the number of secondary land use types.

To improve the classification accuracy, spatial distribution models for population are established for each secondary area to generate the initial population distribution coefficients of different land use types in the district. The population in each sub-district is calculated after being disaggregated. The difference between the

populations in the different sub-districts and the actual population (residual item) is revised for each sub-district.

5 Concluding Remarks

The land resource is a multifunctional natural resource, which is in continuously growing demand under a background of rapid population growth and economic development. Land productivity is one of the important indices in the assessment of effects of the dynamics of land system change. Land productivity is estimated from the natural, social and economic properties of the land resource and based on the sunlight, temperature, water, soil, input level and management conditions. The core modules of the ESLP include the estimation of the cumulative amount of land resources, the determination of land use types and land use intensity, the demands of crop growth on climatic resources, and the assessment of land suitability which includes the maximum potential crop yield and limiting factors of crop production. This paper describes the processes, parameters needed and operation of the estimation model, which will improve the ability of readers to use this model and provide a foundation for its wide application.

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Design and Realizing of Face Recognition Algorithm

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Abstract. Structure and properties of fuzzy ART were described. Choice and match function were presented. In order to extracted face feature, low pass filter, cutting minimum intensity and generating vector histogram were used. Fuzzy ART used the vector histogram as the original input vector data to recognize face feature. when the fuzzy ART network parameters were selected properly, simulation experiments showed that maximum online recognition rate was 90.3% and offline recognition rate was nearly 100%.

Keywords: Neural network, Fuzzy ART, Face recognition, Online.

Introduction

Offline training face recognition systems will only recognize the faces with known models and the face database cannot be updated during the classification procedure and they can work for surveillance systems in company security system or in an airport surveillance system that is trained to recognize known terrorists. When some market survey company and consultant company collect market data on customs, a system to recognize unknown faces is needed[1-4].

Online learning system can automatically learn features of new and store corresponding models of new faces for future use, at the same time, it detect the new faces and extend the database based on the new faces. This process is similar to baby's perception course of known faces and incorporation of new faces. Also, this system can generate an open environment for each recognized face in the database and sort the samples by the confidence measurement, a measure making post-processing easier. Moreover, the system is flexible enough to incorporate and retain important unknown faces.

The algorithm in this paper can automatically detect the new faces and extend the database based on the new faces. The online learning system can learn features of new, reoccurring faces and store corresponding models of new faces for future use. This method is similar to our human perception of known faces and incorporation of new faces. Also, the approach can generate a confidence measurement for each recognized face in the database and sort the candidate by the confidence measurement, which make post-processing easier.

1 Structure and Learning Rules of the Fuzzy ART System

Each fuzzy ART system includes a field F_0 of nodes, that represent a current input vector, a field F_1 , that receives both bottom-up input from F_0 and top-down input from a field F_2 , that represents the active node, or category.

$$F_0: I = (I_1, \dots, I_m) \quad \text{with each } I_i \text{ in the interval } [0,1] \quad (1)$$

$$F_1: x = (x_1, \dots, x_m) \quad (2)$$

$$F_2: y = (y_1, \dots, y_n) \quad (3)$$

Association with each F_2 category node j ($j=1, \dots, N$) is a weight vector

$$W_j = (w_{j1}, \dots, w_{jm}), \quad \text{Initially, } W_{j1}(0) = \dots = w_{jm}(0) = 1 \quad (4)$$

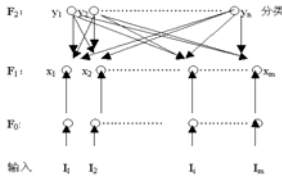


Fig. 1. Architecture of the fuzzy ART system **Fig. 2.** Organization of a codebook

The fuzzy ART weight vector W_j subsumes both the bottom-up and top-down weight vectors of ART1. Fuzzy ART dynamics are determined by a choice parameter $\alpha > 0$; a learning rate parameter $\beta \in [0,1]$ and the vigilance $\rho \in [0,1]$.

$$W_j^{(new)} = \beta(I \wedge W_j^{(old)}) + (1-\beta)W_j^{(old)} \quad (5)$$

Fast learning corresponds to setting $\beta=1$, that is $W_j^{(new)} = I \wedge W_j^{(old)}$, $W_j^{(new)} = I$, the first time category J becomes active. The Fig.1 gives the architecture of the fuzzy ART system.

2 Face Feature Extraction

First applying a simple 3×3 low pass filtering on one facial image and dividing the facial image, a 92×112 pixels image, into 4×4 pixel blocks, each 4×4 block subtracts the minimum intensity of all 4×4 pixel blocks, and intensity-variation blocks (vectors) are so obtained. Vector quantization is applied to the blocks by using a codebook consisting of 33 codevectors, which is systematically created 32 vectors by changing the 8 different directions and 4 distinguished range of intensity variation with the 33th vector having no intensity variations showed in Fig.2. The most similarly matched codevector to the input 4×4 blocks is selected. Then a histogram, 33×1 vectors extracted from one sample image, a 92×112 pixels image is generated. Usually called the codebook space information, the histogram thus stands by the feature vector of the human face.

First the input facial image first passes through a simple 2-D moving average filter. The block division step follows, dividing the facial image into 4×4 pixel blocks with

15/16 overlap using a dividing-partition that slides through as a one by one pixel. Next, To eliminate the dc offset of all the blocks , minimum intensity in the individual 4×4 pixel block is found and subtracted from each pixel in the block. Since only the intensity variation in the block is meaningful for recognition, the overall brightness variation can be effectively compensated. The intensity-variation blocks (vectors) are then taken as input vectors in the Vector Quantization processing[5]. Each input vector is then matched with the codevectors (template vectors) by calculating the distances between them. Manhattan distance is used as a matching measure in the processing. The codevector having the maximum similarity to the input vector is selected by finding the minimum Manhattan distance. The code numbers (index numbers) are transmitted in the image compression applications. Paying attention to the index number information, a codevector histogram is generated by counting the matched frequencies for each codevector. This histogram, called as the codebook space information, becomes the feature vector of the human face showed in Fig.3 and Fig.4. The VQH result acting as the feature vector of 33-dimension forms the original input vector data for the fuzzy ART system.

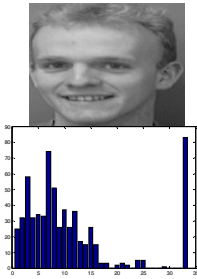


Fig. 3. VQ-Histogram Similarity

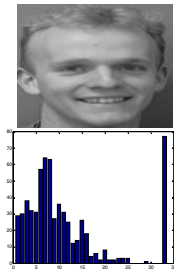


Fig. 4. VQ-Histogram Difference

3 Algorithm in Fuzzy ART

Step 1: Initially, take $\mathbf{w}_{j1(0)} = \dots = \mathbf{w}_{jm(0)} = 1$ ($j = 1, \dots, N$)

The nodes in F2 are called uncommitted or untrained nodes. Each $\mathbf{w}_{ji}$ is monotonically non-increasing through time and hence converges to a limit. The fuzzy ART weight vector $\mathbf{w}_j$ subsumes both the bottom-up and top-down weight vectors of ART1.

Step 2: Normalize to the input by $\mathbf{I} = \mathbf{a} / \max(\mathbf{a})$ for each incoming vector $\mathbf{a}$ which can avoid category proliferation and inaccurate similarity issues which mention in section 2.

Step 3: Present an input pattern to the network, since layer F2 is not active on initialization (i.e., $\dots$, each $\mathbf{y}_j = 0$), the output of layer F1 is $\mathbf{x} = \mathbf{I}$.

Step 4: For each input $\mathbf{I}$ and F_2 node j , calculate choice function

$$\mathbf{T}_j(\mathbf{I}) = \frac{|\mathbf{I} \wedge \mathbf{w}_j|}{|\mathbf{w}_j|} \wedge \frac{|\mathbf{I} \wedge \mathbf{w}_j|}{|\mathbf{I}|} \quad (5)$$

where the fuzzy AND operator $\wedge$ is defined by $((\mathbf{p} \wedge \mathbf{q})_i \equiv \min(\mathbf{p}_i, \mathbf{q}_i))$, and where the norm $||$ defined by $|\mathbf{p}| \equiv \sum |\mathbf{p}_i|, (i=1, \dots, M)$ for any M -dimension vector $\mathbf{p}$ and $\mathbf{q}$. The category choice is induced by J , where the $\mathbf{T}_j = \max\{\mathbf{T}_j : j=1 \dots N\}$, nodes become committed in order $j=1, 2, \dots$, when the j th category is chosen, $\mathbf{y}_j=1$, and $\mathbf{y}_j=0$ for all $j \neq J$.

Step 5: Find the top-down expectation $\mathbf{w}_J$.

Step 6: Combine the input and expectation in F_1 . $\mathbf{x}=\mathbf{I}$, if F_2 is inactive; or $\mathbf{x}=\mathbf{I} \wedge \mathbf{w}_J$ if the J th F_2 node is chosen.

Step 7: Resonance occurs if the match function, $\frac{|\mathbf{I} \wedge \mathbf{w}_J|}{|\mathbf{I}|}$ of the chosen category meets the vigilance criterion $\frac{|\mathbf{I} \wedge \mathbf{w}_J|}{|\mathbf{I}|} \geq \rho$, then continue with next step and learning

ensues. If $\frac{|\mathbf{I} \wedge \mathbf{w}_J|}{|\mathbf{I}|} \leq \rho$, mismatch reset occurs, then the value of the choice function

$\mathbf{T}_j$ is set to 0 for the duration of the input presentation to prevent the persistent selection of the same category during search. We return to step 3 to present the same input pattern and a new index J is chosen. The search process continues until the chosen J satisfies $\frac{|\mathbf{I} \wedge \mathbf{w}_J|}{|\mathbf{I}|} \geq \rho$

Step 8: Once search ends, the weight vector $\mathbf{w}_J$ is updated according to the equation:

$$\mathbf{w}_J^{(new)} = \beta(\mathbf{I} \wedge \mathbf{w}_J^{(old)}) + (1-\beta) \mathbf{w}_J^{(old)}, \text{ that is, } \mathbf{w}_J^{(new)} \text{ moves from } \mathbf{w}_J^{(old)} \text{ towards } (\mathbf{I} \wedge \mathbf{w}_J^{(old)}).$$

For efficient coding of noisy input sets, it is useful to set $\beta=1$, when J is an uncommitted node, and then to take $\beta < 1$, after the category is committed, notice that $\mathbf{w}_J^{(new)} = \mathbf{I}$, the first time category J becomes active.

Step 9: Remove the input pattern, restore all inhibited neurons in F_2 and return to step 1 with a new input pattern.

4 Experimental Results and Discussions

Choice function, learning rate, choice parameter, vigilance parameter etc. influence the recognition rate of neural network. The following experiment only concern with how the choice function and vigilance parameter influence the recognition rate when the learning rate and choice parameter get certain values.

The recognition algorithm with T_j according to fuzzy ART system was programmed in the Matlab7.0 environment with original input data extracted from the publicly available ORL database in which 40 persons with 10 facial images each, (400 images altogether), with a resolution of 92×112 and variations in face angles, facial expressions, and lighting conditions[6]. The first person's 10 facial images are firstly inputted into the system, after that the second person's, then the third person's until the 40th person's ten expression facial images are applied into the system.

The range of vigilance values change is from 0.7822 to 0.7906. The total number of vigilance value is 37. Fig.5 shows the recognition number of last 10 persons. Each person has 10 different images. The number in each line means the serial number of the person. Fig.5 shows the results of online recognition rate.

For choice function T_j , make every person's first to tenth expression images input into the system again to see whether the recognition results is the same as what are the categorized results above. This process is called test procedure and can be seen as an offline learning procedure because the weight vectors are different after the above learning and training process, while the input vectors are the same. Fig.6 shows nearly 100% offline recognition rate is obtained.

When vigilance value is 0.7906, for choice function T_j , the maximum online and offline recognition rate is 90.3% and 99.35%. Table 1 shows that when the network parameters are selected properly, maximum online and offline recognition rate can be reached.

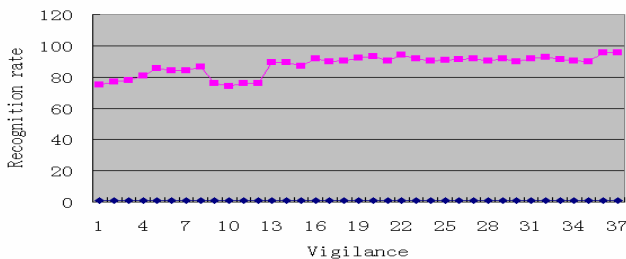


Fig. 5. Online recognition rate

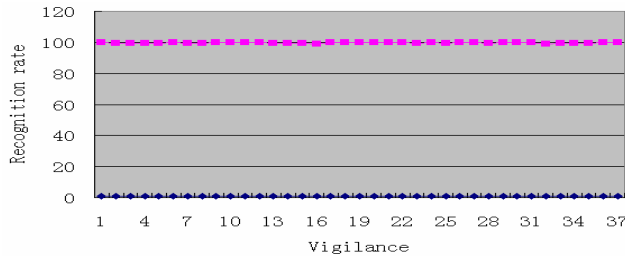


Fig. 6. Offline recognition rate

Table 1. Different choice function, relationship of network parameters and maximum recognition rate

Choice function	Learning rate β	Choice parameter α	Vigilance parameter	Maximum online Recognition rate	Maximum offline Recognition rate
T_j	1	0.00001	0.7906	90.3%	99.35%

Summary

The performance and efficiency of different algorithms can be influenced by many arguments. In fact, whether one algorithm over another is not clear in many occasions when the algorithm is used in given application setting.

The differences between one person’s different expressions sometimes are bigger than two different persons some expression. To evaluate the application of this approach, more work on different method to extract the face features and model of modified ART neural network is needed.

In order to explore this concept further, different forms of memory that can enrich the system to attain more human-like recognition capabilities are needed. Tools that are more targeted to user actual needs must be developed.

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Research on Chaos Caused by a Transitive Map Based on Intelligent Materials

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Abstract. Let (X, d) be a compact metric space, and $(\mathcal{K}(X), H)$ is d induced Hausdorff metric space of all non-empty compact subsets of X . In the paper, we investigated the distributional chaoticity in a sequence of discrete dynamical system (X, f) and the distributional chaoticity in a sequence of set-valued discrete system $(\mathcal{K}(X), \bar{f})$. And we gave a sufficient condition about the existence of distributionally chaotic sets in a sequence in discrete system (X, f) and discrete dynamical system $(\mathcal{K}, H)$.

Keywords: Set-valued discrete systems, distributional chaos in a sequence, periodic points, Hausdorff metric.

1 Introduction

Since the beginning of this century, by the study of the impact of differential inclusions, some scholars began to study set-valued dynamical systems. J. Andres, J. Fiser and L. Jutter [1] [2] studied the set-valued Sharkovskii theorem and set-valued Li-Yorke theorem. These are then applied, via Poincare operators, to Caratheodory differential inclusions. In 2003 Roman-Flores [3] compared the transitivity problems of compact system and a class of set-valued dynamical system induced by this system, and proved that the transitivity of such set-valued dynamic system implies the transitivity of the whole system, but on the contrary it does not hold. They further proposed the basic problem about chaos, whether does the chaoticity of compact system (X, f) implies the chaoticity of its induced set-valued system $(\mathcal{K}(X), \bar{f})$, and on the contrary whether does the chaoticity of $(\mathcal{K}(X), \bar{f})$ imply the chaoticity of (X, f) . Thus we started to study the relationship between individual chaos and groups of chaos.

As a result of groups of chaos have a good application background in the biological species groups, demographics, numerical simulation, and the research in the field of attractor [4] [5], it has aroused the interest of many scholars. In 2004 Fedeli [6] proved that periodic density on (X, f) implies periodic density of its induced set-valued system $(\mathcal{K}(X), \bar{f})$. In 2005, 2006 Gongfu Liao, Xianfeng Ma and the author of this article [7][8], Peris [9] and Mubao Gu [10] also discussed the chaoticity-related issues separately, and pointed out that transitivity and weakly mixing on $(\mathcal{K}(X), \bar{f})$ and (X, f) are equivalent. Roman-Flores [11] proved Robinson Chaos on $(\mathcal{K}(X), \bar{f})$.

In 1994 Schweizer B. and Smítal J.[12] gave the concept of distributional Chaos. This is a kind of Chaos with statistical law. To study the intrinsic link between Li-Yorke Chaos and Schweizer-Smítal chaos, author [13] introduced by the concept of distributional Chaos in a sequence, and proved that Li-Yorke Chaos and distributional Chaos in a sequence of interval mapping are equivalent. In this paper, first of all we give a sufficient condition of distributional chaos in a sequence. Second we discussed distributional chaoticity in a sequence of (X, f) associated to distributional chaos in a sequence of $(\mathcal{K}(X), \bar{f})$. In fact, we proved the main theorem as follows:

The main theorem. Let (X, f) be a compact system, $(\mathcal{K}(X), \bar{f})$ is a set-valued dynamical system induced by (X, f) , if f is topologically transitive and $\exists \bar{x} \in P(f)$, $f^n(\bar{x}) = \bar{x}$, then

- 1) $\exists A \subset X$ such that A is a infinite distributively chaotic set in a sequence of f ;
- 2) $\exists A \subset \mathcal{K}(X)$ such that A is a distributively chaotic set in a sequence of $\bar{f}$.

2 Basic Definitions and Preparations

Throughout this paper, X will be denoted a compact metric space with metric d , and a discrete dynamical system (X, f) is given by the space X and a surjective continuous map $f : (X, d) \rightarrow (X, d)$.

Definition 1. Let $\mathcal{X}(X)$ be the class of all non-empty and compact subsets of X , if $A \in \mathcal{X}(X)$, we define the " $\mathcal{E}$ -dilatation of A " as the set $N(A, \mathcal{E}) = \{x \in X \mid d(x, A) < \mathcal{E}\}$ where $d(x, A) = \inf_{a \in A} d(x, a)$.

The Hausdorff separation $\rho(A, B)$ of $A, B \in \mathcal{X}(R^n)$ is defined as $\rho(A, B) = \inf\{\mathcal{E} > 0 \mid A \subseteq N(B, \mathcal{E})\}$, and the Hausdorff metric on $\mathcal{X}(X)$ is defined by $H(A, B) = \max\{\rho(A, B), \rho(B, A)\}$.

Definition 2. Let X be a topological space, $f : X \rightarrow X$ is a continuous map. f is topologically transitive, i.e., for every pair U and V of non-empty open subsets of (X, d) , there is a non-negative integer n such that $f^{(n)}(U) \cap V \neq \emptyset$.

Definition 3. Let $\{p_i\}$ be a strictly increasing infinite sequence of positive integers, $x, y \in X, t > 0$. Let

$$F_{xy}(t, \{p_i\}) = \liminf_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(d(f^{p_k}(x), f^{p_k}(y)))$$

$$F_{xy}^*(t, \{p_i\}) = \limsup_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(d(f^{p_k}(x), f^{p_k}(y)))$$

If $D \subset X, \forall x, y \in D, x \neq y$,

1) $\exists \delta > 0, F_{xy}(\delta, \{p_i\}) = 0$; 2) $\forall t > 0, F_{xy}^*(t, \{p_i\}) = 1$, then D is said to be distributively chaotic set in $\{p_i\}$ for f , and the two points are said to be distributively chaotic point pair in $\{p_i\}$. f is said to be distributively chaotic in a sequence if f has a distributively chaotic set in a sequence that is uncountable.

Definition 4. Let $\mathcal{K}(X)$ be the space of all non-empty compact subsets of X , we define the natural extension $\bar{f}$ of f to $\mathcal{K}(X)$ as $\bar{f}(A) = \{f(a) \mid a \in A\}$, $A \in \mathcal{K}(X)$. Let $\{p_i\}$ be a strictly increasing infinite sequence of positive integers, $A, B \in \mathcal{K}(X), A = \{x\}; B = \{y\}, x, y \in X; t > 0$. Let

$$\bar{F}_{AB}(t, \{p_i\}) = \liminf_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(H_d(\bar{f}^{p_k}(A), \bar{f}^{p_k}(B)))$$

$$\bar{F}_{AB}^*(t, \{p_i\}) = \limsup_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(H_d(\bar{f}^{p_k}(A), \bar{f}^{p_k}(B)))$$

If $\mathcal{A} \subset \mathcal{K}(X), \forall A, B \in \mathcal{A}, A \neq B$,

1) $\exists \delta > 0, \bar{F}_{AB}(\delta, \{p_i\}) = 0$; 2) $\forall t > 0, \bar{F}_{AB}^*(t, \{p_i\}) = 1$, then $\mathcal{A}$ is said to be a distributively chaotic set in $\{p_i\}$ for $\bar{f}$ and the two points are said to be distributively chaotic point pair in $\{p_i\}$, f is said to be distributively chaotic in a sequence in set-valued discrete system.

Definition 5. Let $\{p_i\}$ be an increasing sequence of positive integers. Let $PR(f, \{p_i\}) = \{(x, y) \in X \times X \mid \forall \varepsilon > 0, \exists i \in N, s.t. d(f^{p_i}(x), f^{p_i}(y)) < \varepsilon\}$, and call it the proximal relation with respect to $\{p_i\}$.

Let $AR(f, \{p_i\}) = \{(x, y) \in X \times X \mid \lim_{i \rightarrow \infty} d(f^{p_i}(x), f^{p_i}(y)) = 0\}$ and call it the asymptotic relation with respect to $\{p_i\}$.

Let $DR(f, \{p_i\}) = X \times X - PR(f, \{p_i\})$ and call it the distal relation with respect to $\{p_i\}$.

Let

$DCR(f, \{p_i\}) = \{(x, y) \in X \times X \mid x, y \text{ be a distributively chaotic point pair of } f \text{ in } \{p_i\}\}$

and call it the distributively chaotic relation with respect to $\{p_i\}$.

Definition 6. Let $f: X \rightarrow X$ be a continuous map, if $\exists n > 0$, such that $f^{(n)}(x) = x, x \in X$, then x is called periodic point of f .

Lemma 1. Let (X, f) be a compact system, let f be a surjective continuous map, then the necessary and sufficient condition for transitivity of f is that there exists $x \in X$ such that $\overline{orb(x)} = X$.

Proof: For a proof, see Ref. [14].

Lemma 2. $DCR(f, \{p_i\}) \subset PR(f, \{p_i\}) \setminus AR(f, \{p_i\})$.

Proof: For a proof, see Ref. [15].

Lemma 3. If both $\{p_i\}$ and $\{q_i\}$ are infinite increasing subsequences of $\{m_i\}$ which is a sequence of positive integers, then there exists an infinite increasing subsequence $\{t_i\}$ of $\{m_i\}$ such that

$$AR(f, \{p_i\}) \cap DR(f, \{q_i\}) \subset DCR(f, \{t_i\}).$$

Proof: For a proof, see Ref. [15].

3 Proof of Main Theorem

Proof. Since f is transitivity, due Lemma [1]. We know $\exists x_0 \in X$ such that

$\bigcup_{k=0}^{\infty} f^k(x_0) = X$. Let $A = \{f^{kp}(x_0) \mid k \in \mathbb{Z}^+\}$, then $A \subset X$, and A is a infinite

set. In the following we prove:

1) $\exists \{p_k\} \subset \mathbb{Z}^+$ such that $A \times A \subset DR(f, \{p_k\})$, suppose $x, y \in A$ such that $x = f^{mp}(x_0), y = f^{np}(x_0)$, then $\exists m, n \in \mathbb{Z}^+, m \neq n$. Suppose $m > n > 0$, since $x_0 \notin P(f)$,

$d(x_0, f^{(m-n)}(x_0)) = d_0 > 0$. And since f is continuous, $\exists \delta > 0$ such that

$d(f^{(m-n)}(x_0), f^{(m-n)}(\xi)) < \frac{d_0}{8}$ for $\forall \xi \in N(x_0, \delta)$. Denote

$\delta_1 = \min\{\delta, \frac{d_0}{8}\}$. Since $\{x_0, f(x_0), \dots, f^n(x_0), \dots\}$ is dense in X , the orbit of

$f^{np}(x_0)$ is dense in X , then $\exists \{p_k\} \subset \mathbb{Z}^+$, such that $d(x_0, f^{p_k+np}(x_0)) < \delta_1$. So

$$d(f^{n_k+mp}(x_0), f^{(m-n)p}(\xi)) = d(f^{n_k+np}(f^{(m-n)p}(x_0)), f^{(m-n)p}(\xi)) < \delta_1 < \frac{d_0}{8}$$

$$\text{and } d(x_0, f^{(m-n)p}(x_0)) \leq d(x_0, f^{n_k+np}(x_0)) + d(f^{n_k+np}(x_0), f^{n_k+mp}(x_0)) \\ + d(f^{n_k+mp}(x_0), f^{(m-n)p}(\xi)) + d(f^{(m-n)p}(\xi), f^{(m-n)p}(x_0))$$

$$\leq \frac{d_0}{8} + d(f^{n_k+np}(x_0), f^{n_k+mp}(x_0)) + \frac{d_0}{8} + \frac{d_0}{8},$$

$$\text{i.e., } d(f^{n_k+np}(x_0), f^{n_k+mp}(x_0)) = d(f^{n_k}(x), f^{n_k}(y)) > d_0 - \frac{3}{8}d_0 > \frac{d_0}{2}.$$

So $A \times A \subset DR(f, \{p_k\})$.

2) There exists $\{q_k\} \subset \mathbb{Z}^+$ such that $A \times A \subset AR(f, \{q_k\})$, and

suppose $x, y \in A$, then $\exists m, n \in \mathbb{Z}^+, m \neq n$, suppose $m > n > 0$, and let

$x = f^{mp}(x_0), y = f^{np}(x_0)$ we just prove that there exists $\{q_k\} \subset \mathbb{Z}^+$ such that

$$d(f^{q_k}(x), f^{q_k}(y)) = d(f^{q_k+mp}(x_0), f^{q_k+np}(y_0)) < \frac{1}{k} \text{ for } \forall k \in \mathbb{Z}^+.$$

Since f is continuous map, $\exists \varepsilon_k > 0$ such that

$$d(f^{(m-n)p}(x), f^{(m-n)p}(y)) < \frac{1}{4k}, \text{ for}$$

$\forall y \in N(x, \varepsilon_k)$. Denote $\varepsilon'_k = \min\{\varepsilon_k, \frac{1}{4k}\}$. Since the orbit of x_0 is dense in

X , the orbit of $f^{np}(x_0)$ is dense in X . $\exists \{q_k\} \subset \mathbb{Z}^+$ such

that $d(f^{q_k+np}(x_0), \bar{x}) < \varepsilon'_k$,

$$\text{Then } d(f^{q_k}(x), f^{q_k}(y)) = d(f^{q_k+mp}(x_0), f^{q_k+np}(y_0))$$

$$\leq d(f^{q_k+np}(x_0), \bar{x}) + d(\bar{x}, f^{(m-n)p}(\bar{x})) + d(f^{(m-n)p}(\bar{x}), f^{q_k+mp}(x_0)) < \frac{1}{k},$$

i.e., $\lim_{k \rightarrow \infty} d(f^{q_k}(x), f^{q_k}(y)) = 0$. So, $(x, y) \in AR(f, \{q_k\})$,

i.e., $A \times A \subset AR(f, \{q_k\})$. Let $\{p_k\} \cup \{q_k\} = \{m_i\}$, then $\{m_i\}$ is a infinitely increasing subsequence. Due Lemma [3], there exists an infinitely increasing

subsequence $\{t_i\}$ of $\{m_i\}$ such that $AR(f, \{p_i\}) \cap DR(f, \{q_i\}) \subset DCR(f, \{t_i\})$.

In the following we prove that $\mathcal{A} \subset \mathcal{K}(X)$ such that $\mathcal{A}$ is distributively chaotic set in a sequence of $\bar{f}$. Let $\mathcal{A} = \{(\{x\}, \{y\}) \mid x, y \in A\}$, then $\mathcal{A} \subset \mathcal{K}(X)$. We just prove that for $\forall (\{x\}, \{y\}) \in A \times A$ is a distributively chaotic set in a sequence of $\mathcal{K}(X), \bar{f}$.

Let $i: x \rightarrow \{x\}$, then due the definition of Hausdorff metric, and we know $H_d(\{x\}, \{y\}) = d(x, y)$. So

$H_d(\bar{f}^n(\{x\}), \bar{f}^n(\{y\})) = d(f^n(x), f^n(y))$, then for $\forall t > 0$ and $\forall \{x\}, \{y\} \in \mathcal{A}$.

$$\begin{aligned} \bar{F}_{\{x\}\{y\}}(t, \{p_i\}) &= \liminf_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(H_d(\bar{f}^{p_k}(\{x\}), \bar{f}^{p_k}(\{y\}))) \\ &= \liminf_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(d(f^{p_k}(\{x\}), f^{p_k}(\{y\}))) = 0 \\ \bar{F}_{\{x\}\{y\}}^*(t, \{p_i\}) &= \limsup_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(H_d(\bar{f}^{p_k}(\{x\}), \bar{f}^{p_k}(\{y\}))) \\ &= \limsup_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \chi_{[0,t)}(d(f^{p_k}(\{x\}), f^{p_k}(\{y\}))) = 1 \end{aligned}$$

So, $\{x\}, \{y\}$ is a distributively chaotic point pair in sequence, thus $\mathcal{A}$ is a distributively chaotic set in a sequence.

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Unlimited Numeric Class Based on Deque

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Abstract. This paper develops $2n$ based number system, studies the expression of digital symbols presented with built-in data type variable in programming languages and the calculation algorithm of $2n$ based numbers. It gives the implementation scheme of unlimited numeric class based on automatic scalable queue. In this scheme, one unlimited number is made up of two queues: one for integer part and one for decimal part, each element of the queue is one digital symbol of $2n$ based number system. The unlimited numeric class can express integer and decimal with unlimited digitals, it can be a member of base library of programming languages.

Keywords: $2n$ based number system, unlimited numeric class, queue, deque.

1 Introduction

Numeric data type is the base object of programming languages, for example, C++ defines its built-in data types such as char, int, long, _int64, float and so on. The precision of these built-in data types can meet the needs of most applications. But in some special conditions, these types can not express huge integer or decimal accurately because the binary bits of built-in data type is limited. In visual C++, a number of BYTE has 8 binary bits; the maximum integer of type _int64 has 64 binary bits, numbers bigger than _int64 must be turned to variables of float type to avoid the problem of overflow. Although the float type can express bigger numbers, it is imprecise in expressing integer and decimal numbers.

Huge numeric data is useful in high precision applications. Large primes and integers are often used in digital data encryption, for instance, the security of the classic algorithm RSA commonly used to encrypt data and authenticate identification is founded on the difficulty of huge integer factorization, and it has successfully resisted kinds of attacks. With the developing of computer attack technology, larger integer number is requisite. In addition, large numbers from hundreds to thousands of decimal symbols can be useful in geometric reasoning, compute algebra, cryptogram and microcosmic simulation.

Not only large integer exceeds the expression ability of built-in number type, precise decimal such as Pi oversteps the expression ability of float type too. So it is necessary to develop a special numeric type to express large integer or decimal with many more decimal digits accurately.

The existing research pays much more attention on large integer and loses sight of precise decimal. There are two ways to realize large integer, one is turning large

number composed of decimal digit symbols to a string, and all arithmetic calculations including add, sub, multiply, division are converted to operations of the strings in the light of manual pattern. For example, a 4096-bit integer may be turned to a decimal string with thousands of chars. The strength of this solution is that it is easy to be understood and it avoids overflow of large number, but it has two shortcomings: one is that calculation between chars has poorer efficiency than built-in integer types; the second is that it will take long time to loop on long strings of decimal digit symbols. Another solution is considering large number as a binary bits stream, all arithmetic calculations are performed by shifting and logic operating of binary bits. This solution has the strength of high space rate, and shortcomings of lower time rate, and the program code will be complicated.

In real projects, a limited array with specific length is usually used to express large number, and calculations will be realized by operations on array elements. It has a higher efficiency of element access, but it is necessary to compile another similar class based on an array with different length when large number need to be expanded and it is difficult to operate between classes with different array length.

In the solution based on limited array, the calculate speed is higher when the number system basement is bigger [1]. Reference [2] designed a number system based on 2^{32} , turned a 1024 bit integer to an array with 32 elements of 2^{32} based number system, and realized calculations imitating human's work pattern on elements. Reference [3] advanced a scheme of large integer based on char string, constructed a calculation system and analyzed its performance. Different kinds of calculations of large integer were studied in references [4-9].

The unlimited numeric class in this paper is founded on scalable queue and 2^n based number system, it is unlimited and precise to express large integer and long decimal, and it can be computed efficiently by taking full advantage of high compute ability of built-in data type.

2 2^n Based Number System

In the real world, there are ten symbols from 0 to 9 in decimal number system, and the radix is 10. Different positions have different rights. The size is the sum of every digital multiplies the right of its position. For example, the value of number 987.65 can be computed through the formula Eq. 1:

$$987.65 = 9 \times 10^2 + 8 \times 10^1 + 7 \times 10^0 + 6 \times 10^{-1} + 5 \times 10^{-2} \quad (1)$$

Binary is used to express data in computer; the radix of binary number system is 2. Other number systems such as hexadecimal and octal are familiar. The value of one number in different number system is unaltered.

In the same way, 2^n based number system can be defined as following:

- 1) There are 2^n symbols from 0 to $2^n - 1$ in the system;
- 2) The base radix is 2^n .

For instance, number in 2^n based number system can be computed as formula Eq. 2

$$B_2 B_1 B_0 . B_{-1} = B_2 \times (2^n)^2 + B_1 \times (2^n)^1 + B_0 \times (2^n)^0 + B_{-1} \times (2^n)^{-1} \quad (2)$$

In computer software, it is suitable to figure each digital symbol of 2^n based number system with different combination of n binary bits. Given an example, in octal number system, symbols 0~7 can be represent with combination of three binary bits: 000, 001, 010, 011, 100, 101, 110, and 111. Namely, three binary bits can be regarded as a digital symbol of octal number system. In 2^8 based number system, it is appropriate to use a byte to figure the digital symbols, and in 2^{16} based number system, a word can be used to figure the digital symbols, and if n is 32, it is right to use four bytes to figure the digital symbols of 2^{32} based number system, and so on.

The arithmetic and logic operation of numbers is finally operated on the digital symbols in all number systems. In order to store digital symbols of 2^n based number system expediently, the best way is figuring each digital symbol with a variable of built-in data type in programming language such as byte, int, long, _int64 et. Because the basic calculate operations of these symbols have been carried out efficiently by the compiler. Besides, considering that the length of calculation result of two digital symbols may be 2 digitals, the principle to define suitable n is that the longest built in type of specific language can hold two digital of 2^n based number system, namely, n does not exceed half of the length of the maximum integer type.

Number of 2^n based number system can be organized with a queue of digitals. Two queues are needed to combine a class of 2^n based number system, one encases the integer part and the other encases the decimal part. If these queues are automatically scalable, two queues and a Boolean variable denote the positive or negative symbol can construct an unlimited number class.

3 Working Principle of Unlimited Numeric Class

There are kinds of scalable queues in C++ STL, such as deque, vector and list. All of them support random access of all elements, and each of them has its own specialty. Vector is good at efficient insertion and deletion at the end of queue and the operation time at the head or in the middle of queue is linear. Unlikely, operating time of deque on random position is efficient and invariable. By comparison, deque has the advantage of limited array and list at the same time, it is suitable to be the container of digital queue of unlimited numeric class.

Unsigned _int64 is the longest built in integer type of visual C++, so it is right to define n as 32. The maximum digital of 2^{32} based numeric system is 0xffffffffH which can be seated in an unsigned long variable. An unsigned _int64 variable can handle the sum or product of two digital. In 2^{32} based number system, a number with M binary bits is $[M/n]$ digitals' long, and the calculation of unlimited numeric class has been turned to operations of deque elements and calculations of unsigned long variables.

Each element of integer queue and decimal queue is a digital of 2^{32} based number system; the data structure can be defined as following:

```
Class UnlimitedNumber
{ private:  bool PositiveFlag;
           //number sign, true represents positive number
           deque<unsigned long>  integerqueue;
           //integer deque, the head is low position digital
```

```

deque<unsigned long> decimalqueue;
//decimal queue, low decimal position on head
};

```

Underside, the addition and division of unlimited numeric class will be discussed.

Addition of two objects of this class can be switched to addition or subtraction of two numbers with the same positive flag, multiplication and division can be transformed into operation of positive flag, shift of queue elements and additions or subtractions.

After decimal point position has been aligned and two dequeues have been expanded to the same length, the addition of two unlimited numbers is performed by a loop from the head of decimal queue to the end of decimal queue and the head of integer queue to the end of integer queue. In case of adding unlimited numeric object A and B, assuming that unlimited number R is used to save the result, integer i represents the relative position of a digital symbol, a_i , b_i and r_i are their digital in position i , unsigned long variable $C(0 \text{ or } 1)$ is the carry from digital position $i-1$, unsigned `_int64` variable M is the depositary of the sum of $a_i + b_i + C$, then the lower half part of M is r_i and the high half part of M is the next carry C . The carry from the end of decimal deque will attend the addition of digitals in the head of integer deque.

Division must test quotient again and again. The quotient test procedure must recur to multiplication and subtraction of unlimited numeric classes. For example, there are unlimited numeric classes A, B, C and D, A is the dividend, B ($B \neq 0$ and $A > B$) is the divisor, C will be the quotient and D will be the remainder, the division arithmetic can be described as following steps:

Step 1, Shift A and B in order to turn B into an unlimited numeric class without decimal part;

Step 2, Copy the highest part of A with the length of B to D, D does not have decimal part, insert an element 0 to the end of integer queue of D;

Step 3, If $D < B$, then this quotient digital is 0, insert an element 0 to C;

If $D = B$, then insert an element 1 to the lower position of C, it means this quotient digital is 1, and do $D = D - B$;

If $D > B$, then try the quotient as following:

1, Copying the highest two digital of D to $d2$ (unsigned `_int64`), copy the highest one digital of B to b (unsigned `_int64`), assuming q (unsigned `_int64`) is the try quotient;

2, q varies from $d2/(b+1)$ to $\min(d2/b, 2^{32}-1)$, it is possible to find one q by dichotomy settling for $D \leq B \cdot (q+1)$ and $D > B \cdot q$. At this time, the right quotient must be q or $q+1$, if $D < B \cdot (q+1)$ then the quotient is q , else the quotient is $q+1$. The quotient would be inserted to the lower position of C;

3, Subtract the product of B and the quotient from D. Here the highest digital of D must be 0, because $D < B$ and the length of D is 1 digital more than B;

Step 4, Insert the next digital from A to the lower position of D, and delete the highest element of D (it is 0), and repeat step 3 until all elements of A has been treated.

Step 5, Shift D in the contrary way of step 1, then D is the remainder.

4 Summary

It is convenient to define unlimited numeric class and implement the conversion functions with other built-in data types in C++. It will be used as easy as built-in data types.

Because the length of the integer part and decimal part are all unlimited and automatically scalable, the unlimited numeric class in this paper is obviously better than other built-in types in expression capability. Compared with solutions based on limited array, the unlimited numeric class has an obvious superiority that the length can change automatically to meet the actual need, and it is efficient in memory using.

One of the relative weaknesses of unlimited number class is the lower calculation speed, because the element access efficient of deque is lower than fixed array. In one experiment to calculate $(X*Y \bmod Z)$, the unlimited numeric class spends about 15s to perform 4096 bit calculation, this time is about 50 times more than calculation of big integer based on fixed array. It is not too bad that the calculation time on 1024-bit numbers of unlimited numeric class is acceptable. The speed of unlimited number class will need improved.

Another weakness of unlimited numeric class is that infinite decimal can exhaust the computer source. For instance, the precise result of $1/3$ is endless, so it is necessary to limit the digitals of such kinds of decimal.

Unlimited numeric class developed in this paper is valuable to be a member of base library of programming languages, and it can be one basement part of cryptogram class library.

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Experimentation and Finite Element Analysis of Electric Field Structure of Electrospinning Machine

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Abstract. The electric field, which is used to vary the nanofibre morphology significantly, is a crucial parameter in electrospinning. It is crucial to analyze the distribution of electric field in electrospinning machine. Based on ANSYS, the finite element model of electric field is established, and the distribution of the electric field is calculated and analyzed. The geometry of the electric field structure is optimized. The results of electrospinning experiment show that the orientation and diameter distribution of fiber are improved after the optimum of the electric field.

Keywords: Electrospinning, Electric field analysis, Electric field structure, ANSYS.

1 Introduction

Electrospinning is a simple and inexpensive process that produces continuous nanofibres from polymer solutions or melts, and attracts much attention all over the world with the development of nanotechnology [1]. Due to lots of special advantages [2], there are many potential applications of electrospinning technology and electrospinning nanofibre [3, 4]. As explained in the literature, the entire electrospinning process is governed by the external electric field due to the applied voltage and induced electric field caused by the free and induced charges on the fluid surface [5, 6]. Therefore, the electric field is a crucial parameter in electrospinning, and parameters such as voltage, distance between the needle tip and the target, shape of the collector, and needle characteristics can be used to control the electric field. These parameters can be used to vary the nanofibre morphology significantly. Consequently, it is important and essential to analyze the distribution of electric field in electrospinning machine.

In this paper, the finite element model of electric field is established based on ANSYS, and the distribution of the electric field is calculated and analyzed. The geometry of the electric field structure is optimized. Finally, the validity of simulation result is verified by morphology of electrospun fibres.

2 Structure and Work Principle of Electrospinning Machine

The equipment of Electrostatic spinning consisted of a high pressure generator, an injection unit, a needle (capillary tubing) and a fiber-collecting unit is as shown in Fig. 1. In the process of electrostatic spinning, polymer solution or fusant jetted out of spinning jet under high-pressure and formed a electriferous jet flow. Before arriving the receiving unit, the electriferous flow condensed for the volatilizing of solvent and then the Polymer solidified and grew into polymer fibre. Finally the fiber of polymer deposited onto the receiving unit. Insert the anode which exported from high voltage static generator into the polymer solution or meltwater. And connect another electrode with the receiving unit. When there is no external voltage, polymeric fluid saved in capillaries and would not flow out for the effect of surface tension. When there is a voltage, numbers of electrostatic charge engendered on the surface of the fluid because of the electric field force. At first electric field force was not strong enough to cause the electric charge to pour forth from the liquor due to the external voltage was weak. With the voltage stronger, the liquid drop on the top of electriferous capillary was elongated to form electriferous cone (also known as Taylor cone). When electric field force came to the specific critical value, electriferous cone formed a stream of electriferous jet flow as a result of the repulsive force of electric charge on the fluid surface is stronger than the surface tension. The jet stream of electriferous polymer was throughout a process of unstable elongation which caused the jet stream lengthen and thin down. Meanwhile volatilized solvent and solidified fiber were in disorderly rows on gathering unit to form fiber felt (net or membrane).

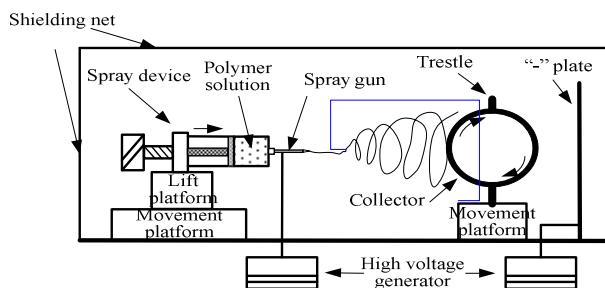


Fig. 1. The structure of Electrostatic spinning

3 Finite Element Analysis and Optimization of Work Electric Field

Simplifying of finite element analysis model. For getting the distribution type about electric field of electrostatic spinning, the electric-field distribution between spurt and negative pole metal plate was the major factor. Therefore we could omit spinning unit, gathering unit and control platform which hardly influenced the whole electrostatic field. Thus the whole working model became three parts: the metal spinneret, the negative pole metal plate and the shield net. We got the distribution chart of field strength vector by using electrostatic field simulation in 3D space shown in Fig. 2. We could find out that the vector diagram was not clear. Furthermore the

enlargement of calculated amount resulted in the increase of simulation time. In addition, the high voltage electrostatic spinneret and the negative plate were factors of creating electric field. Because the model had the character of rotational symmetry, the electrostatic field had the character of space symmetry. Considering the node number restriction on ANSYS model and the distributional symmetry of electric field strength, we simplified the model to a two dimension model of electric field to analyze, is as shown in Fig. 3.

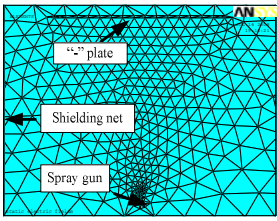
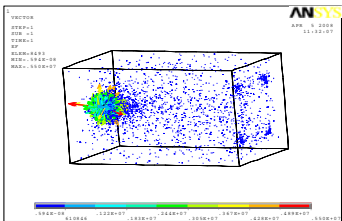


Fig. 2. Vector distributions in 3-D electrostatic field **Fig. 3.** The simplified FEA model

Table 1. Parameters setting of the model

Model	Spray gun	“-”plate	Air medium	Shielding net
Dielectric constant	2	2	1	5
Voltage load	8000V	-5000V	----	0V

FEA of electric field. Using traditional H-method to FEA of electrostatic field [7, 8], we thus proposed some assumptions: 1) the dielectric constant of medium is constant and doesn’t depend on electric field; 2) influences of electric charge of electrification spinning fiber was ignored; 3) effects of control elements on electric-field distribution would be neglected; 4) we supposed the volume density of field electric charge $\rho=0$. Through selecting various kinds of unit and comparing analysis results with actual data, we chose 8 nodal points two dimension unit (PLANE121). Table 1 shows the material property, unit type and setting of electric tension loading.

Simulated result of electrostatic field. Fig. 4 and Fig. 5 show the distribution of electric-field vector which got after analyzing. In high voltage electrostatic spinning electric field analysis, mainly should be considered the distribution situation of electrostatic spinning working electric field strength. Simulated result indicated that the distribution of electric field strength had the following characteristics: 1) Fig. 4 shows that: Same as the physical truth, the electric-field vector crosswise of electrostatic spinning working electric field was axial symmetric distribution. 2) Fig. 5 shows that we could analyze that: Same as the physical truth, the maximum of field strength appeared on the position of spinning pipe orifice and its direction pointed upward vertical to the negative plate. The maximum of field strength was $E=2.64\times10^6\text{ V/m}$. 3) The allocation plan of spinneret shown in Fig. 6, we find out that: the nearer the electric-field strength was to the negative plate, the faster the

electric-field strength declined. The field strength sudden dropped to a lower value especially in a small distance near the spinneret pipe orifice.

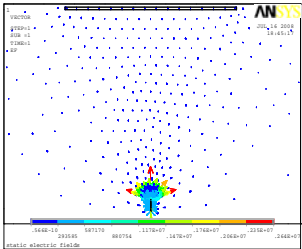


Fig. 4. The distribution of the vector about electric-field

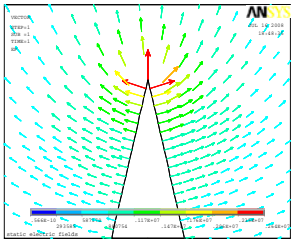


Fig. 5. The vector allocation plan of electric intensity

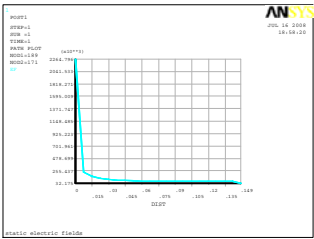


Fig. 6. The vector allocation plan of spinneret

Optimization of electric field. Controlling the shape and the strength of macroscopic electric field could weaken the instability phenomenon of fluidic from the analysis of Reneker’s electrostatic spinning process [9]. A shield net was added to the spinning machine to enclose the electric field in a settled area completely. Comparing with the traditional spinning machine in which the electric field exposed in the whole space, a slight variation of spinning electrostatic field structural parameter would cause a significant change of the shape and the field strength of macroscopic electric field and then influenced the effect of spinning. Therefore the structure optimization problem of electric field generalized as follows: though optimizing the geometrical forms of spinning electrostatic field structure in satisfying actual design condition, this made the lowest value of voltage when spinning caught the necessary value of field strength.

When optimizing and designing, we kept the voltage values at the negative plate invariantly while defining the distance between spinneret and the negative plate L , the width of shield W , the diameter of the negative plate D and the voltage loading V as the optimization design variable. According to the geometrical relationship of parameters and the self-characteristic of spinning experiment, we designed that the variation of the variable X should be content to the follows:

$$X = \{30cm > L > 10cm, 100cm > W > 60cm, 40cm > D > 20cm, 15000v > V > 6000v\}$$

The maximum field strength value of electric field was the state variable which was defined not less than proper functioning value. This optimization design didn't define the target function. The optimization design was a technology of searching and disposing the design space. Calculating the minimum was not the optimized ultimate goal. Our optimization design objective was to obtain the design array with design conditions, the design array of external voltage loading minimum without defining the target function. We collected 8 nodal points and two dimensions. The maximum of iterations was 30.

Optimization results. The changing situation of main parameters is as shown in Table 2. Based on the comparison of the results of before and after optimization, we can know that the maximum value of electric field $E=2.68\times10^6\text{ V/m}$ is satisfied with the electrospinning requirement. In comparison to before optimization, the voltage value is reduced by 10.54%. This decreases the interference of metal motion components in electric field to the distribution of electric field and improves the distribution of electric field. So we can get the excellent morphology of nanofiber from electrospinning.

Table 2. The comparison of before and after optimization

	L(cm)	W(cm)	D(cm)	V(v)	E(10^6V/m)
Before optimization	15	80	30	8000	2.64
After optimization	11.5	68.3	36.2	7156.8	2.68

4 Electrospinning Experiment

Experimental system of the electrospinning machine. Experimental system of the electrospinning machine is shown in Fig. 7, which is consistent of following components: high-voltage power supply, injection unit, metal receiver, two-dimension workbench and shield mesh. High-voltage power supply, which is made of electrical department of Tsinghua University, can realize the continuous adjustment of the voltage in the range from 0V to 100KV. Shield mesh with uniform gap is weaved by metal wire. In order to reduce the interference of electric field to input signal, shielded cable is used as the connecting line between control platform and injection unit, between computer and control card.

Preparation of spinning solution. Polyimide is selected as solution electrospinnability. Preparation of spinning solution is as follows:At room temperature, a definite amount of ODA is dissolved to DMAc and stirred continuously until ODA dissolute completely and become colorless transparent solution. The equal equivalence ODPA is added to the colorless transparent solution in batches. While it attains equal equivalence, the viscosity of polyimide increases rapidly, but not appear climbing pole phenomenon. After filtration, spinning solution can be got.



Fig. 7. Experimental system of the electrospinning machine

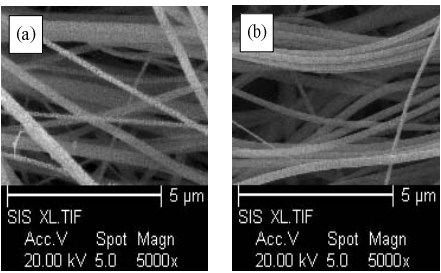


Fig. 8. The SEM image of polyimide non-woven fabric

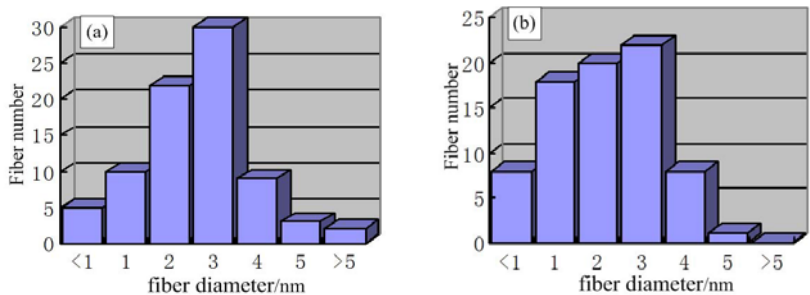


Fig. 9. The distribution of fiber diameter

Conditions and methods of experiment. At environment temperature 24~25.5°C and humidity 54%~59%, electrospinning experiment is performed. Injection device provide steady thrust. Under the action of this thrust, spinning solution is extruded uniformly from pipe orifice of a capillary tube with a pipette or needle of small diameter. The work electric field is formed by electrostatic between spinneret and negative electrode plate. Extruded solution forms spinning under the action of the electric field. At joint action of electric field force and gravity, spinning be collected to metal receiver. In the process of experiment, we can adjust the test parameters according to experimental requirement. Contrast experiment be performed using the structure parameters listed in Table 2.

Results and analysis of experiment. Fig. 8(a) and Fig. 8(b) are the SEM image of polyimide non-woven fabric obtained in before and after the electric field structure optimization respectively. We can see obviously that dispersity of fiber diameter in Fig. 8(a) is larger than in Fig. 8(b), and fiber orientation in Fig. 8(a) is not better than in Fig. 8(b). Fig. 9(a) and Fig. 9(b) are the distribution of fiber diameter in before and after the electric field structure optimization respectively. From Fig.9, after the optimization of electric field structure, the distribution of fiber diameter of polyimide non-woven fabric is equal and has an certain directivity.

5 Conclusions

1) Based on ANSYS, the finite element model of electric field is established, and the distribution is calculated. The features of distribution are analyzed. Simulation analysis provides some useful and valid reference for the optimization of electric field.

2) The electric field is optimized by the optimization of the structure parameters, and a set of optimal sequence is got. This sequence is satisfied with work requirements of electrospinning. In comparison to before optimization, the voltage value is reduced by 10.54%. This protects the control components and ensures the stability of the control elements and operator's safety.

3) Based on the experimental system of the electrospinning machine, contrast experiment is performed in before and after the optimization of electric field. Experimental results show that optimization of electric field can improve the electric environment and the distribution of fiber diameter of polyimide non-woven fabric is equal and has an certain directivity.

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Construction of Finitely Supported Tight Wavelet Frames with Two Generators

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Abstract. In this note, the notion of the notion of tight wavelet frames is introduced. We demonstrate that there exist wavelet frame generated by two functions which have good dual wavelet frames, but for which the canonical dual wavelet frame does not consist of wavelets, according to scaling functions. That is to say, the canonical dual wavelet frame cannot be generated by the translations and dilations of a single function wraps.

Keywords: Frame operator, tight wavelet frames, dual wavelet frame, scaling functions, stable wavelet bases, time-frequency analysis method, lifting techniques, bracket product.

1 Introduction

The rise of frame theory in applied mathematics is due to the flexibility and redundancy of frames. The structured frames are much easier to construct than structured orthonormal bases. Redundancy is useful in the case of lossy data and provides more numerical stability. Although the frame concept is pure Hilbert space concept, it was recognized early on that the usefulness of the frames goes far beyond Hilbert space theory. For Instance, wavelet frames are used to detect smoothness and compression properties of functions, Gabor frames characterize the time-frequency concentration of distributions and frames of reproducing kernels yield sampling theorems in function space. The notion of frames was introduced by Duffin and Schaeffer[1] and popularized greatly by the work of Daubechies and her coauthors[2,3]. After this ground breaking work, the theory of frames began to be more widely studied both in theory and in applications[4-7], such as signal processing, image processing, data compression and sampling theory. Every frame determines a frame operator which is invertible and also yields the standard dual frame of the original frame. The notion of frame multiresolution analysis as described by [5] generalizes the notion of multiresolution analysis by allowing non-exact affine frames. This article is motivated from the observation that standard methods in sampling theory provide examples of multiresolution structure which are not FMRA's. Inspired by [5] and [7], we introduce the notion of tight wavelet frames generated by several functions of integer translates in space $L^2(\mathbb{R})$.

2 The Properties of Frame Operator and Tight Wavelet Frames

We introduce some notations and notions. Let X be a separable Hilbert space and Λ a given countable index set. A sequence $\{\tilde{\lambda}_v\}_{v \in \Lambda} \subset X$ is a frame in X if there exist positive real numbers C and D such for all $\xi \in X$,

$$C\|\xi\| \leq \sum_{v \in \Lambda} |\langle \xi, \tilde{\lambda}_v \rangle|^2 \leq D\|\xi\|, \quad (1)$$

where C and D are called the lower frame bound and upper bound, respectively. In particular, when $C = D = 1$, we say that $\{\tilde{\lambda}_v\}_{v \in \Lambda}$ is a normalized tight frame in X . The frame operator $S : X \rightarrow X$, which is associated with a frame $\{\tilde{\lambda}_v\}_{v \in \Lambda}$, is defined to be

$$S\eta = \sum_{v \in \Lambda} \langle \eta, \tilde{\lambda}_v \rangle \tilde{\lambda}_v, \quad \eta \in X \quad (2)$$

It is obvious that $\{\tilde{\lambda}_v\}_{v \in \Lambda} \subset X$ is a frame in X with lower frame bound C and upper frame bound D if and only if S is well defined and $CI \leq S \leq DI$, where I denotes the identity operator on X . A sequence $\{\tilde{\lambda}_v\}_{v \in \Lambda} \subset X$ is a Bessel sequence if (only) the upper inequality of (1) follows. If only for all $Y \in M \subset X$, the upper inequality of (1) holds, the sequence $\{\tilde{\lambda}_v\}_{v \in \Lambda} \subset X$ is a Bessel sequence with respect to (w.r.t.) the subspace M . If $\{\tilde{\lambda}_v\}_{v \in \Lambda}$ is a frame of a Hilbert space X , there exist a dual frame $\{\tilde{\lambda}_v^*\}_{v \in \Lambda}$ such that

$$\forall f \in X, \quad f = \sum_{t \in \Lambda} \langle f, \tilde{\lambda}_t \rangle \tilde{\lambda}_t^* = \sum_{t \in \Lambda} \langle f, \tilde{\lambda}_t^* \rangle \tilde{\lambda}_t. \quad (3)$$

Let $\{\tilde{\lambda}_v\}_{v \in \Lambda}$ be a frame in a Hilbert space X with lower frame bound C and upper bound D . Then its frame operator S is invertible and $C^{-1}I \leq S^{-1} \leq D^{-1}I$, that is to say, S^{-1} is also a frame operator. Moreover, we have the following result.

Theorem 1[8]. Let $\{\xi_v\}_{v \in \Lambda}$ be a frame in X . Then the frame operators $S : X \rightarrow X$, and $S^{-1} : X \rightarrow X$ are self-adjoint operators, respectively.

The family $\{S^{-1}\xi_v\}_{v \in \Lambda}$ is said to be the canonical dual frame of the frame $\{\xi_v\}_{v \in \Lambda}$ and (4) is the canonical representation of any h in X using the frame $\{\xi_v\}_{v \in \Lambda}$ in X . Generally speaking, for a given frame $\{\xi_v\}_{v \in \Lambda}$ in X , there are many dual frames other than its standard dual frame. However, the standard dual frame $\{S^{-1}\xi_v\}_{v \in \Lambda}$

enjoys the following optical property(see[1]). For any element $h \in X$, $\sum_{v \in \Lambda} \left| \langle h, S^{-1} \xi_v \rangle \right|^2 \leq \sum_{v \in \Lambda} |c_v|^2$, whenever $h = \sum_{v \in \Lambda} c_v \xi_v$, $\{c_v\}_{v \in \Gamma} \in \ell_2(Z)$. In other words, the representation in (4) using the canonical dual frame has the smallest norm of the frame coefficients to represent a given element in space X .

It is well known that frames with certain structures, such frames of translates, Gabor frames, and wavelet frames, are very useful in both theory and application. The interested reader can consult[1,2,5] and references therein on the theory of frames. In the following, we will recall two nice families of frames and their canonical dual frames. A frame of translates is derived from two functions ψ_1, ψ_2 in $L^2(R)$ by integer translates. That is, $\{\psi_l(\cdot - k), k \in Z, l = 1, 2\}$ is a frame in $L^2(R)$ defined as the closed linear span of $\psi_l(\cdot - k), k \in Z, l = 1, 2$. Then it is well known that its standard dual frame is given by $\{[S^{-1}\psi_l](\cdot - k) : k \in Z, l = 1, 2\}$; like the original frame, it is generated by the integer translates of two functions since. $S[h(\cdot - k)] = [Sh](\cdot - k)$ for all $k \in Z$ and $h \in L^2(R)$. A Gabor frame is generated from two functions in $L^2(R)$ by modulates and integer shifts. In other words, a Gabor frame is a frame in $L^2(R)$ given by the Gabor system $\{e^{2i\pi j b} \psi_l(\cdot - ka) : l = 1, 2, k \in Z\}$, where a and b are real constants. A direct calculation shows that $S[e^{i2\pi j b} f(\cdot - ka)] = e^{i2\pi j b} [Sf](\cdot - ka)$ for all $j, k \in Z$ and $f \in L^2(R)$. Therefore, the standard dual frame of a Gabor frame generated by $\{h_1, h_2\}$ is also yielded by modulating and translating the two functions $\{S^{-1}h_1, S^{-1}h_2\}$. We are about to discuss the standard dual frame of a wavelet frame. Throughout this paper, we shall use the following notation

$$h_{l:j,k} = 3^{j/2} h_l(3^j \cdot - k), \quad j, k \in Z, \text{ where } h_l \in L^2(R), \quad l = 1, 2.$$

A wavelet frame is generated from several functions in $L^2(R)$ by dilates and integer translates. We say that $\{h_1, h_2\}$ generates a wavelet frame in $L^2(R)$ if $h_{l:j,k} : j, k \in Z, l = 1, 2$ is a frame in $L^2(R)$. We say that $\{h_1, h_2\}$ and $\{\tilde{h}_1, \tilde{h}_2\}$ generates a pair of dual wavelet frame if each of them generates a wavelet frame and

$$\forall \varphi, g \in L^2(R), \quad \langle \varphi, g \rangle = \sum_{l=1}^2 \sum_{j \in Z} \sum_{k \in Z} \langle \varphi, \tilde{h}_{l:j,k} \rangle \langle h_{l:j,k}, g \rangle. \quad (6)$$

Theorem 2[7]. Suppose that (h, α, β) is a normalized tight Weyl-Heisenberg frame for the subspace $\Omega = \overline{\text{span}}\{h_{m\alpha, n\beta}\}$. (i) Assume that $\alpha\beta = m/n$, where m, n are positive integers such that $\text{ged}(m, n) = 1$. Then (h, α, β) has a unique Weyl-Heisenberg dual in Ω if and only if

$$\langle h, h_{m\alpha, n\beta} \rangle = 0 \text{ for all } (m, n) \notin mZ \times nZ.$$

(ii) Assume that $\alpha\beta$ is irrational number, Then (h, α, β) has a unique W-H dual in Ω if and only if

$$\langle h, h_{m\alpha, n\beta} \rangle = 0 \text{ for all } (m, n) \neq (0, 0).$$

3 The Special Tight Dual Frame of a Wavelet Frame

In this part, we shall discuss the standard dual frame of a wavelet frame with two generators in general. Then we present the main results. Define the dilation and translation operators on $L^2(R)$ (see[6])as follows: $D^j \varphi := 3^{j/2} \varphi(3^j \cdot)$ and $T_u \varphi := \varphi(\cdot - u)$, $j, u \in Z$, $\varphi \in L^2(R)$. Suppose that $\{h_1, h_2\}$ yields a wavelet frame in $L^2(R)$. Let S denote its frame operator defined as follows:

$$h \in L^2(R), \quad Sh = \sum_{l=1}^2 \sum_{j,k \in Z} \langle h, h_{l,j,k} \rangle h_{l,j,k}. \quad (7)$$

It is evident to observe that $SD^j = D^j S$ for all $j \in Z$ and $D^j T_k = T_{4^{-j}k} D^j$. We define the period $P(\{h_1, h_2\}) \in N \cup \{0\}$ of the wavelet frame generated by $\{h_1, h_2\}$ as follows:

$$\langle P(\{h_1, h_2\}) \rangle := \{k \in Z : S^{-1} T_{k+n} h_l = T_k S^{-1} T h_l, \forall n \in Z, l = 1, 2\} \quad (8)$$

where $\langle x \rangle$ denotes the additive group generated by x . Let W stand for the closed linear span of $h_l(\cdot - k)$, $k \in Z, l = 1, 2$, and $\tilde{W} := S^{-1}W$. Then (8) implice

$$\langle P(\{h_1, h_2\}) \rangle = \{k \in Z : S^{-1} T_k \phi = T_k S^{-1} \phi, \forall \phi \in W\} = \{k \in Z : T_k S g = f T_k g, \forall g \in \tilde{W}\}.$$

when $\{\psi_1, \psi_2\}$ generates a wavelet frame in $L^2(R)$ then the set $\{\psi_{l,j,k} : l = 1, 2 \text{ and } k = 0, 1, \dots, 3^J - 1\}$ also generates the same wavelet frame for any nonnegative integer J since $[\psi_{l,j,k}]_{j,m} = \psi_{l:j+J, k+3^J m}, l = 1, 2$.

Theorem 3. Suppose $\{h_1, h_2\}$ generates a wavelet frame in $L^2(R)$. For any nonnegative integer J , the following statements are equivalent: (i) There exist $2 \cdot 3^J$ functions $\tilde{h}_1, \tilde{h}_2, \tilde{h}_{2 \cdot 3^J}$ such that they generate the canonical dual frame of the wavelet frame $\{h_{l:j,k} : j, k \in \mathbb{Z} \text{ and } l = 1, 2\}$; (ii) $\{F^{-1}[h_{l:j,k}] : k = 0, 1, \dots, 3^J - 1 \text{ and } l = 1, 2\}$ and $\{h_{l:j,k} : k = 0, 1, \dots, 3^J - 1 \text{ and } l = 1, 2\}$ generate a pair of dual wavelet frame in $L^2(R)$; (iii) $P(\{h_1, h_2\}) \mid 3^J$, where $P(\{h_1, h_2\})$ defined in (8). Moreover, when $\{h_1, h_2\}$ yields a wavelet frame which is a Riesz basis, (i)-(ii) are also equivalent to (iv) $V_J(\{h_1, h_2\})$ is shift-invariant where $V_J(\{h_1, h_2\})$ is the closed linear span of $h_{l:j,k} : k \in \mathbb{Z}, j < J \text{ and } l = 1, 2$.

Proof. If (a) is true, by setting $S^{-1}[h_{l:j,k-1}] = \tilde{h}_{k+3^J(l-1)}, l = 1, 2$ and $k = 1, 2, \dots, 3^J$, we obtain statement (b) is established. The converse obviously holds. Since

$$S[S^{-1}h_{l:j,k}]_{j,m} = SD^jT_m S^{-1}D^jT_k h_l = D^jS(T_m S^{-1}T_{3^{-j}k} D^j h_l) = D^jT_{m+3^{-j}k} D^j h_l = h_{l:j+J,k+3^J m},$$

we note that (b) is equivalent to (9) below,

$$[S^{-1}h_{l:j,k}]_{j,m} = S^{-1}h_{l:j+J,k+3^J m}, \quad \forall j, k, m \in \mathbb{Z}. \quad (9)$$

In particular, taking $j = -J$ in equation (9), we have

$$\begin{aligned} S^{-1}T_{k+3^J m} h_l &= S^{-1}h_{l:0,k+3^J m} = [S^{-1}h_{l:j,k}]_{-J,m} = D^{-J}T_m S^{-1}D^J T_k h_l \\ &= D^{-J}T_m D^J S^{-1}T_k h_l = D^{-J}D^J T_{3^J m} S^{-1}T_k h_l = T_{3^J m} S^{-1}T_k h_l, \quad l = 1, 2. \end{aligned}$$

Therefore, $P(h_1, h_2) \mid 3^J$. Conversely, if $P(\psi_1, \psi_2) \mid 3^J$ then

$$S^{-1}h_{l:j+J,k+4^J m} = D^{j+J}S^{-1}T_{k+4^J m} h_l = D^{j+J}T_{3^J m} S^{-1}T_k h_l = D^jT_m D^J S^{-1}T_k h_l = D^jT_m S^{-1}D^J T_k h_l = S^{-1}[h_{l:j,k}]_{j,m}.$$

Hence, (9) holds and (b) $\Leftrightarrow$ (c).

When $\{h_1, h_2\}$ generates a wavelet frame in $L^2(R)$ which is also Riesz basis, it is obvious that (a) $\Leftrightarrow$ (d). To prove the converse, define $\phi_{l:j,k}$ as the orthogonal projection of $h_{l:j,k}$ onto the space which is the closed linear span of $\{h_{l':j',k'} : l' = 1, 2, j'k' \in \mathbb{Z}\} \setminus \{h_{l:j,k}\}$. Define a function

$$\tilde{h}_{l,j,k} = (h_{l,j,k} - \phi_{l,j,k}) / c_{l,j,k}, \text{ where } c_{l,j,k} := \langle h_{l,j,k} - \phi_{l,j,k}, h_{l,j,k} \rangle \neq 0.$$

As (d) holds, It is easy to verify that $\{\tilde{h}_{l,j,k} : k = 0, \dots, 3^J - 1, l = 1, 2\}$ yield its canonical dual frame.

4 Summary

In the paper, we prove that the frame operator and its inverse are all self-adjoint operators. We prove that the canonical dual wavelet frame cannot be generated by the translates and dilates of a single function.

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Analysis of the Schemes of Some Reservoir on Its Dam Foundation Seepage Prevention and Slope Protection against Waves in the Northwest Arid Area

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Abstract. To solve the commonly existing problems of small and medium reservoir dam in the arid area of northwest China that the stormy erode to the water meet face of the dam body is serious and seepage from its foundation is big, we put forward the program about dam foundation seepage control design and slope protection to the small reservoir in the article, then giving an example about how to remove the dangerous of a reservoir and its strengthening, we make the design on the dam foundation seepage slope protection and processing then we get good effect.

Keywords: reservoir, remove the dangerous and strengthening, sand dam, slope protection against stormy, dam foundation seepage.

1 Introduction

The reservoir located in Xinxiang production and construction corps, division 67, which is regiment for between plain mainly by sand dunes and is made up by dam, water channel, into sluices, punches culvert, punches sluices and canal. Its area of the surface of the water is 1261,300 m², the design capacity is 2980,000 m³, the dead capacity is 180,000m³, the benefit capacity is 2800,000 m³. The total length of the dam is 3273 m, the design top height is 635.0 m, the design water level is 633.5 m, the maximum height of the dam is 8.98 m, the design top width is 5.0 m.

Small reservoirs are sand dam is commonly in Yili, mostly of which are constructed by arranging necessary work-relief funds of masses in the 1960s. On the one hand there is quite a part of the small reservoirs that the dam foundation is cleared incompletely, so the seepage in big, on the other hand there is no slope protection facilities on the upstream, thus the stormy erode is especially serious. The toe of the dam collects water, which is very serious. What is more, reed is everywhere. On the main wind direction, the up vertical steep brush camp is 1.1 m, which is a serious threat to dam safety operation.

2 Calculation of Wave Slope Protection

Revetment shape. Concrete revetment is applied quite often in Yili, which takes advantage in many facts, such as its effect against wave is good, its engineer service life is long, its impervious effect is strong, and its construction technology is easy to grasp, so slope of this shape is very suitable for the sand dam in yili. Therefore, we put the concrete slab revetment form to use.

Revetment range. According to the regulation in < the earth-rock RCC design code> and < the small hydropower engineering rolling type earth-rock fill dam design specification >, slope protection should protect to 1.5 m downward the death water. According to the characteristics of Yili, most of the reservoir are sand dam, after years of running, basically formed "L", namely, often formed camp vertical steep above the general water level, and below the soil slope is 1 : 10~1 : 20.

The reservoir design to lay the concrete revetment to 1 times under the thickness of ice in freeze period, namely 632 m; According to the status quo survey, parts and the parts over 632 m undergo a more serious erosion, so we choose 632 m as the slope protection bottom and 635 m on the top. After investigation, we find that many sand dam in Yili have been reinforced in recent years and operation after a few years, to our joy, they all in excellent condition. So we don't have to set the meet water concrete revetment engineering in this area (function of preventing wind and waves) to dead water below 1.5 m downward.

Revetment slope. Under the condition of dam stability and concrete in meet, the smaller the slop, the more conducive to reduce the quantity of concrete and increase the expander thrust resentencing to the ice. According to the calculation formula introductive in< design of the earth dam>, calculate the height demand about the expander thrust of slope protection, then derived the slop of revetment, its computation formula is:

$$H = \frac{\frac{M-f}{1+Mf}T + td(1+M^2)^{0.5} + 0.5Mt^2}{\gamma(1+M^2)^{0.5}} \quad (1)$$

Type: H - the perpendicular height of the concrete slope protection above the underside of ice, m;

M - slope ratio of concrete revetment ;

f - the friction coefficient between the concrete slab and gravel cushion, 0.8;

T - the expander thrust of ice, 52.22 KN/ m²; d - ice thickness, take 0.3 m ;

γ - concrete density, 24 KN/ m³;

T - concrete thickness, 0.15 m;

We can see the calculation results from table 1 and figure 1.

Table 1. Relation between revetment slope and the height of concrete revetment

revetment slope/M	the height of concrete revetment/H
1.0	1.15
1.5	2.58
2.0	3.01
2.5	3.07
3.0	2.98
3.5	2.85
4.0	2.70

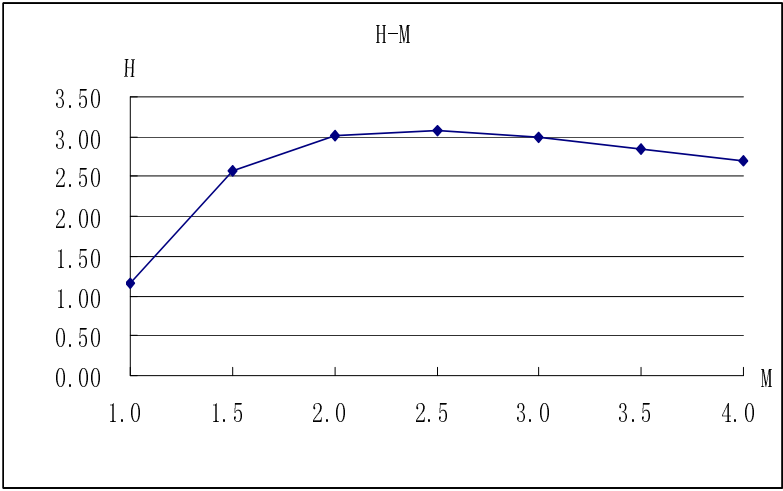


Fig. 1. Relation between revetment slope and the height of concrete revetment

The results show that concrete revetment slope makes a large difference in the expansion thrust against ice, but they're not direct ratio. Slope of 1:2. 5 is the most detrimental to the expander thrust. When the slope coefficient is 1:1~1:2, the smaller the slope coefficient, the larger the ice destructive power to the revetment. when the slope coefficient is 1:2. 5~1:4, the larger the slope coefficient, the smaller the ice destructive power to the revetment. Considering a final determination, 1:3 is the best slope coefficient.

3 Calculation of Dam Foundation Seepage

The dilapidated reservoirs in Yili are mainly located on sand dunes, and all with problem of dam foundation seepage, in need of proofing. There are two kinds of measures to prevent, one is vertical, the other one is horizontal. When take the horizontal, a certain level should be guaranteed in the horizontal bedding length to prevent erosion and crypto-currents, then make the downstream slope less than permissible value combining the facilities of drainage and decompression. While, after long-term of water-storage, there will be some deposition, which will bring certain difficulties to the management to the tail end of the horizontal bedding. In keeping the dam foundation seepage stability and permeability section, the horizontal is no more thorough than the vertical.

As to a reservoir, there is a natural vertical anti-seepage, and according to a geological report, the dam foundation deeps to a certain depth of 10m below, with the permeable layer is weak, so vertical anti-seepage can have very good effect on anti-seepage. Commonly, we can take plastic membrane or concrete impervious wall plastic membrane have some imperfection to a certain degree, such as, damages of plant roots, destroy from mice, etc. What's more, it is limited in the depth of anti-seepage ; The main advantage of the concrete impervious wall is that it can adapt to a variety of dam body and complex foundation hydrology and engineering geology conditions, and is far stronger than plastic membrane in durability.

Concrete impervious wall is started early in the 1950s in Italian and French, then various countries have successively introduced and promoted it. At the end of the 1950s, concrete impervious wall began to be researched and on trial in China. After our country tried it on in Shandong province successfully in 1958, we have successively put in to use in dams in Miyun baihe, maojiacun, tongjiazi, etc, all making a very good effect. After the 1980s, the domestic water conservancy department developed impervious wall with multicapital soil-cement agitator arm of small diameter. Wall thickness is a little thinner, in soil, sand or gravel layer, the thickness can reduce to 0.1 m, with the cost reducing to about 100 yuan per m^2 , which is amount to plastic membrane, and the drilling can go deep into 18m, completely suitable for a reservoir.

The reservoir finally chooses impervious wall with multicapital soil-cement agitator arm of small diameter to prevent seepage. The bottom of impervious wall go deep into 1m below the semi-permeable layer, the top is connected to the concrete revetment to obtain good effect on the protection of dam foundation.

4 Conclusions

As to the base reinforcement for a reservoir, slope protection against stormy in sand dam should take the concrete revetment, and 1:3 is appropriate for the slope coefficient; Seepage treatment shall take impervious wall with multicapital soil-cement agitator arm of small diameter, the technology is mature. The base reinforcement for small and medium-sized reservoirs in northwest arid area needs a comprehensive analysis of various factors to solve the technical problems of revetment and dam foundation.

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Speckle Denoising for Digital Holographic Reconstructed Image Base on Image Edge Detection

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Abstract. The presence of speckle in digital holographic reconstructed image has seriously limited the application of digital holography in many fields, to further analysis and processing, analyzed the principle of edge detection and wavelet threshold denoising, a speckle reduction method is given. At first, get the edge image, and get adaptive thresholds, adopt a compromise threshold function to processing the edge image and non-edge image wavelet coefficients, and add the processed wavelet coefficients corresponding to the two images, then make inverse transform to get the denoised image. The result shows that the method can reduce the speckle noise and keep the edge of image well.

Keywords: Digital holography, speckle noise, wavelet transform, compromise threshold function, Neyman-Pearson criterion, edge detection.

1 Introduction

In recent years, the fast development of high resolution CCD and computer technology has made the implement of recording and reconstructing holograms by digital means become possible. The speckle noise in digital hologram is mainly due to coherent imaging and the limited CCD pixel size, so the speckle is inevitable. The speckle noise seriously reduces the quality and resolution of reconstructed image, and limits the applications of digital holography.

As the difficult of further improving spatial resolution of CCD, currently the digital holographic speckle denoising is commonly in two ways: the first is the use of partial coherent light source or low-coherence light source; the second is using digital image processing technology. Partial coherent light source can reach the effect of laser speckle reduction, but it depends on the use of high brightness partial coherent light source, otherwise it will reduce the quality of the reconstructed image; using the median filter [1], wavelet transform [2] and other digital image processing technology can reduce speckle noise, but will meet the same problem that is the contradiction between denoising and edge preserving.

2 Wavelet Threshold Denoising Base on Edge Detection

Image denoising based on wavelet transform has been extensively studied, and wavelet threshold denoising has been widely used. This paper propose a new wavelet

threshold denoising method base on edge detection to suppress the speckle noise of digital holographic reconstructed image, and improved the threshold selecting method and the determination of threshold function.

Reconstructed Image Edge Detection. Edge is the basic features of the image, preserving edge of the object image is a basic requirement to follow-up analysis. As digital holographic reconstructed image contains a lot of speckle, it can influence the edge detection. The Gauss - Laplace (LoG) algorithm is a better edge detector, LoG algorithm not only has the characteristics of smoothing , but also has the sharpening characteristics.

LoG edge detection method [3] is characterized by: first, the image convolute with the Gaussian filter $G(x, y)$, it can smooth the image and reduce the noise; and then apply no-directional Laplace operator ∇^2 to detect image edge. Let the original image is $f(x, y)$, make convolution with the following Eq. 1 to obtain the output $h(x, y)$ of LoG.

$$h(x, y) = \nabla^2 [G(x, y) * f(x, y)] \quad (1)$$

Using the convolution theorem, (1) becomes as:

$$h(x, y) = [\nabla^2 G(x, y)] * f(x, y) \quad (2)$$

In Eq. 2, ∇^2 is Laplace Operation, and $G(x, y) = 1/2\pi\delta^2 e^{-(x^2+y^2)/2\delta^2}$.

After the above convolution operation to the image, the zero-crossing points can be determined by judging the changes of sign, which are the edge points.

Wavelet threshold denoising. Donoho proposed the wavelet threshold denoising method, its main principle is: the wavelet coefficient amplitudes of the signal are high and the number of wavelet coefficient is small; the amplitudes of noise is low and the number is large.

Threshold function. To estimate the decomposed wavelet coefficients, choosing threshold and threshold function must to be done. Commonly used threshold functions are hard threshold function, soft threshold function and some improved threshold functions such as the compromise of hard and soft threshold function [4]. Hard threshold method can make discontinuity in some point, and will appear oscillation while reconstruct signal. Soft threshold has good continuity, but it makes the reconstructed signal have the lower signal to noise ratio and larger mean square errors.

To overcome the shortcomings of hard and soft threshold function, we proposed a compromise threshold function. L.Breiman shows the definition of Non-negative dead zero threshold function [5,6] as followings:

$$W_{j,k}^G = \begin{cases} 0, & |W_{j,k}| \leq \lambda \\ W_{j,k} - \lambda^2 / W_{j,k}, & |W_{j,k}| > \lambda \end{cases} \quad (3)$$

In Eq. 3 $W_{j,k}$ is wavelet coefficients, λ is threshold. The non-negative dead zone threshold function gets a better compromise between the hard and soft threshold function. In order to show the advantage of non-negative dead zone threshold algorithm, a new threshold function expressed as Eq. 4 was proposed, where $W_{j,k}$ is modified as follows:

$$W'_{j,k} = \begin{cases} 0, & |W_{j,k}| \leq \lambda \\ W_{j,k} - \lambda^3 / W_{j,k}^2, & W_{j,k} > \lambda \\ W_{j,k} + \lambda^3 / W_{j,k}^2, & W_{j,k} < -\lambda \end{cases} \quad (4)$$

The shrinkage of the wavelet coefficient was modified with weighting algorithm according to the different threshold to smooth the noising image. The compromise threshold algorithm keeps the peak feature remained while smoothes the noise image, at the same time reflect the local feature of the reconstructed image better, and have smoothing characteristics like the soft threshold done.

Wavelet threshold. How to choose the threshold of the threshold function relates to the denoising effect directly. Universal threshold is very effective when the signal is smooth, but if the signal isn't smooth, the losing of singularities can cause signal distortion. To preserve singularities such as image edge, reference [7] proposed a threshold decision method base on Neyman-Pearson criterion.

Let H_0 represents that wavelet coefficients WF of image $f(x, y)$ does not exist or only noise WN exists, H_1 represents that WF exists, that is

$$\begin{aligned} H_0 : WY &= WN \\ H_1 : WY &= WF + WN \end{aligned} \quad (5)$$

Let $p\{H_0 | WY\}$ represents the conditional probability density when H_0 is true, and $p\{H_1 | WY\}$ represents the conditional probability density when H_1 is true, likelihood ratio is $\lambda(WY) = p\{H_0 | WY\} / p\{H_1 | WY\}$. Suppose λ_0 is the detection threshold, then H_0 is true if $\lambda(WY) \leq \lambda_0$ while H_1 is true if $\lambda(WY) > \lambda_0$. The equivalence test is that H_0 is true if $WY < t$ while H_1 is true if $WY > t$, t is the threshold. Set false alarm probability $\alpha \in (0, 1)$, to gain a maxim detecting probability, according to Neyman-Pearson criterion, the threshold should obeys the followings

$$2 \int_t^{+\infty} p\{H_0 | WY\} d(WY) = 2 \int_t^{+\infty} \frac{1}{\sqrt{2\pi}\sigma} e^{-x^2/2\sigma^2} dx = \alpha \quad (6)$$

$$t = \mu_{\alpha/2} \sigma \quad (7)$$

Where $\mu_{\alpha/2}$ is the upper fractile of standard normal distribution at $\alpha/2$. As the noise variance σ^2 are different at each scale s ($s = 2^j$), then produces as $\sigma_j^2 = \sigma^2 / 2^j$ ($j = 1, 2, \dots, J$), which makes $t_j = \mu_{\alpha/2} \sigma_j = \mu_{\alpha/2} \sigma / 2^{j/2}$, t_j is the local threshold and independent at each scale.

3 Denoise the Reconstructed Image of Digital Holography

The image denoising method based on wavelet threshold can deal with additive noise, but the speckle is a random multiplicative noise. By making logarithmic transformation, the multiplicative noise suppression issue can be transformed into estimating the signal in additive Gaussian noise.

Wavelet threshold denoising method mainly base on the basic principles that the coefficients with larger amplitude are generated from the importance signals. However, the wavelet coefficients of high frequency signal are mixed with the noise and the image edge details, it can't completely separate the edge and noise simply based on the size of the amplitudes. We proposed a new image edge preserving and wavelet threshold denoising algorithm, the following steps describe the algorithm implementations:

Make logarithmic transformation to the digital holographic reconstructed image, it will convert the image with multiplicative noise into the image with Gaussian noise;

Detect the Image edge with high accuracy LoG algorithm, it will get gray edge image;

Make wavelet transform to the noisy image and the edge image with the same scale respectively;

Take the wavelet coefficients of the noisy image subtract the wavelet coefficients of the edge image, it will get the wavelet coefficients of non-edge image;

Process the wavelet coefficients of the edge image and the non-edge image with wavelet threshold method respectively. In order to keep signal and reduce noise, in the paper, we use above described Neyman-Pearson criteria to selecting the threshold values, set false alarm probability and calculate the thresholds in different scales, then process the wavelet coefficients with the calculated thresholds in different scales according to the compromise threshold function proposed in the paper;

After processing the wavelet coefficients of the edge image and non-edge image with selected threshold, add wavelet coefficients of corresponding decomposing scales and decomposing direction together, and make the wavelet inverse transform, then get the denoised reconstructed image;

Make exponential transformation to the reconstructed image to obtain the final denoised image.

4 Experiment Results

The hologram of an object (tube inner-wall) was recorded by digital holography system, digital reconstruction and the corresponding denoising process completed in

the MATLAB. The digital holography reconstructed image of the tube inner-wall is shown in Fig. 1(a), which the first diffraction order and the conjugate image have been removed, and there is serious speckle in the reconstructed image. Denoise the reconstructed image using the above described method, the disposed image is shown in Fig. 1(e), the edge of the reconstructed image is shown in Fig. 1(f).

In order to compare the methods in this paper, apply the mean filter, the Wiener filter and the general wavelet method to denoise the reconstructed image, the resultant image are shown in Fig. 1(b), Fig. 1(c) and Fig. 1(d) respectively. The peak value Signal-to-Noise Ratio (PSNR) is the main parameter to evaluate the denoised image, the quality and the effect of the disposed image are good when the PSNR is higher. The PSNR of the denoised images using the method of this paper, mean filter, Wiener filter and the general wavelet method are 29.1524dB, 23.5615 dB, 27.0697 dB, 25.6794 dB respectively.

By comparing the denoised images and PSNR, it shows that after performing the method of this paper, as detecting the edge beforehand, the outline of the denoised image is clear, the detail is sharp, and the PSNR is improved.

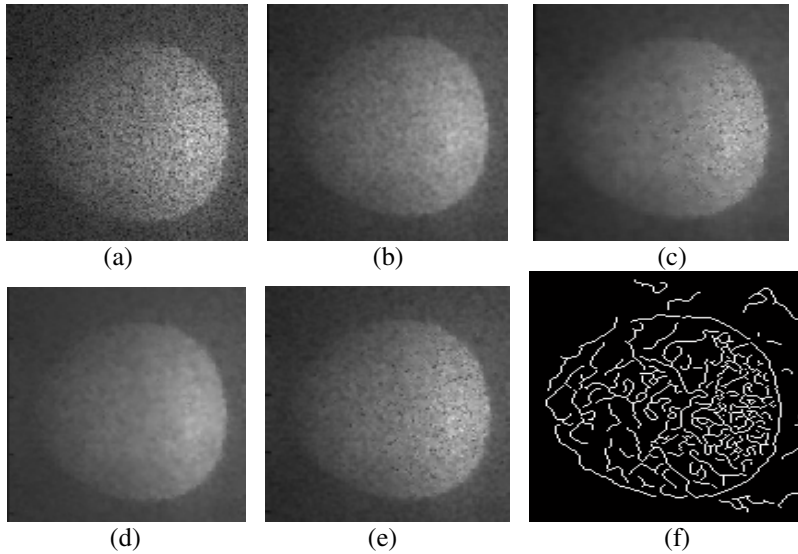


Fig. 1. (a) Reconstructed image. (b) The image processed by mean filter. (c)The image processed by Wiener filter. (d) The image processed by general Wavelet denoising. (e)The image processed by the method of this paper. (f) Edge image

5 Conclusions

The presence of speckle noise is serious drawback in digital holography. In this paper, perform Gauss - Laplace edge detection method and wavelet threshold denoising base on Neyman-Pearson criterion and compromise threshold function to reduce speckle noise of the reconstructed digital holographic image. The experimental result shows that the method not only reduces the speckle noise of the reconstructed image but also

keeps the edge of the reconstructed image well, and it makes good basis for further analyzing and disposing to the reconstructed image.

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The Alternating Direction Iterative of Axial Symmetric Electrostatic Field without Charge Current Distribution

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Abstract. In this paper, the problems of calculating and solution about axial symmetric electric fields were studied. And accurate theory model was established which can apply in high-performance numerical calculation. The new calculating method was proposed using Maxwell's equations and calculus under the condition that electric field is static, axial symmetric, without charge current distribution, finite, differentiable, integrable. This new calculating method was called alternating iterative method, and expression form was also given. The electric field outside of axis can be expressed as each order derivative and one-dimensional integration of electric field which on the symmetric axis. By means of this method, the result is progression form, which is the best form for computer approximate calculation. It is very easy, quickly and accurately to carry out numerical calculation by using this method. This paper provided this new calculation method, not only has important theoretical significance, but also has broad prospect of application.

Keywords: alternating direction iterative, without charge current distribution, electrostatic field, axial symmetry, Maxwell's equations.

1 Introduction

The electromagnetic fields' transporting, detecting and calculating have give rise to people's attention, to solve these problems, people propose many special methods. In the process, scientists gave fast multipole method [1], implicit marching-on-in-time method [2], Green function method [3], etc.

In natural world, axial symmetric phenomena are very common and important. The solutions for axial symmetric electromagnetic fields are also very common and important in the theory and practical application of electromagnetic fields. If it is highly axial symmetric, that is, the electric field is only a function of cylindrical coordinates r , it can be solved directly by using Gauss's theorem, loop theorem and axial symmetry. Otherwise, if it is normally axial symmetric, that is, the electric field is relative to both cylindrical coordinates r and z , it is very difficult to get its generally analytic solutions. In this case, we can perform approximate calculation by using computers. Yet, owing to the complexity of problems and improper handling of them at times, the approximate solutions are not easy to approach exact solutions, or it takes a long time to get more ideal approximate solutions, or even it is quite difficult

to perform approximate calculation. Along with the high performance of electronic computers in recent years, numerical simulation and analytical calculations of electromagnetic fields have been prosperous. In the process of researches and calculations people have presented many methods, such as sparse-matrix canonical-grid method [4], two-grid method [5], multilevel sparse-matrix canonical-grid method [6], time domain finite difference method [7], impedance approximate method [8], etc.

To optimize algorithm and improve computational efficiency, this paper built a precise theoretical model and gave a computational method with high performance. In the circumstances of the axial symmetric, without charge current distribution and static electric field which is limited, integrable and differentiable on the symmetric axis, this paper gives a new kind of computing method and its results in the series form by using Maxwell equations and calculus. That is, the out-of-axis electric field can be determined by the electric field on the symmetric axis and its different order derivatives. The procedure and results of approximate calculation state that the results in the series form are the most ideal results for computer to perform approximate calculation with extremely high degree of accuracy and quick speed.

The new computing method given by this paper is very important in theory and application since signal detection and calculation is an important part in scientific research and engineering. Along with the progress of science and technology, scientific researchers invented many measuring or detecting devices [9]. They can directly measure or detect signals by using them [10]. On the other hand, the researchers did in-depth theoretical studies in the analysis and presumption of the signal components [11]. In fact, many signals can be described as electromagnetic wave. So the problems become the calculation or detection of electromagnetic wave. As known, in some cases, measuring devices can not reach the regions of some signals because of limitation. So this paper gives a new kind of computing method and results to calculate or detect signals. That is, the electric field on one point can be calculated, detected or presumed with another point. As you know, an electric field can be regarded as a static state approximately if the signal changes slowly. Then, to the static and passive field, there is certain theoretical and applied value for the study how to solve the electric field at one point by calculating or detecting another point. To optimize algorithm and improve computational efficiency, this writer built a precise theoretical model and gave a computational method with high performance. Not long ago, the authors studied the electric field without charge distribution using the method [12-20]. This paper is its further development.

The Alternating Iteration of Axial Symmetric and Static Electric Field

As is known to all, the differential form of Maxwell's equations is

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad (1)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (2)$$

$$\nabla \cdot \vec{D} = \rho \quad (3)$$

$$\nabla \cdot \vec{B} = 0 \quad (4)$$

We choose cylindrical coordinates r , φ , z , and the z axis is the symmetric axis of the electric field. In the circumstances of vacuum, without charge current distribution and static state, applying Maxwell's equations and axial symmetry, the equations of the electric field to follow are

$$-\vec{e}_r \frac{\partial E_\varphi}{\partial z} + \vec{e}_\varphi \left(\frac{\partial E_r}{\partial z} - \frac{\partial E_z}{\partial r} \right) + \vec{e}_z \frac{1}{r} \frac{\partial(rE_\varphi)}{\partial r} = 0 \quad (5)$$

$$\frac{1}{r} \frac{\partial(rE_r)}{\partial r} + \frac{\partial E_z}{\partial z} = 0 \quad (6)$$

From the (5) and (6), we have

$$E_r(r, z) = -\frac{1}{r} \int_0^r \frac{\partial E_z(r, z)}{\partial z} r dr \quad (7)$$

$$E_z(r, z) = E(z) + \int_0^r \frac{\partial E_r(r, z)}{\partial z} dr \quad (8)$$

$$E_\varphi(r, z) = 0 \quad (9)$$

$E(z) = E_z(0, z)$ in the (8).

The equations (7), (8) and (9) show that the axial symmetric, without charge current distribution and static state electric field $E_\varphi(r, z)$ is identically vanishing.

However, because of the mutual nestification of $E_r(r, z)$ and $E_z(r, z)$, none of them can be solved directly. In order to solve $E_r(r, z)$ and $E_z(r, z)$, we suggest the new computing method (alternating iteration method). That is, one should choose a proper initial value and make use of the (7) and (8) to perform alternating iteration. Obviously, approximate solutions are given by the alternating iteration of finite degrees and times. With increasing the degrees and times of alternating iteration, the solutions are more exact. After the alternating iteration of infinite degrees and times, the exact solutions of the out-of-axis electric field can be given. Here, we choose $E_z(r, z)$'s value on the symmetric axis as the initial value, that is

$$E_{0z}(r, z) = E_z(0, z) = E(z) \quad (10)$$

$E(z)$ was also expressed into

$$E(z) = \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} E^{(2 \times 0)}(z) (r)^{2 \times 0} \quad (11)$$

Substituting the (10) into the (7), we can get

$$E_{0r}(r, z) = \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} E^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \quad (12)$$

$E^{(n)}(z)$ is the n th derivative of $E(z)$ with respect to z in the (12).

Substituting the (12) into the (8), we get

$$E_{1z}(r, z) = \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} E^{(2 \times 0)}(z)(r)^{2 \times 0} + \frac{(-1)^1}{(1!)^2 2^{2 \times 1}} E^{(2 \times 1)}(z)(r)^{2 \times 1} \quad (13)$$

Substituting the (13) into the (7), we obtain

$$\begin{aligned} E_{1r}(r, z) &= \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} E^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \\ &+ \frac{(-1)^{1+1}}{(1+1)!1!2^{2 \times 1+1}} E^{(2 \times 1+1)}(z)(r)^{2 \times 1+1} \end{aligned} \quad (14)$$

Substituting the (14) into the (8), we get

$$\begin{aligned} E_{2z}(r, z) &= \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} E^{(2 \times 0)}(z)(r)^{2 \times 0} + \frac{(-1)^1}{(1!)^2 2^{2 \times 1}} E^{(2 \times 1)}(z)(r)^{2 \times 1} \\ &+ \frac{(-1)^2}{(2!)^2 2^{2 \times 2}} E^{(2 \times 2)}(z)(r)^{2 \times 2} \end{aligned} \quad (15)$$

Substituting the (15) into the (7), we obtain

$$\begin{aligned} E_{2r}(r, z) &= \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} E^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \\ &+ \frac{(-1)^{1+1}}{(1+1)!1!2^{2 \times 1+1}} E^{(2 \times 1+1)}(z)(r)^{2 \times 1+1} + \frac{(-1)^{2+1}}{(2+1)!2!2^{2 \times 2+1}} E^{(2 \times 2+1)}(z)(r)^{2 \times 2+1} \end{aligned} \quad (16)$$

The rest may be deduced by analogy. The exact solutions of $E_z(r, z)$ and $E_r(r, z)$ can be given by the alternating iteration of infinite degree. That is

$$E_z(r, z) = \sum_{n=0}^{\infty} \frac{(-1)^n}{(n!)^2 2^{2n}} E^{(2n)}(z)(r)^{2n} \quad (17)$$

$$E_r(r, z) = \sum_{n=0}^{\infty} \frac{(-1)^{n+1}}{(n+1)!n!2^{2n+1}} E^{(2n+1)}(z)(r)^{2n+1} \quad (18)$$

2 Conclusions

In the circumstances of the static, axial symmetric, without charge current distribution, finite, differentiable, integrable, this paper provides a new kind of computing method (alternating iteration method) and its results in the series form by making use of Maxwell equations and calculus. That is, the out-of-axis electric field can be determined by the electric field on the symmetric axis and its different order derivatives. It has been exact enough, and it is very easy to perform approximate calculation with quite high speed. Therefore, the theory, method and results given by this paper not only are of certain theoretical meaning, but also are of quite great-applied value. Especially to those problems of some out-of-axis areas that are not easy to measure or get exact solutions from theory, it is easy, quick and exact to solve them by using the method and results given by this paper.

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The Influence Research of Surface Water Depth to Infiltration

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Abstract. The infiltration research is very important in slope engineering. When surface soil is saturated under rainfall condition, the boundary condition on surface soil is usually to be considered as imposed head instead of flux, and the water depth is simplified as 0. However, how does it influence the infiltration if ignore the water depth? In this paper, based on Richards' equation, the infiltration process of a homogeneous soil column under a fixed head boundary on the column top is simulated by FEM method. With five different water depths on the top, the infiltration rate and cumulative infiltration are calculated. The results show that the depth of water has great influence to infiltration rate and cumulative infiltration. The mistakes of the method simplifying the water depth as 0 can not be neglected.

Keywords: infiltration rate, FEM method, numerical simulation.

1 Introduction

Rainfall is one of the most important factors inducing landslides [1]. The previous studies show that the affects of rainfall to slope stability are to reduce the suction of soil, the strength of soil and produce disadvantage hydrodynamic pressure. In order to quantitative assess the adverse affects, one method widely adopted is to simulate the seepage of slope, and then calculate the stress and deformation of slope, and assess the slope safety factor at last. So the seepage simulation will directly affect the slope stability evaluation [2].

Under intensive rainfall condition, one of rainwater infiltrate into soil; another of rainwater become runoff. While the interactions between runoff and seepage is very complex. At present, many researches have done on creating couple mathematic model of runoff and seepage and its numerical simulation. A simplified method is to ignore the water depth of runoff and use Richards' equation to describe the seepage of soil [3]. This method is easy to realized and applied. However, how does it influence the infiltration if ignore the water depth?

In this paper, based on Richards' equation, the infiltration process of a homogeneous soil column under a fixed head boundary on the top is simulated by FEM method. The water depth on the top is assumed as 0cm, 5cm, 10cm, 15cm and 20cm respectively. The influence of water depth to infiltration is researched by the comparison of calculation results.

2 Analysis Method

Mathematical formulation. The governing equation for the subsurface flow is Richards's equation which is based on mass conservation and Darcy's law [4].

$$\sigma(h) \frac{\partial h}{\partial t} - \frac{\partial}{\partial x} \left[K_x(h) \frac{\partial \phi}{\partial x} \right] + \frac{\partial}{\partial y} \left[K_y(h) \frac{\partial \phi}{\partial y} \right] + \frac{\partial}{\partial z} \left[K_z(h) \frac{\partial \phi}{\partial z} \right] - q_g = 0 \quad (1)$$

Where t is time [T], the x and y axis are horizontal directions, the z axis is vertical upward, h is the pressure head [L], $\sigma(h)$ is the specific volumetric storativity [L-1], $K_x(h)$, $K_y(h)$, $K_z(h)$ are the hydraulic conductivity [LT-1] along x , y and z directions respectively, $\phi = h + z$ presents water potential [L], z is the elevation [L] and q_g represents sink and/or source of water [T-1]. Neglecting hydro mechanical coupling in the unsaturated zone, the specific volumetric storativity reduces to the soil capillary capacity $C(h) = \partial \theta / \partial h$ in the unsaturated zone [L-1], where h is the water pressure in the unsaturated zone. In the saturated zone, the specific volumetric storativity reduces to the specific volumetric storage S^* . The specific storativity and the hydraulic conductivity can be defined in the whole pressure domain as follows:

$$\sigma(h) = \begin{cases} C(h) & \text{for } h < 0 \\ S^* & \text{for } h \geq 0 \end{cases} \quad (2)$$

$$K(h) = \begin{cases} K_{sat} K_r(h) & \text{for } h < 0 \\ K_{sat} & \text{for } h \geq 0 \end{cases} \quad (3)$$

Where K_{sat} is the saturated hydraulic conductivity of the medium [LT-1] and K_r is relative permeability. The main advantage using this pressure head formulation is that both saturated and unsaturated flows can be simulated in a single computational domain.

To solve the governing equation (1), boundary conditions (BC) must be imposed. Both Neumann (imposed flux) and Dirichlet (imposed head) BC can be imposed at the domain boundaries.

$$\phi|_{S_1} = \phi_b(x, y, z, t) \quad \text{on } S_1 \quad (4)$$

$$k_x \frac{\partial \phi}{\partial x} \cos(n_b, x) + k_y \frac{\partial \phi}{\partial y} \cos(n_b, y) + k_z \frac{\partial \phi}{\partial z} \cos(n_b, z) = q_{gb} \quad \text{on } S_2 \quad (5)$$

Where S_1 and S_2 are boundaries of the domain, ϕ_b is the water potential on S_1 , n_b is the normal direction of S_2 , q_{gb} is the normal flux through S_2 .

Simulation methods. The infiltration process of a homogeneous soil column with 5cm length and width, 50cm height (shown in Fig.1) under a fixed head boundary on the column top is simulated by FEM method. The water depth on boundary ABCD is fixed at 0, 5cm, 10cm, 15cm and 20cm respectively. The element of FEM grid is

5cm long and wide, 1cm high. There are 50 elements and 204 nodes of FEM grid. Soil-water characteristic curve and permeability function of soil is shown in Fig.2, saturated conductivity $K_s=0.000722\text{cm/s}$. The simulation duration is 3600 seconds.

Table 1. The list of disperse data of the soil-water characteristic curve

θ	0.028	0.062	0.085	0.116	0.178	0.265	0.306	0.35
$h(\text{cm})$	200.0	100.0	80.0	60.0	40.0	20.0	10.0	0.0

Table 2. The list of disperse data of the permeability function

θ	0.028	0.050	0.10	0.15	0.175	0.20	0.225	0.25
K_r	0.001	0.0075	0.015	0.03	0.05	0.082	0.25	0.55
θ	0.275	0.2875	0.30	0.306	0.175	0.35		
K_r	0.886	0.963	0.992	0.01	0.997	1.0		

The initial condition is obtained by following steps: suppose initial bulk water content 0.1, and then the seepage calculated with impermeable boundary during 3 hours is considered as initial condition. Boundary condition on ABCD is $\Phi=50, 55, 60, 65$ and 70cm respectively, and boundary condition on AEFB, BFGC, CGHD, DHEA and EFGH is impermeable.

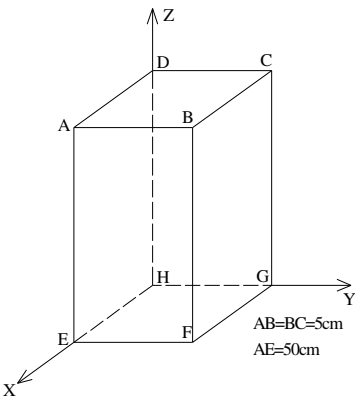


Fig. 1. Soil column model

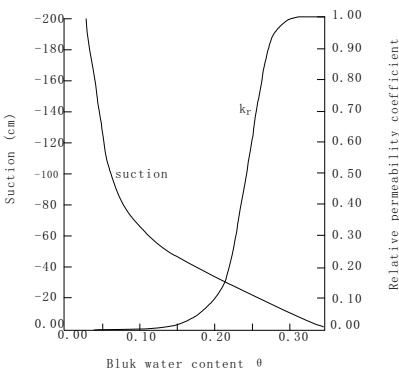


Fig. 2. SWCC and permeability function

3 Calculation Results and Analysis

Calculation results. The infiltration rate evolutions under different water depth are shown in Fig.3. It could be seen that infiltration rate is large at the beginning, and rapidly decreases soon after, and basically maintains a certain value after 720 seconds. The rule of evolutions under different water depths is same. The water is deeper; the

infiltration rate is lager at the same time. The relationship between cumulative infiltration and water depth is shown in Fig.4. It could be seen that the cumulative infiltration increases linearly with the incensement of water depth basically.

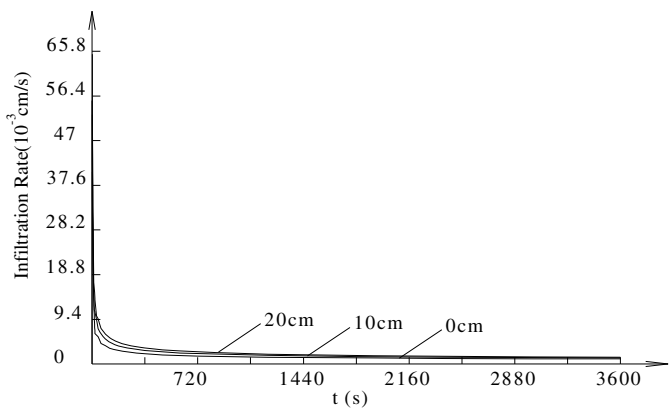


Fig. 3. The infiltration rate evolutions under different water depth

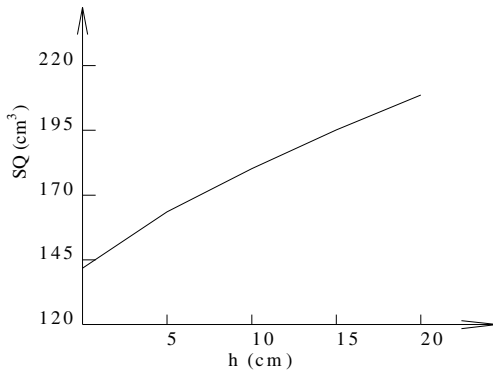


Fig. 4. The relationship between cumulative infiltration and water depth

The infiltration rate at the beginning (I0), infiltration rate at the end (I1), and average infiltration rate (Ia) and cumulative infiltration (SQ) under different water depths are listed in Table 3.

Table 3. Some statistical data of infiltration processes

Water depth(cm)	0	5	10	15	20
I0 (10 ⁻³ cm/s)	40.38	46.33	52.39	58.68	65.08
I1 (10 ⁻³ cm/s)	1.06	1.18	1.28	1.36	1.43
Ia (10 ⁻³ cm/s)	1.56	1.82	2.01	2.17	2.33
SQ (cm ³)	141.75	163.50	181	195.00	209.52

Results Analysis. The I1 and Ia of 5cm, 10cm, 15cm and 20cm water depth are compared with 0cm water depth, and the results are shown in Table 4. It could be seen from the table that if water depth researches 20cm which is ignored, the error of I1 is very large, and is about 34.91%. While the error of Ia is about 49.36%. Furthermore, the water depth increases per 10cm, the error increases about per 10%. So, if ignore the water depth when runoff occurs under rainfall condition, the large error would be brought out.

Table 4. The comparisons of I1 and Ia

		5cm	10cm	15cm	20cm
I1	Error (10^{-3} cm/s)	0.12	0.20	0.30	0.37
	Extent %	11.32	18.87	28.30	34.91
Ia	Error 10^{-3} cm/s	0.26	0.45	0.61	0.77
	Extent %	16.67	28.85	39.10	49.36

4 Conclusion

In order to show the influence of water depth to infiltration rate and cumulative infiltration, based on Richards’ equation, the infiltration process of a homogeneous soil column under a fixed head boundary on the top is simulated by FEM method. The water depth on the top is assumed as 0cm, 5cm, 10cm, 15cm and 20cm respectively. The calculation results show that if water depth researches 20cm, the error of average infiltration rate would be 49.36%. So the depth of Water accumulation under rainfall condition should not be ignored.

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A Method Based on Bochs for Accelerating the x86 Timing Emulator

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Abstract. System structure software simulation technology is a method on realizing the simulation of the computer system hardware in the system structure levels of functionality and performance characteristics by applying the software. The system structure software simulation technology has become an indispensable link for the design, evaluation, and verification of a modern computer system. The speed is very important factor to constrain the use of simulator. Two levels of technical measures from the development and running of simulator are taken to improve the simulator speed. A method based on Bochs is presented and improve to verify the timing simulator. This approach can maintain the accuracy of timing simulation based on the timing simulator to further accelerate the speed of the verification.

Keywords: Bochs, X86 compatible processor, Timing simulator.

1 Introduction

Simulator plays a very important role in the computer system design and development process. At design stage, the simulator can be used to obtain the most optimal solution from various coarse-grained simulations. During product development period, the simulator can be used to evaluate a variety of micro-structural design and selection of some compromise. Product development later, the simulator is mainly used for the target system software development, i. e., hardware and software development can be made to accelerate the speed of the system development at the same time. After the system is completed, the simulator can get rich in trace information, and is used for the analysis of the bottleneck and performance optimization of the system. A number of simulators have been developed, including SimpleScalar [1], SimOS [2], M5 [3], Liberty [4], IBM's Mambo [5], AMD's SimNow [6], and so on. In typical processor design process, more than 60% of manpower and material resources are spent in the evaluation and validation [7]. System structure software simulation technology can greatly reduce the cost of computer system development and shorten the development cycle on hand. The use of architecture software simulation technology can assess and verify many possible architecture designs in a relatively short period.

The operations of micro-structure can be simulated in timing simulator, including the processor pipeline, multi-launch, order execution, branch prediction, and read and write operations of the cache memory system. As the state of the system is varied, the

executing cycles of each instruction will be changed. Clock-level simulation has a realistic simulation on the operation state of the target system, so it is primarily used in the analysis of the system performance. A method based on Bochs is presented and improve to verify the timing simulator.

2 Bochs Working

Bochs is a highly portable open source IA-32 (x86) PC emulator written in C++, that runs on most popular platforms, including emulation of the Intel x86 CPU, common I/O devices, and custom BIOS. Bochs can be compiled to emulate a 386, 486, Pentium/PentiumII/PentiumIII/Pentium4 or x86-64bit CPU including optional MMX, SSEx and 3DNow! instructions. Bochs is capable of running most Operating Systems inside the emulation including Linux, DOS, Windows® 95/98 and Windows® NT/2000/XP or Windows Vista.

Bochs can be compiled and used in a variety of modes to provide complete x86 PC emulation, including the x86 processor, hardware devices, and memory. OS's and software is run within the emulator on your workstation via Bochs. For instance, Win'95 applications can be run through a displaying window to simulate a monitor as a PC on a Unix/X11 workstation.

In this paper, Bochs runs a 64bit Linux system, and the working principle of Bochs is showed in Figure 1. The operations of CPU in Bochs are: Fetching → Implementation → Output. After reset, CPU runs in the real mode with EIP = 0x0000FFF0. In the cache of CS, the Base=0xFFFF0000, the address of BIOS ROM (CS: EIP=0xFFFFFFF0) is determined by adding EIP and Base, where user's programs begin to run. After programs run into the CPU cycles, flag is tested in every cycle besides fetching and executing work. If there is no reset or exit command, CPU will always keep circulating.

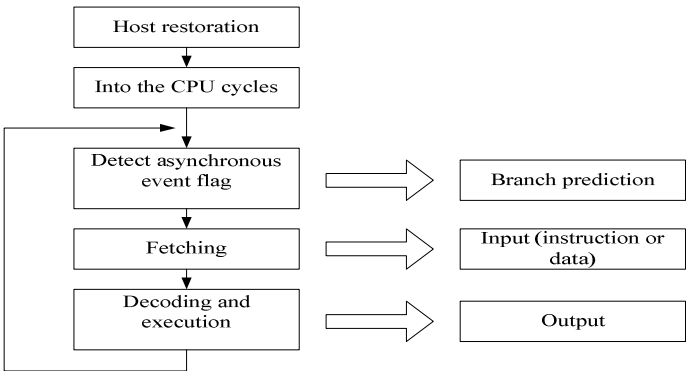


Fig. 1. Working principle of Bochs.

3 Timing Simulator Based on Bochs

3.1 The Executive Drive Method for Timing Simulator

Simulator is a program running on the hosting machine. In the detailed simulation, the program needs to have operation results of each strip dynamic instructions and processor state recorded in clock level. The data, including registers state, memory, cache behavior and branch predictor of state, is so huge that the simulator's speed is slow in the detailed simulation. At present, the most successful accelerating software for emulator is SMARTS, whose running speed is 9MIPS. Compared to the hardware running on the host machine, it defers 4-5 orders of magnitude. In order to assess performance of general-purpose processor, new test packets for standard test are presented and released continuously by International Standardization Organization (ISO). Currently, SPEC CPU2006 packages are used as the latest test procedures. Multiple load test procedures are contained in standard packets for performance test to evaluate processor performance from several aspects. Therefore, testing program is used to run on the simulator for making the simulation results credible. However, the simulation cannot be finished in relatively short period because of the great load performance test. The influence of various configurable parameters on the system, such as the cache and translation look aside buffer (TLB), is not independent. According to different purpose of simulation and parameters, it will spend the different time to simulate test procedures and to observe the influence of the modifying parameter on the whole system. Thus, more time will be taken to simulate operation, in order to gain a better system structure.

Due to the slow simulation speed, the method of Executive Drive is provided to verify the feasibility of timing simulator. This technique was used in the page replacement algorithm [8] and cache management approach. The information generated by running every instruction is used as the input of the simulator on Executive Drive simulation, and to stimulate the function and performance of some processor's architecture. The divide and conquers strategy [9] can be adopted on Executive Drive simulation, as shown in Figure 2. The load to be executed in the simulation is supposed as w , and then the target executing environment for this load is T . The problems of executing w in environment T can be divided into two sub problems, including tracking information and simulation based on tracking information. The environment where the trace is generated is set as G . When w is executed in G , the trace will be recorded. These records are called tracking information. Then the simulator will use tracking information as input to simulate w in the target environment T .

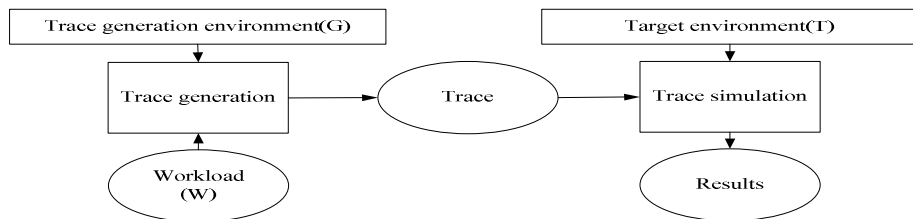


Fig. 2. The schemes of divide and conquers strategy.

SPEC CPU2006 is chosen as w and Bochs as the environment G. In order to assess the performance of compatible processor, the trace information is very detailed, including the source operand (register number), the linear address, and physical address. The trace is used as the input of timing stimulator whose target structure is x86 compatible processor. By this way, the timing stimulator will show the number of instructions and cycles in real-time way. Through the method described above, the feasibility of x86 timing simulator can be verified.

3.2 Improvement

The feasibility of the timing simulator can be verified using the method above. But there are bottlenecks existing in the trace generation process, when accelerating the speed of the timing simulator. A new method is presented to optimize the formation rate of the trace generated in Bochs for accelerating the speed of the x86 timing simulator.

Many instructions need to access TLB in the function of Bochs. The linear address space is divided into several pages by processors (such as 4K, 2M, 4M length), and can be mapped to physical memory or disk. When a logical address described in the memory cell is used in a program or task, a logical address is firstly changed into a linear address by the processors, and then the linear address is changed into physical address through the paging mechanism. In order to reduce bus's accessing cycles during conversion, the common page directory and page table cached in the TLB are made by Bochs to finish most of the address translation without accessing memory.

In order to get the address of page table at every level, the initial approach is to close the optimization part of the TLB. By this way, every instruction needed to access memory will search page table, and then, the physical address in page table is taken out. But after this operation, many instructions need to access the TLB, and Bochs have a negative effect on trace generation, which indirectly limit the speed of timing simulator. Therefore, a method is proposed here to eliminate the negative effects.

The function of the TLB is modified by adding an array to record page table entries, which is accessed by instructions and stored in the TLB. Therefore, during the course of taking trace, the optimization part of the TLB is not necessary to be closed, and only to record up to four addresses in the function. When current instruction is not hit in the TLB, the address information in TLB can be obtained from last instruction's data structure instead of accessing page table again. The generation speed of trace is significantly improved. Thereby this method indirectly speeds up the x86 timing simulator. The number of executive instruction per second reached 496K after improvement, as well as the timing stimulator can execute 467K x86 instructions per second before improvement. The speed can be increased by 5%.

4 Conclusion

An Executive Drive method is presented to use Bochs for generating trace to drive x86 timing simulator. The influence factors of timing simulator's speed are analyzed. An optimizing method on the TLB of Bochs is proposed to accelerate the process of

trace's generating. The experiment results show that the method can effectively accelerate the speed of x86 timing simulator.

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An Empirical Comparison of Two Boosting Algorithms on Real Data Sets Based on Analysis of Scientific Materials

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Abstract. Boosting algorithms are a means of building a strong ensemble classifier by aggregating a sequence of weak hypotheses. In this paper, multiple TAN classifiers generated by GTAN are combined by a combination method called Boosting-MultiTAN. This TAN combination classifier is compared with the Boosting-BAN classifier which is boosting based on BAN combination. We conduct an empirical study to compare the performance of two algorithms, measured in terms of overall test correct rate, on ten real data sets. Finally, experimental results show that the Boosting-BAN has higher classification accuracy on most data sets, but Boosting-MultiTAN has good effect on others. These results argue that boosting algorithms deserve more attention in machine learning and data mining communities.

Keywords: boosting, combination method, TAN, BAN, Bayesian network classifier.

1 Introduction

Classification is a fundamental task in fault diagnosis, pattern recognition and forecasting. In general, a classifier is a function that chooses a class label (from a group of predefined labels) for instance described by a set of features (attributes). Learning accurate classifiers from pre-classified data is a very active research topic in machine learning and data mining. In the past two decades, many classifiers have been developed, such as decision trees based classifiers and neural network based classifiers.

Boosting[1-4] is a general method for improving the performance of any “weak” learning algorithm. In theory, boosting can be used to significantly reduce the error of any “weak” learning algorithm that consistently generates classifiers which need only be a little bit better than random guessing. Despite the potential benefits of boosting promised by the theoretical results, the true practical value of boosting can only be assessed by testing the method on “real” learning problems. In this paper, we present such experimental assessment of two new boosting algorithms.

The first provably effective boosting algorithms were presented by Schapire and Freund[1] in 1995. Boosting works by repeatedly running a given weak learning algorithm on various distributions over the training data, and then combining the

classifiers produced by the weak learner into a single composite classifier. The first provably effective boosting algorithms were presented by Freund[3] and Schapire[5]. More recently, we described and analyzed AdaBoost, and we argued that this new boosting algorithm has certain properties which make it more practical and easier to implement than its predecessors.

TAN[6] and BAN[7] are augmented Bayesian network classifiers provided by Friedman and Cheng J. They treat the classification node as the first node in the ordering. The order of other nodes is arbitrary; they simply use the order they appear in the dataset. Therefore, they only need to use the CLB1 algorithm, which has the time complexity of $O(N^2)$ on the mutual information test (N is the number of attributes in the dataset) and linear on the number of cases. The efficiency is achieved by directly extending the Chow-Liu tree construction algorithm[8] to a three-phase BN learning algorithm: drafting, which is essentially the Chow-Liu algorithm, thickening, which adds edges to the draft, and thinning, which verifies the necessity of each edge.

In this paper, multiple TAN classifiers generated by GTAN are combined by a combination method called Boosting-MultiTAN. This TAN combination classifier is compared with the Boosting-BAN classifier which is boosting based on BAN combination. We conduct an empirical study to compare the performance of two algorithms, measured in terms of overall test correct rate, on ten real data sets. Finally, experimental results show that the Boosting-BAN has higher classification accuracy on most data sets, but Boosting-MultiTAN has good effect on others. These results argue that boosting algorithm deserve more attention in machine learning and data mining communities.

2 Two New Boosting Algorithms

2.1 Boosting-MultiTAN Algorithm

GTAN[9] is proposed by Hongbo Shi in 2004. GTAN used conditional mutual information as CI tests to measure the average information between two nodes when the statuses of some values are changed by the condition-set C . When $I(x_i, x_j | C)$ is larger than a certain threshold value $\mathcal{E}$, we choose the edge to the BN structure to form TAN. *Start-edge* and $\mathcal{E}$ are two important parameters In GTAN. Different *Start-edges* can construct different TANs. GTAN classifier is unstable that can be combined with a quite strong learning algorithm by boosting.

The Boosting-MultiTAN algorithm may be characterized by the way in which the hypothesis weights w_i are selected, and by the example weight update step.

Boosting-MultiTAN (Dataset, T) :

Input: sequence of N example $Dataset = \{(x_1, y_1), \dots, (x_N, y_N)\}$ with labels $y_i \in Y = \{1, \dots, k\}$, integer T specifying number of iterations.

Initialize $w^{(1)}_i = 1/N$ for all i , $TrainData - l = Dataset$

Start-edge $= l; t = 1; l = 1$

While $((t \leq T) \text{ and } (l \leq 2T))$

1. Use *TrainData-t* and *start-edge* call GTAN, providing it with the distribution.
 2. Get back a hypothesis $TAN^{(t)}:X \rightarrow Y$.
 3. Calculate the error of $TAN^{(t)}$:

$$e^{(t)} = \sum_{i=1}^N w^{(t)}_i I(y_i \neq TAN^{(t)}(x_i)).$$
 If $e^{(t)} \geq 0.5$, then set $T=t-1$ and abort loop.
 4. Set $\mu^{(t)} = e^{(t)} / (1 - e^{(t)})$.
 5. Updating distribution $w^{(t+1)}_i = w^{(t)}_i (\mu^{(t)})^s$,
 where $s = 1 - I(y_i \neq TAN^{(t)}(x_i))$.
 6. Normalize $w^{(t+1)}_i$ to sum to 1.
 7. $t=t+1, l=l+1, start-edge=start-edge+n/2T$.
 8. end While
- Output* the final hypothesis :
- $$H(x) = \arg \max_{y \in Y} (\sum_{t=1}^T (\log(1/\mu^{(t)})) I(y = TAN^{(t)}(x))).$$

3 Boosting-BAN Algorithm

Boosting-BAN works by fitting a base learner to the training data using a vector or matrix of weights. These are then updated by increasing the relative weight assigned to examples that are misclassified at the current round. This forces the learner to focus on the examples that it finds harder to classify. After T iterations the output hypotheses are combined using a series of probabilistic estimates based on their training accuracy.

The Boosting-BAN algorithm may be characterized by the way in which the hypothesis weights w_i are selected, and by the example weight update step.

Boosting-BAN (Dataset, T) :

Input: sequence of N example $Dataset = \{(x_1, y_1), \dots, (x_N, y_N)\}$ with labels $y_i \in Y = \{1, \dots, k\}$, integer T specifying number of iterations.

Initialize $w^{(1)}_i = 1/N$ for all i , $TrainData-1 = Dataset$

Do for $t=1, 2, \dots, T$

1. Use *TrainData-t* and threshold $\mathcal{E}$ call BAN, providing it with the distribution.
 2. Get back a hypothesis $BAN^{(t)}:X \rightarrow Y$.
 3. Calculate the error of $BAN^{(t)}$:

$$e^{(t)} = \sum_{i=1}^N w^{(t)}_i I(y_i \neq BAN^{(t)}(x_i)).$$
 If $e^{(t)} \geq 0.5$, then set $T=t-1$ and abort loop.
 4. Set $\mu^{(t)} = e^{(t)} / (1 - e^{(t)})$.
 5. Updating distribution $w^{(t+1)}_i = w^{(t)}_i (\mu^{(t)})^s$,
 where $s = 1 - I(y_i \neq BAN^{(t)}(x_i))$.
 6. Normalize $w^{(t+1)}_i$ to sum to 1.
- Output* the final hypothesis :
- $$H(x) = \arg \max_{y \in Y} (\sum_{t=1}^T (\log(1/\mu^{(t)})) I(y = BAN^{(t)}(x))).$$

4 The Experiments

We conducted our experiments on a collection of machine learning datasets available from the UCI[10]. A summary of some of the properties of these datasets is given in Table 1. Some datasets are provided with a test set. For these, we reran each algorithm 20 times (since some of the algorithms are randomized), and averaged the results. For datasets with no provided test set, we used 10-fold cross validation, and averaged the results over 10 runs (for a total of 100 runs of each algorithm on each dataset).

In our experiments, we set the number of rounds of boosting to be $T=100$.

The results of our experiments are shown in Table 2. The figures indicate test correct rate averaged over multiple runs of each algorithm. The bold in the table show that the classification is superior than another one obviously. From Table 2 in the 10 datasets, Boosting-BAN did significantly and uniformly better than Boosting-MultiTAN.

Table 1. Datasets used in the experiments

No.	Dataset	Instances	Classes	Attributes	Missing values
1	Iris	150	3	4	×
2	Kr-rs-kp	3169	2	36	×
3	LED	1000	10	7	
4	Mushroom	8124	2	22	√
5	Promoters	106	2	57	×
6	Segment	2310	7	19	×
7	Soybean Large	683	19	35	√
8	Tic-Tac-Toe	958	2	9	×
9	Wine	178	3	13	×
10	Zoology	101	7	16	×

Table 2. Experimental results

No.	Dataset	Boosting-MultiTAN	Boosting-BAN
1	Iris	93.8	90.5
2	Kr-rs-kp	93.3	99.3
3	LED	73.9	72.3
4	Mushroom	99.9	100
5	Promoters	89.3	91.7
6	Segment	94.3	96.4
7	Soybean Large	92.6	93.7
8	Tic-Tac-Toe	74.7	79.2
9	Wine	97.3	98.5
10	Zoology	96.8	97.7

On the data sets “Iris” and “LED”, the Boosting- MultiTAN was inferior to the Boosting-BAN. The Boosting-BAN correct rate was better than the Boosting-MultiTAN correct rate in another 8 datasets. The reason is, in these cases the rate of attributes and classes are less than other Datasets. This reveals that the features in the two datasets are most dependent to each other. These weak dependencies can improve the prediction accuracy significantly, as we see from Table 2.

5 Summary

GTAN and BAN classifiers are unstable, by setting different parameters, we can form a number of different TAN and BAN classifiers. In this paper, multiple TAN classifiers generated by GTAN are combined by a combination method called Boosting-MultiTAN. This TAN combination classifier is compared with the Boosting-BAN classifier which is boosting based on BAN combination. Finally, experimental results show that the Boosting-BAN has higher classification accuracy on most data sets.

When implementing Boosting classifiers, we were able to calculate the value of $\mathcal{E}$ directly given our prior knowledge. Of course, in a real situation we would be very unlikely to know the level of class noise in advance. It remains to be seen how difficult it would prove to estimate $\mathcal{E}$ in practice.

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A Fourth-Order Newton-Type Method Free from Second Derivative for Solving Non-linear Equations

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Abstract. In this paper, we present a class of third-order Newton-type methods for solving non-linear equations by considering linear combination of two well-known third-order methods. Based on this, we obtain a fourth-order convergent method. The proposed approach is free from second derivatives. In each step, it only requires two evaluations of the given function and one evaluation of its first derivative. Analysis of efficiency demonstrates that the algorithm is superior and performs well.

Keywords: Nonlinear equations, Newton's method, Iterative method, Order of convergence.

1 Introduction

Solving nonlinear equations is one of the most important problems in numerical analysis. Iterative methods are usually used to solve nonlinear equations. Throughout this paper, we consider iterative methods to find a simple root x^* of a nonlinear equation $f(x) = 0$, where $f: D \subseteq \mathbb{R} \rightarrow \mathbb{R}$ for an open interval D is a scalar function and it is sufficiently smooth in a neighborhood of x^* .

It is well known that classical Newton's method (NM) is a basic and important method for solving non-linear equation [1] by the iterative scheme

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}, \quad (1)$$

which is quadratically convergent in the neighborhood of x^* .

In recent years, many iterative methods for solving nonlinear equations have been developed [1-9]. However, many of these methods depend on the second or higher derivatives in computing process which strictly restrict their practical applications. Thus, in term of practical application, it is very necessary to research methods which are free from the restriction of derivative.

Recently, there has been some progress on iterative methods improving Newton's method for solving nonlinear equations that do not require the computation of second or higher derivatives. Furthermore, several fourth-order iterative methods which are free from second derivatives and only require three evaluations of the function and its first derivative are proposed.

Motivated and inspired by these recent activities, in this paper, we present a new class of third-order Newton-type method. Based on this, a fourth-order method is

given, which is free from second derivative of the given function and per iteration it only requires two evaluations of the given function and one evaluation of its first derivative. Numerical examples demonstrate that the method is more efficient and performs better than classical Newton's method.

2 The New Method and Its Convergence Analysis

There are many modifications about Newton's method. In [2], Potra-Pták proposed a two-step method which is defined by

$$x_{n+1} = x_n - \frac{f(x_n) - f(y_n)}{f'(x_n)}, \quad (2)$$

where $y_n = x_n - \frac{f(x_n)}{f'(x_n)}$. It is a third-order modification of Newton's method.

Recently, in [3], C. Chun presents the following new modification of Newton's method

$$x_{n+1} = x_n - \frac{f(x_n) + 2f(y_n)}{f'(x_n) + f'(y_n)} \cdot \frac{f(x_n)}{f'(x_n)}. \quad (3)$$

Formulae (2) and (3) are both second-derivative-free methods. So in term of practical application, they may be superior to any third-order methods requiring the evaluation of the second derivative.

Now, we consider the linear combination of formulae (2) and (3) which produces a class of new iterative method

$$x_{n+1} = x_n - \theta \cdot \frac{f(x_n) - f(y_n)}{f'(x_n)} - (1 - \theta) \cdot \frac{f(x_n) + 2f(y_n)}{f'(x_n) + f'(y_n)} \cdot \frac{f(x_n)}{f'(x_n)}. \quad (4)$$

where θ is real number and $y_n = x_n - \frac{f(x_n)}{f'(x_n)}$ is the Newton iterate. Obviously, when $\theta = 0$, formula (4) becomes (3), while we have (2) if $\theta = 1$ in (4). For (4), we have

Theorem 1. Assume that the function $f: D \subseteq \mathbb{R} \rightarrow \mathbb{R}$ has a single root $x^* \in D$, where D is an open interval. If $f(x)$ has first, second and third derivatives in the interval D , then the order of convergence of the methods defined by (4) is at least three, and the iterative method satisfies the error equation

$$e_{n+1} = (3\theta - 1)e_n^3 + [(11 - 4\theta)c_2c_3 - (5 + 4\theta)c_2^3]e_n^3 + O(e_n^4). \quad (5)$$

Furthermore, if $\theta = 1/3$, then the order of convergence of the methods at least four, and the iterative method satisfies the error equation

$$e_{n+1} = \frac{1}{3}c_2(29c_3 - 19c_2^2)e_n^4 + O(e_n^5), \quad (6)$$

where $e_n = x_n - x^*$, $c_k = \frac{f^{(k)}(x^*)}{k!f'(x^*)}$, $k = 2, 3, \dots$

Proof. Let $e_n = x_n - x^*$, and $d_n = y_n - x^*$, where $y_n = x_n - \frac{f(x_n)}{f'(x_n)}$. Using Taylor expansion and taking into account $f(x^*) = 0$, we have

$$f(x_n) = f'(x^*)[e_n + c_2e_n^2 + c_3e_n^3 + c_4e_n^4 + O(e_n^5)]. \quad (7)$$

Furthermore, we have

$$F'(x_n) = f'(x^*)[1 + 2c_2e_n + 3c_3e_n^2 + 4c_4e_n^3 + O(e_n^4)]. \quad (8)$$

Dividing (7) by (8) gives us

$$\frac{f(x_n)}{f'(x_n)} = e_n - c_2e_n^2 + (2c_2^2 - 2c_3)e_n^3 + (7c_2c_3 - 4c_2^3 - 3c_4)e_n^4 + O(e_n^5), \quad (9)$$

and so we have

$$d_n = e_n - \frac{f(x_n)}{f'(x_n)} = c_2e_n^2 - (2c_2^2 - 2c_3)e_n^3 - (7c_2c_3 - 4c_2^3 - 3c_4)e_n^4 + O(e_n^5). \quad (10)$$

Again expanding $f(y_n)$ about x^* , we obtain

$$f(y_n) = f'(x^*)[d_n + c_2d_n^2 + c_3d_n^3 + c_4d_n^4 + O(e_n^5)]. \quad (11)$$

Therefore, Substituting (10) into (11), we obtain

$$f(y_n) = f'(x^*)[c_2e_n^2 - (2c_2^2 - 2c_3)e_n^3 - (7c_2c_3 - 4c_2^3 - 3c_4)e_n^4 + O(e_n^5)]. \quad (12)$$

Furthermore, from (7) and (12), we have

$$f(x_n) + f(y_n) = f'(x^*)[e_n + 2c_2e_n^2 - (2c_2^2 - 3c_3)e_n^3 - (7c_2c_3 - 5c_2^3 - 4c_4)e_n^4 + O(e_n^5)], \quad (13)$$

and

$$f(x_n) + 2f(y_n) = f'(x^*)[e_n + 3c_2e_n^2 - (4c_2^2 - 5c_3)e_n^3 - (14c_2c_3 - 10c_2^3 - 7c_4)e_n^4 + O(e_n^5)]. \quad (14)$$

Thus, division of (13) by (8) gives us

$$\frac{f(x_n) - f(y_n)}{f'(x_n)} = e_n - 2c_2^2e_n^3 - (7c_2c_3 - 9c_2^3)e_n^4 + O(e_n^5), \quad (15)$$

and division of (14) by (13) we have

$$\frac{f(x_n) + 2f(y_n)}{f(x_n) + f(y_n)} = 1 + c_2e_n + 2c_3e_n^2 + (3c_4 - 14c_2c_3 + 7c_2^3)e_n^3 + O(e_n^4). \quad (16)$$

Therefore, from (9) and (16) we have

$$\frac{f(x_n) + 2f(y_n)}{f(x_n) + f(y_n)} \cdot \frac{f(x_n)}{f'(x_n)} = e_n + c_2^2e_n^3 + (5c_2^3 - 11c_2c_3)e_n^4 + O(e_n^5). \quad (17)$$

From (4), we have

$$e_{n+1} = e_n - \theta \cdot \frac{f(x_n) - f(y_n)}{f'(x_n)} - (1 - \theta) \cdot \frac{f(x_n) + 2f(y_n)}{f(x_n) + f(y_n)} \cdot \frac{f(x_n)}{f'(x_n)}. \quad (18)$$

Substituting (5) and (17) into (18), we obtain

$$e_{n+1} = e_n - \theta \cdot [e_n - 2c_2^2e_n^3 - (7c_2c_3 - 9c_2^3)e_n^4 + O(e_n^5)] - (1 - \theta) \cdot [e_n + c_2^2e_n^3 + (5c_2^3 - 11c_2c_3)e_n^4 + O(e_n^5)]. \quad (19)$$

Therefore, we have

$$e_{n+1} = (3\theta - 1)e_n^3 + [(11 - 4\theta)c_2c_3 - (5 + 4\theta)c_2^3]e_n^4 + O(e_n^5).$$

This means that the methods defined by (4) are at least cubically convergent for any real number θ . The proof is completed.

Furthermore, when $\theta = 1/3$, the order of convergence is four. From (19), we have the error equation:

$$e_{n+1} = \frac{1}{3}c_2(29c_3 - 19c_2^2)e_n^4 + O(e_n^5). \quad (20)$$

The proof is completed.

If we take $\theta=1/3$ in (4), we can obtain the new method

$$x_{n+1}=x_n+\frac{1}{3}\left[\frac{f(x_n)}{f'(x_n)}+\frac{f(x_n)-f(y_n)}{f(x_n)+f(y_n)}\cdot\frac{f(y_n)}{f'(x_n)}\right], \tag{21}$$

where $y_n=x_n-\frac{f(x_n)}{f'(x_n)}$ is the Newton iterate. Because the formula (21) can be viewed as the composition of Potra-Pták [2] method and Chun method [3], we call it Potra-Pták-Chun method (PPCM for simplicity).

Now, we consider efficiency index [4] defined as $p^{1/w}$, where p is the order of the method and w is the number of function evaluations per iteration required by the method. We can see that the method defined by (4) has the efficiency index equal to 1.4422 when θ is not equal to $1/3$, and the Potra-Pták-Chun method (21) has the efficiency index equal to 1.5874 when $\theta=1/3$. Therefore, both of them are better than that of Newton's method 1.4142.

3 Numerical Results

Now, we employ PPCM defined by (4) proposed in this paper to solve some nonlinear equations and compare it with Newton's method (NM), Potra-Pták method [2] (PPM) and Chun method [3] (CM). Displayed in Table 1 are the number of iterations (IT) and the number of function evaluations (NFE) required such that $|f(x_n)| < 1.E-16$.

In table 1, we use the following functions.

- $f_1(x)=2\sin(x)-x$, $x^*=1.8955$.
- $f_2(x)=(x-1)^3-1$, $x^*=2$.
- $f_3(x)=\sin(x)e^x+\ln(x^2+1)$, $x^*=0$.
- $f_4(x)=x^3+4x^2-10$, $x^*=-1.3652$.
- $f_5(x)=(x-2)^3-1$, $x^*=3$.

Table 1. Comparison of various iterative methods

Functions	x_0	IT				NFE			
		NM	PPM	CM	PPCM	NM	PPM	CM	PPCM
f_1	1	14	7	9	7	28	21	27	21
	2.1	5	3	3	3	10	9	9	9
f_2	1.5	7	56	7	4	14	168	21	12
	-3.5	11	73	13	7	22	219	39	21
f_3	2	6	4	4	4	12	12	12	12
	0.5	6	4	5	4	12	12	15	12
f_4	-0.3	54	49	55	14	108	147	165	42
	-0.5	131	8	115	12	262	24	345	36
f_5	4.5	6	4	4	4	12	12	12	12
	9.8	8	5	6	5	16	15	18	15

The computational results in Table 1 show that, as far as the numerical results are considered, for most of the cases, PPCM requires less number of function evaluations than NM. Therefore, it can compete with NM and works better than classical Newton's method.

4 Conclusion

We present a new class of Newton-type second-derivative-free method for solving non-linear equations. Based on this, we obtain a fourth-order Newton-type method which only requires three evaluations of the function and its first derivative. Analysis of efficiency shows that the new algorithm is more efficient and performs better than Newton's method.

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A Cooperative Co-evolutionary Particle Swarm Optimization Algorithm Based on Niche Sharing Scheme for Function Optimization

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Abstract. This paper proposes a novel cooperative co-evolutionary particle swarm optimization algorithm combined with niche sharing scheme to solve function optimization problem. As the core of this algorithm, niche sharing scheme strengthens diversity of population and improves the quality of individuals. In the experiment, eight benchmark functions are selected to evaluate the performance of the novel algorithm. The simulation shows that NCPSO algorithm finds the better solutions for every function than that by PSO and CPSO. Therefore, NCPSO is a more effective and efficient algorithm in comparison with PSO and CPSO.

Keywords: Cooperative Co-evolutionary approach, Particle swarm optimization, Niche Sharing Scheme, Function Optimization.

1 Introduction

In practical optimization problems, objective functions often lead to multimodal domains. If the problem has several global optima or some local optima that might be good alternatives to the global optima, it is desirable to locate some of them during search process [1,2].

Optimization has been an active area of research for several decades. In optimization problems, the objective is to find the minimum or maximum of the function. Unconstrained optimization problems can be formulated as:

$$\min(or \max) f(\vec{x}), \vec{x} = (x_1, x_2, \dots, x_D) \quad (1)$$

where D is the number of the parameters to be optimized.

Particle swarm optimizer (PSO) is one of the significant swarm intelligence algorithms widely used for solving global optimization problems, which was originally presented by Dr. Eberhart and Dr. Kennedy in 1995 [3]. Some researchers presented improved particle swarm optimizations in [4-8]. In this paper, a new intelligent optimization algorithm called cooperative co-evolution algorithm based on niche technology (NCP SO) is put forward, which is designed to cooperate with other swarms. In this niche evolutionary environment, crossover and mutation operations are involved to search optimal solution.

The remainder of the paper is designed as follows. In section 2, traditional PSO is depicted briefly. The following section 3 introduces the principle of NCP SO algorithm. Next, NCP SO algorithm is used for functions optimization. Finally, we draw a conclusion in section 5.

2 Depict of Particle Swarm Optimizer

The population of PSO is called a swarm and each individual in the population of PSO is called a particle. The particles are controlled by the following equations:

$$v_{id}(k+1) = v_{id}(k) + c_1 r_1 (p_{id}(k) - x_{id}(k)) + c_2 r_2 (p_{gd}(k) - x_{id}(k)) \quad (2)$$

$$x_{id}(k+1) = x_{id}(k) + v_{id}(k+1), (i = 1, 2, \dots, m; d = 1, 2, \dots, d) \quad (3)$$

where $i=1,2,\dots,m$, m is the number of particles in swarm; $d=1,2,\dots,D$, D is the dimension of the particle; p_{id} is the best position found by that particle so far; p_{gd} is the best position found by any particle so far; v is the velocity of particle in a single dimension; x is the position of particle in a single dimension; k is the iteration number; c_1, c_2 are acceleration constants; r_1, r_2 are random numbers evenly distributed between $[0,1]$.

3 The Proposed Cooperative Co-evolution Particle Swarm Optimizer Based on Niche Theory(NCP SO)

Niche Sharing Scheme in NCP SO algorithm. Niche sharing scheme refers to that each individual's fitness value in population is adjusted according to sharing function reflecting analogical degree between one individual and another. After that, algorithm can conduct the operation of choosing via the adjusted fitness value in order to ensure the diversity of population during the process of evolution. Like that, an evolutionary environment with niche method is created in the meantime.

Sharing function mentioned above defines analogical degree between two individuals in the form of scientific value calculated, which is given with

$S(d(x_i, x_j))$, where $d(x_i, x_j)$ refers to a certain relationship between individual x_i and x_j . The bigger the value of sharing function is, the more analogical the individuals in the population is. The sharing function $S(d(x_i, x_j))$ is depicted as follows:

$$S(d(x_i, x_j)) = \begin{cases} 1 - \frac{d_1(x_i, x_j)}{\varepsilon_1} & d_1(x_i, x_j) < \varepsilon_1, d_2(x_i, x_j) \geq \varepsilon_2 \\ 1 - \frac{d_2(x_i, x_j)}{\varepsilon_2} & d_1(x_i, x_j) \geq \varepsilon_1, d_2(x_i, x_j) < \varepsilon_2 \\ 1 - \frac{d_1(x_i, x_j)d_2(x_i, x_j)}{\varepsilon_1\varepsilon_2} & d_1(x_i, x_j) < \varepsilon_1, d_2(x_i, x_j) < \varepsilon_2 \\ 0 & \text{others} \end{cases} \quad (4)$$

Where, $d_1(x_i, x_j)$ is Euclidean distance between the encoding of individual x_i and that of x_j . $d_2(x_i, x_j)$ is the distance of fitness between individual x_i and x_j .

In order to measure the analogical degree of an individual in a population, sharing degree called S_i is defined, which is calculated through sum of the sharing function values between the individual and others with the expression is given as follows:

$$S_i = \sum_{j=1, j \neq i}^M S(d(x_i, x_j)), i = 1, 2, \dots, M \quad (5)$$

Where, M is the size of one population.

Finally, new fitness values of all individuals can be calculated according to the equation:

$$f'_i = \frac{f_i}{S_i}, i = 1, 2, \dots, M \quad (6)$$

The core of niche based on sharing scheme is to adjust the fitness values of all individuals. With this way, population's diversity can be ensured to improve the effect of algorithm's searching optimal solution.

Pseudo-code of NCPSO. Fig.1 is the pseudo-code of NCPSO.

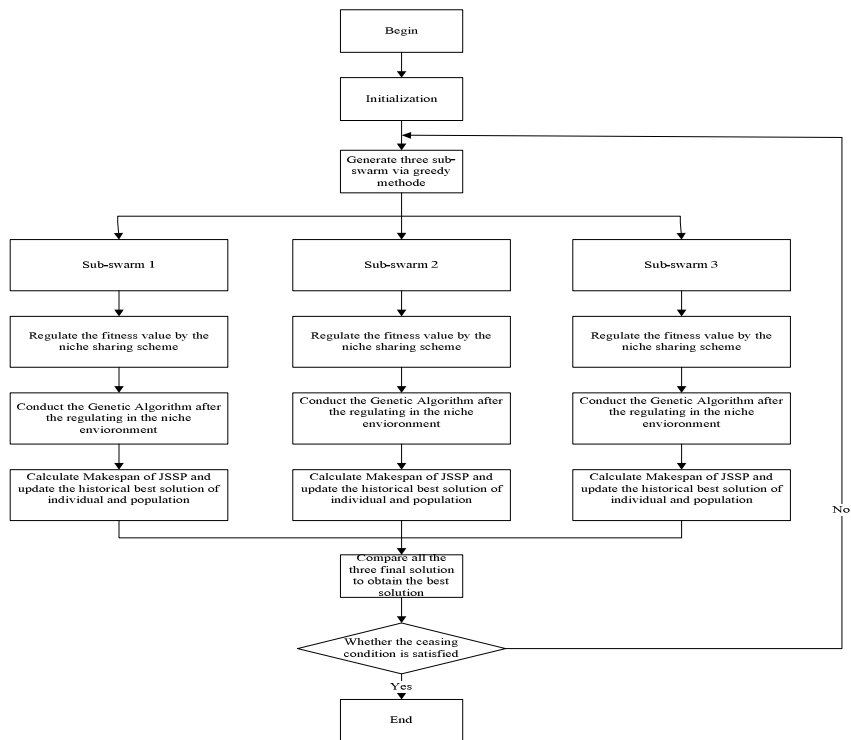


Fig. 1. The pseudo-code of NCPSO

4 NCPSO for Functions Optimization

Testing function. To illustrate the effectiveness and performance of NCPSO algorithm for optimization problems, a set of eight representative benchmark functions listed in Table 1 was employed to evaluate it in comparison with PSO and CPSO.

Table 1. Eight benchmark functions

Function number	function	feasible solution space
f_1	$f(x) = \sum_{i=1}^n x_i^2$	$x_i \in [-100, 100]$
f_2	$f(x) = \sum_{i=1}^n (\sum_{j=1}^i x_j)^2$	$x_i \in [-100, 100]$
f_3	$f(x) = \max_i \{ x_i , 1 \leq i \leq n \}$	$x_i \in [-100, 100]$
f_4	$f(x) = \sum_{i=1}^{n-1} (100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2)$	$x_i \in [-100, 100]$

Table 1. (continued)

f_5	$f(x) = -20 \exp(-0.2 \sqrt{\frac{1}{n} \sum_{i=1}^n x_i^2}) - \exp(\frac{1}{n} \sum_{i=1}^n \cos 2\pi x_i) + 20 + e$	$x_i \in [-32, 32]$
f_6	$f(x) = \frac{1}{4000} \sum_{i=1}^n (x_i - 100)^2 - \prod_{i=1}^n \cos(\frac{x_i - 100}{\sqrt{i}}) + 1$	$x_i \in [-600, 600]$
f_7	$f(x) = 10^6 x_1^2 + \sum_{i=2}^n x_i^2$	$x_i \in [-100, 100]$
f_8	$f(x) = \sum_{i=1}^n (x_i - i)^2$	$x_i \in [-100, 100]$

Experimental results and comparison. The experimental results (i.e., the mean and the standard deviations of the function values found in 10 runs) for each algorithm on each test function are listed in Table 2. To evaluate the performance of the proposed NCP SO, global version of standard PSO and CPSO are used for comparisons. All experiments were repeated for 10 runs. The parameters of PSO, CPSO and NCP SO algorithm are listed in Table 2.

Table 2. Comparison results of the PSO, CPSO, and NCP SO algorithms

F O S	GEN PS	Di m	PSO			CPSO			NCP SO		
			min	max	average	min	max	average	min	max	average
f1 0	1000 100	30	4.82E-06	3.15E-04	8.51E-05	8.67E-50	9.05E-47	1.83E-47	0	0	0
		50	4.52E-06	3.00E-04	6.98E-05	1.07E-23	2.79E-12	5.38E-13	0	1.57E-16	3.14E-17
		100	4.62E-05	5.80E-04	3.88E-04	1.0482	7.6337	3.9228	1.45E-05	2.09	0.8175
f2 0		15	0.0584	0.2617	0.1176	2.99E-38	5.09E-36	1.37E-36	0	6.67E-36	1.33E-36
		50	89.1334	91.1499	90.1416	0.001	0.0017	0.0014	5.96E-04	8.39E-04	7.17E-04
f3 0		20	0.8645	4.6425	2.1138	3.40E-24	2.49E-23	1.13E-23	0	0	0
		15	2.3568	1706.6	412.2867	0.0011	0.0028	0.0021	7.38E-04	0.4353	0.088
f5 0		20	1.94E-07	1.96E-06	6.57E-07	4.44E-15	7.99E-15	5.15E-15	4.44E-15	7.99E-15	5.15E-15
f6 0		15	9.90E-03	0.0811	0.0404	7.40E-03	0.0418	0.0251	0	0.0663	0.0344
f7 0	1000 100	30	1.40E-05	4.15E-04	1.69E-04	1.78E-50	6.39E-48	2.31E-48	0	0	0
	1000 30	30	3.80E-03	0.0462	0.021	7.35E-40	1.83E-37	3.84E-38	0	0	0
f8 0	1000 100	20	3.33E-14	4.57E-12	1.11E-12	0	0	0	0	0	0
	1000 40	40	9.62E-05	4.30E-03	1.20E-03	7.89E-31	6.65E-29	3.36E-29	0	3.32E-27	6.83E-28

Remark: In Table 2, F and Dim denote function and its dimension respectively; OS is the optimal solution; PS and GEN indicate the population size and algorithm terminate generation.

In the Table 2, the best solution of each function is marked with bold face. Three forms of results containing minimum, maximum and average solution are introduced to evaluate the quality of PSO, CPSO and NCPSO algorithm.

From Table 2, NCPSO algorithm finds the better result for each function, which indicate that this algorithm is superior to PSO and CPSO algorithm. The average solutions for f_1 with Dim=30, f_3 with Dim=20, f_7 , f_8 with Dim=20 found by NCPSO algorithm except are zero, which show that NCPSO algorithm is stable and easy to overcome premature. Also, not only the low but also high dimensional functions are optimized well by NCPSO, such as f_1 with Dim=30, 50, 100 and f_3 with Dim=20, 50. In addition, taking f_7 for example, f_7 with small PS=30 and great PS=100 can find the best solution finally, which is better than other algorithms. Therefore, the proposed novel algorithm improves the ability of searching global optimal point and is easy to jump out local solutions.

5 Conclusion

In this paper, a cooperative co-evolution algorithm based on niche technology (NCPSO) is proposed to solve functions optimization. Eight benchmarks functions are selected to be optimized using NCPSO algorithm in comparison with PSO and CPSO. Finally, the experimental results show that NCPSO algorithm is efficient and effective. Compared with PSO and CPSO, the algorithm improves the speed and capacity to find the optimal solution.

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Research on Comprehensive Evaluation of Biomass Energy Using Performance in Rural Areas

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Abstract. It is very important to save energy and to achieve emission reduction for China. On the basis of analysis of rural biomass resources utilization forms and status, a rural biomass resources use synthetic effectiveness evaluation index system is established. The comprehensive evaluation method based on nonlinear programming and NLP-ESM is constructed. Evaluation weights are converted into solving a nonlinear programming problem. The comprehensive evaluation result shows that the best choice for rural energy is methane. This evaluation result has very important reference values for the relevant decision-makers to establish rural energy and biomass resources developing planning.

Keywords: biomass resource, rural energy planning, comprehensive evaluation, exponential scale method.

Introductions

In the background of energy exhausting and ecological environment worsening, the issues of energy conservation, emissions reduction and environmental protection become more and more concern for the world. The researches relevant biomass resource utilization is flourishing. Lots of researches show that methane is a kind of very good rural energy ^[1-5]. Rural biogas project can greatly reduce the traditional energy consumption, reduce emissions, dramatically improve the economic benefits of planting and breeding industry and has very obvious social and environmental benefits. However, at present, the competitiveness of methane gas industry in rural area is very weak.

This paper fully considers the particularity of rural energy demand, and provides a scientific and comprehensive evaluation for all kinds of using patterns of biomass resource in order to achieve an economic, social, environmental and resource optimum coupling.

1 Rural Biomass Utilization Technology and Use Means

There are different ways to use biomass resources, but different USES show different advantages and utilization efficiency. Therefore, before making biomass industry planning, and determining biomass utilization ways, it is necessary to establish a

set of scientific comprehensive evaluation index system to analyze and evaluate the comprehensive efficiency of the utilization ways, make scientific rural energy development planning, so as to optimize the rural energy structures, reduce greenhouse gas emissions, increase farmers' income, improve the rural living conditions and promote rural economic and social sustainable development.

2 The Evaluation Index System of Utilization Efficiency

On the basis of on-the-spot investigation and research, according to the current situation of rural energy demand, this paper presents five kinds of biomass energy alternatives of stove burning(C1), biomass cogeneration(C2), methane(C3), ethanol(C4) and bio-diesel(C5), and construct the following utilization performance evaluation index system of rural biomass resources shown in Fig.1:

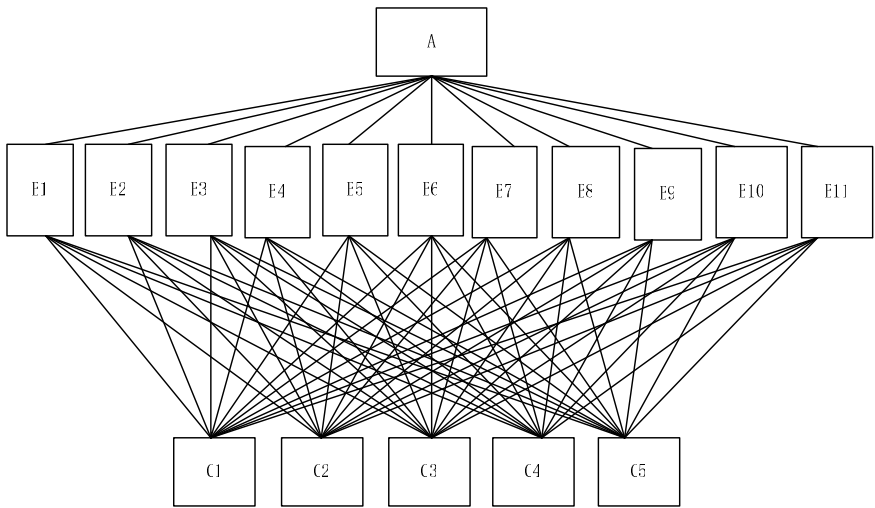


Fig. 1. The evaluation index system of rural biomass resources use efficiency

Where, A: rural biomass resources comprehensive evaluation target; B1: energy price; B2: investment payoff period; B3: Raw material costs; B4: Energy alternative;B5: Policy support; B6: Technology maturity; B7: Raw material obtains; B8: Promoting employment; B9: Farmers' income; B10: Greenhouse gas emission; B11: Resource recycling utilization rate; C1~C5 stand for five kinds of alternatives.

3 Evaluation Methodology

AHP is one of the most typical qualitative and quantitative integrated system engineering methods, and is widely used in various complex comprehensive evaluation problems. Scale system is the conversion foundation of AHP method from qualitative to quantitative. Exponential scale method (ESM) and 1-9 scale method are

the most common scale methods. The latter often appears inconsistent circumstance between judgment matrix and critical thinking. With many excellent properties and accord with Weber-Fechner psychology law, ESM is approved widely and highly praised. The key problem of ESM application is how to construct the sorting weights of reasonable subjective judgment matrix S and objective distinction judgment matrix O . Therefore, exponential scale method is adopted to construct a kind of NLP - ESM evaluation method in this paper. The (0,2) scale method is applied to construct the subjective judgment matrix S , and then the consistency problem of the objective matrix is transformed into a nonlinear optimization problem, which can be solved by LINGO.

Suppose the index system contains three layers named A, B, C; layer A is evaluation goal, layer B contains n indexes, and layer C contains m evaluating schemes. The modeling process of NLP-ESM is as follows:

Step 1: With layer A as criterion, the indexes in layer B are pair wise contrasted. The (0,2) scale method is applied to construct matrix $S = \{s_{ij} \mid i, j = 1 \sim n\}$, where,

$$s_{ij} = \begin{cases} 2, & \text{index } i \text{ more important than index } j \\ 1, & \text{index } i \text{ equally important than index } j \\ 0, & \text{index } i \text{ less important than index } j \end{cases}$$

Step 2: Transforming matrix S into matrix O . Calculating the importance sorting

index value $r_i = \sum_{j=1}^n s_{ij}, i = 1 \sim n$, then matrix O can be obtained:

$O = \{o_{ij} \mid i, j = 1 \sim n\}$, where, $o_{ij} = a^{r_i - r_j}$, $a(a > 1)$ is the objective importance ratio of the adjacent two-level.

Step 3: Optimizing a through LINGO, and then calculating the sorting weights $w_i, i = 1 \sim n$. According to the definition of judgment matrix, the following the equation can be obtained: $o_{ij} = w_i / w_j (i, j = 1 \sim n)$. If the judgment matrix O can satisfy the equations above, then O has complete consistency. So,

$$\sum_{k=1}^n (o_{ik} w_k) = \sum_{k=1}^n (w_i / w_k) w_k = n w_i, (i = 1 \sim n), \sum_{i=1}^n \left| \sum_{k=1}^n (o_{ik} w_k) - n w_i \right| = 0.$$

Obviously, $\sum_{i=1}^n \left| \sum_{k=1}^n (o_{ik} w_k) - n w_i \right| = 0$, the smaller the value left, the higher

consistency degree is. If the equation equal to 0, then matrix O has complete consistency. Based on this, the single sorting and consistency test of each index in layer B can be summed up the nonlinear optimization problem as formula (1):

$$\begin{aligned} \min CIF(n) &= \sum_{i=1}^n | \sum_{k=1}^n (o_{ik} w_k) - n w_i | / n \\ s.t. & \sum_{k=1}^n w_k = 1, w_k > 0 (k = 1 \sim n) \end{aligned} \quad (1)$$

Where, $CIF(n)$ is consistency function, and the sorting weights $w_k (k = 1 \sim n)$ and the ratio parameter a are optimization variables. If $CIF(n) < 0.1$, then we can think matrix O has satisfactory consistency, and the variables can be acceptable.

Similarly, the single sorting weights $w_{ci}^k (i = 1 \sim m)$ and consistency function $CIF^k(m) (k = 1 \sim n)$ layer C relative to layer B can be determined. If $CIF^k(m) < 0.1$, then we can think matrix O has satisfactory consistency, and the single sorting weights w_{ci}^k can be acceptable.

Step 3: Calculating the total sorting weights of evaluating schemes in layer C and testing the consistency. $w_{ci}^A = \sum_{k=1}^n w_k w_{ci}^k (i = 1 \sim m)$, $CIF^A(m) = \sum_{k=1}^n w_k CIF^k(m)$. The bigger the value of w_{ci}^A is, the better the NO. i scheme is. According to w_{ci}^A , the performance ranks of the schemes can be sorted.

4 Biomass Resources Use Efficiency Evaluation

The evaluation results can be obtained through Delphi method, Matlab7.0 and LINGO11.0. The importance ranking index vector of each index in S^A is: $R = (11, 4, 11, 14, 12, 4, 19, 4, 4, 19, 19)$, and the optimization result is that when the ratio parameter $a = 1.2026$, the consistency function value $CIF = 6.751 \times 10^{-6} \ll 0.1$, and the sorting vector is:

$$w = (5.22, 1.43, 5.22, 9.08, 6.28, 1.43, 22.83, 1.43, 1.43, 22.83, 22.83) \times 10^{-2}$$

Similarly, the single sorting weights of each scheme in layer C can be obtained as follows:

Table 1. Single sorting weights of each scheme

	S^{B_1}	S^{B_2}	S^{B_3}	S^{B_4}	S^{B_5}	S^{B_6}
w_{c1}	0.0902	0.3716	0.3716	0.0414	0.0591	0.3904
w_{c2}	0.2453	0.1236	0.1236	0.3732	0.2598	0.1700
w_{c3}	0.1643	0.2576	0.2576	0.3732	0.4259	0.2576
w_{c4}	0.2995	0.1236	0.1236	0.1061	0.1585	0.0910
w_{c5}	0.2007	0.1236	0.1236	0.1061	0.0967	0.0910
α	1.2215	1.2013	1.2013	1.3695	1.2802	1.2312
$CIF (\times 10^{-6})$	6.3936	4.7654	4.7654	3.4697	6.5103	5.3089
	S^{B_7}	S^{B_8}	S^{B_9}	$S^{B_{10}}$	$S^{B_{11}}$	
w_{c1}	0.3082	0.1312	0.1312	0.0797	0.0973	
w_{c2}	0.1769	0.2364	0.2364	0.1672	0.0973	
w_{c3}	0.3082	0.1596	0.1596	0.3507	0.3810	
w_{c4}	0.1222	0.2364	0.2364	0.2012	0.2122	
w_{c5}	0.0845	0.2364	0.2364	0.2012	0.2122	
α	1.2031	1.1031	1.2032	1.2036	1.2152	
$CIF (\times 10^{-6})$	3.6480	0.2341	0.2341	0.7090	1.3817	

From the results above, we can see that the consistency function values of index layer and scheme layer are far less than 0.1, so, we can draw a conclusion that each objective distinction judgment matrix has very high consistency and the sorting weights have very high reliability.

According to the method above, the total sorting vector of the schemes relative to target layer is: $w_c^A = (0.1570, 0.1812, 0.3330, 0.1738, 0.1560)$, the consistency function value is 2.7673×10^{-6} . The evaluation result is: methane(C3) > cogeneration(C2) > ethanol(C4) > stove burning(C1) > bio-diesel(C5).

5 Conclusions

It becomes more and more urgent to plan for the rural energy construction. This study focuses on biomass resource utilization ways of rural biomass resources to meet the demand for energy in rural areas. Biomass energy can meet the growing energy needs in rural areas. Five kinds of utilization modes are concerned on in this paper. Biomass resource development planning should give priority to of methane gas industry in rural areas. Meanwhile, the raw material collecting channel, biogas production mode and service system for biomass resource should be established as soon as possible. The government should further intensify the support for rural biogas industry from financing, taxation, land supply etc. In fact, biomass resources can be applied through other ways. In the future, we will carry on further investigation on it.

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A Shooting Algorithm Based on the Best Zone and Dynamic Referencing Circle for Soccer Robot

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Abstract. To improve the shoot success ratio of soccer robot in a robot soccer match, an improved shooting algorithm is proposed on the basis of deeply analyzing shortcomings of the basic shooting algorithm-- the shooting algorithm based on the zone and dynamic referencing circle. The best shooting point is selected reasonably by introducing the concept of the best shooting zone. Simultaneously, using the dynamic referencing circle optimizes moving path which makes the robot smoothly transit to the shooting point by the approximate Archimedean axiom, then the ratio of successful shooting has been improved evidently by the direct shooting. The result of simulation shows this algorithm validity.

Keywords: robot soccer, shoot algorithm, dynamic referencing circle, the best shooting zone.

1 Introduction

In recent years, the robot soccer has become popular research subject in the emerging artificial intelligence research area[1], it involves robot control, wireless communication, real-time vision system and machine learning and so on[2]. The robot soccer game carries on under one real-time, continual and dynamic environment; therefore, the robot soccer game becomes a standard test platform in order to study the multi-agent system [3, 4].

In the paper an improved shooting algorithm is proposed on the basis of deeply analyzing shortcomings of the basic shooting algorithm, namely the shooting algorithm based on the zone and dynamic referencing circle. The best shooting point is selected reasonably by introducing the concept of the best shooting zone, simultaneously, using the dynamic referencing circle optimizes moving path which makes the robot transit to the shooting point by the approximate Archimedean axiom smoothly, then the ratio of successful shooting has been improved clearly by the direct shoot. The result of simulation shows this algorithm validity.

2 The Base Shooting Algorithm

The basic shooting algorithm of soccer robot is shown in figure 1, the distribution of the algorithm can be shown as follows.

Step 1: the shooting point A of robot R, its formula can be defined as follows:

$$\theta = \arctan \left| \frac{Y_G - Y_S}{X_G - X_S} \right|. \quad (1)$$

$$X_A = X_S - K \times \cos \theta. \quad (2)$$

$$Y_A = Y_S - K \times \sin \theta. \quad (3)$$

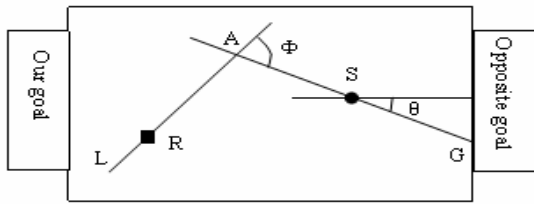


Fig. 1. The basic shooting algorithm of soccer robot

Where, (X_G, Y_G) is the coordinate of opposite goal central point G, (X_S, Y_S) is the coordinate of soccer S, (X_A, Y_A) is the coordinate of shooting point A, K is constant, its value should be equal to or bigger than the sum of the robot radius and the soccer radius.

Step 2: robot R moves to shooting point A;

Step 3: adjust the shooting angle of robot R;

Step 4: robot R shoots;

Step 5: If robot R shoots successfully, then finished, otherwise, transferred Step 1.

Obviously, the basic shooting algorithm is simple and realizes easily, but during the entire process robot R needs to experience the multiple acceleration and deceleration process, meanwhile it must adjust the shooting angle, thus the shooting robot will bungle a military opportunity for increasing the shooting time, even it will bump into the ball or occurrence the situation of “the own goal”.

3 An Improved Shooting Algorithm

The Shooting Algorithm Based on Dynamic Referencing Circle. We improve firstly moving path of robot shoot on the basis of analyzing shortcomings of the basic shooting algorithm in the paper.

The distribution of the improved shooting algorithm is shown in figure 2. Where G is shooting point, R is shooting robot, S is the position of the soccer, r is circle o radius, spot S is tangential point of circle o and the straight line SG, spot M is tangential point of circle o and the straight line RM. Radius r changes along with the change of the angle $\angle GSR$, in order to cause moving path of the robot R to be short

and smooth, in order to cause the shoot success ratio to be quite high too, the definition formula of Radius r can be shown as follows.

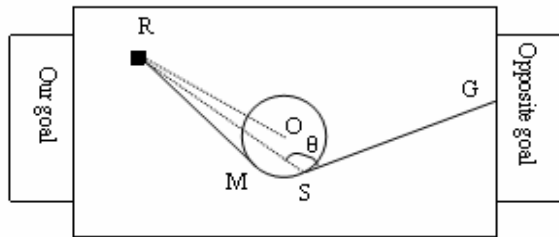


Fig. 2. The shooting algorithm based on dynamic referencing circle

$$r = 3a \times \left| 1 + \tan \frac{\theta}{2} \right|. \quad (4)$$

Where θ is the angle $\angle GSR$, a is Robot's length.

Obviously, the robot moving path is not a straight line, but the approximate Archimedes axiom.

The distribution of the algorithm based on dynamic referencing circle can be shown as follows.

Step 1: the initialization of the algorithm;

Step 2: The robot calculates radius r and the center of circle coordinate (x_0, y_0) by formula (4) according to its position;

Step 3: When robot R locates the inside of dynamic referencing circular arc, the robot makes the arc motion after R to S ;

Step 4: When robot R locates the outside of dynamic referencing circular arc, the robot makes the accelerated motion after R to M to reach the new position, then changes step 2;

Step 5: The robot arrives at point s and shoots vigorously;

Step 6: The algorithm changes step 2 if the robot shoots unsuccessful;

Step 7: the end of the algorithm.

The Shooting Algorithm Based on the Best Shooting Zone. The distribution of the algorithm based on the best shooting zone is shown in figure 3, our shooting robot is $R(x_r, y_r)$, opposite goalkeeper is $R_g(x_g, y_g)$, soccer is $S(x_s, y_s)$. The current time is t , the soccer makes the straight line moving after shooting robot R shoots, supposed the shooting robot R arrives at opposite goal line P_1P_2 in the t' time and intersects point K with P_1P_2 , the moving distance of opposite goalkeeper R_g is l in the time section $(t'-t)$, Namely the moving scope is $S_1(x_g, y_g + l) \sim S_2(x_g, y_g - l)$, thus the dashed line P_1B, P_2B, S_1B, S_2B will devise shooting zone into three different zones of I, II, III Number. If our robot R shoots in I number zone and opposite goalkeeper can judge the direction correctly, soccer will be intercepted fully possibly; If our robot R shoots in III number zone, the shooting can defeat because the soccer shoots outside opposite goal line P_1P_2 ; If our robot R shoots in II number zone, opposite goalkeeper will block

the soccer unsuccessfully because the time is insufficient, even if he can judge the direction correctly. Therefore, II number zone is the best shooting zone for our robots.

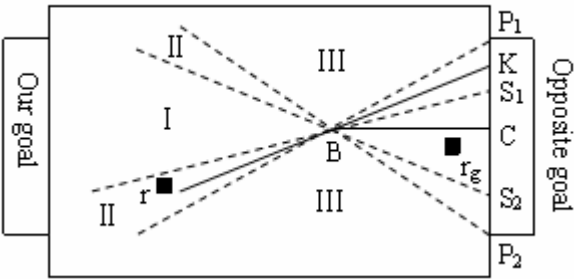


Fig. 3. The shooting algorithm based on the best shooting zone

Supposed the abscissa of the goal line is x , BC is perpendicular line of the goal line, BK is moving path of the soccer, clamp angle of BK and x axle is θ , thus shooting distance is $BK = \frac{|x - x_b|}{\cos \theta}$ and shooting time is $\Delta t = t' - t$, After robot R shoots, the soccer makes the uniform deceleration line movement, supposed the initial speed is v , therefore, we suppose that soccer makes the uniform rectilinear movement because shooting distance is very short.

$$\Delta t = \frac{BK}{v} = \frac{|x - x_b|}{v * \cos \theta} . \tag{5}$$

Moving distance of opposite goalkeeper is $s \leq v_{\max} * \Delta t$ in Δt time, its distance must satisfy the following relations in order to shoot successfully:

$$|y_k - y_g| > s_1 \text{ or } |y_g - y_k| > s_2 . \tag{6}$$

If opposite goalkeeper R_g is underneath the goal line, shooting to the goal line P_1S_1 gets to success easily; otherwise, opposite goalkeeper R_g is above the goal line, shooting to the goal line P_2S_2 gets to success easily.

4 Simulation Results

In order to confirm this algorithm is feasible, using MATLAB carries on the simulation experiment separately to the basic shooting algorithm and the shooting algorithm based on dynamic referencing circle, the result of experiment can be shown as table 1.

Table 1. The Result of Experiment

algorithm	the total number of shooting	the number of scoring	the number of defeating	success ratio
the basic shooting algorithm	300	173	127	56.67%
the shooting algorithm based on dynamic referencing circle	300	214	86	71.33%

It can be shown from table 1, the shooting algorithm based on dynamic referencing circle surpasses obviously the basic shooting algorithm because of optimizing the robot moving path and reasonably selecting the best shooting target point, therefore, the shoot success ratio is quite high.

5 Summary

In the paper the improved shooting algorithm is proposed to optimize the shooting path which looks like the Archimedes axiom, simultaneously the algorithm selects the best shooting zone and the best shooting point because of considering opposite goalkeeper's position and the state of motion, thus the shooting success ratio can get the effective enhancement.

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The Mixing Characteristics of a Transverse Jet under Different Reynolds Number and Velocity Ratio

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Abstract. In order to study the mixing characteristics of a lateral jet issuing into crossflow, a flow-visualization based experimental setup was built. A phase tunable laser and CCD system was employed to investigate the structure of the flow field of a lateral jet issuing into crossflow under different jet to crossflow velocity ratio and under different Reynolds number. The central trajectory and the spread width are obtained through the calculation of the matrix of the gray data. Experimental results showed that the larger jet to crossflow velocity ratio resulted in deeper penetration depth, yet it is not the greater access to the spread width, but there is an optimized jet to crossflow velocity ratio to obtain the largest spread width.

Keywords: lateral jet, central trajectory, spread width.

1 Introduction

LJICF(Lateral Jet In Cross-Flow) is widely exist in industry, such as the sewage disposal of chemical plant, the problem of cross-pipe hybrid diffusion in chemical equipment, the tail of the chimney of boiler in power plant ,the dust pollution problem of urban construction [1]. LJICF is an old but novel hydrodynamics problem, and many experimental studies have been reported previously. There are many overseas research works, such as, Kelso et al. [2] adopted the flow visualization technology and hot-wire anemometer to study the flow field and the development of vortex system of LJICF circular vents, results showed that the converse vortex pair led the mixing between the jet fluid and cross-flow fluid. Desantes et al. [3] studied the slope and the diffusion mixing characteristics of the gas-liquid lateral jet in crossflow, indicating that the slope and the diffusion mixing characteristics of the gas-liquid phase jet is similar with gas phase jet. Margason et al. [4] and Karagozian et al. [5] presented a good review about LJICF. In China, Guo et al. [6] investigated the flow distribution of JICF in circular vents using hot-wire anemometer, and revealed the effect of the jet angle on the vortex movement. Li et al. [7] explored the central trajectory of jet in LJICF circular vents and the vortex structures using particle image velocimetry, and obtained the effect of virtual quality sources on the development of vortex. Li et al. [8] studied airflow inclination and the characteristics of vortex system evolution of LJICF by using the method of numerical simulation.

The previous research works have been carefully examined center trajectories and the characteristics of vortex development. However, previous works concerning the jet extension of the width is rare. Salzman et al. [9] explored the particle dispersion characteristics of the gas-liquid lateral jet by using fluid sampling. Unfortunately, none of above studies focused on jet spread width. In practical application of LJICF, except considering the penetration depth of jet, the spread width is also should be considered. In this work, the flow distribution structures of a lateral jet in crossflow based on smoke particle tracer and CCD-laser technology are presented. The change law of central trajectory and spread width of LJICF with jet-to-crossflow velocity ratio and Reynolds number are shown and discussed.

2 Experimental System

The scheme of experimental system of LJICF is shown in Fig.1. LJICF is composed by a square crossflow tunnel and a circle jet nozzle. The dimension of the cross section of organic glass crossflow tunnel is 50mm×50mm, and its height is 600mm, and it is settled vertically. A stainless steel rectifier layer is installed in the cross section above the bottom about 80mm, whose thickness is 1mm and the rate of porosity is 0.76. Another two rectifier layers are also installed above to obtain the evenly flowing crossflow. The lateral jet is ejecting from circular vents to crossflow, and it settled in the central of a side which is 300mm above the bottom of quadrate crossflow tunnel, and the inner diameter of the jet d is 6 mm. The entering depth of the jet is 30mm. Professional black paint of the jet vent is carried out to prevent the reflecting effect.

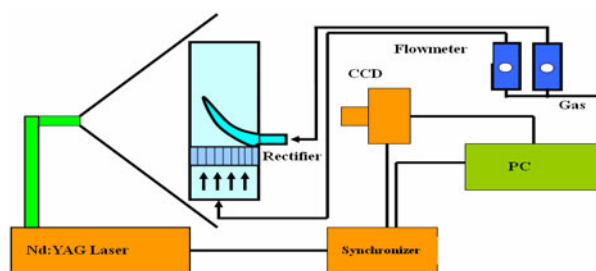


Fig. 1. Sketch map of the experimental system of a lateral jet issuing into crossflow

The working substance of crossflow and jet are both air, the flow rate is controlled by two glass rotor flowmeters, their precisions are 6% and 4% separately. The laser adopted Nd: YAG pulsed laser, whose maximum pulse energy is 200 mJ, and the maximum operating frequency is 15 Hz. The resolution of CCD is 1920×1080. The cooperative work between laser and CCD is controlled by MicroPulse 725 synchronizer. Tab.1 shows the experimental cases. Q_c that in tab.1 stands for the flow rate of crossflow, Q_j stands for the rate of jet flow, and r is the jet-to-crossflow velocity ratio, Re is the Reynolds number which is based on jet velocity and cross-flow dimensions.

Table 1. Experimental cases of a lateral jet issuing into crossflow

No.	Q_c (ml/s)	Q_i (ml/s)	r	Re
1	556	25	4.0	2 947
2	833	25	2.7	2 947
3	1110	25	2.0	2 947
4	1110	50	4.0	5 895

3 Experimental Results and Discussions

The center trajectory change law of the experimental cases in table 1 is shown in Fig.2. The jet-to-crossflow velocity ratio seriously affected the jet penetration depth, and as the system Reynolds number changed, the jet penetration depth of the system differs somewhat under the same velocity ratio. When the Reynolds number equals 2947, the working condition of $r=4.0$ resulted in the penetration depth $y=8.5d$ in $x/d=1.5$, while the working condition $r=2.7$ resulted in the jet penetration depth $y=3.8d$, and the working condition of $r=2.0$ resulted in the jet penetration depth $y=2.8d$. The largest jet penetration depth is three times as the minimal, therefore, in the condition of fixed jet mass flow rate and jet spout diameter, the crossflow velocity should be improved to reduce the jet-to-crossflow velocity ratio in pollution diffusion system. When Reynolds number changes from 2947 to 5895, and in the plane of $x/d=1.5$, the working condition of $r=4.0$ resulted in jet penetration depth $y=3.8d$, which equaled to that of the case with Reynolds number of 2947 and jet-to-crossflow velocity ratio of 2.7. In other words, if the Reynolds number keeps constant, different jet-to-crossflow velocity ratios cause different jet penetration depth. Yet, when Reynolds number changes, situation is different. The case with jet-to-crossflow velocity ratio of 4.0 resulted in a jet penetration depth of $8.5d$ while the Reynolds number changed to 5895, the corresponding penetration depth is $3.8d$, and so the former is 2.24 times as the latter. It revealed that the jet deflection characteristics were affected by lots of factors, and jet-to-crossflow velocity ratio and Reynolds number are two important parameters.

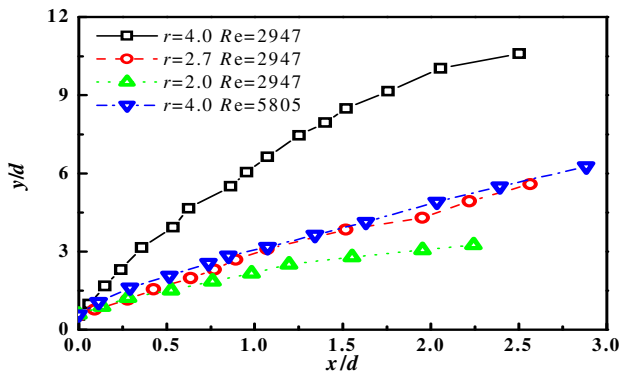


Fig. 2. Change law of the central trajectory of a lateral jet issuing into crossflow

For mixed diffusion systems, the jet penetration depth mentioned above is an important system parameter. However, when inspecting the system's diffusion characteristics, jet spread width is another important system parameter. Jet spread width w needs to be defined. Few literatures concerns this issue, only literature [9] defined the spread with as the distance between a series of two points, which has a particle concentration of 30% of the highest concentrations. In this work, the following definition was used: along jet penetration depth direction, there exists a point with a biggest grey value, which has been used to define central trajectory. In the other hand, there are two horizontal points has a grey value of 15% of the biggest grey value, then the distance between this two points defined as jet spread width. Therefore, the obtained results are shown in Fig 4. As shown in Fig.3, in all working conditions, the jet flow spread with reduced slightly first, then rapidly increased, and finally decreased sharply. When Reynolds number equals 2947, the cases of $r=4.0$, $r=2.7$ and $r=2.0$ resulted in a series of biggest jet spread width of $w=2.4d$, $w=3.3d$ and $w=1.8d$. The biggest jet spread width's position in turn is $y=7.5d$, $y=3.3d$ and $y=2.5d$. For the mixing perspective, the $r=2.0$ working condition's jet spread width is small, while the $r=4.0$ working condition's jet spread width is much larger, and the $r=2.7$ working condition's jet spread width is largest, indicating it has good mixing characteristic. In addition, Fig.4 showed that when Reynolds number is 5895, the $r=4.0$ working condition's jet spread width is similar to that with Reynolds number of 2947 and $r=2.7$. This revealed that the optimized jet-to-crossflow velocity for largest spread with is different in different Reynolds number, and that it is not the greater access to the spread width, but there is an optimized jet to crossflow velocity ratio to obtain the largest spread width.

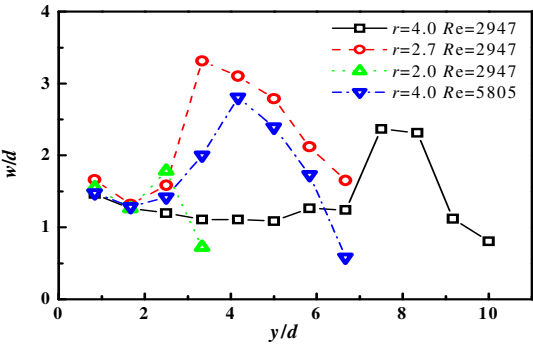


Fig. 3. Change law of the spread width of a lateral jet issuing into crossflow

4 Summary

Adjustable synchronous laser visualization technology was adopted to investigate the blending and mixing characteristics of a lateral jet issuing into crossflow. Following conclusions were drawn.

(1) When the Reynolds number is fixed, the greater jet-to-crossflow velocity ratio obtains deeper jet penetration depth, yet it is not the greater access to the spread width, but there is an optimized jet to crossflow velocity ratio to obtain the largest spread width.

(2) When the Reynolds number is different, the same jet-to-crossflow velocity ratio results in different jet penetration depth, and the optimized jet-to-crossflow to obtain largest jet spread width is also different.

(3) The blending and spreading characteristics of a lateral jet issuing into crossflow is complex, and they are affected by a lot of factors, among those the jet-to-crossflow velocity ratio and the Reynolds number are two important parameters.

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Numerical Simulation on the Complex Flow Mechanism for PEMFC's Porous Electrode

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Abstract. The integrated 3-D percolation model is proposed for the study of proton exchange membrane fuel cell (PEMFC). The method of finite element is employed to numerical simulate of the model and study the transport phenomenon within the cell. Several physical and chemical processes such as fluid flow, heat transfer, electrochemical kinetics and multi-component delivery are taken into consideration. The whole cell structure, consisting of bipolar plates, gas flow channel, diffusion layer, catalyst layer and proton exchange membrane are studied in the model. The different nature of the layer structure is reflected by corresponding physical parameters; therefore, by solving transport equations and coupled electrochemical dynamic equations, the concentration distribution of reactants within cell is acquired. Furthermore, after analyzing the internal mechanism of this distribution and its impacts on cell performance, the optimizing and higher efficiency design can be realized for the PEMFC by refer to this paper.

Keywords: Flow mechanism, Finite element method (FEM), Porous electrode, PEMFC.

1 Introduction

Fuel cells offer a high-efficiency energy conversion technology to the ever-increasing demand for environment friendly energy generation and now have many potential applications. Thus fuel cells are gaining importance in an energy conscious world. Fuelled by hydrogen, PEMFC is a clean and efficient green power, possessing all the merits of low working temperature, fast start, high specific power, simple structure and easy operation. Hence it has gradually gained the most attention among low-carbon energy-supply technologies in recent years. Through the electrochemical reaction, it directly turns the chemical energy of fuel into electricity. Since the hydrogen and oxygen reaction processes do not involve combustion and the Carnot's principle is avoided, it can achieve a very high energy conversion rate in theory.

A 3-D, comprehensive, steady-state mathematical model have been set up. The transport phenomena occur in the whole fuel cell is described by the generalized equation, and different physical parameters and source terms are employed for different layers. The flow characteristics, distributions of temperature, potentials, and chemical components are obtained by resolving the transport equation set and coupling the electrochemical kinetics equations.

The growing interest in utilizing fuel cells has driven researchers to solve many problems and to improve materials such as porous electrodes. The performance of the PEMFC is decided by several factors such as the platinum loading, cell design, composition of the electrode materials, type and thickness of membrane and electrode structure. Among them, the porous electrode is energy converter and its performance determines the working efficiency of PEMFC. Therefore, simulation study on the complex flow mechanism of porous electrode will provide theoretical references for improving the unit apparent area of electrode reaction rate, reducing the true current density in electrodes, increasing active material's utilization and decreasing energy loss in the cell. Although 1-D, 2-D and 3-D simulation have been practiced in a large amount so far [1-6], reasonable numerical-simulation work should be carried out for necessity to get a deeper understanding of the internal transport mechanism of PEMFC and its impacts on cell performance. However, up to now, it remains to be a challenging job [7-15].

This paper aims to present a new 3-D mathematical model of PEMFC [13], for acquiring the concentration distribution of reactants within the porous electrode. Finally, by examining their impacts on cell performance and efficiency, it provides a reference for the design and optimization of PEMFC.

2 Model Building

Usually, the monomer of PEMFC is composed of the anode, cathode and proton exchange membrane. To be more specific, it can be divided into seven parts as the Fig. 1a presents. From left to right, they are anode bipolar plate, anode gas flow channel, anode diffusion layer, anode catalyst layer, proton exchange membrane, cathode catalyst layer, cathode diffusion layer, cathode gas flow channel and cathode bipolar plate. The overall spatial structure of the cell model can be seen in the Fig. 1b. The cell stack is piled up by a number of single cells in series combination, in which bipolar plate and MEA piled alternately. The plates of a single cell are engraved with many flow channels to supply reactants and remove resultants. Taking the cell's characteristics of repeatability in the z direction into account, only one channel is selected to calculate.

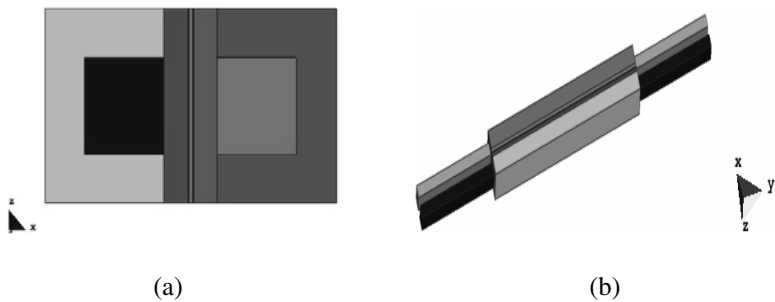


Fig. 1. (a) schematic diagram of the model's cross-section xz and locations of each part (b) schematic diagram of the overall spatial structure of the model.

The finite element method [12,13] adopted for model building is of high accuracy and strong adaptability. As a highly effective numerical analysis method, FEM is widely used in heat transfer, electromagnetic field, fluid dynamics and other continuity problems. The mathematical model in this paper applies the following assumptions: the cell is operating in steady state; the gas mixture is ideal gas; water flows in the form of gas, ignoring the volume occupied by liquid water; fluid flow in PEMFC is laminar; the flow channel is long enough, i.e., fluid in the outlet is fully developed; electrochemical kinetics is controlled by the Butler-Volmer equation [6]; diffusion layer, catalyst layer and proton exchange membrane are porous media which have the same nature of different faces.

Model Equations. Model equations of PEMFC include five categories, namely, the mass conservation equation, the momentum conservation equation, the material conservation equation, the temperature control equation and the potential control equation. Their specific function expressions [6,15], respectively, are as follows:

$$\nabla \cdot (\rho \phi \mathbf{u}) = S_m. \quad (1)$$

$$\nabla \cdot (\rho \phi \mathbf{u} \mathbf{u}) = -\phi \nabla p + \nabla \cdot (\rho \mu_{eff} \nabla \mathbf{u}) + S_u. \quad (2)$$

$$\nabla \cdot (\phi \mathbf{u} \mathbf{C}_k) = \nabla \cdot (D_{k,eff} \nabla \mathbf{C}_k) + S_k. \quad (3)$$

$$\nabla \cdot (\lambda_{eff} \nabla T) = \nabla \cdot (\phi \rho \mathbf{C}_p \mathbf{u} T) + S_T. \quad (4)$$

$$\nabla \cdot (\sigma_{e,eff} \nabla \Phi_e) + S_{\Phi_e} = 0. \quad (5)$$

$$\nabla \cdot (\sigma_{s,eff} \nabla \Phi_s) + S_{\Phi_s} = 0. \quad (6)$$

In the equations, Φ stands for the porosity of porous medium; ρ and $\mathbf{u}$ separately stand for the density and the intrinsic velocity vector of fluid; S_m is the mass source term, it equals to the sum of variation including reactants and resultants in the catalytic reaction layer, and zero at others; p and μ_{eff} respectively refer to the pressure of fluid and the effective viscosity coefficient; S_u is the source term of the momentum equation; λ_{eff} is the effective thermal conductivity; $D_{k,eff}$ is the effective diffusion coefficient of component k ; C_k is the molar concentration of component k ; S_k is the increase or decrease speed of the chemistry component in the electrochemistry reaction within the catalytic reaction layer; $\sigma_{s,eff}$ and $\sigma_{e,eff}$ separately stand for the effective conductivity of the carbon phase and membrane phase; Φ_e and Φ_s respectively are membrane phase and carbon phase potential; S_{Φ_e} and S_{Φ_s} separately refer to the gain or loss speed of the proton and the electron in the electrochemistry reaction; T indicates the temperature; C_p is the specific heat

of constant pressure; S_T express the heat quantity from the ohm, reversible, activate and polarization heating effect.

Table 1. The operating conditions and basic physical parameters of the cell

the length of the cell	[cm]	2.5
the width of the cell	[cm]	0.2
the width of the ABL	[cm]	0.05
the width of the AGC	[cm]	0.1
the width of the ABL	[cm]	0.03
the width of the ACL	[cm]	0.001
the width of the MEM	[cm]	0.005
the width of the CCL	[cm]	0.001
the width of the CBL	[cm]	0.03
the width of the CGC	[cm]	0.1
the width of the CBL	[cm]	0.05
cell voltage	[V]	0.9
anode inlet pressure	[kPa]	100
cathode inlet pressure	[kPa]	100
H2 percentages at anode inlet /Molar fraction		1.0
O2 percentages at cathode inlet /Molar fraction		0.21
cell temperature	[K]	353.15
anode water saturation temperature	[K]	353.15
cathode water saturation temperature	[K]	353.15
cathode inlet relative humidity		1.0
stoichiometry number of anode		3.0
stoichiometry number of cathode		3.0
constant current density applied	[A/cm^2]	0.3

Boundary Conditions. At the endpoint of y value, all the variables use periodic boundary conditions. Suppose that hydrogen is zero on the interface which is between membrane and cathode catalytic layer, and oxygen is zero on the interface which is between membrane and anode catalytic layer. Because the area of calculation is unified, we needn't to use boundary conditions no matter which interstratified interface it is. Besides, the parameter of interface must be taken into account particularly. In the inlet of channel, the parameters of gas mixture are limited to the first boundary conditions, and in the outlet, it is assumed to be long enough. Boundary conditions of all potential equations about electrolyte adopt Neumann equations entirely.

For the solution of each component equation, the selected calculation domain is restricted in the place where component exists. Because of heat equation and chemical composition transfer equation, the source item and electrochemical kinetics equation are coupled. Therefore, we must use iterative method which can make all variables in convergence.

3 The Concentration Distribution of Components and Related Analysis

In the process of solving this mathematical model, major cell parameters and basic operating conditions are shown in Table 1. Some other physical property parameters can be found in the references, such as Bernardi's [1], Argyropoulos's, Gurau's, Um's et al [5].

It is meaningful to find out the concentration distributions of reactants, particularly the ones of hydrogen and oxygen within the porous electrode's diffusion layer and catalyst layer. The concentration distributions determine the cell's response rate and its local current density, which will eventually have a huge impact on the cell's working efficiency. Fig. 2a and 2b, respectively, represent the molar concentration distribution of hydrogen and oxygen within interface between diffusion layer and catalyst layer. It can be seen from the figures that the concentration of reactants in direction z is symmetrically distributed. Since the molar concentration of hydrogen and oxygen near the channel inlet is larger, the reaction occurrence is faster as well as the speed of concentration decrease along the flow direction, according to the reaction kinetics. However, when it comes to the middle point, the large drop of reactants' concentration leads to a slow-down of reaction kinetics. Therefore, the variation in concentration is less obvious in the later stage.

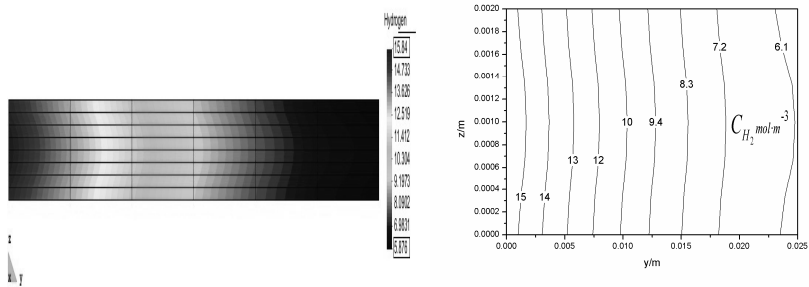


Fig. 2. (a) The concentration distribution of hydrogen on the interface between catalyst layer and diffusion layer.

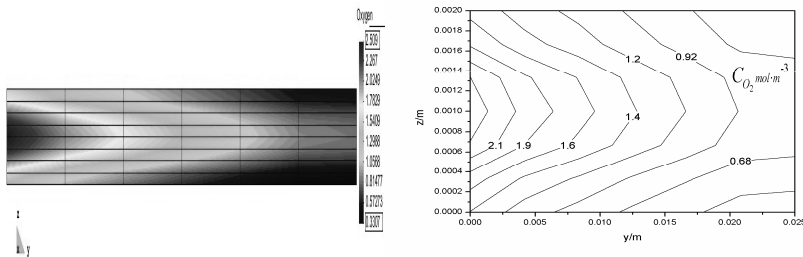


Fig. 2. (b) The concentration distribution of oxygen on the interface between catalyst layer and diffusion layer.

Fig. 3a and 3b, respectively, represent the reactant concentration distribution of hydrogen and oxygen within the xy plane when $z = 0.00075\text{m}$ and the voltage is 0.9V . It can be seen from the figures that the trends of the two curves are very similar. That is, due to the occurrence of electrochemical reaction within the catalyst layer, the concentration decreased gradually along the flow channel. Moreover, because the set condition 0.3 is moderate current density, reactant concentration decrease along the flow channel is not so obvious. Therefore, its limiting current density condition is not reached.

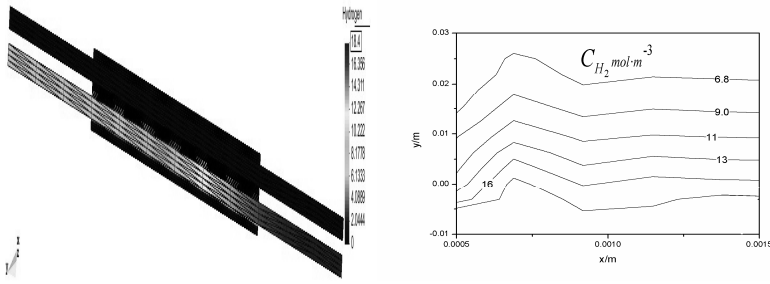


Fig. 3. (a) when $z = 0.00075\text{m}$, the distribution of hydrogen concentration on plane xy .

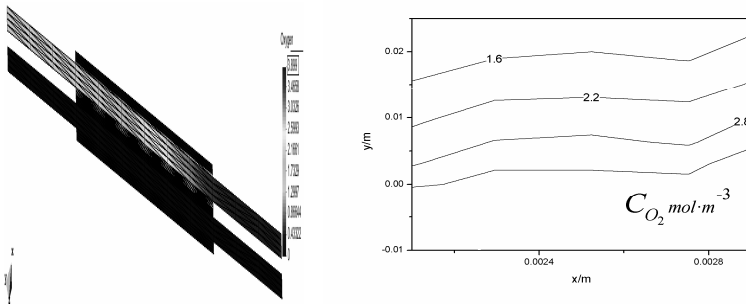


Fig. 3. (b) when $z = 0.00075\text{m}$, the distribution of oxygen concentration on plane xy .

4 Conclusions

This paper has proposed an integrated 3-D mathematical model for PEMFC and acquired the spatial concentration distribution of components by numerical simulations using finite element method. All these consequences will provide some references for designing and optimising PEMFC. Several important conclusions can be drawn from the present simulation results.

1. The spatial concentration distribution curves predicted by the present model show good agreement with the experimental data for the PEMFC. These conditions include the voltage of 0.9 and the current density of 0.3 within interfaces

on the porous electrode's catalyst layer and diffusion layer. In addition, when z equals to three-quarter width, the distribution of gas concentration can be determined. These important parameters can be precisely captured by the present fuel-cell model.

2. Based on the simulation results of different positions, the distribution of hydrogen and oxygen concentration are coupled well with the reaction mechanism. Besides, they also can reflect the performance and the status any time PEMFC works.

3. The electrochemical reactions, taking place within porous electrode's catalyst layer, led to the concentration of reactants decreased along the flow direction and their decline degree are decided by current density and reaction speed.

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Autocorrelation Performance Improvement of Hopfield Hyperchaos Sequence Based on APAS Theorem

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Abstract. Hyperchaos sequences have been widely used as complex pseudorandom sequences. However, the autocorrelation performance of some well known Hyperchaos sequences, such as Hopfield sequence, is poor, and their applications are limited. Based on recently presented APAS theorem, we have modified the Hopfield map to Symmetrical-Hopfield(S-Hopfield) map, and the autocorrelation performance of the S-Hopfield sequence is excellent, whereas other performances of the S-Hopfield sequence remain invariant or become better, and this sequence can be used more widely.

Keywords: Chaos, Hopfield map, Autocorrelation, Phase space.

1 Introduction

In communication and radar, chaotic sequences have been widely used as pseudorandom sequences[1-10], and their autocorrelation performances are very important for signal detection and identification. But the autocorrelation performance of some chaotic sequences, such as Hopfield sequence[11], is poor, and their application are limited. The problem of how to judge whether the autocorrelation performances of a chaotic sequence is good has, hitherto, not been completely solved, because we have no simple yet effective method to assess and improve the autocorrelation performance of an arbitrary chaotic sequence. Until APAS theorem has been presented in Ref.[10], and the problem has been solved partly.

The Hopfield map[11] is a well known Hyperchaos map whose positive Lyapunov exponents are more than one, and the structure of the Hopfield map is more complex than that of general chaos maps whose positive Lyapunov exponent is only one, so the Hopfield map can be used more widely. But because of poor autocorrelation performance of the Hopfield sequence, its application is limited. In this paper, based on the APAS theorem, we have modified Hopfield map to Symmetrical-Hopfield (S-Hopfield) map. The S-Hopfield sequence reaches excellent autocorrelation performance, and is not complex, whereas its other performances, such as chaotic property, ergodicity, spectrum, cross-correlation, Lyapunov exponent, etc, remaine invariant or become better, thereby, this sequence can be used more widely.

The autocorrelation problem of the Hopfield sequence

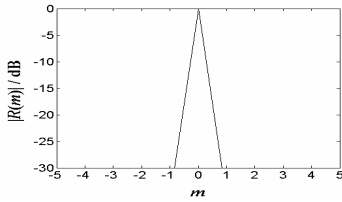


Fig. 1. Normalized autocorrelation function of Tent and Logistic sequences

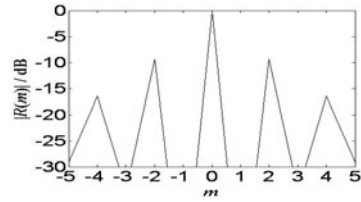


Fig. 2. Normalized autocorrelation function of Hopfield map

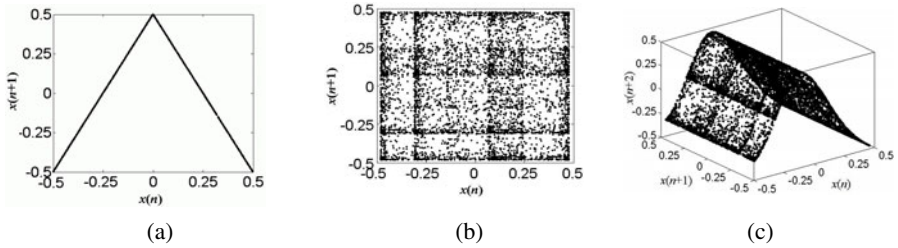
The shape of a good performance autocorrelation function should resemble a sharp needle, as shown in figure 1. It has a sharp and prominent main peak, with no obvious side lobes, so signals can easily be detected and identified. We study the autocorrelations of some well known chaotic sequences, such as Tent, Logistic and the Hopfield sequence. The autocorrelation functions of the Tent and Logistic sequences are similar and are depicted in figure 1, their main peak is sharp and prominent, and their side lobes are low and hardly distinguishable, so the performance is very good.

But the autocorrelation function of the Hopfield sequence remains a problem. The autocorrelation function of the Hopfield sequence is illustrated in figure 2. Its side lobes are high and obvious, so its autocorrelation performance is poor. Therefore, we need to modify the Hopfield sequence for improving its autocorrelation performance, meanwhile, make its other performances remain invariant or become better for improved applications.

2 APAS Theorem

By recently presented Autocorrelation Phase-space Axis Symmetric(APAS) theorem[10], we can estimate the autocorrelation performance of a sequence by testing whether its trajectory in delay 1 phase space is x- or y-axis symmetrical. If the trajectory is x- or y-axis symmetrical, then its autocorrelation performance is good: that is, its autocorrelation has sharp and prominent main peak, and has no obvious side lobes.

The delay 1 phase trajectory of the Tent sequence is shown in figure 3(a), its trajectory is y-axis symmetrical, and meets the conditions of the APAS theorem. Then its autocorrelation performance is good, as shown in figure 1, and it satisfies the APAS Theorem. To many other chaotic sequences which meet the conditions of the APAS theorem, such as Logistic sequence, we archive the same result.



(a) Delay 1 phase space trajectory of Tent sequence
 (b) Delay 1 phase space trajectory of Hopfield sequence
 (c) 3 dimension phase space trajectory of Hopfield sequence

Fig. 3. Delay 1 phase space trajectories of Tent and Hopfield sequences

The APAS theorem has been proved and verified detailedly in Ref.[10].

3 Improving Autocorrelation Performance of the Hopfield Sequence

Studying Hopfield map[11], on the delay 1 phase figure of the Hopfield sequence, the density of the points at left and below side is different from that of the points at right and up side, therefore, the delay 1 phase trajectory of the Hopfield sequence is neither x- nor y-axis symmetrical, and doesn't meet the conditions of APAS theorem, as shown in figure 3(b),(c), then its autocorrelation performance is poor, as shown in figure 2, and satisfies the APAS theorem. Thus, we have found the reason that the Hopfield sequence has poor autocorrelation performance.

Based on the APAS theorem, we have changed the Hopfield sequence phase trajectory structure, and have made its delay 1 trajectory become y-axis symmetrical. We call this sequence the Symmetrical Hopfield (S-Hopfield) sequence, as shown in figure 4(a),(b). The structure of the S-Hopfield map is shown as follows.

$$\begin{cases} x_1(n+1) = 10 \tanh[ay(n)] \exp[-y(n)] \\ y(n+1) = 10 \tanh[x_1(n)] \exp[-bx_1(n)] \\ u(n+1) = c - d |u(n)| \\ \begin{cases} x(n+1) = h[x_1(n+1) - 2.05] & \text{if } u(n+1) \geq 0 \\ x(n+1) = -h[x_1(n+1) - 2.05] & \text{if } u(n+1) < 0 \end{cases} \end{cases} \quad (1)$$

where $x(n) \in \mathbb{R}$ is state variable, and the parameters a, b, c, d, h are positive numbers. If the values of a, b, c, d, h are in suitable area, such as $a = 1.2, b = 1.5, c = 0.5, d = 1.999, h = 0.35$, the $x(n)$ can evolve in chaotic state, and satisfies $x(n) \in [-0.5, 0.5]$. By choosing different suitable initial values of $x_1(0), y(0)$ and $u(0)$, we can produce different and certain chaotic sequences $x(n)$.

Because the delay 1 phase trajectory structure of the S-Hopfield sequence is x- and y-axis symmetrical, as shown in figure 4 (b), so meets the conditions of the APAS

theorem, then its autocorrelation performance becomes good, and is as good as that of the Tent sequence, that is, the autocorrelation function has a sharp and prominent main peak, and has no obvious side lobes, as shown in figure 4(c).

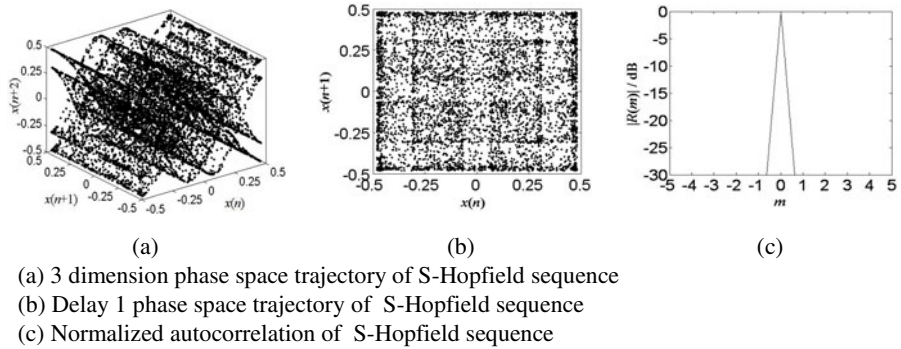


Fig. 4. Delay 1 phase space trajectory of S-Hopfield sequence and its autocorrelation function

4 Other Characteristics of the S-Hopfield Sequence

After improving autocorrelation performance, we study other characteristics of the Hopfield and S-Hopfield sequence, such as, chaotic property, ergodicity, spectrum, cross-correlation, Lyapunov exponent, etc.

We generally hope spectrums of chaotic sequences are flat, and resemble that of noise, then the spectrums are beneficial to counteracting analysis and prediction. But because of the poor autocorrelation performance of the Hopfield sequence, after Fourier transform, its spectrum is not flat, and we observed some obvious peaks, and the performance is poor, as illustrated in figure 5(a). Whereas the autocorrelation performance of the S-Hopfield sequence is good, as shown in figure 4(c), then, its spectrum is flat, and has no obvious peak, and the performance is good, as shown in figure 5(b). So, the spectrum performance of the S-Hopfield sequence is better than that of the Hopfield sequence.

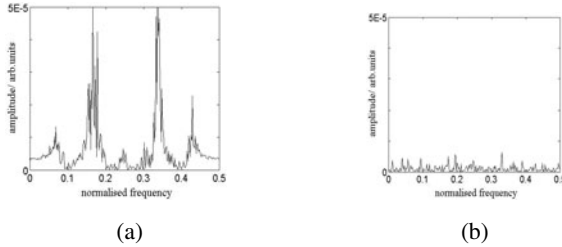


Fig. 5. (a) Spectrum of Hopfield sequence, (b) Spectrum of S-Hopfield sequence

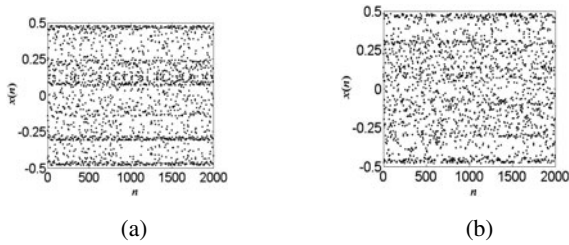


Fig. 6. (a) Evolution of Hopfield sequence, (b) Evolution of S-Hopfield sequence

The maximal Lyapunov exponent of the Hopfield sequence is 0.3. The scatter rate of the S-Hopfield sequence is bigger than that of the Hopfield sequence, so the Maximal Lyapunov exponent of the S-Hopfield sequence is greater than that of the Hopfield, is about 1.8. Greater Lyapunov exponent is, greater divergence rate is, and more difficult to be analyzed and predicted are, then is more beneficial to its applications.

From figure 6(a), (b) we can see that, the evolution of the S-Hopfield is more random and balanced, and is better than that of the Hopfield sequence. The cross-correlations of the Hopfield and S-Hopfield sequences almost have no obvious difference, and we can consider that they are resemble.

So, other characteristics of the S-Hopfield sequence, such as chaotic property, ergodicity, spectrum, cross-correlation, Lyapunov exponent, etc, remain invariant or become better than those of the Hopfield, too.

5 Conclusion

For improving the autocorrelation performance of the Hopfield sequence, based on the APAS theorem, we have modified the Hopfield map to the S-Hopfield map, and the S-Hopfield sequence has excellent autocorrelation performance, whereas its other performances, such as chaotic property, ergodicity, spectrum, cross-correlation, Lyapunov exponent, etc, remain invariant or become better, and the S-Hopfield sequence can be used more widely.

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Prediction of Precipitation Based on Artificial Neural Networks by Free Search

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Abstract. FS-BP model was used to try to predict precipitation. The last six years' precipitation were selected as input variable and the next year's precipitation as output variable. The results show that the mean relative error of the prediction is 2.92%. T-test and regression analysis indicates that the predicted value differs just slightly from the observed value and their correlation coefficient was 0.9901. The FS-BP model is quite higher than BP model in accuracy and stability, and serves as useful tool in further research on prediction of precipitation.

Keywords: Precipitation, BP neural network, Free search, Prediction.

1 Introduction

Drought and water shortage are two of the key affecting factors to crop production and food security[1]. The precipitation in a region, not only affects the development and utilization of water resources, but also is closely related to the natural disasters such as drought, and so on. Therefore, accurate prediction of rainfall, can not only provide a scientific basis for the development and utilization of water resources, but also provide technical support to the agricultural production, the measures of disaster prevention and mitigation. At present, the prediction of precipitation often adopts the numerical methods and statistical methods to establish mathematical prediction models and empirical statistical model. Because factors affecting the rainfall are rather mass, and the relations among the factors are complex, the models established are complex, differently applicability, more larger error, and their empirical parameters are limited to the application scope, and difficult to accurately determine. So, it is difficult to use conventional methods to accurately predict future rainfall in an area[2]. Artificial neural networks (ANN) ,in particular, BP (back propagation network) network model has the self-organizing, adaptive and self-learning function, with a strong ability to deal with nonlinear problems, is very propitious to the prediction of precipitation, which has more affecting factors. However, BP network model exists defects, such as easy to fall into local minimum and no convergence of shock, and so on.,so a new algorithm - free search algorithms (FS)[3] is introduced to optimize the initial weight of BP network to increase its speed and stability. Through the integrated of free search algorithm and artificial neural network to predict

precipitation, which provides a reference for the further research of the the Semi-Arid trend analysis.

2 FS Algorithm

2.1 Summary of Principles

FS is a new algorithm, which is proposed by Kalin Penev and Guy Littlefair[3]. The algorithm draws on the activities of higher social animals, the individual has a higher intelligence, a wide range of activities, the larger autonomy and better environmental adaptability. The individual of the group has a different ability of perception and activity, they are abstractions and modeling. The conceptual difference in comparison to existing methods is that FS dose not determine the explored search space, but by the probabilistic principle[4]. Compared to particle swarm algorithm [5-6] (PSO), genetic algorithm[7] (GA) and differential evolution algorithm [8] (DE), FS has simpler principle, less parameters, more convenience operation and better optimization ability.

2.2 Algorithm Model

The structure of the algorithm consists of three major events: initialization, exploration and termination. The aim is to determine the optimal value (maximum or minimum) of the objective function (such as optimization function). In the algorithm model, the perception is defined as sensitivity, activity is defined as the search radius, the search radius determines the scope of individual optimization, the local search or global search. The algorithm is structured as follows:

(1) initialization

$$x_{0ji} = X_{\min i} + (X_{\max i} - X_{\min i}) \text{random}_{ji}(0,1) \quad (1)$$

Where $j=1,2,\dots,m$, m is the population size, $i=1,2,\dots,n$, n is the number of dimensions, x_{0ji} is initialization weight; $X_{\min i}$ 、 $X_{\max i}$ are the search space borders, $\text{random}(0,1)$ is a random value between 0 and 1.

(2) exploration

The exploration walk generates coordinates of a new location x_{tji} as

$$x_{tji} = x_{0ji} - \Delta x_{tji} + 2\Delta x_{tji} \text{random}_{tji}(0,1) \quad (2)$$

The modification strategy Δx_{tji} as

$$\Delta x_{tji} = D_{ji} (X_{\max i} - X_{\min i}) \text{random}_{tji}(0,1) \quad (3)$$

Where $t=1,2,\dots,T$, t is the current step, T is step limit per walk, D_{ji} is the variable neighbour space, $D_{ji} \in [D_{\min}, D_{\max}]$.

The individual behaviors, during the walk, is modelled and described as

$$f_{ij} = f(x_{iji}), f_j = \max(f_{ij}) \quad (4)$$

Where f_j is the only location marked with pheromone from an animal after the walk.

The pheromone generation is

$$Ph_j = f_j / \max(f_j) \quad (5)$$

The sensibility generation is

$$S_j = S_{\min} + \Delta S_j \quad (6)$$

Where $\Delta S_j = S_{\max} - S_{\min} \cdot \text{random}_j(0,1)$, $S_{\min} = Ph_{\min}$, $S_{\max} = Ph_{\max}$.

Acceptable criteria for termination are

$$X'_{0ji} = x_{ji} (Ph_q \geq S_j) \quad (7)$$

Where $q=1,2,\dots,m$.

(3) termination

Algorithm determines whether the termination condition meets or not, if so, accept the optimal solution. And if not, continue the exploration search. Therefore, FS concept is clear, requires less parameters, less demanding on the initial value, the algorithm optimization process is easy to use program implementation.

3 FS Algorithm to Optimize BP Neural Network Model

BP network's initial weights are randomly assigned, and the final determination results of the weights tend to rely heavily on the choice of the initial weights. As BP network error surface presents multiple local optima, if the initial weights settings are not ideal, BP network is vulnerable to falling into local optimum[9]. in the FS algorithm, the search behavior of animal groups is not limited, but by the probability of description, thus using the FS algorithm to optimize the weights of BP network, and through optimized weight enter the network, which makes the traditional BP neural network get better solution to the problems that the sensitive to initial weights and easy to fall into local optimum solutions and other issues [10]. Network model specific steps:

(1) Data Processing

To make the network has good convergence and mapping capability, the data normalized to [0,1], the use of Equation eight is normalized data:

$$x'_i = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \quad (8)$$

Where $x_{\max}$ 、 $x_{\min}$ are the maximum and minimum rainfall over the years, x_i is the precipitation, x'_i is the normalized value of precipitation, i is the year.

(2) FS construction of initial weights optimization

Neural network initial weights are generated by the conventional approach, and optimized by FS algorithm. Every complete set of neural network weights, W_i ($i = 1, 2, \dots, m$), is equivalent to an individual animal, where m is the population size.

Optimal objective function is the mean square error function,

$$E = \frac{1}{N} \sum_{i=1}^N (y_i^d - y_i)^2 \tag{9}$$

Where E is MSE; N is the number of samples, y_i^d is ideal output, y_i is actual output value.

The minimum squared error of network weights are searched by the FS algorithm, that is, to obtain the minimum value of the MSE function (optimal value), the optimal solution is the corresponding weight.

(3) Construction of model

According to the optimization value by the FS algorithm as the initial weight, build three-layer structure network model. The middle layer of the network's neurons transfer function is S-type tangent function using tansig , the output layer neuron transfer function is S-function using logsig . Training function is the momentum BP algorithm training function, the momentum factor set to 0.9, learning rate set to 0.05, the maximum number of times the training set to 10000, expected error is 0.001.

4 Application Instance Analysis

The precipitate data from 1988 to 2009 in Fuxin Mongolian Autonomous County of the Northeast semi-arid areas are used to establish the model. Because the precipitate change is single factor time series, the first steps are correlation analysis of data to determine the input and output sample group. The results of statistical correlation analysis show that there is a certain correlation between the precipitation of the first 6 years and precipitation in the first 7 years. Therefore, select the first 6 years of precipitation as input, precipitation in the next year as the network output, that is, the data from 1988 to 2009 were divided into 16 group, as the network input and output. The results show in Figure 1 and 2.

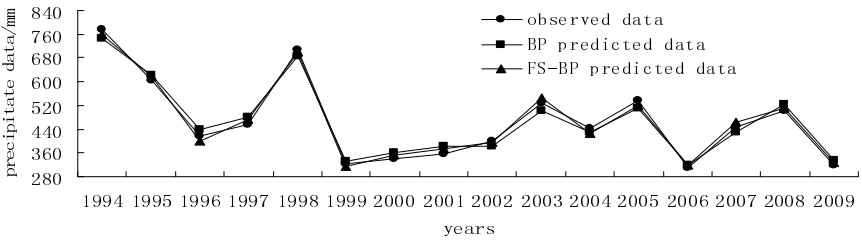


Fig. 1. Comparison between observed and predicted data of precipitation

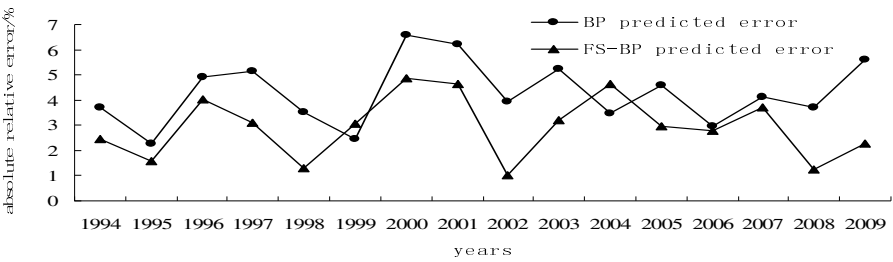


Fig. 2. Comparison of prediction errors between BP model and FS-BP model

From Figure 1, the observed data and the FS-BP predicted data have smaller difference, the average error is only 2.92%, the minimum relative error is only 1%, by analyzing the observed data and the predicted data, it can be seen that correlation between the observed data and the predicted data is better, the correlation coefficient of determination was 0.9901 (Figure 3), the significant value of t test is 0.772, greater than 0.05 (Table 1), the observed data and the predicted data have no significant difference, which indicated that the model has high accuracy.

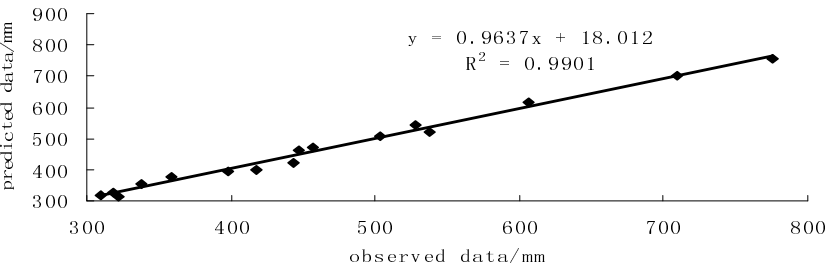


Fig. 3. Correlation between observed and predicted data of precipitation

Table 1. Results of T-examination between observed and predicted data with precipitation

item	Mean	Std. Deviation	Std.Mean	T	Df	Sig. (2-tailed)
O-P	-1.0563	14.2901	3.5725	-0.296	15	0.772

Compared with traditional BP model, the FS-BP average relative error is 1.36% lower, FS-BP error range is 5.60% lower (Figure 2), so, FS-BP model is better on both accuracy and stability than the traditional BP model. Therefore, compared with the traditional BP model, BP network model based on free search algorithm predicted accuracy and more satisfactory, which indicate that the BP model based on the free model search algorithm (FS-BP) can predict precipitation.

5 Conclusions

In this paper, FS-BP model was used to try to predict precipitation. The results showed that: FS-BP model has better prediction of precipitation, the average error is

only 2.92%, coefficient of determination is 0.9901. FS-BP model is better than traditional BP model in the history sample accuracy and stability. It indicates that the FS-BP model can predict precipitation. Compared with traditional mathematical prediction and statistical models, FS-BP model operates simpler, computes less, and improves the prediction accuracy and efficiency, has a certain practicality.

Although the FS-BP model predicted precipitation can achieve better results, but it should go on further research: (1)The research of the free search algorithm is just beginning, has not much published literature, and not formation of a mature system analysis compared to the other algorithm. So many issues need further study. (2)Because the precipitation data series is shorter, there is no additional information on the predicted results for test. Meanwhile, the other impact factors of precipitation as the input factors for model predictions did not study, which had some effect on the versatility of the model, so the model approach for further study needs to be done.

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Research on Investor Sentiment Effect on A-Share Market in China Based on Analysis of A-Share Materials

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Abstract. According to daily and weekly data of account open rate as well as stock market returns, we set a vector auto-regression model to make a study on the effect of investor sentiment change on Shanghai and Shenzhen stock markets. The result shows: investor sentiment has greater effect on Shenzhen stock market than on that of Shanghai, and its effect on stock market is greater in the long run than in short term. Besides, volatility of account open rate is the Granger reason of the yield volatility of Shanghai and Shenzhen 300 index, Shanghai A-share index, and Shenzhen A-share index; while vice versa, that depends on different time limits.

Keywords: Investor sentiment, Stock returns, VAR (Vector Auto-Regression).

1 Introduction

On A-share market, investors fix a price for the invested shares according to their expectations of the listed enterprises' making profit or loss in the future, and decide the category and quantity of shares to buy in or sell out. Investor sentiment is an important indicator which shows their psychology and the corresponding behavior characteristics, thus it is one of the important researches in behavioral finance theory.

Meijin Wang and Jianjun Sun [1](2004) measure sentiment with index from CCTV comment, and make research on relationships between stock return and investor sentiment in China. They find that the investor sentiment changes not only affect the return of Shanghai and Shenzhen stock markets remarkably, but also reversely modify their volatility of rate of return. Dan Zhang and Shiguang Liao [2](2009) use discount rate of Closed-end Fund and implied volatility of Call Warrant to reflect investor sentiment in stock market in China indirectly, and find that investor sentiment change is the systematic factor which affects market returns, thus it can predict the future market returns and its volatility pretty well. Delong Huang, Fenghua Wen and Xiaoguang Yang [3](2009) single out the proxy variable of investor sentiment aiming at the stock market in China, build the composite index number of investor sentiment in our stock market, and adopt turnover rate, new open account rate, discount rate of Closed-end Fund as indicators of investor sentiment, finally they get to know that different investor sentiment has remarkable effects on stock returns. Yanran Wu and

Liyan Han (2007)[4] put forward that A-share and new accounts of Closed-end Fund can be used as indicators of investor sentiment.

Seen from these research literatures, investor sentiment notably affects the stock market in China, whose degree of effects depends on different indicators and time chosen. The paper adopts the account opening rate to measure investors' enthusiasm in entering the market, thus measuring investor sentiment.

2 Measures and Sample of Investor Sentiment

The paper uses new open A-share account rate to measure investor sentiment here,

New open A-share account rate = (new open A-share accounts—new closed A-share accounts)/ daily ending A-share accounts

New accounts every day embodies the activity level of investor trading. When investors are optimistic or in high spirits, high speculative demand impels new investors entering the market actively and the number of new accounts leaps; when investors are pessimistic or in low spirits, the market tends to wait and see, speculative demand becomes low and control the speculative impulse of new investors and finally make them put off their entering the market or change their investment direction. So daily new open accounts represent the degree of investors' speculative demand, while new closed A-share accounts represent investors' desire to delist. The differences between them is the daily net increased A-share accounts, so new open account rate shows investors' will to enter the market to some degree and can be used as an indicator of investor sentiment. To adopt new open account rate as an indicator of daily investor sentiment and for convenience's sake, we call it account rate for short.

Rate of return of Shanghai A-share index, Shenzhen A-share index, and Shanghai and Shenzhen 300 index are used to measure returns in A-share stock market. There are 603 observed value in daily data, whose sample spacing is from June 20th, 2005 to January 11th, 2008. There are 250 observed value in weekly data, whose sample spacing is from June 20th, 2005 to July 23rd, 2010. Among these, data of account rate is quoted from the website of China Securities Depository and Clearing Corporation Limited(SD&C); rate of return of Shanghai A-share index, Shenzhen A-share index, and Shanghai and Shenzhen 300 index is from Guo Tai'an database, and we use Eviews6.0 for its empirical test.

3 Main Mathematical Model and Econometric Methods

The paper sets a quaternion VAR model to analyze the dynamic effect of D_khbl—account rate volatility—to volatility of stock return (D_shanga—volatility of Shanghai A-share index return, D_shena—volatility of Shenzhen A-share index return, D_hushen—volatility of Shanghai and Shenzhen 300 index return).

Here, the account rate volatility $D\_khbl_t = khbl_t - khbl_{t-1}$, shows the volatility gap in account rate between phase t and phase $t-1$; rate of return $S_t = (S_t - S_{t-1}) / S_{t-1} \times 100$, S_t and S_{t-1} represents the close index of phase t and

phase $t-1$; volatility of Shanghai A-share index return $D\_shanga_t = shanga_t - shanga_{t-1}$, shows its volatility gap in rate of return between phase t and phase $t-1$; volatility of Shenzhen A-share index return $D\_shena_t = shena_t - shena_{t-1}$, shows its volatility gap in rate of return between phase t and phase $t-1$; volatility of Shanghai and Shenzhen 300 index return $D\_hushen_t = hushen_t - hushen_{t-1}$, shows the reverse rate of return gap of its volatility gap in rate of return between phase t and phase $t-1$.

The mathematical expression of VAR(p) model is

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t, t = 1, 2, \cdots, T \quad (1)$$

Here, y_t is endogenous variable vector of k dimension, x_t is exogenous variable vector of d dimension, p is lag order, and T is the number of samples. Suppose y_t is a stationary random process, then expression (1) can be expressed as a moving average process of infinite vector.

$$Y_t = B + \sum_{s=0}^{\infty} \Phi_s \varepsilon_{T-s} \quad (2)$$

Here, Φ is a coefficient matrix, B is a constant matrix. The element in row i and column j of Coefficient matrix Φ_s shows that if other error items don't change in any phase, and when the corresponding error item ε_{it} of variable j suffers a unit of impact in phase t , the effect produced on endogenous variable i in phase $t+s$ is the very impulse response of variable i to variable j in phase s in VAR system.

4 Empirical Results

4.1 Deciding the Lag Order of VAR Model

As D_khbl 、 D_hushen 、 D_shanga 、 D_shena are stable, a VAR model can be set to these four data, to show the dynamic effect between account rate and the volatility of stock market returns. To decide the lag order of VAR model, the SIC principle is used here, we find the optimum lag order through examination of daily data is 3^① and weekly data is 2.

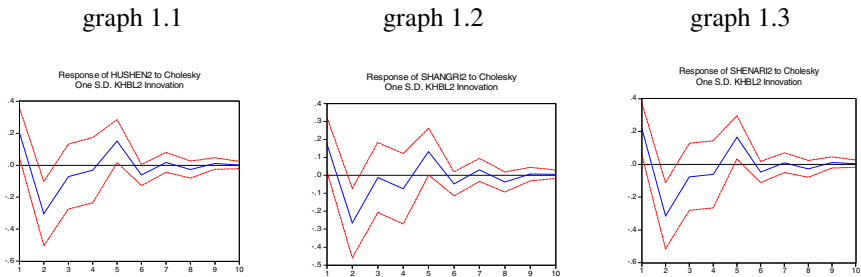
4.2 Impulse Response Function Curve and Predicted Variance Decomposition Chart

As VAR model is an atheoretical model, and it needs no apriori restrictions on variables, so when doing VAR model analysis, we often don't analyze the effect on another variable result from some change of one variable, but analyze the dynamic influence to the whole system when some change happens to an error term or some impact happens to the model. This kind of analysis is called impulse response

function. Based on VAR(3)model and VAR(2)model built before, we are going to describe how the causal factors in the model response dynamically to the systematic impact with the help of impulse response function.

(1) Analysis of effect and impulse response between account rate and volatility of stock market return in daily data

Graph 1.1,1.2 and 1.3 are impulse response function curves of imitated daily data of Shanghai and Shenzhen 300 index, Shanghai A-share index and Shenzhen A-share index. Graph 1.1 represents the overall environment of the two stock markets. After it gives an one percent forward impact to account rate change, it shows a maximum inverse impact in phase 2, reaching 0.302 percent; then the inverse impact gets smaller and gets close to zero in phase 4; then it turns to forward impact and reaches the maximum value in phase 5 and tends to level off after phase 5. Graph 1.2 and 1.3 represents the impulse response of single market (Shanghai stock market and Shenzhen stock market). The account rate changes in graph 1.2 and 1.3 has similar effect: they both reach the negative maximum value in phase 2, that's to say, when account rate changes 1%, it brings 0.266% and 0.314% negative impact to Shanghai A-share index and Shenzhen A-share index. In phase 5, it is forward impacts and reaches the maximum, reaching 0.133% and 0.164%, and levels off after phase 6. Compare the same phase in graph 1.2 with graph 1.3, account rate change has greater effect on Shenzhen stock market than on Shanghai stock market. We can see from graph 2.1 that in the above three impulse response function curves, the contribution of account rate change tends to be stable in phase 6. We can see from graph 5 that impact effect of account rate change on the rate of return of these three A-share indexes are 2.60%, 2.11%, and 2.85%. To make a conclusion, the impact on the rate of return of the whole A-share index is smaller than that on Shenzhen A-share index, but greater than that on Shanghai A-share index, therefore, it has greater effect on Shenzhen stock market than on Shanghai stock market. This conclusion agrees with the fact that Shanghai and Shenzhen 300 index includes indexes on both Shanghai and Shenzhen stock markets.

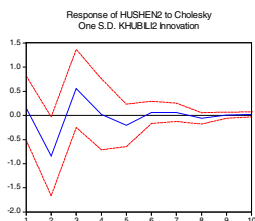


Note: Graph 1.1 is the impulse response of D_hushen which is caused by D_khbl impact. Graph 1.2 shows the impulse response of D_shanga which is caused by D_khbl . Graph 1.3 shows the impulse response of D_shen which is caused by D_khbl . The x-coordinate indicates time interval after the impact happens, and y-coordinate indicates the intensity of impact. In the graph, solid lines are impulse

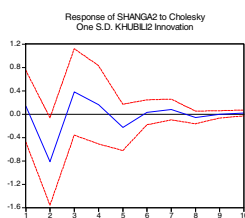
response curves, and broken lines are twofold plus or minus departure zone of standard deviation.

Graph 2.1, 2.2 and 2.3 are impulse response function curves of imitated weekly data of Shanghai and Shenzhen 300 index, Shanghai A-share index and Shenzhen A-share index. Graph 2.1 represents the overall environment of the two stock markets. Similar to daily data, after it gives an one percent forward impact to account rate, it shows a maximum reverse impact in phase 2, reaching 0.845 percent; then the inverse impact becomes small till zero; in phase 3 it returns to forward impact and reaches 0.559 percent rapidly and finally tends to level off. Graph 2.2 and 2.3 represents the impulse response of Shanghai and Shenzhen stock markets, the account rate changes in graph 2.2 and 2.3 has similar effect: they both reach the negative maximum value in phase 2, that's to say, when account rate changes 1%, it brings 0.810% and 0.904% negative impact to Shanghai A-share index and Shenzhen A-share index. In phase 3, it gets back to forward impacts rapidly, reaching 0.383% and 0.611%, and levels off after phase 3. In the following three impulse response function curves, the contribution of account rate change tends to be stable in phase 6. We can see from graph 2.2 that impact effect of account rate change on rate of return of these three A-share index are 2.432%, 2.388%, and 2.623%. To make a conclusion, the impact on rate of return of the whole A-share index is smaller than that on Shenzhen A-share index, but greater than that on Shanghai A-share index, therefore, it has greater effect on Shenzhen stock market than on Shanghai stock market. This conclusion agrees with the fact that Shanghai and Shenzhen 300 index includes indexes on both Shanghai and Shenzhen stock markets, and it is also similar to the conclusion of daily data.

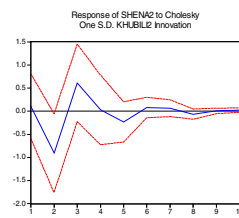
graph 2.1



graph 2.2



graph 2.3



Note: Graph 2.1 is the impulse response of D_hushen which is caused by D_khbl impact. Graph 2.2 shows the impulse response of D_shanga which is caused by D_khbl . Graph 2.3 shows the impulse response of D_shena which is caused by D_khbl . The x-coordinate indicates time interval after the impact happens, and y-coordinate indicates the intensity of impact. In the graph, solid lines are impulse response curves, and broken lines are twofold plus or minus departure zone of standard deviation.

(3) Contemporary comparison on the two impulse response and effect analysis

Compare (1) with (2), we come to the following conclusions: impulse response of daily data levels off at phase 5 or 6, while impulse response curve of weekly data levels off at phase 3. Besides, daily data has a smaller and slower impact effect on

stock returns than weekly data, which shows that investor sentiment has greater effect on stock market in the long run than in short term.

5 Conclusion

The paper makes a study of investor sentiment effect on A-share stock market return by using VAR model and impulse response function. The results are as follows:

(1) The volatility of A-share new investors reflects the activity level of transactions on A-share market, which can be used as a sentiment indicator.(2)In the long run, investor sentiment effect on stock market is fast and strong. It means that the effect is much stronger in the long term than in the short term.(3)No matter in short term or in the long term, account rate volatility has a greater effect on Shenzhen than on Shanghai stock market. As most of the listed enterprises in Shenzhen are SME(small and medium enterprise), investor sentiment in short term has greater effect on shares of those SME.

The analysis above shows that, as a measure of investor sentiment, account rate has distinct effect on stock market return. But it also has its limitations.It is a problem to be studied in the future that how to reflect sentiment with integrated consideration of investor psychology and corresponding behavior characteristics.

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Block Permutation Cipher in Chaos with Feistel Structure for Wireless Sensor Networks

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Abstract. In nodes of wireless sensor networks, the block cipher technology with chaos permutation and nonlinear Feistel structure with permutation is proposed for single byte confidential communication. The chaos sequence was generated from the permutation key and chaos parameters. The plaintext in one byte was encrypted by exclusive-or operation with chaos sequence, and then was input into multiple turn Feistel structure. Finally the ciphertext was generated by permutation operation with the chaos sequence again. The square operation, nonlinear and chaos permutation operation was enclosed into the cipher function in the Feistel structure. The test was completed in nodes. The result is that the algorithm can be used for encryption and decryption in single chip microprocessor exactly and suitable for nodes in wireless sensor networks. The conclusion is that the chaos permutation cipher may enforce the safety in sensor networks.

Keywords: Chao, permutation, cipher, wireless sensor networks, Feistel structure.

1 Introduction

It will bring into redundancy bytes when using multiple bytes in wireless sensor networks block cipher algorithm because the data of WSN is little [1]. The block length of the algorithm such as DES, RC5, AES and SKIPJACK is not less than 32 bits. The least length in RC6 block cipher is 128bits. The papers[2] have given the single byte block cipher with permutation and Feistel structure, in which nonlinear algorithm was used for enforcing safety, but the permutation operation is only exchanging position of bits, which is not enough for safety. If alternating the permutation into cipher permutation, the performance of the algorithm will enhance greatly. The chaos is similar to pseudo-random sequence [3], which is good for confusion data distribution in cipher permutation [4].The paper[5] afford a cipher algorithm with chaos in multiply byte block but the chaos is not used in cipher permutation operation of the Feistel structure to enforce security. If the cipher permutation is used in the Feistel structure, the algorithm will be more robust in security.

In the paper, the block cipher structure with cipher permutation is introduced at first. And then, the chaos cipher permutation is given, and the cipher permutation with Feistel is posed. In the end, the experiment of the algorithm is completed. The conclusion is draw.

2 Block Cipher Structure

The algorithm based on permutation encryption and Feistel structure in single byte for wireless sensor networks safety shown in figure 1. The eight bits plain text ‘pcode’ is permuted with encryption by ‘epermutation’, and then delivered to multiple turns Feistel structure to encrypt. In the end through the operation ‘epermutation’, the eight bits cipher text ‘mcode’ is gotten. Where $K_i(i = 1, \cdots, n)$ are encryption keys.

In the permutation, the permutation key ‘pkey’ and chaos parameter ‘ukey’ was added to encrypt operation in discrete chaos. Where the permutation encryption key ‘epermutation’ was used in every turn Feistel structure again. The block cipher structure may be used for encryption as well as decryption. The sequence of keys is reverse to input in the decryption and encryption, for example, the keys sequence for

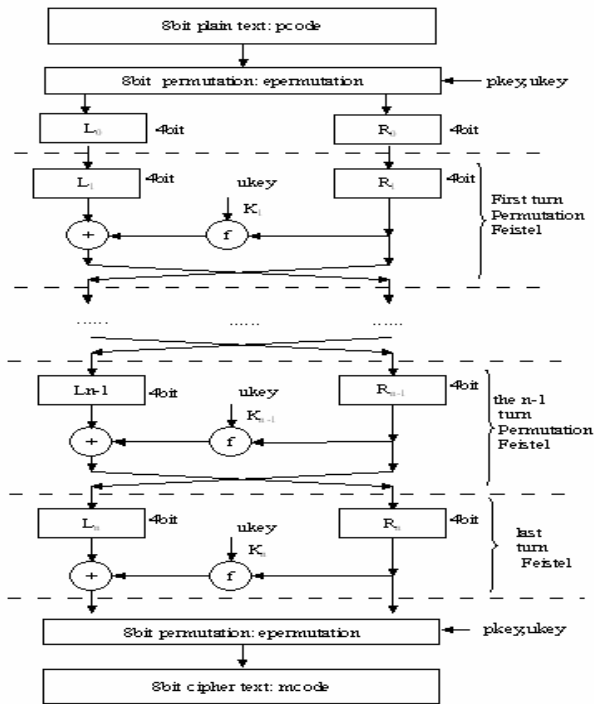


Fig. 1. Block cipher structure in cipher permutation

encryption is $K_1, K_2, \dots, K_n$, and then the keys sequence for decryption is $K_n, K_{n-1}, \dots, K_1$.

3 Chaos Cipher Permutation

Generation Chaos Keys from Permutation Keys and Chaos Parameter

The characteristic of cipher space depends on plaintext and cipher text space. In order to enhance safety, the keys space in cipher algorithm is close to be normal distribution. In fact, the pseudo-sequence is used for the most cipher. The chaos sequence is similar to pseudo-sequence, which can be used for keys.

The permutation key 'pkey' is considered as the initial for discrete chaos sequence 'ekey' and the parameter for iteration. The first value of the sequence is:

$$ekey(0) = pkey / 255 \quad (1)$$

Then calculation as the Logistic mapping in 'pkey' times:

$$ekey(n+1) = ukey \times ekey(n)[1 - ekey(n)] \quad (2)$$

Where $ukey$ is the chaos parameter and $ukey \in [3.58, 4]$, $ekey \in [0, 1]$. $n = 0, 1, \dots, pkey - 1$ is iteration times. In the last turn, the result is fixed number as:

$$ekey = INT(ekey(pkey) \times 255) \quad (3)$$

Where $ekey$ is the permutation key and the $INT[.]$ is fixed number operation.

Permutation Cipher Operation---epermutation

The ciphertext 'mcode' is from the exclusive OR operation by the encryption key 'ekey' and 'pcode':

$$mcode = pcode \oplus ekey \quad (4)$$

The high half-byte and low half-byte of the ciphertext 'mcode' is respectively to R_0 and L_0 , which will be inputted into the multiple turns Feistel structure.

4 Permutation Feistel Cipher

Structure of the Permutation Feistel Cipher

The processing of Feistel structure in eight bits block is expressed as follows:

$$\begin{cases} R_i = L_{i-1} \oplus T \\ L_i = R_{i-1} \\ i = 1, \dots, n \end{cases} \quad (5)$$

where $R_i, R_{i-1}, L_i, L_{i-1}$, and T are four bits respectively where i is the turn of the Feistel structure. It do not exchange half byte in the last turns. Where:

$$T = f(R_{i-1}, K_i) \quad (6)$$

Where f is cipher function.

Permutation Feistel Cipher Function

In the cipher function 'f', the inputs are the cipher key K_{i-1} and half byte data R_{i-1} , the output is half byte data 'T'. At first, the half byte data R_{i-1} is processed as the following:

$$\begin{cases} x = R_{i-1} \times R_{i-1} \\ y = (x \ll 2) - (x^2) \gg 6 - 1 \end{cases} \quad (7)$$

The R_{i-1} is squared, and then generating the byte data 'y' through nonlinear operation. Then using key K_{i-1} as permutation key using chaos parameter ukey, the data 'y' is encrypted in chaos permutation as the following:

$$W = \text{epermutation}(y, K_{i-1}, \text{ukey}) \quad (8)$$

where W is one byte data, and will be processed as the following fomular:

$$\begin{cases} z = W \oplus K_{i-1} \\ T = (z \& (0x0f)) \mid (z \gg 4) \end{cases} \quad (9)$$

The byte data z is generated by the exclusive OR operation with W and K_{i-1} . In the end, the half byte data T was gotten by the exclusive OR operation with high half byte and low half byte of the byte data z .

5 Test

The algorithm is suitable for wireless sensor networks nodes in 8 bits microprocessor, because the plaintext pcode, permutation key pkey, and encryption $K_i (i = 1, \dots, n)$ are 8 bits only the chaos parameter ukey is 16 bits float. The test is on the nodes based on 80C51single chip microprocessor, with led display. In 80C51, the P1 ports is using for plaintext the P2 ports is using for ciphertext, the P3 ports is using for decrypted data. The result is shown in figure 2. In figure 2, the plaintext is 0x8b, the ciphertext is 0xdf, and the decrypted data is 0x8b as plaintext.

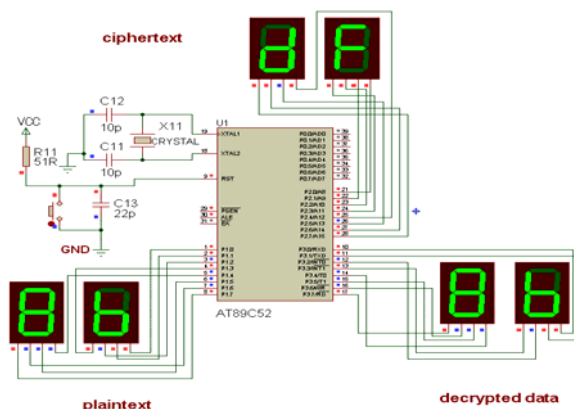


Fig. 2. Test for nodes

6 Conclusion

An algorithm with permutation cipher and permutation Feistel structure for wireless sensor networks was proposed in the paper. The chaos operation was used in the permutation, and the permutation was used Feistel structure. The chaos sequence is generated from the Logistic iteration with permutation key and chaos parameter. The plaintext is feed into chaos sequence by exclusive-or operation, and then was feed into multiple turn Feistel structure. In the end, it was encrypted by permutation cipher. The algorithm may be used either for encryption or for decryption. The test shows that the algorithm may be realized in single chip microprocessor which is suitable for nodes in wireless sensor networks. The security may enforce with chaos permutation cipher and permutation Feistel structure.

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Growth Responses and Phytoremediation Characteristics of *Mirabilis Jalapa* L. in Benzo[a]pyrene and Pyrene Co-contaminated Soils

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Abstract. Pot culture experiments were conducted to investigate the effect of Benzo[a]pyrene(B[a]P) and pyrene on seed germination and growth factors of *Mirabilis Jalapa* L. and their uptake, accumulation and dissipation. The results showed that B[a]P and pyrene at the lower concentrations could accelerate seed germination and photosynthesis rate. There weren't significant relationships between shoot height, root length, or biomass and the concentrations of B[a]P and pyrene in soil. The relative absorptivity of B[a]P and pyrene in roots of *M. Jalapa* was less than 11%. But the amount of B[a]P and pyrene in shoots was close to zero. The relative removal rate of B[a]P and pyrene was up to 83-99% and 5-98%, respectively. Therefore, Plant-promoted rhizomorph biodegradation is the dominant contribution to remove B[a]P and pyrene. *M. Jalapa* might be useful for phytoremediation of B[a]P and pyrene co-contaminated sites.

Keywords: Phytoremediation, B[a]P, pyrene, *Mirabilis Jalapa* L.

1 Introduction

Polycyclic aromatic hydrocarbon (PAH) contamination is of major environmental concern on a world scale, in particular, with the rapid urbanization and industrialization in China [1, 2]. PAHs can be formed by incomplete combustion or pyrolysis of organic materials and enter the soil environment via atmospheric precipitation. Benzo[a]pyrene (B[a]P) and pyrene are two ubiquitous environmental pollutants used as a representative indicator of total PAH level, which has been classified as a priority contaminant in USA, UK, China and other countries because it is known to act as potential carcinogens, teratogenicity or acute toxicity. It easily comes into water, air and soil, and can be absorbed by human beings, thus leading to various diseases or death.

Phytoremediation has been recognized as a cost-effective technology that uses plants to degrade, assimilate, metabolize or detoxify metal and organic chemical contamination [2]. Up to now, there are numerous promising results indicating that the technique might become viable alternative to mechanical and chemical approaches in decontamination of metal polluted sites or a final polishing solution for organic contamination [2]. For example, some field trials of phytoremediation have resulted in accelerated reduction of organic pollutants such as PAHs, polychlorinated biphenyls (PCBs), and trichloroethylene (TCE) in the rhizosphere. However, there are seldom studies involved in phytoremediation of B[a]P and pyrene co-contaminated soils, especially for the growth and remediation effectiveness of *Mirabilis Jalapa* L..

2 Materials and Methods

Soil characterization. The tested soil samples were collected from the John Innes seed compost in UK. This compost contains a mixture of fine peat, sharp sand, loam, 0.5 kg phosphate rock and 0.7 kg base fertilizer. The proportion of N, P and K in the base fertilizer was 14:14:18. The moisture content of the fresh tested soil was 21.21%.

Experiment procedure. According to the Environmental Guidelines of Soil Quality Assessment for Exhibition Sites in China (HJ 350–2007), the soils should be remedied when the concentration of B[a]P was up to 0.66 mg kg^{-1} . Thus, in this study B[a]P or pyrene treatments were control, 0.01, 0.1, 1.0, 10.0 and 100.0 mg kg^{-1} , respectively, as simulating non-, low-, medium- and serious contamination. Half soils were put into autoclaved bags and autoclaved at 121°C for 90 mins in boxers. Hexane solution containing B[a]P and/or pyrene was mixed with 500 g soil as a different portion, then mixed with 500 g soil when hexane volatilized completely. The contaminated soils were incubated for one week in polybags. B[a]P and pyrene (purity > 99%) were obtained from Sigma Chemical Co., UK. The seeds of *M. Jalapa* (*M. jalapa* Broken Colours) were bought from Thompson & Morgan. In order to make sure the good germination, all pots were put into polybags and closed after sowing seeds for 20 days.

The seeds of *M. Jalapa* were sterilized in 1% (v/v) hydrogen peroxide for 30 min, washed with tap water and soaked in water for 1 day, then sowed directly into prepared soils. Five seedlings of *M. Jalapa* with a similar size, about 3–4 weeks old, and 6–7 cm height with 4–6 leaves were left in each pot. The soil surface was covered with a layer of silica sand to minimize B[a]P volatilization. Each treatment was prepared in 6 triplicate. The position of pots was changed randomly every week. Loss of water was made up using tap water to reach the field water-holding capacity and this humidity was maintained by spraying every other day throughout the cultivation, and saucers packed with polybags was placed under each pot to collect potential leachate during the experiment. The lights was kept 12 hrs everyday and the temperature was kept $20\text{--}25^\circ\text{C}$.

The plants were harvested for about 80 days after planting and washed with deionized water, and separated into roots and shoots. After drying parts of samples with filter paper, the sub-samples were freeze-dried (under -18 °C Power-DRY) and weighed to determine the biomass. The soil samples were homogenized sufficiently to pass through a 200-mesh sieve and kept into freezer.

Determination of B[a]P and pyrene in soils and plants. Extraction of B[a]P in soils and plants was performed according to King et al.[3] and Fan et al.[4]. Briefly speaking, 3g dried soil (shoot, or root) samples were weighed into 50 ml conical flask after power drying. 15 ml hexane was added into flask and shake flask, then leave it overnight in fume cupboard. All samples were extracted by ultrasonication for 30 min for 2 successive extractions. The extraction was centrifuged at 4000 rpm for 5 min to separate the supernatant from the soil or plant. The extractant was concentrated by evaporation of hexane under a stream of nitrogen, centrifuged again with micro-tube filters for 5 min and the residue was dissolved in hexane with a final volume of 2.0 ml for GC analysis.

Extractants (1 µl) were analyzed by a ion-quad trapped GC-MS and J & W Scientific DB-5MS column which was 30m long with an internal diameter of 0.25 mm and a film thickness of 0.25 µm. Separation was achieved according to the following program: the column temperature was 50°C (hold for 4 min), then increase at 20°C/min to 240°C, then increase at 30°C/min to 300°C (hold for 2 min). The injector temperature was 250°C and the carrier gas was Helium at 1.30 mls/min. Experiments on PAH recovery were carried out by adding a known concentration of PAH standards to uncontaminated soil and plant. The results showed satisfactory recovery was well for soils and plants.

Statistical analysis. All treatments were replicated six times in the experiments. The means and standard deviations (SD) were calculated by the Microsoft Office Excel 2007. One-way ANOVA analysis of variance was carried out with SPSS18.0. When a significant ($P < 0.05$ or $P < 0.01$) difference was observed between treatments, multiple comparisons were made by the LSD test.

3 Results and Discussion

Seed germination and growth of *M. Jalapa* in co-contaminated soil. It was observed that the addition of B[a]P and pyrene could facilitate the germination of *M. Jalapa* seeds under the medium B[a]P and perene levels for autoclaved soil, resulting in an increase at the rate of 3-6% when compared with the control group. However, there were inhibitive effects on the germination of the seeds for non-autoclaved soil, showing 14-30% reduction relative to the control. The germination of the seeds in autoclaved soil was better than that in non-autoclaved soil.

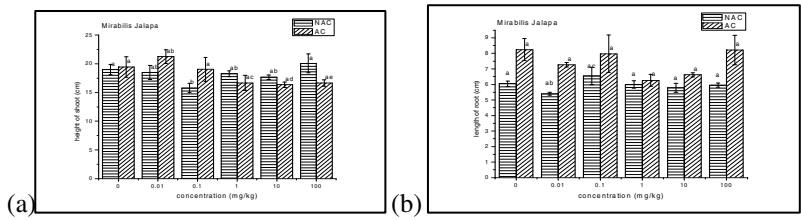


Fig. 1. The average shoot height (a) and root length (b) of *M. Jalapa* in NAC/AC soil spiked with PAHs (error bar means $\pm$ SD; a, b and c means if there is a significance between data at $\alpha=0.05$, $P<0.05$), Note: a) NAC means non-autoclaved soil; b) AC means autoclaved soil.

Fig. 1 (a) showed that there was not significant relationship between the height of *M. Jalapa* shoots and the concentrations of B[a]P and pyrene in soil. In non-autoclaved soil, it showed that the addition of B[a]P and pyrene inhibited the height of shoots, reaching the minimum height of shoots at 0.1 mg kg⁻¹. As for autoclaved soil, it was observed that the addition of B[a]P and pyrene facilitated an increase in the height of shoots at 0.01 mg kg⁻¹. When the concentration was up to 1.0 mg kg⁻¹, autoclaved soil still favored increasing the height of shoots.

Fig. 1 (b) showed that the effect of B[a]P and pyrene in soil on growth of *M. Jalapa* roots was not statistically significant compared with the control. It was also observed that autoclaved soil facilitated the growth of plant roots. The length of roots was lower than that in the control except 0.1 mg kg⁻¹.

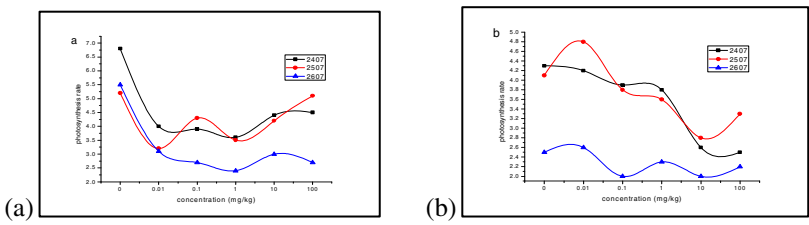


Fig. 2. Comparison in photosynthesis rate of *M. Jalapa* in NAC(a)/AC(b) soil

Photosynthesis rate of *M. Jalapa* in co-contaminated soil. It revealed that the co-contamination could inhibit photosynthesis rate of *M. Jalapa*. Lower contents of B[a]P and pyrene had mild influences on the photosynthesis, and higher contents of B[a]P and pyrene had intense effects on the photosynthesis. For non-autoclaved soil, photosynthesis in the control was at the highest and there was not significant relationship between the photosynthesis rate and the concentrations of B[a]P and pyrene (Fig. 2a); for autoclaved soil, photosynthesis of *M. Jalapa* changed frequently as a result of weather and light changes. As a whole, photosynthesis of *M. Jalapa* reduced with an increase in the concentrations of B[a]P and pyrene in soil (Fig. 2b).

Biomass change in *M. Jalapa* under joint stress of B[a]P and pyrene. Fig. 3a showed changes in the fresh and dried shoot weight of *M. Jalapa* growing in B[a]P and pyrene co-contaminated soil. It was observed that there was not significant

relationship between biomass of *M. Jalapa* shoots and the contents of B[a]P and pyrene in soil. The fresh and dried weight of shoots in non-autoclaved soil tended to increase under joint stress of B[a]P and pyrene co-contamination. Although the fresh and dried weight of shoots in autoclaved soil tended to decrease under the joint stress, the effect was not statistically significant when compared with that in the control.

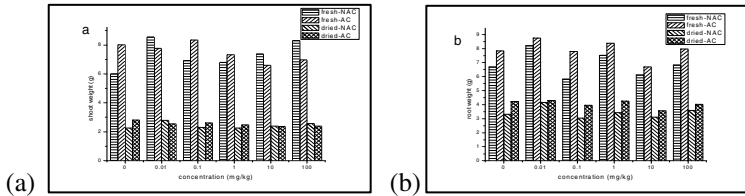


Fig. 3. The fresh and dried weight of *M. Jalapa* shoots(a) and roots(b) in co-contaminated soil

The biomass changes of *M. Jalapa* roots are depicted in Fig. 3b. The fresh and dried weight of roots in non-autoclaved soil was lower than that in autoclaved soil all the time, but the difference was not significant with an increase in the concentrations of B[a]P and pyrene in soil.

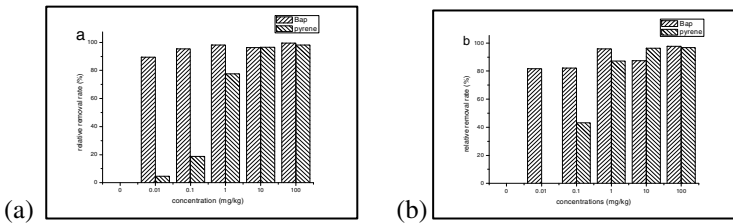


Fig. 4. The removal rate of B[a]P and pyrene in NAC(a)/AC(b) spiked soil

The removal of B[a]P and pyrene in spiked soil. Fig. 4 described changes in the removal rate of B[a]P and pyrene in autoclaved and non-autoclaved soil. The removal rate of B[a]P was 89-99% in non-autoclaved soil and 83-98% in autoclaved soil, respectively (Fig. 4a). With an increase of B[a]P in soil, the removal rate in non-autoclaved soil increased. The removal rate of B[a]P in autoclaved soil was lower than that in non-autoclaved soil, indicating that there were less fungus species in initial autoclaved soil, thus having reduced the removal rate. The removal rate of pyrene was 89-99% in non-autoclaved soil and 74-97% in autoclaved soil, respectively, and increased with an increase in the content of pyrene (Fig. 4b). When the concentration of pyrene was low, the removal rate in autoclaved soil could be higher than that in non-autoclaved soil. When the concentration of pyrene was low, the removal rate in autoclaved soil could be higher than that in non-autoclaved soil. On the contrary, the removal rate in autoclaved soil was lower than that in non-autoclaved soil when the concentration of pyrene was high.

Accumulation of B[a]P and pyrene in *M. Jalapa* plants. The accumulation of B[a]P in roots of the tested plants could basically increase with an increase in the content of B[a]P in non-autoclaved and autoclaved soils. There was a significant positive correlation between B[a]P uptake in the roots and B[a]P in soil. The corresponding relationships can be expressed using the following regression equations:

$$YB_{\text{root-nac}} = 0.22X_b - 0.36 \quad (R^2 = 0.21; P < 0.05) \quad (1)$$

$$YB_{\text{root-ac}} = 0.16X_b - 0.18 \quad (R^2 = 0.40; P < 0.05) \quad (2)$$

Where $YB_{\text{root-nac}}$ and $YB_{\text{root-ac}}$ are the concentrations of B[a]P in roots in non-autoclaved soil and autoclaved soil, respectively; X_b is the concentration of B[a]P in soils.

The ability of B[a]P uptake and translocation by *M. Jalapa* was still weak. The highest amount of B[a]P concentrated in roots was at 10.0 mg kg^{-1} in non-autoclaved soil and at 1.0 mg kg^{-1} in autoclaved soil, and higher than that in shoots. B[a]P added into soil was mainly concentrated in the roots, up to 100% of the plants, because the concentration of B[a]P in shoots was zero in both non-autoclaved soil and autoclaved soil.

In B[a]P-pyrene co-contaminated soil, the concentration of pyrene in tissues of the plants was in the sequence root > shoot. The accumulation of pyrene in roots could basically increase with an increase in the content of pyrene in soil. A positive correlation between uptake of pyrene in roots and the content of pyrene in soil can be expressed using the following regression equations:

$$YP_{\text{root-nac}} = 0.0081X_p + 0.0005 \quad (R^2 = 0.86; P < 0.05) \quad (3)$$

$$YP_{\text{root-ac}} = 0.0068X_p - 0.0005 \quad (R^2 = 0.78; P < 0.05) \quad (4)$$

Where $YP_{\text{root-nac}}$ and $YP_{\text{root-ac}}$ are the concentration of pyrene in roots in non-autoclaved soil and in autoclaved soil, respectively; X_p is the concentration of pyrene in soils.

The ability of pyrene uptake and translocation by *M. Jalapa* was also weak. The highest amount of pyrene concentrated in roots was at 10.0 mg kg^{-1} in non-autoclaved soil and at 100.0 mg kg^{-1} in autoclaved soil, and higher than that in shoots. The accumulation of pyrene was also mainly concentrated in roots, up to 100% of the plants.

4 Conclusions

This study examined growth responses and phytoremediation potential of *M. Jalapa* in B[a]P and pyrene co-contaminated soil. All growth factors showed that *M. Jalapa* had a low-grade tolerance to B[a]P and pyrene co-contamination, although B[a]P and pyrene could inhibit the seed germination of *M. Jalapa* and its photosynthesis rate. The co-contamination of B[a]P and pyrene had mild effect on shoot height, root length, and the fresh and dried weight (biomass) of *M. Jalapa*. As a potential remediation plant, *M. Jalapa* could strongly uptake B[a]P and pyrene by its roots. However, the amount of B[a]P and pyrene accumulated in shoots was close to zero.

The residual concentration increased with an increase in the initial content of B[a]P and pyrene in soil. The removal rate of B[a]P was up to 89-99% in non-autoclaved soil and 83-98% in autoclaved soil, respectively. The removal rate of pyrene was up to 89-99% in non-autoclaved soil and 74-97% in autoclaved soil, respectively. Less fungi in the initial soil favored the removal of pyrene, but reduced the removal of B[a]P. It can be believed that the plant-enhanced dissipation of B[a]P and pyrene was the predominant contribution as plant-promoted rhizospheric microflora degradation in soil. Thus, *M. Jalapa* could be basically used for phytoremediation of B[a]P and pyrene co-contaminated soils.

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The Alternating Direction Iterative of Axial Symmetrical and Static Magnetic Field without Charge and Current Distribution

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Abstract. In this paper, the problems of calculating and solution about magnetic fields were studied. An accurate theory model was established which can apply in high-performance numerical calculation. The new calculating method was proposed using Maxwell's equations in the circumstances of that magnetic field is static, axial symmetric, without charge and current, finite, differentiable and integrable. This calculating method was called alternating iterative method. The expression form was also given on the basis of the calculating method. The magnetic field outside of axis can be expressed as each order derivative and one-dimensional integration of magnetic field which on the symmetric axis. By means of this method, the expression form is progression, which is the best form use for computer to conduct approximate calculation. It is very easy, quickly and accurately to carry out numerical calculation by using this method. The calculation method has important theoretical significance and broad prospect of application.

Keywords: alternating direction iterative, without charge and current distribution, magnetic field, static, axial symmetry.

1 Introduction

As everyone knows, axial symmetric phenomena are very common and important in natural. The solutions for axial symmetric electromagnetic fields are also very common and important in the theory and practical application of electromagnetic fields. If it is highly axial symmetric, that is, the magnetic field is only a function of cylindrical coordinates r , it can be solved directly by using Gauss's theorem, loop theorem and axial symmetry. Otherwise, if it is normally axial symmetric, that is, the magnetic field is relative to both cylindrical coordinates r and z , it is very difficult to get its generally analytic solutions. In this case, we can perform approximate calculation by using computers. Yet, owing to the complexity of problems and improper handling of them at times, the approximate solutions are not easy to approach exact solutions, or it takes a long time to get more ideal approximate solutions, or even it is quite difficult to perform approximate calculation. Along with the high performance of electronic computers in recent years, numerical simulation and analytical calculations of electromagnetic fields have been prosperous. In the

process of researches and calculations people have presented many methods, such as sparse-matrix canonical-grid method [1], two-grid method [2], multilevel sparse-matrix canonical-grid method [3], time domain finite difference method [4], impedance approximate method [5], etc.

To optimize algorithm and improve computational efficiency, this paper built a precise theoretical model and gave a computational method with high performance. In the circumstances of the axial symmetric, without charge current distribution and static magnetic field which is limited, integrable and differentiable on the symmetric axis, this paper gives a new kind of computing method and its results in the series form by using Maxwell equations and calculus. That is, the out-of-axis magnetic field can be determined by the magnetic field on the symmetric axis and its different order derivatives. The procedure and results of approximate calculation state that the results in the series form are the most ideal results for computer to perform approximate calculation with extremely high degree of accuracy and quick speed.

The new computing method given by this paper is very important in theory and application since signal detection and calculation is an important part in scientific research and engineering. Along with the progress of science and technology, scientific researchers invented many measuring or detecting devices [6]. They can directly measure or detect signals by using them [7]. On the other hand, the researchers did in-depth theoretical studies in the analysis and presumption of the signal components [8]. In fact, many signals can be described as electromagnetic wave. So the problems become the calculation or detection of electromagnetic wave. As known, in some cases, measuring devices can not reach the regions of some signals because of limitation. So this paper gives a new kind of computing method and results to calculate or detect signals. That is, the magnetic field on one point can be calculated, detected or presumed with another point. As you know, a magnetic field can be regarded as a static state approximately if the signal changes slowly. Then, to the static and passive field, there is certain theoretical and applied value for the study how to solve the magnetic field at one point by calculating or detecting another point. To optimize algorithm and improve computational efficiency, this writer built a precise theoretical model and gave a computational method with high performance. Not long ago, the authors studied the electric field and magnetic field using the method [9-16]. This paper is its further development.

The Alternating Iteration of Axial Symmetric and Static Magnetic Field

As is known to all, the differential form of Maxwell's equations is

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad (1)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (2)$$

$$\nabla \cdot \vec{D} = \rho \quad (3)$$

$$\nabla \cdot \vec{B} = 0 \quad (4)$$

We choose cylindrical coordinates r , φ , z , and the z axis is the symmetric axis of the magnetic field. In the circumstances of vacuum, without charge current distribution and static state, applying Maxwell's equations and axial symmetry, the equations of the magnetic field to follow are

$$-\frac{\partial B_\varphi}{\partial z}\bar{e}_r + \left(\frac{\partial B_r}{\partial z} - \frac{\partial B_z}{\partial r}\right)\bar{e}_\varphi + \frac{1}{r}\frac{\partial(rB_\varphi)}{\partial r}\bar{e}_z = 0 \quad (5)$$

$$\frac{1}{r}\frac{\partial(rB_r)}{\partial r} + \frac{\partial B_z}{\partial z} = 0 \quad (6)$$

From the (5) and (6), we have

$$B_r(r, z) = -\frac{1}{r}\int_0^r \frac{\partial B_z(r, z)}{\partial z} r dr \quad (7)$$

$$B_z(r, z) = B(z) + \int_0^r \frac{\partial B_r(r, z)}{\partial z} dr \quad (8)$$

$$B_\varphi(r, z) = 0 \quad (9)$$

$B(z) = B_z(0, z)$ in the (8). The equations (7), (8) and (9) show that the axial symmetric, without charge current distribution and static state magnetic field $B_\varphi(r, z)$ is identically vanishing. However, because of the mutual nestification of $B_r(r, z)$ and $B_z(r, z)$, none of them can be solved directly. In order to solve $B_r(r, z)$ and $B_z(r, z)$, we suggest the new computing method (alternating iteration method). That is, one should choose a proper initial value and make use of the (7) and (8) to perform alternating iteration. Obviously, approximate solutions are given by the alternating iteration of finite degrees and times. With increasing the degrees and times of alternating iteration, the solutions are more exact. After the alternating iteration of infinite degrees and times, the exact solutions of the out-of-axis magnetic field can be given. Here, we choose $B_z(r, z)$'s value on the symmetric axis as the initial value, that is

$$B_{0z}(r, z) = B_z(0, z) = B(z) \quad (10)$$

$B(z)$ was also expressed into

$$B(z) = \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} B^{(2 \times 0)}(z)(r)^{2 \times 0} \quad (11)$$

Substituting the (10) into the (7), we can get

$$B_{0r}(r, z) = \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} B^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \quad (12)$$

$B^{(n)}(z)$ is the n th derivative of $B(z)$ with respect to z in the (12).

Substituting the (12) into the (8), we get

$$B_{1z}(r, z) = \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} B^{(2 \times 0)}(z)(r)^{2 \times 0} + \frac{(-1)^1}{(1!)^2 2^{2 \times 1}} B^{(2 \times 1)}(z)(r)^{2 \times 1} \quad (13)$$

Substituting the (13) into the (7), we obtain

$$\begin{aligned} B_{1r}(r, z) &= \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} B^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \\ &+ \frac{(-1)^{1+1}}{(1+1)!1!2^{2 \times 1+1}} B^{(2 \times 1+1)}(z)(r)^{2 \times 1+1} \end{aligned} \quad (14)$$

Substituting the (14) into the (8), we get

$$\begin{aligned} B_{2z}(r, z) &= \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} B^{(2 \times 0)}(z)(r)^{2 \times 0} + \frac{(-1)^1}{(1!)^2 2^{2 \times 1}} B^{(2 \times 1)}(z)(r)^{2 \times 1} \\ &+ \frac{(-1)^2}{(2!)^2 2^{2 \times 2}} B^{(2 \times 2)}(z)(r)^{2 \times 2} \end{aligned} \quad (15)$$

Substituting the (15) into the (7), we obtain

$$\begin{aligned} B_{2r}(r, z) &= \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} B^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \\ &+ \frac{(-1)^{1+1}}{(1+1)!1!2^{2 \times 1+1}} B^{(2 \times 1+1)}(z)(r)^{2 \times 1+1} + \frac{(-1)^{2+1}}{(2+1)!2!2^{2 \times 2+1}} B^{(2 \times 2+1)}(z)(r)^{2 \times 2+1} \end{aligned} \quad (16)$$

Substituting the (16) into the (8), we get

$$\begin{aligned} B_{3z}(r, z) &= \frac{(-1)^0}{(0!)^2 2^{2 \times 0}} B^{(2 \times 0)}(z)(r)^{2 \times 0} + \frac{(-1)^1}{(1!)^2 2^{2 \times 1}} B^{(2 \times 1)}(z)(r)^{2 \times 1} \\ &+ \frac{(-1)^2}{(2!)^2 2^{2 \times 2}} B^{(2 \times 2)}(z)(r)^{2 \times 2} + \frac{(-1)^3}{(3!)^2 2^{2 \times 3}} B^{(2 \times 3)}(z)(r)^{2 \times 3} \end{aligned} \quad (17)$$

Substituting the (17) into the (7), we obtain

$$\begin{aligned}
 B_{3r}(r, z) &= \frac{(-1)^{0+1}}{(0+1)!0!2^{2 \times 0+1}} B^{(2 \times 0+1)}(z)(r)^{2 \times 0+1} \\
 &+ \frac{(-1)^{1+1}}{(1+1)!1!2^{2 \times 1+1}} B^{(2 \times 1+1)}(z)(r)^{2 \times 1+1} + \frac{(-1)^{2+1}}{(2+1)!2!2^{2 \times 2+1}} B^{(2 \times 2+1)}(z)(r)^{2 \times 2+1} \\
 &+ \frac{(-1)^{3+1}}{(3+1)!3!2^{2 \times 3+1}} B^{(2 \times 3+1)}(z)(r)^{2 \times 3+1}
 \end{aligned} \quad (18)$$

The rest may be deduced by analogy. The exact solutions of $B_z(r, z)$ and $B_r(r, z)$ can be given by the alternating iteration of infinite degree. That is

$$B_z(r, z) = \sum_{n=0}^{\infty} \frac{(-1)^n}{(n!)^2 2^{2n}} B^{(2n)}(z)(r)^{2n} \quad (19)$$

$$B_r(r, z) = \sum_{n=0}^{\infty} \frac{(-1)^{n+1}}{(n+1)!n!2^{2n+1}} B^{(2n+1)}(z)(r)^{2n+1} \quad (20)$$

2 Conclusions

According to the study, we can get a conclusion. In the circumstances of the static, axial symmetric, without charge and current distribution, finite, differentiable, and integrable, this paper provides a new kind of computing method (alternating iteration method) and its results in the series form by making use of Maxwell equations and calculus. That is, the out-of-axis magnetic field can be determined by the magnetic field on the symmetric axis and its different order derivatives. It has been exact enough, and it is very easy to perform approximate calculation with quite high speed. Therefore, the theory, method and results given by this paper not only are of certain theoretical meaning, but also are of quite great-applied value. Especially to those problems of some out-of-axis areas that are not easy to measure or get exact solutions from theory, it is easy, quick and exact to solve them by using the method and results given by this paper.

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Control Schistosomiasis Spreading Based on the Snail's Hydrodynamic Characteristics in China: A Review

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Abstract. Schistosomiasis remains one of the most prevalent parasitic infections in the world, and also which threatens some area of China. The dispersion of snails along the rivers and channels is the main factor of the enlarging infected area of Schistosomiasis. This paper reviews the ecological hydrodynamic characteristics of snail and the technologies for preventing snail transmission via water conservancy projects, indicates the shortage of the related research, which can provide the new thoughts for preventing schistosomiasis spreading via water conservancy projects.

Keywords: Schistosomiasis spreading, snail, hydrodynamic characteristics, water conservancy projects.

1 Introduction

Schistosomiasis remains one of the most prevalent parasitic infections in the world. It is endemic in 76 countries and territories, and continues to be a global public health concern in the developing worlds [1]. Schistosomiasis has long history, is widespread and with serious damage, it is estimated that Schistosomiasis threatens 652 million persons, infects 193 million persons and 120 million persons have symptoms [2]. Schistosomiasis is also a major parasitic disease in China and is mostly found in the areas along the Changjiang River, It was been estimated that about 13 provinces and 373 counties covering an area of about 3480 km² are threatened by the disease [3]. The snail (*Oncomelania hupensis*) is the only intermediate host in China. There are kinds of final hosts for Schistosomiasis, so it is difficult to control Schistosomiasis spreading from preventing people's infection. Practice has improved that control snail transmission can prevent the spreading and infection of Schistosomiasis, which has great significance for the prevention and cure of Schistosomiasis.

The existence, reproduction and transmission of snail all have close relation with water, so the transmission of snail along the rivers and channels is one of the key factors for the enlarging infected area of Schistosomiasis [4]. According to a survey [5], along the 14 main rivers in Hubei Province including Changjiang River and Hanjiang River, snails diffuse from 114 of total 381 irrigation culverts or gates, accounting for 29.9%; along the Dongting lake in Hunan Province, snails diffuse from

157 of total 539 irrigation culverts or gates, accounting for 29.2%; and there are similar situation in other infected area. So how to prevent snail transmission with water and eliminate them is a burning question.

In China, some water conservancy projects based on the snail's hydrodynamic characteristics, for instance, settling basin for snails and installation preventing snails via collecting water from middle layer, have been constructed and also have been proved useful for preventing snail transmission. But these water conservancy projects also have some inadequate in region applicability, structure layout, investment, management, and so on, which can not be applied in all region. So the hydrodynamic characteristics of snail and the technologies of water conservancy combined for schistosomiasis prevention need more deeply research [6].

2 The Ecological Characteristics of Snail

2.1 The Distribution of Snail

The snails locate in south of 33°15' N [7], the highest altitude for snail existence is 3000m [8]. According the geographic feature of snail distribution area, which can be divided into three types, river net, massif and lake marsh. The pattern of river net mainly locates at the plain area downstream of Changjiang River, massif pattern can be found in Sichuan, Yunnan, Guangxi, Fujian and Taiwan Province; the area along Dongting Lake, Poyang Lake and other small lakes can be called the pattern of lake marsh.

2.2 The Growth and Reproduction of Snail

The copulation, spawning, incubation and growth of snail have been influenced by air temperature, water, illumination, plant, and so on. The suitable air temperature for snail copulation is 15-20°C. The suitable temperature for spawning is 20-25°C and then the suitable soil moisture is 40.1%. Under normal situation, adolescent snail growing mature and starting copulation should take about 2.5 months, the length of time has close relation with local geography, climate and other conditions. 13°C is the best temperature for adult snail existence. [9]

2.3 The Transmission of Snail

The crawling speed of snail is very slow, the maximum crawling speed is about 2.98cm/min [10], and the snail can only crawls on the ground with mud or grass, under warm and humid environment. So the transmission of snail is mainly along with water flow, there are three patterns: water surface transport, water bottom transport and suspended in water [11].

And water surface transport can be divided into two situations: 1) snail absorbs on the floating debris; 2) adolescent snail suspends in water. With much faster flow speed, the abjunction rate of snail is much higher. From the aspect of debris, mouldered wood has the lowest abjunction rate, and followed by wood, tree leaves, reed leaves, and grass stems [12].

3 The Hydrodynamic Characteristics of Snail

The density and geometry of snail are the basic information for the research of hydrodynamic characteristics of snail. The settling, starting and voluntary movement characteristics are the important theoretical basis for the technologies preventing snail transmission combined with water conservancy projects.

3.1 The Density and Geometry of Snail

The density of live snail is between 1.75 and 1.84 g/cm³, the average value is (1.80±0.1) g/cm³; the density of spawn is between 2.25 and 2.33 g/cm³, the average value is (2.29±0.1) g/cm³ [13].

The geometry is similar with cone, which can be described by the height h and the diameter D of snail. At different growth stages, the geometry of snail is not completed similar. According to the dimensionless value h/D , the geometry of snail can be divided into three levels, form I to III [14].

3.2 The Settling Characteristic of Snail

The settling process of snail in still water is relatively stable, almost with no horizontal movement. When releasing snail by any methods (with snail mouth downward, upward or horizontal) in settling experiment, the snail always settles in horizontal pattern [14]. The settling resistance coefficient in still water of mature snail is smaller, but which is opposite for the spawn, that's because of the geometry of spawn and snail, spawn is almost a ball, but the snail is similar with a cone, so the snail with one day age has the biggest resistance coefficient [15].

Similar with the settling characteristic in still water, the snail also settles in horizontal pattern. When the velocity less than 10 cm/s, the snail do not move again when they reach the bottom; when the velocity greater than 10 cm/s, the snail will slide or roll along the bottom; when the velocity less than 10 cm/s, the settling trajectory is almost a line; when the velocity greater than 10 cm/s, the settling trajectory is slightly similar with a parabolic [16]. The settling resistance coefficient in non-still water not only has relation with snail's age, but also has relation with flow velocity, with greater velocity the snail has greater resistance coefficient [15].

3.3 The Starting Characteristic of Snail

The snail has three types of starting states: no absorption force, absorbed on movable bed and absorbed on static bed, the starting velocity is smallest in the state with no absorption force, and the starting velocity is biggest in the state of absorbed on static bed, the middle state is absorbed on movable bed [14]. Except of flow velocity, there are more factors influence the starting characteristic of snail under water, for instance, water depth, time, the biological characteristics of snail, and so on, which need more deeply research.

3.4 The Voluntary Movement Characteristics in Water of Snail

Under non-still water condition, the crawling speed of snail with 7 week age is fastest (1.54 cm/min) with 0.09 m/s flow velocity. The crawling speed of adult snail is fastest (1.79 cm/min) with 0.15 m/s flow velocity [17]. When the flow velocity less than 0.2 m/s, 52% snails crawl against water current; when the flow velocity greater than 0.2 m/s, snails can not crawl against water current [18]. Snails crawl non-directionally in still water [18].

3.5 Preventing Snail Transmission Combined with Water Conservancy Projects

According to the hydrodynamic characteristics of snail, we can design specific water conservancy projects to prevent snail transmission. In China, the measures can be divided into engineering aspects and non-engineering aspects, the engineering aspects include settling basin for snails, installation preventing snails via collecting water from middle layer, the platform or belt for preventing snails, covered conduit, elevating or lowering plain, hardening bank or channel, and so on; the non-engineering aspects include the operation and management of these water conservancy projects. These measures can be applied according to the local conditions. For the present, settling basin for snails and the installation preventing snails via collecting water from middle layer are widely applied for preventing snail transmission.

3.6 Settling Basin for Snails

Settling basin is used for settling and intercepting snails. According to the hydrodynamic characteristics of snails, settling basin can be built downstream of gates or pump stations, which must have larger discharge area with slow flow velocity, so the snails can settle in basin and can efficiently avoid snail's transmission. The largest velocity in basin is less than 20 cm/s, the design length of the basin should reach 2-3 times of settling distance of snails. For the gates with larger discharge, more construction land and investment are needed, and also the management is more difficult, so the settling basin can not suitable for all region.

In order to improve the effect of settling basin, usually the blocking network is installed in settling basin. But the blocking network is easily damaged, and is easily blocked by float debris, which is difficult for maintenance in actual operation; another method is that building a blocking wall in settling basin. But the blocking wall narrows the discharge area and influences the flow pattern seriously, which will enlarge the construction land and investment.

3.7 Installation Preventing Snails via Collecting Water from Middle Layer

Snails always distribute in water surface and water bottom, according to this hydrodynamic characteristic, the installation preventing snail via collecting water from middle layer is used for preventing snail transmission. The installation collects water from middle layer by culvert, the water inlet should be designed for avoiding eddy flow and float debris entering into culvert. The changes of water level in

upstream, the eddy in water inlet, and blocked and damaged of blocking network all influence effect for preventing snail seriously.

3.8 Summary

The transmission of snails along the rivers and channels is mainly factors for the enlarging infected area of Schistosomiasis. Preventing snail transmission according the hydrodynamic characteristics by water conservancy projects is a key measure. But the actually applied water conservancy projects have some disadvantages as described above. Though we have do some research on the ecological hydrodynamic characteristics of snail, for example, density, geometry, settling characteristic, starting characteristic of snail, and so on, we also need to know more, for instance, the settling characteristic of snail in vertical flow and curved flow. On the basis of the research, some more technologies based on the ecological hydrodynamic characteristics of snail should be developed, which can provided new methods and thoughts for preventing snails and schistosomiasis spreading via water conservancy projects.

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Parameter Inversion of Constitutive Model of Soil Using Neural Networks

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Abstract. Neural network models are developed for estimating model parameters of conditioned soils in EBP shield. The parameter identification of nonlinear constitutive model of soil mass is based on an inverse analysis procedure, which consists of minimizing the objective function representing the difference between the experimental data and the calculated data of the mechanical model. The models are found to have good predictive ability and are expected to be very useful for estimating model parameters of conditioned soils in EBP shield.

Keywords: Soil constitutive model, Parameter identification, Neural network, Tangent modulus of soil.

1 Introduction

Shield tunnelling has become a well-established tunnel construction method in various ground conditions. It is characterised by relatively complex interactions between the soil, the tunnel boring machine (TBM), the hydraulic jacks, the tunnel lining and the tail void grout [1]. It is sometimes difficult to clearly identify correlations between key parameters from measurement data due to the varying conditions of the measurements and the resulting large scatter. If realistic numerical models are used, simulations represent a useful tool to identify and quantify such correlations. To choose a constitutive model, one must verify its ability to represent the real behaviour of the soil under the considered loading. Excavating a tunnel leads to a complex loading which will generate in particular a rotation of principal stresses. The elastic parameters from this relationship vary according to the stress state. The Young's modulus increases with confining pressure and decreases with increasing shear stress. In a finite element simulation of a geotechnical problem, calibrations of the models used to reproduce soil behavior often pose significant challenges. Real soil is a highly nonlinear material, with both strength and stiffness depending on stress and strain levels. Numerous constitutive models have been developed that can capture many of the important features of soil behavior. An effective and more objective way to calibrate a soil model employs inverse analysis techniques to minimize the difference between experimental data (laboratory or field tests) and numerically

computed results. The paper purpose is to propose a new method to estimate nonlinear model parameters of soil mass based on the neural network and finite element method.

2 Neural Network Model for Parameter Estimating in Conditioned Soil

In common engineering practice the choice of the soil model employed for a specific job mostly depends on both the expertise of the analyst and the economic aspects in terms of computation cost. However, application of a different soil model will lead to different results. This might be one of the reasons for a considerable deal of discomfort among practitioners related to the reliability of such computations. Hence, it might be interesting to investigate the range of predicted response, resulting from the application of different soil models. The behaviour of an elastic perfectly-plastic material is governed by a yield criterion and an associated flow rule. The Drucker-Plager criterion is a simple modification of the Von Misses criterion involving the influence of the hydrostatic pressure on failure. The yield function of the Mohr-Coulomb model is[2]

$$f = [\tau] - c - \sigma_n \tan \varphi = 0 \quad (1)$$

Where, $[\tau]$ is the shear strength of material; c is cohesion of material; φ is the friction angle of material; σ_n is the normal stress. The yield function of the Drucker-Plager model can be expressed as follows[3]:

$$f(I_1, J_2) = \alpha I_1 + \sqrt{J_2} - k = 0 \quad (2)$$

Where, I_1 is the first stress invariant and J_2 is the second deviatoric stress invariant.

An artificial neural network model is a system with inputs and outputs based on biological nerves. The system can be composed of many computational elements that operate in parallel and are arranged in patterns similar to biological neural nets. A neural network is typically characterized by its computational elements, its network topology and the learning algorithm used [4]. The architecture of BP networks includes an input layer, one or more hidden layers, and an output layer. The nodes in each layer are connected to each node in the adjacent layer. Notably, Hecht-Nielsen proved that one hidden layer of neurons suffices to model any solution surface of practical interest. Hence, a network with only one hidden layer is considered in this study. Before an ANN can be used, it must be trained from an existing training set of pairs of input-output elements [5]. Training methods based on back-propagation offer a means of solving this nonlinear optimization problem based on adjusting the network parameters by a constant amount in the direction of steepest descent, with some variations depending on the flavor of BP being used [6]. The optimization algorithm used to train network makes use of the Levenberg-Marquardt approximation. This algorithm is more powerful than the common used gradient descent methods, because the Levenberg-Marquardt approximation makes training more accurate and faster near minima on the error surface.

2.1 Parameter Estimating Approach for Conditioned Soils in EPB Shield

In order to fulfill all the requirements for a successful EPB technology application, as well as to extend the applicability of such technology over a wider range of soils, it becomes necessary to inject some additives that transform the soil into a material that shows the required features: Good plasticity, low permeability and pulpy consistency. In order to determine the material mechanical parameters of conditioned soils, the finite element method and artificial neural network are used, and the parameter estimate approach is developed. FEM is applied to supply training samples for parameter estimate approach based on neural network. Fig 1 shows typical deformation graph for slump simulation.

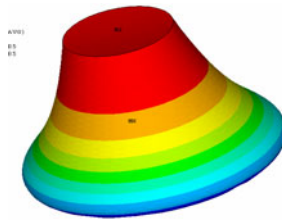


Fig. 1. Typical deformation graph for slump simulation

There are 6 measured points in the FEM models. The vertical location of measured points are located in the elevation 5,10,15,20,25,30cm, respectively. The vertical and horizontal deformation is recorded for estimating soil parameters. The 40 samples are randomly generated according to the mean values and standard deviation of conditioned soil parameters. The 35 training samples are randomly selected, and other 5 samples are used to validate the effectiveness of estimating approach. The topology structure of neural network is composed of 12 input nodes, 25 hidden nodes and 4 output nodes. Estimated model parameters include deformation modulus(E), Poisson ratio(μ), friction angle(φ) and cohesion(C). Table 1 lists estimated model parameters of conditioned soils. Fig. 2 shows deformation graph for slump test of conditioned soil.

Table 1. Estimated model parameters

Parameters	E/kPa	μ	C/kPa	φ°
Values (test 1)	580.0	0.42	8.0	31.0
Values (test 2)	350.0	0.46	3.0	24.0



Fig. 2. Deformation graph for slump test of conditioned soil

3 Conclusions

Determination of the shear strength of soils has been a priority issue for engineers and mathematicians. In order to establish a realistic model, a number of numerical simulations and laboratory tests were performed. Results also indicate that ANN-based models are more successful with reference to multiple regression-based models. In addition, the selection of learning algorithm is also crucial for the performance of the developed ANN model. For this reason it should be emphasized that specific care should be dedicated to the selection of learning algorithm for every ANN-based modeling study. Based on the comparison of the results with the numerically simulated observations, the models are found to have reasonably good predictive ability and are expected to be very useful especially for parameter identification of conditioned soils in shield tunneling.

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Optimal Estimation of Forest Carbon Sequestration Based on Eddy Correlation Method

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Abstract. Forest ecosystem is a large and complex dynamic systems, carbon balance of forests directly affects the balance of the global ecosystem, studying quantitatively the balance of payments problems of carbon dioxide in the global atmosphere, land, marine and other ecosystems is today's hotspot and difficulty. This article was based on the research of eddy correlation method, relaxed eddy accumulation method and chamber method, improved eddy accumulation method, and introduced the concept of relaxation and the box-style ideas, using this method to estimate quantitatively carbon sequestration of trees and analyze comparatively the results, so made the estimation of forest carbon sequestration efficiency increase significantly, reduced the estimation error and cost.

Keywords: Forest carbon sink, Carbon balance, Carbon estimates, Eddy correlation method.

Introduction

Carbon sinks means process, activities and mechanisms for carbon storage body in nature to clear the CO₂ from the air. Carbon sink plays a very important role in reducing greenhouse gas concentrations in the atmosphere and slowing global warming [1]. Forest carbon sink has more economic and efficient benefits than other emission reduction ways, "Kyoto Protocol" makes forest carbon sink as the main alternative way to CO₂ emissions reduction [2].

Forests are the main terrestrial ecosystems, in terrestrial ecosystems eighty percent of aboveground and forty percent of underground parts of the organic carbon come from the forest, as a part of the global climate system, integrity and less destruction of forests is carbon source; forest played a decisive role in maintaining the ecological balance of land, protecting ecological safety and preventing ecological crisis; has significant implications for climate change and carbon balance present or future. Thus, estimating forest carbon stocks and evaluating forest carbon sequestration function is of great significance. Existing manual methods of forest resources inventory which have more human disturbance, error and inaccurate measurement and have no comprehensive measurement instrument, can not meet the market needs, we need to propose new solutions to the problem. Therefore, we need to grasp a

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reasonable digital method for estimating trees oxygen carbon fixation to adapt to the development trend of the times.

1 Basic Method of Estimating Carbon Sequestration

International estimation of forest carbon sequestration in a variety of methods, they are: biomass method, volume method, eddy correlation method, relaxation eddy accumulation method, and chamber method [3]. As the differences of level of the regional studies, the time scale, spatial scope and sophistication, different plot settings and estimation methods, so that the reliability and comparability of results is poor. Therefore, studying a new method of estimating carbon sequestration is necessary, especially under the premise of reducing the greenhouse effect around the corner, we should grasp an accurate estimation method of forest carbon sequestration ability, in this paper that is based on the micrometeorological eddy correlation method, we combined the concept of relaxation and the idea of chamber method, studied a more appropriate estimation method.

Micrometeorological method obtains the gas flux by measuring the surface layer turbulence conditions and gas concentrations by measured. The basic conditions of this method is that the micrometeorological parameters measurements must be carried out in constant flux layer, requiring a large area of uniform surface conditions, thus, the gas transport flux at a height can be considered to be measured near the surface of the gas flux [4].

Eddy correlation method is based on the micro-meteorology, in a reference height monitors CO_2 concentration, speed and direction, the vertical eddy flux of CO_2 in a fixed height above the canopy layer can be expressed as:

$$F_c = \overline{\rho'_c w'} \quad (1)$$

$$\rho'_c = \rho_c - \overline{\rho_c} \quad (2)$$

$$w' = w - \overline{w} \quad (3)$$

Where: F_c is the eddy flux of CO_2 , ρ_c is defined as the concentration of CO_2 , w is the vertical wind speed, ρ'_c is the instantaneous difference of the CO_2 average density, w' is the instantaneous wind speed, among them, the cross is the average over some time, vertical exchange of substances in the atmosphere is often carried out by through the vortex flow of air, this vortex drove different substances in the air including CO_2 up or down through a reference surface, the difference between them is sequestration of ecosystems studied by researchers fixing or releasing CO_2 [5]. Eddy correlation method is known because it can measure directly forest ecosystem CO_2 flux in long-term and can provide basic data for the establishment and calibration of other models.

Relaxation eddy accumulation method originated in the eddy accumulation method, the basic idea is to collect 2 groups gas sample based on the size and

direction of the vertical wind speed for measuring. Use this method for estimating the amount of forest carbon sequestration, the estimation methods is:

$$F_{co_2} = \beta \sigma_w \rho_{air} (C_{up} - C_{down}) \quad (4)$$

Where: F_{co_2} is the CO₂ flux, σ_w is the standard deviation of vertical wind speed, ρ_{air} is the air concentration; $C_{up} - C_{down}$ is the difference of CO₂ average concentrations in two collection bag per half-hour, β is a semi-empirical constant [6].

Chamber Method [7] is that making a special box with a certain size cover a certain area of the top soil or plants, cutting off from the free exchange of gases within and outside the box, measuring changes with time of the greenhouse gases inside and calculating the gas exchange flux, in a closed system, CO₂ concentration with time is the flux of CO₂, namely:

$$F = V \frac{\Delta c}{\Delta t} \quad (5)$$

Where: F is the CO₂ flux, V is the determination of chamber size, $\frac{\Delta c}{\Delta t}$ is CO₂ change rate; In an open system, in the determination room air is flowing at constant velocity, measuring the CO₂ concentration difference of the inflow and outflow of air in the chamber to calculate CO₂ flux:

$$F = d \Delta c \quad (6)$$

Where: F is the CO₂ flux, d is the constant velocity of air flow in the determination room, and Δc is the CO₂ concentration difference of the inflow and outflow of air in the chamber. Application of chamber method, the total flux of entire forest ecosystem is CO₂ assimilation rate of assimilation organs and CO₂ release rate of non-assimilation organs.

2 Optimization of Carbon Sequestration Estimation Methods

Vortex flow of different materials in the air often make measurement of CO₂ instantaneous concentration exist a big deviation, therefore, in order to obtain more accurate density measurement, measurement need to be done in a relatively stable external conditions and exclude possible interference of the external natural environment, however, estimation should take into account all factors from inside and outside to make the estimation results more close to reality.

Eddy correlation method can be continuous, direct measurement of net CO₂ exchange capacity between ecosystem scale vegetation and atmosphere, but the observation with eddy correlation method during the day can not be divided directly into ecosystem photosynthesis and ecosystem respiration, if you want to get the ecosystem respiration during the day, you need to establish the relationship between night CO₂ flux and environmental factors to extrapolate daytime ecosystem

respiration, when atmospheric turbulence is weak in the night, the eddy correlation method for the observation of ecosystem respiration itself exists error, this would affect estimation of daytime ecosystem respiration and determination of the ecosystem carbon budget; the introduction of the relaxation concept in the thought of eddy accumulation makes irregular sampling into regular sampling, monitoring ecosystem growth status of each time period through regular sampling can get more representative sample for analysis and estimation; on this basis, we introduced ideas of box-style method and let a certain air flow through the box, determine the gas exchange flux by measuring gas concentrations of air measured in the entrance and the exit of box, this makes up shortages of eddy correlation flux observation under weak turbulent exchange in the night and the problem of distinguish among flux components during the day, you can also evaluate the spatial variability of ecosystem respiration level by multi-point observations.

Based on the above method, the amount of ecological systems by studied fix or release CO_2 can be expressed as:

$$F = \rho w T \quad (7)$$

$$\overline{F} = \overline{\rho w T'} = \overline{\rho w T} - \overline{\rho w T} \quad (8)$$

Where: F is the instantaneous flux, ρ is the air density, the standard state for the 1.29kg/m^3 , w is the vertical wind speed, T is the temperature of the gas flow, $\overline{F}$ is defined as the average vortex flux, The upper right superscript (short stroke) of letters is the average value of the vertical direction flow, that is vortex fluctuations, cross refers to average in a period of time (15 ~ 30 min). This method takes into account the net carbon dioxide exchange capacity between species and atmospheric through photosynthesis and respiration under different light conditions during the day or night, the eddy correlation method estimation algorithm introduces the gas temperature factors, uses the ideas of relaxation and measurement method of box-type, the comprehensive use of several methods not only brings the convenience to measurement, but also makes the estimation results more accurate, and get the data which is closed to the actual value through comparing and analyzing multiple sets of measurement results. Parameters of this method is less and easily measured, which makes up a series of inadequate, such as high labor intensity of artificial inventory methods, complex operation, error of measurement, low accuracy, and improves estimation efficiency of forest carbon sequestration and oxygen release.

Let's make carbon sequestration case of representative species of evergreen trees, deciduous trees, evergreen shrubs, deciduous shrubs in vigorous growth season as a research basis, study is done in the sunny, no wind or breeze and the natural lighting conditions, estimated daily carbon ($\text{gm}^{-2}\text{d}^{-1}$) of different tree species which grow in adequate sunlight from June to August per unit leaf area (m^2), digitally processed the estimation results using Visual C++6.0 program, and compared changes between different tree species per unit leaf area daily carbon sequestration and the seasonal average carbon sequestration, data from reference [8].

Table 1. The changes of different species carbon sequestration

plant type	species	June (%)	July (%)	August (%)
Evergreen Trees	Magnolia Grandiflora	-26.2	22.5	3.6
	Privet	-6.6	37.0	-30.4
	Loquat	-21.8	20.6	1.3
	Japanese Viburnum	-23.0	38.5	-15.4
	Camphor	-54.1	38.3	12.6
	Citron	-61.2	40.6	20.7
Deciduous Tree	Peach	-10.1	2.2	8.0
	Sophora Japonica	3.3	27.6	-30.8
	Locust	-39.5	18.7	20.9
	Weeping Willow	-19.1	-32.6	13.7
	Magnolia	-43.8	42.4	1.5
	Purple Plum	-36.5	35.8	0.7
	Ginkgo	-33.5	26.8	6.7
Evergreen Shrub	Oleander	15.7	10.5	5.3
	Gold Leaf Privet	-44.5	44.0	0.6
	Osmanthus	-24.3	31.5	-6.8
Deciduous Shrub	Admiralty Flower	-8.3	32.5	-24.0
	Chimonanthus	-20.9	21.7	-0.7
	Greeting Spring	-29.5	40.0	-10.5

According to the results, we can see that from table 1: Most of the trees, shrubs in the high temperature in July (usually at 28 degrees), the carbon sequestration is relatively higher, generally higher than the seasonal average value, especially the Gold Leaf Privet of evergreen shrubs, Magnolia of deciduous tree, Citron of evergreen tree and Greeting Spring of deciduous shrubs; and in the low temperature in June (average 25 degrees) the amount of carbon is generally lower than average, especially Citron, followed by Camphor and Gold Leaf Privet, but Sophora Japonica and Oleander are higher than average; as the temperature changes significantly in August, the temperature is different between day and night, different species carbon sequestration also shows irregular changes. From the comparison, we can find that: most of the trees, shrubs in the high temperature season has also high carbon sequestration, but there are few species with low-carbon when the temperature is high, for example, the Weeping Willow of deciduous trees in the high temperature whose carbon sequestration is much lower than the average, this indicates that carbon sequestration of the species is affected obviously by temperature and other external conditions, also have a certain relationship with its own internal factors. Therefore, when estimating the amount of forest carbon sequestration, in addition to consider the external natural environment, such as outside air temperature, but also can not ignore the impact factors of trees itself.

3 Conclusion

Forest is the earth's largest terrestrial ecosystem, is the main component of global carbon cycle, impacted by climate and environment, forest carbon sequestration

showed minor changes in the trend, therefore, estimating forest carbon storage should be based on specific conditions, select the appropriate method for estimating carbon sequestration. Taking into weather conditions influence on the trees photosynthesis and respiration, in this paper, we optimized eddy correlation method combining relaxation eddy accumulation method and box-type methods, not only reduced the error of estimation results caused by weather interference and amount of computation, but also effectively increase the estimation efficiency of forest carbon sequestration.

The estimation of forest carbon sequestration quantitatively labeled and tested forest carbon emissions, for ecological and environmental protection, the ecological benefits of planting trees, evaluation of environmental effects of tree species and age has a vital role; for forest "carbon sink" function and sustainable development is important. Estimating accurately the carbon stocks of forest various parts can better evaluate the potential of forest carbon sequestration, effectively controls the emissions of CO₂, and thus reduces global warming.

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Middle Atmospheric Density and Temperature Detection Using Rayleigh Lidar

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Abstract. The vertical distribution of middle atmospheric density and temperature can be obtained in the altitude range 30 to 90 kilometer by using Rayleigh Lidar. According to the data from actual measurement, the inversion results are in good agreement with those of the standard atmosphere model CIRA86. Generally, in the altitude range 30-65 km, the deviation of the atmospheric density measured by the Lidar from that of CIRA86 is no more than 5%, and the deviation of the temperature is less than 3 k. However, the deviation of the temperature above 75 km is very large.

Keywords: Lidar, Rayleigh-scatter, middle atmosphere, atmospheric density and temperature.

1 Introduction

Lidar is the extension of microwave radar. Because of its short wavelength and strong directional beam, Lidar inherently has high detection sensitivity and spatial resolution. Furthermore, the interactive between laser and the detected material enters into micro level because of its short wavelength, and this properties make the Lidar has the ability to distinguish very thin material. Just with this characteristic, the Lidar has come to be an important mean in atmospheric remote sensing.

Early radar ordinarily be used to atmospheric remote sensing in the altitude range 0-30 km. There are two aspects we should pay attention. One is that, since the low atmospheric has high density, the Rayleigh scattering echo generated by atmospheric molecules is much stronger. Furthermore, amount of aerosol in low atmospheric cause stronger Mie scattering echo. Because it is very difficult to distinguish these two echoes, the low-altitude Lidar is hardly be used in atmospheric and aerosol research [1].

This paper introduces a Lidar used to remote sensing in the altitude range 30-90 km. There is no aerosol above 30 km, so the Lidar echo signal completely come from the Rayleigh scattering of high atmospheric. That is why the Lidar is especially for the middle atmospheric remote sensing. However, the atmospheric density quickly lower with increasing altitude, the Lidar echo signal become very weak, and makes this technique very difficulty to use [2]. We introduce the primary structure of the Lidar and the inversion method of atmospheric density and temperature. The

temperature and density profile of the middle atmospheric in the altitude range 30-90 km is given in this paper. The inversion results are compared with those of CIRA86, and the reasons of this difference are discussed in this paper.

2 Lidar Technique

Generally, high atmospheric Lidar is composed of transmitter, echo signal receiver and data acquisition and control. The system structure is show in Fig. 1. Q-switched Nd:YAG laser is used in our Lidar. Its wavelength is 532 nm, single-pulse energy is about 200 mJ, pulse repetition rate is 10 Hz, and beam launch angle less than 1 mrad. The telescope used to receive the echo signal is Cassegrain telescope with 1 meter diameter, and its receiver perspective is 1-2 mrad. The backscattering signal is conversed by EMI9817B (PMT), and the output is amplified and then detected by photo-counter. The result is stored and displayed on computer. With the cooperation of PMT equipped with electronic gating circuit, the mechanical chopper settled near the focal plane can efficiently suppress the nonlinear effects and signal induced noise which generated by the PMT effected by the low atmospheric. A cooler that its function is alleviate thermal noise and dark current noise is equipped with PMT. The multi-channel photo counter (MCs) with maximum count rate 150MHz is employed to detect the high atmospheric weak echo signal. To suppress sky background noise, a narrow-band interference filter with bandwidth 0.87 nm and peak transmittance 51% is placed in front of the PMT.

The laser beam of Rayleigh Lidar interacting with air molecules can be used to detect temperature and density profile [3]. In this paper, we show that above method is effective with our practice. Lidar was first be used in atmospheric remote sensing in June 1980. The basic principle of Rayleigh Lidar is that the monochromatic light be launched into atmospheric and the backscatter timing provides the structure and components information of the atmospheric [4].

Two-axis method is used to suppress the strong echo signal in low atmospheric, because the detected target of the Lidar is the atmospheric above 30 km. The two-axis method is that by using increasing the distance between beam and the receiving telescope and strictly controlling the receiver perspective to suppress the effect of low atmospheric echo signal.

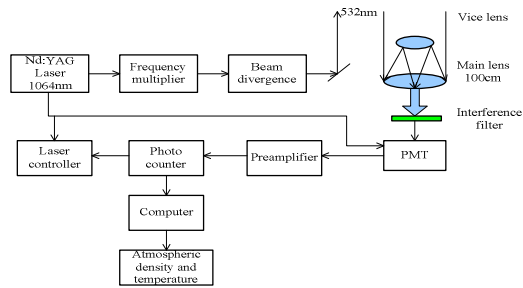


Fig. 1. The structure of Rayleigh Lidar system

3 Data Inversion

3.1 Atmospheric Density Profile Inversion

Lidar equation can be expressed as follows.

$$N(z) = \frac{c_q \rho(z)}{Z^2} \exp[-2 \int_0^z \sigma(z') dz'] \quad (1)$$

Where c_q is the system constant, $\rho(z)$ is the atmospheric density, and $\sigma(z)$ is the atmospheric extinction coefficient.

Since the atmospheric extinction coefficient $\sigma(z)$ is very small above the altitude 30 km, the decay item $\exp[-2 \int_0^z \sigma(z') dz']$ can be neglected. To avoid the difficulty of directly detecting the system constant, altitude z_0 is selected as the reference where atmospheric contains no aerosol^[5]. According equation (1), we have

$$N(z_0) = \frac{c_q \rho(z_0)}{z_0^2} \quad (2)$$

With equation (1) and (2), the atmospheric density profile can be show as follows.

$$\rho(z) = \frac{N(z) z^2 \rho(z_0)}{N(z_0) z_0^2} \quad (3)$$

3.2 Atmospheric Temperature Inversion

In order to obtain the distribution of atmospheric temperature, two steps must be taken. First, obtain the atmospheric density by the Lidar equation. And then, get the atmospheric temperature profile according to the atmospheric statics equation and gas equation^[6]. This paper uses recursive method to obtain the temperature distribution. Furthermore, the Lidar equation can be rewritten by the echo distance correction. The algorithm is as follows.

$$N(z) z^2 = c_q \rho(z) = X \quad (4)$$

Assume that X_0 is the echo of upper detection limit z_0 (85 km). Then X_1 can be defined as $z_1 = z_0 - dz$. According to the equation (4), we have

$$\frac{X_1}{X_0} = \frac{\rho(z_1)}{\rho(z_0)} = \frac{n(z_1)}{n(z_0)} \quad (5)$$

Where $n(z_1)$ and $n(z_0)$ are the number density of the atmosphere in the altitude z_1 and z_0 , respectively.

The ideal gas equation is as follows.

$$P = nkT \quad (6)$$

With equation (5) and (6), we have

$$\frac{X_1}{X_0} = \frac{P_1}{P_0} \cdot \frac{T_0}{T_1} \quad (7)$$

According to the atmospheric physics, gas pressure ratio can be show as follows.

$$\frac{P_1}{P_0} = 1 + \left(\frac{n_1 + n_0}{2} \right) \frac{Mgdz}{RT_0} \quad (8)$$

Where g , R and M are acceleration of gravity, universal gas constant and Molar mass of atmospheric molecule, respectively.

Following recurrence formulas (9) can be derived from equation (7) and equation (8).

$$T_1 = \left(\frac{X_1}{X_0} \right) \left(T_0 + \frac{Mgdz}{2R} \right) + \frac{Mgdz}{2R} \quad (9)$$

In order to obtain the whole atmospheric temperature distribution in the detected range, the integral operation of equation (9) is made from the upper detected limit z_0 to the lower limit. The standard error T_1 derived from equation (10) is as follows.

$$\sigma_{T_1}^2 = \left(T_0 + \frac{Mgdz}{2R} \right)^2 \left[\frac{\sigma_{X_0}^2}{X_1^2} + \frac{X_0^2 \sigma_{X_1}^2}{X_1^4} \right] + \left(\frac{X_0}{X_1} \right)^2 \sigma_{T_0}^2 \quad (10)$$

Where $\sigma_{X_0}^2$, $\sigma_{X_1}^2$ and $\sigma_{T_0}^2$ are the standard deviation squared of X_0 , X_1 and T_0 , respectively.

4 Observation Results and Discussion

We obtain the data by the Raleigh Lidar in the clear night of in Apr 6-7, 2009. Cumulative multi-pulse echo signals are used to improve the SNR. The time resolution of the sampling is 8 min, the spatial resolution is 150 m, and the maximum height of the sampling is 150 km. During data processing, the atmospheric echo between 120 km and 150 km can be seen as background noise. The way to eliminate the background noise is as follows. First, fit a curve according to the echo of each group echo signal between 120km and 150 km. In order to get more accurate results,

median filters are used to the echo between 120 km to 150 km before fitting. Then, the background noise of all the detected range can be derived by extrapolation. Using original echo subtracts above background noise, we can get the echo profile deducted background noise. Considering the fluctuations of the echo signal in the atmosphere, a moving average filter with window size 3 km is necessary to deal with the echo signal. Here the reference altitude is 30 km, and the reference values of density and temperature in designated altitude chosen from CIRA-86.

The typical echo curve of this Lidar is as shown in Fig. 2.

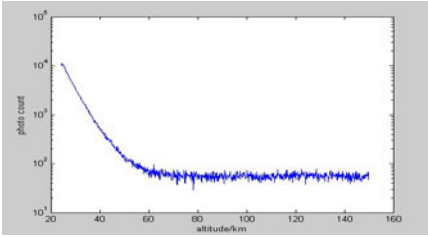


Fig. 2. Typical echo curve of the Rayleigh Lidar (time resolution 8 min, spatial resolution 150 m)

According the data obtained by the Rayleigh Lidar during 9 hours, the distribution of middle atmospheric density variations with increasing altitude at night in local area is as show in Fig. 3. The solid line in Fig.3 is the density profile obtained by the actual measurement data inversion. The dot in the figure is the results derived from CIRA86.

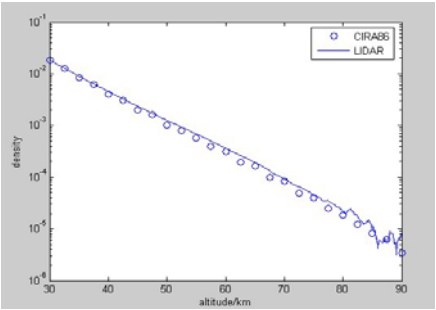


Fig. 3. Middle atmospheric density profile (spatial resolution 150 m, time resolution 9 hours)

It can be seen from Fig. 3 that except the significant fluctuation of the Lidar actual measurement results at high end of the detection range, the results of the atmospheric density inversion is in good agreement with those of CIRA86. The results show that suing Lidar to detect atmospheric density is feasible.

Since the photo counting fluctuation usually meet Poisson law, the estimation error generated by the photo counting fluctuation is proportional to the reciprocal of square root of the received photo number.

$$\sigma\rho = \frac{1}{\sqrt{p_r(z)}} \quad (11)$$

Where $p_r(z)$ is the Lidar echo photo number which doesn't contain the noise floor. Under the condition of deducting the noise floor of the Lidar echo, the results show that relative error of the atmospheric density detected by the Lidar is inversely proportional to the square root of the echo photo number. Obviously, any technique to improve the Rayleigh Lidar's signal strength is the efficient method to reducing relative error.

According to the equation (9), the distribution of middle atmospheric temperature is show in Fig. 4.

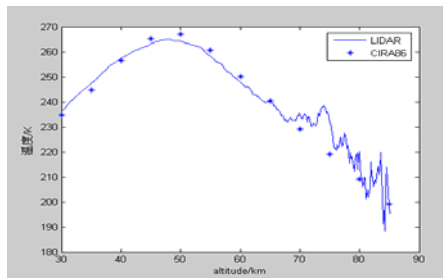


Fig. 4. Middle atmospheric temperature profile (spatial resolution 150 m, time resolution 9 hours)

As can be seen from Fig. 4, the top of the stratosphere is at the altitude 48 km with temperature 265.68 k. These results are agreed with those of CIRA86. However, comparing the results derived from standard atmospheric model CIRA86, the temperature measured by the Lidar still exist a certain error. In the altitude range 30-65 km, the measured temperature is in good agreement with CIRA86, but in the altitude range 75-85 km, because only a small number of photos can be detected near the upper detected limit and background noise is difficult to be deducted, the temperature error is relatively large.

In addition, during the calculation process of standard atmospheric model CIRA86, the non-local thermodynamic equilibrium^[7] may be overvalued, such that the results in altitude range 55-65 km is slightly higher, those in altitude range 65-80 km is slightly lower, and those in altitude range 80-90 km is slightly higher. Because the temperature of CIRA86 model which is slightly higher in the altitude range 80-90 km is taken as the original value, there is an obvious temperature error at the top of the Lidar profile. The temperature uncertainty of the top of the profile will result in large temperature error. However, the error rapid decline with decreasing altitude. The temperature uncertainty at the top of profile is 15%, and in the location where 15 km from the top, the temperature uncertainty is less than 2%. Take into account this situation, different types of priori knowledge of temperature are trying to be used to avoid this error. In our paper, the error of the Lidar measurement temperature from that of CIRA86 is in acceptable ranges. It is also show that the Lidar is effective and practical.

5 Conclusions

From above analysis, we can see that the Lidar is effective and convenient in detecting the middle atmospheric density and temperature in the altitude range 30-90 km. Under the condition of time resolution 9 hours and spatial resolution 150 m, the detection results are as follows. The detection accuracy of the density under 50 km is less than 1%, in the altitude range 50-70 km the accuracy is less than 5%, and in the altitude range 70-90 km the accuracy is less than 10%. The detection accuracy of the temperature under 45 km is less than 1%, in the altitude range 45-65 km the accuracy is less than 5%, and in the altitude range 65-85 km the accuracy is less than 10%. The study results show that the Lidar is an effective means in middle atmospheric research.

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Improvement and Application of Medical Image Segmentation Method Based on FCM

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Abstract. FCM algorithm is a classic algorithm applied to image segmentation during the processing of medical images. This article aims at a further study of the traditional FCM algorithm, including testing and improving the cluster category, weighting exponent and other elements which may influence the result of image segmentation. And for the image segmentation steps of FCM algorithm, we correct the maximum fuzzy membership of samples in the iteration. Then, we compare and analyse the results of the traditional algorithm and the improved one. The outcome demonstrates that the improved algorithm greatly improves the result of image segmentation. The improved algorithm makes an ideal achievement in practise.

Keywords: FCM, Medical Image, Image Segmentation, Membership.

Introduction

Medical images are basically fuzzy when being processed, so the FCM technology can be applied to the processing of medical images. The internal uncertainty of images can arise, due to human body's complex anatomical structure, irregular shapes of tissues and organs, differences of individuals, and the asymmetry of magnetic field, partial volume effect and noises during the imaging. Therefore, we introduce the fuzzy theory to the processing and analysing of images and obtain a better result from the image segmentation based on fuzzy set theory.

1 FCM Traditional Algorithm

FCM algorithm was first proposed by Dunn, then improved and promoted by Bezdek. It is Bezdek who figured out the iterative optimal algorithm based on the principle of least square method and proved that this algorithm converges to an extreme value. FCM algorithm has an excellent convergence by using iteration to optimize object function and get the fuzzy classification of data sets. The basic idea of FCM is as follows: We classify the finite set $X=\{x_1, x_2, \dots, x_n\} \in R$ formed by n samples into c categories, and c is the predetermined category number. $m_i (i=1, 2, \dots, c)$ is the center of each category, and $\mu_j(x_i)$ is the membership of Sample i in Category j . If every sample x_i has a membership of μ_{ik} in category k , the classification result can be shown by a fuzzy membership matrix $U=\{\mu_{ik}\} \in R_n \times c$, and the cluster rule function can be defined by membership function (1).

$$J(U, M) = \sum_{j=1}^c \sum_{i=1}^n [\mu_j(x_i)]^b \|x_i - m_j\|^2 \quad (1)$$

In this formula, $\|x_i - m_j\|$ is the Euclidean Distance between x_i and m_j , and b is the fuzzy weighting exponent which is a function in charge of the fuzzy degree of the cluster result. U is the fuzzy C segmentation matrix of C , and M is the set of X cluster centers. FCM algorithm aims at obtaining the minimum U and M of rule function. In FCM algorithm, the sum of all sample membership in each cluster must be 1, namely,

$$\sum_{j=1}^c \mu_j(x_i) = 1, i = 1, 2, \dots, n \quad (2)$$

We use (2) to compute the minimum of (1), and define $J(U, M)$ has a partial derivative of 0 to m_j and $\mu_j(x_i)$. The necessary condition for a minimum is as follows.

$$m_j = \frac{\sum_{i=1}^n [\mu_j(x_i)]^b x_i}{\sum_{i=1}^n [\mu_j(x_i)]^b} \quad j=1, 2, \dots, c \quad (3)$$

$$\mu_j(x_i) = \frac{(1 / \|x_i - m_j\|^2)^{1/(b-1)}}{\sum_{k=1}^c (1 / \|x_i - m_k\|^2)^{1/(b-1)}}$$

In (3),

$$i=1, 2, \dots, n; j=1, 2, \dots, c \quad (4)$$

FCM algorithm continues according to the following iterative steps:

- (1) Specify cluster number c , parameter b , stop threshold ε , and iterative number $t=1$ (the allowed maximum t is $t_{\max}$);
- (2) Initialize each cluster center m_i ;
- (3) Use current cluster center to compute membership function according to (4);
- (4) Use the current membership function to update cluster center of each category according to (3);
- (5) Select a proper matrix norm. If $\|M^{(t+1)} - M^{(t)}\| \leq \varepsilon$ or $t \geq t_{\max}$, the computation stops. Otherwise, $t=t+1$ and move back to (3).

When the algorithm is converging, we can get the cluster center and membership of every sample in each category, then the classification of FCM ends. In the end, we defuzzy the classification result, turning the fuzzy cluster into specific cluster and achieve the final clustering segmentation.

2 Problems in FCM Algorithm

Since the FCM algorithm integrates with the fuzzy set theory which can better portray the fuzziness and randomness of human visual sense and deal with the uncertainty in solving problems, image segmentation based on FCM algorithm is becoming an important branch in processing images, especially the FCM algorithm which can materialize a better segmentation. However, as matter of fact, the fuzzy clustering objective function is a non-convex function and there are a lot of local extreme values, so improper initialization will result in converging to local extreme values and the optimal fuzzy segmentation of data sets cannot be obtained. Besides, when there is a large number of data, the iteration will cost much more time, which confines the actual application of this algorithm. Therefore, an initialization close to the optimal solution can converge to a global optimal solution with less iterative steps, which will cost less time.

There are the problems in image segmentation based on FCM algorithm:

(1) The specification of cluster category number c and weighting exponent b . The category number must be determined before clustering, or the clustering cannot carry out. In practise, especially with automatic system, it is very hard to realize this. The value of b is directly related to the speed and accuracy of segmentation, and has a huge impact on practical application.

(2) The specification of the initial cluster center and membership matrix. If the initial value of clustering iteration is close to a local extreme, the computation will be trapped in local extreme and the global optimal value will not be available.

3 Improvement of FCM Algorithm

(1) The specification of parameter c and b

Theoretically, $C_{\max}$ can be $n-1$, but from the point of cluster effectiveness

$C_{\max}$ should be far less than the sample data number. Referring to [1,2,7], usually

$$C_{\max} = \frac{n}{3} \text{ or } C_{\max} = \sqrt{n}, \text{ and in this article } C_{\max} = \frac{n}{3}.$$

As for weighting exponent b , its value is in charge of the fuzziness of the FCM cluster result. In FCM algorithm, the smaller the weighting exponent b is, the clearer the ownership of each pixel is, the faster the iterative convergences and the less the iteration time is, so that the segmentation time can be shorter and the speed can be faster. Besides, its value influences the accuracy of the segmentation. When the data have a good compactness and separability, since the fuzziness is small between categories, we can still get a better classification result with a bigger b value to do the job. The optimal range for b is $[+1, \infty]$, but b cannot be too big, because the closer b is approaching to infinity, the fuzzier the segmentation is, then we cannot get the accurate cluster result. Zadeh proposed a range $1.1 < b < 5$ based on experiences, and

later a proper value $b=2$ with the physical explanation of FCM algorithm, and in this algorithm $b=2$.

(2) The Correction of Fuzzy Membership u_{ij}

The cluster center is actually the weighted average of all the samples. In other words, each sample has a relative impact of attraction on the cluster center. U_{ij} represents the size of the attraction and the bigger the value is, the bigger the attraction is, vice versa. This attraction avoids the appearance of dead nodes, but also slow the converging speed. Through increasing the maximum membership value of the sample and inhibiting the value of others, we can reduce the impact of samples on the cluster center non-maximum membership, and speed up the convergence. So we correct u_{ij} as:

$$\mu_j(x_i) = \begin{cases} \alpha \mu_j(x_i) + (1 - \alpha) & \mu_j(x_i) > 0.5 \\ \mu_j(x_i) & \mu_j(x_i) \leq 0.5 \end{cases} \quad (5)$$

$0 \leq \alpha \leq 1$ is the inhibitor and $1 - \alpha$ is the inhibitor rate. In this article, $\alpha=0.5$.

4 Conclusion and Analysis

CT image has a high density resolution, showing the organization density of imaging through the gray scale between black and white. The areas close to black have less ability of absorption, namely low density areas, like soft tissue, while the areas close to white have more ability of absorption, namely high density areas, like skeleton. So it has a strong capability of differentiating the skeleton and soft tissue, and makes an accurate medical diagnosis of the organization structure of peritoneal and pelvic and various lesions. Figure1 is the segmentation result of peritoneal and heart with the improved algorithm. Skeleton, soft tissue, and background are segmented more precisely based on CT image, which will surely help doctors make more accurate judgements.

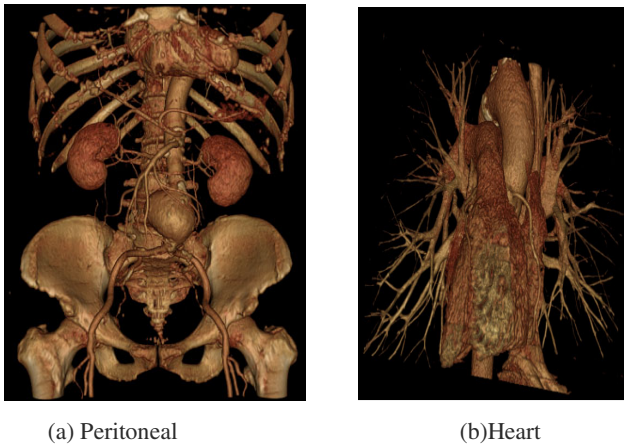


Fig. 1. Segmentation Image of Peritoneal and Heart

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Algorithm for NC Tool Paths Automatic Generation on Surfaces Based on Space-Filling Curves

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Abstract. Due to the inadequate residue amount in traditional algorithm, this article further studies the generation principles and algorithms of offsetting curves and space-filling curves, and tool-path generation in parameter field and surfaces. The problem in generating and jointing space-filling curves of different powers is solved by constructing space-filling curves with control vector. By dividing the data of rectangular region into rectangular blocks, and combining the space-filling curves and offsetting curve algorithm, the mixed tool-path is successfully generated.

Keywords: Automatic Generation of Tool-path, Space-filling Curves, Surface, Offsetting Curves.

Introduction

In the industry of mechanical processing and manufacturing, NC machine is widely applied to processing cutting surfaces with high precision. Usually, the cutting surface of the parts is smooth with smooth rules. However, when processing unprocessed surfaces with irregular curves, such as worm wheel blade and aerofoil of aircraft, if we use the traditional tool-path generation algorithm, such as offsetting curves, osculating process and nonconstant offset, the surface ridge of parts will have traces, similar to that on a cream cake after a comb slides over, or cutting marks left by the linear grid on the surfaces.

In order to get an ideal surface finish, after tool completes the process according to the schedule, the tool will perform once again at an angel of 90° from the original path, so that the queue fringe traces will turn into fishing net like. This will lead to the obvious increase of the surface finish, but at the same time it will increase the time and money cost in processing parts. In order to save time and money, this article combines offsetting curve and MOORE curve generation algorithm to generate tool-path.

1 The Offsetting Curve Generation Algorithm

We can assume the rectangular coordinate equation of plane smooth curve as $y = f(x)$, and the normal line L_f for any point $P(x, y)$ on the curve is Equation (1).

$$Y - y = -\frac{(X - x)}{f'(x)} \quad (1)$$

Therefore, any point (X_p, Y_p) on offsetting curve Ld which has a fixed distance of positive constant D from the curve must satisfy Equation(2).

$$\begin{cases} X_p = x - \frac{D \times f'(x)}{\sqrt{1 + (f'(x))^2}} \\ Y_p = y + \frac{D}{\sqrt{1 + f'(x)^2}} \end{cases} \begin{cases} X_p = x + \frac{D \times f'(x)}{\sqrt{1 + (f'(x))^2}} \\ Y_p = y - \frac{D}{\sqrt{1 + (f'(x))^2}} \end{cases} \quad (2)$$

Fig.1 shows the generated tool-paths based on offsetting curve.

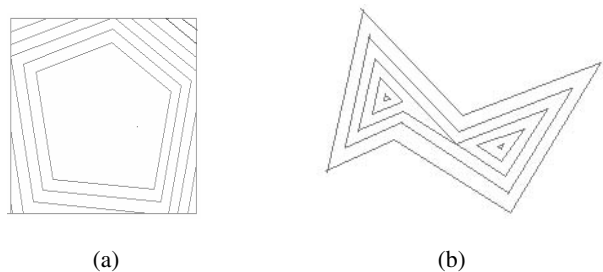


Fig. 1. Tool paths based on offsetting curve

2 The Generation Theory of MOORE Space-Filling Curve

MOORE space-filling curve successively divides the rectangular region at one third point of the original length into smaller areas. Meanwhile, a series of new points are generated according to Equation (3)

$$\begin{aligned} P_{N1} &= \text{BEVEL} \times P_1 + (1 - \text{BEVEL}) \times P_2 \\ P_{N2} &= (1 - \text{BEVEL}) \times P_1 + \text{BEVEL} \times P_2 \end{aligned} \quad (3)$$

In Equation (3), P1 and P2 are the endpoints of the original part, while PN1 and PN2 are new endpoints transformed from P1 and P2. The endpoint number will double after each transformation, which makes the continuity of curves clearer.

Parameter BEVEL is confined. If the value of BEVEL is bigger than 0.5, the paths will cross, which will result in useless tool moving, and there will be an extra waste of time and materials, so the ideal value of Parameter BEVEL is between 0-0.5 after careful computation. Fig.3 shows the result of different Parameter BEVEL values, 0.75, 0.5 and 0.4, 0.25.

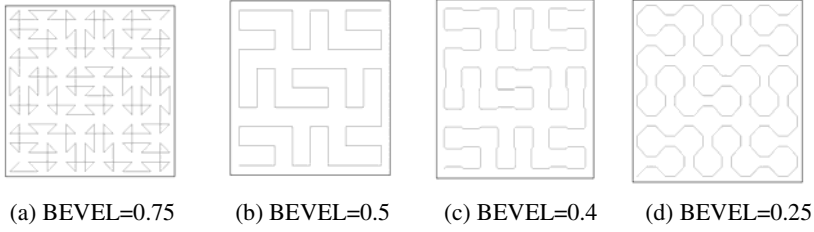


Fig. 2. Tool paths based on Moor curve

3 Path Planning Based on Space-Filling Curves

Since we use recursive algorithm in MOORE space-filling curves, the power of surfaces is confined by the power of MOORE, and it is impossible to generate curves of each power in each subfield. It is also difficult to divide the region and joint curves in different subfields. In order to solve those problems, we construct a system with control vector based on L system and referred to fractal theory.

The system with control vector can be described as: V represents the alphabet, and V' is all the word sets in V , and a character string system is an ordered three-element set $G = \langle V, w, P \rangle$, and w is a nonempty word, called axiom, $w_i = [a_1, a_2, \dots, a_j, \dots, a_p]$, $a_1, a_2, \dots, a_j, \dots, a_p \in V$. The fractal image of w_i can be obtained by jointing the components in order. P is the finite set of the generation

$$a_j \rightarrow x \text{ } \underline{\underline{\text{when}}} \text{ } c_j = 1$$

formula, $P = \{p_i \mid i = 1, 2, \dots, g\}$ and $p_i = \{a_j \rightarrow a_j \text{ } \underline{\underline{\text{when}}} \text{ } c_j = 0\}$. Letter a_j is

the precursor while Word x is the successor. For each $a_j \in V$, if P_i exists, the system with control vector is certain.

Introducing control vector $c_i = [c_1, c_2, \dots, c_j, \dots, c_p]$, we can obtain the w_i fractal image of MOORE word by jointing the components in order.

$$\begin{aligned} A &= [b', a, a, c'], A' = [c, a', a', b], B = [d', b, b, a'], B' = [a, b', b', d], \\ C &= [a', c, c, d'], C' = [d, c', c', a], D = [c', d, d, b'], D' = [b, d', d', c]. \end{aligned}$$

$$p_1 = \begin{cases} a \rightarrow A \text{ when } c_j = 1 \\ a \rightarrow a \text{ when } c_j = 0 \end{cases}, p_5 = \begin{cases} a' \rightarrow A' \text{ when } c_j = 1 \\ a' \rightarrow a' \text{ when } c_j = 0 \end{cases}; p_2 = \begin{cases} b \rightarrow B \text{ when } c_j = 1 \\ b \rightarrow b \text{ when } c_j = 0 \end{cases}$$

$$, p_6 = \begin{cases} b' \rightarrow B' \text{ when } c_j = 1 \\ b' \rightarrow b' \text{ when } c_j = 0 \end{cases};$$

$$p_3 = \begin{cases} c \rightarrow C \text{ when } c_j = 1 \\ c \rightarrow c \text{ when } c_j = 0 \end{cases}, p_7 = \begin{cases} c' \rightarrow C' \text{ when } c_j = 1 \\ c' \rightarrow c' \text{ when } c_j = 0 \end{cases}; p_4 = \begin{cases} d \rightarrow D \text{ when } c_j = 1 \\ d \rightarrow d \text{ when } c_j = 0 \end{cases}$$

$$, p_8 = \begin{cases} d' \rightarrow D' \text{ when } c_j = 1 \\ d' \rightarrow d' \text{ when } c_j = 0 \end{cases}$$

The following is the steps of generation:

- (1) Select a control vector $C_1 = [1]$ at random;
- (2) Get the second power word $w_2 = [b', a, a, c']$ according to Rule p_1 and Rule p_5 ;
- (3) Select a control vector $C_2 = [1, 0, 1, 1]$ at random;
- (4) Get the second power word $w_3 = [a, b', b', d, a, b', a, a, c', d, c', c', a]$;
- (5) Iterate the above steps to get any fractal image with control vector.

4 Surface Tool-Paths Based on Space-Filling Curve

Surface tool-paths are generated respectively according to Bezier surface and B-spline surface.

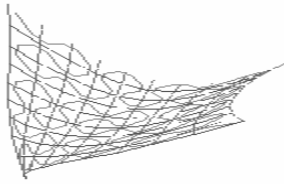
The common mathematical expression of Bezier surface is $P(t) = \sum_{i=0}^n B_{i,n}(t)Q_i$ $0 \leq t \leq 1$. Q_i is the position vector of each vertex, and $B_{i,n}(t)$ is the base function of Bernstein.

The control vertex $P_{i,j} (i = 0, 1, \dots, n; j = 0, 1, \dots, m)$ of the given $(n+1) \times (m+1)$ grid can construct a surface patch with base function $B_{i,n}(u), B_{j,m}(v)$.

$$P(u, v) = \sum_{i=0}^n \sum_{j=0}^m P_{i,j} B_{i,n}(u) B_{j,m}(v)$$

When $\begin{cases} (i = 0, 1, \dots, n; j = 0, 1, \dots, m) \\ u \in [0, 1], v \in [0, 1] \end{cases}$, the surface is called Bezier surface of $n \times m$ power. Fig.4 shows the too-path on Bezier surface.

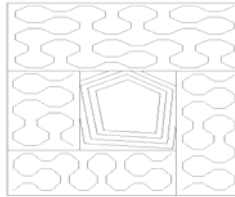
Given the node vectors of parameter axis u and v as $U = [u_0, u_1, \dots, u_{m+p}]$ and $V = [v_0, v_1, \dots, v_{n+q}]$, B-spline surface of $p \times q$ step can be defined as $P(u, v) = \sum_{i=0}^m \sum_{j=0}^n P_{ij} N_{i,p}(u) N_{j,q}(v)$. In Fig.4(b) shows the tool-paths on B-spline surfaces.



(a) Tool-paths on Bezier surfaces



(b) Tool-paths on B-spline surfaces



(c) Tool-paths on mixed surfaces

Fig. 3. Tool paths on surfaces

Besides, the main problem for space-filling curve is the rectangular region. By combining offsetting curve algorithm and space-filling curve algorithm, the data of rectangular region can be divided into rectangular blocks, and mixed tool-paths are generated, so the joint between rectangular regions is realized. Fig.4(c) shows the tool-paths on mixed surfaces.

5 Conclusion

This article aims at illustrating the theory of offsetting curve and MOORE space-filling curve algorithm in detail. By applying MOORE space-filling curve to NC tool-path generation in parameter field and combining MOORE space-filling curve algorithm and offsetting curve algorithm based on L system with fractal image theory, we construct MOORE space-filling curve with control vectors. It can deal with the problem of rendering space-filling curves with higher power in specific subfields. At the same time, mixed tool-paths are generated on the same surface, and the application of space-filling curve on tool-path can reduce the time and machine losses, as well as improve the surface finish. This technology is of great potential in generating tool-path.

However, the valid region of space-filling curve is rectangular regions, so the further research on any other border of processed region is still necessary.

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Research on a Distributed Database System Based on Peer-to-Peer Model with Scientific Materials

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Abstract. As for P2PDDB system, the operation of data on local nodes is fully transparent. It means that users can operate the local database just like the centralized database without needing to care data fragment and node location. But it does not indicate we can operate all global data from just one node. The operation of data on other nodes must be authorized. Therefore, under the premise of not considering the heterogeneous conversion transparency, P2PDDB system data operation is pre-transparent. In general, when developing a new system, either users or developers prefer homogeneous database management system, rather than that of heterogeneous which is for special needs.

Keywords: P2P, distributed database, load balancing.

1 Introduction

With the continuous expansion of business scale and gradual spread of terrain, the original centralized data management method can not meet the needs for enterprise development. At the right historical moment emerges the distributed database system, which is consistent with the needs of today's information system applications and in line with management ideas and management methods of business organization, and gradually becomes the mainstream of distributed database management system (DDBMS) [1]. Peer-to-peer (P2P) technology providing a method of searching, exchanging and sharing data in a loose and distributed environment featured by cross-platform, cross-standard and cross-management, is characterized by good distributive, load balancing and scalability and widely studied and applied in many areas [2-6] .

2 P2PDDB System Model

P2PDDB is composed of hosts located on different physical nodes. Each node adopts C/S modeled database system or stand-alone database system, and has its own local database and local database management system. Nodes inside the network are loose in structure and equal in status. Information resources are distributed in many hosts, and shared through mutual teamwork. Random two nodes inside the network may communicate directly. If the system only uses the horizontal fragment, the data

structure of each node is totally identical. Data will be distributed nearby to improve efficiency. P2PDDB system architecture is shown as figure 1.

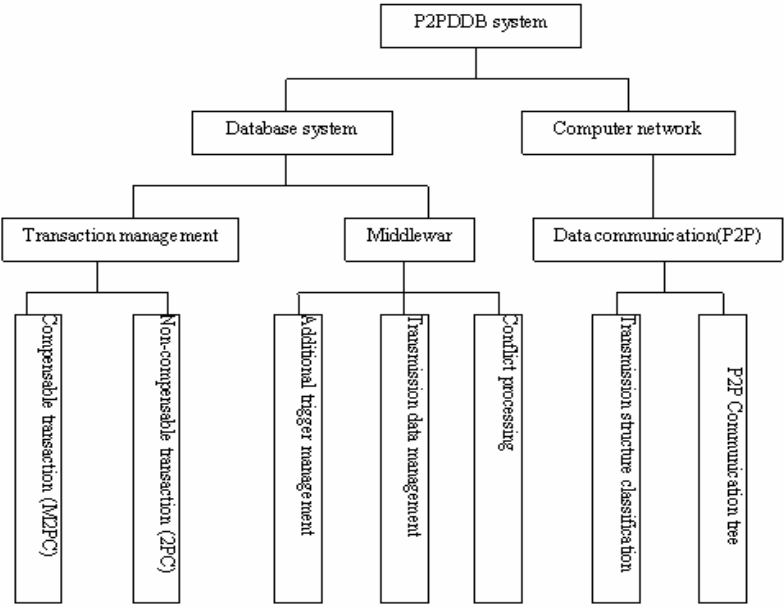


Fig. 1. P2PDDB system structure

P2PDDB system structure composes of database system and computer network. Transactions in the database system are classified into two kinds, namely compensable transactions and non-compensable transactions. When committing compensable transactions, M2PC protocol, or the principle of weak consistency will be adopted so as to reduce the node's waiting time. Data communication uses P2P model and tree type network topology structure to lower the possibility of network communication bottleneck. In addition, to coordinate the transaction management and data communication, middleware is introduced. It is composed of triggers and can also track users' operations.

3 Transaction Commit Protocol

Traditional distributed transaction management uses 2PC protocol. Sub-transactions in ready state can not be committed until the global transaction is determined. Global transaction requires the strict observation of atomicity, consistency, isolation and durability (ACID) feature, and the transition of operational data from one consistent state to the next. As for long transactions, it will reduce the system availability greatly and likely lead to deadlock.

Due to the complexity of DDBMS caused by distributivity, this paper presents the M2PC protocol based on the amendment and addition of original 2PC protocol, which is a sufficient and strict condition for transaction commit, but is not a necessary condition. The submission transaction of 2PC is split into two phases: The first phase is committing sub-transactions respectively, and then committing global transaction after all sub-transactions committing successfully. The conversion from the first phrase to the next invisibly increases the communication times between launching node and other nodes. The complexity of network environment and the protocol's regarding all transactions as non-compensable will result in the long waiting time for nodes, even make transactions ready to be committed end, and easily cause deadlock phenomenon especially for long transactions. In response to these problems, modify the transaction commit condition, it means, relax the commit condition of global transaction and keep the commit condition of sub-transactions. The M2PC protocol allows the weak consistency of data, which means that data on different nodes may be different in a period of time, but consistent on all nodes after transactions are successfully committed, allowing the result of operation on one node not immediately reflected on other nodes.

The M2PC protocol re-divides original transactions into two categories (see figure 2): compensable transactions and non-compensable transactions. The submission of transactions of M2PC is split into two phases: The first phase is to decide and commit non-compensable transactions according to 2PC, and then to commit compensable transactions.

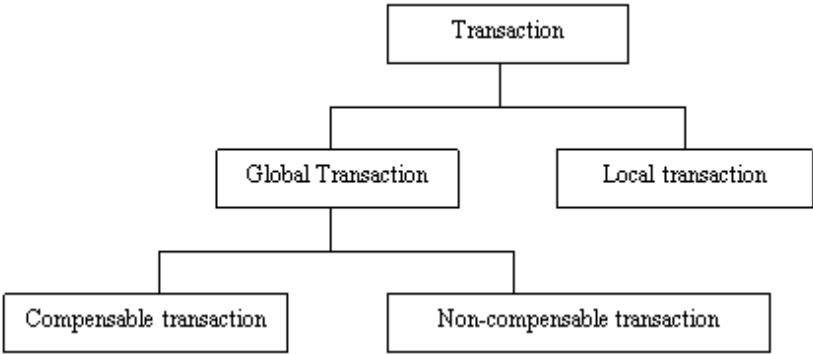


Fig. 2. Classification of transactions

4 Trigger Conflict Solution

In the implementation process of additional trigger, the original application may have the same trigger time sequences, trigger events and trigger levels, which will not conflict with additional triggers, but the transmission data, produced in the receiving node, may conflict. Triggers of delete and update timing, though can automatically eliminate conflicts without any disposal, will affect the system operating efficiency.

In addition, the trigger of insert timing must be removed when conflicting; otherwise the system will not work correctly.

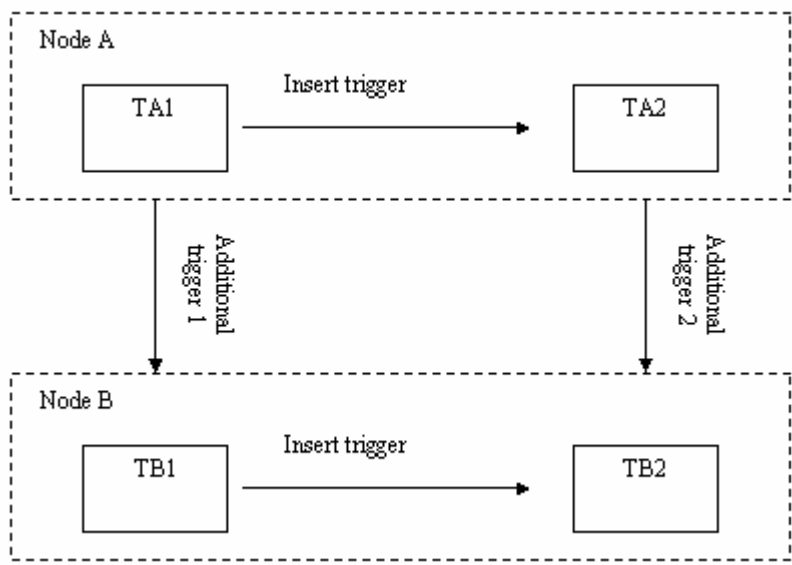


Fig. 3. Trigger conflict

Forexample, TA1andTA2aretablesinnodeA, and corresponding to TB1 and TB2 are tablesinnodeB(see figure 3). If there is insert timing trigger between TA1 and TA2, changes in TA1 will cause conflict in node B table TB2.

Additional trigger set to achieve data distribution is the creating source of transmission data and the core program for data distribution and sharing. It is the middleware designed for maintaining the consistency of the data transfer process in P2PDDB. There are two ways to solve conflicts: One is to compile and debug triggers in advance and then set the work state through data distribution set; The other is to generate through the program in the process of setting, which needs the use of data dictionary and cursor technology of database management system.

5 Conclusion

The system can handle both compensable transaction and non-compensable transactions. As for compensable transactions, we can take the advantage of the delayability of sub-transactions to increase the flexibility of transaction processing, improve the system's capacity to deal with long transactions and system performance, reduce the communication cost and avoid the deadlock phenomenon caused by long transactions. The business processing and data distribution processing in the system are relatively independent. In the process of system development, developers have single tasks and clear duties. Developers responsible for system business do not need

to care much about the data distribution process, which reduces the software bugs, shortens the development cycle and enhances the versatility.

We sincerely hope that through the study of M2PC protocol, data transmission and additional triggers can we establish a sound P2PDDDB system structure and make it a theoretical guide for practical development of distributed database systems.

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The Experimental Study on Ozone to Remove NO by DBD

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Abstract. In order to study the reduction efficiency of NO with Ozone produced by dielectric barrier discharge (DBD). The NO removal experiments with different O₂ flow were performed. As a result, the NO removal rate changed little with discharge power at different concentration of O₂. The NO removal rate improved with concentration of O₂ increasing at same energy density. More NO₂ oxidized with higher ozone concentration and higher discharge power, which lead to concentration of NO₂ decrease. Therefore, concentration of O₂ is important factor as for removal of NO with ozone produced by DBD.

Keywords: dielectric barrier discharge, ozone, NO removal, NO₂.

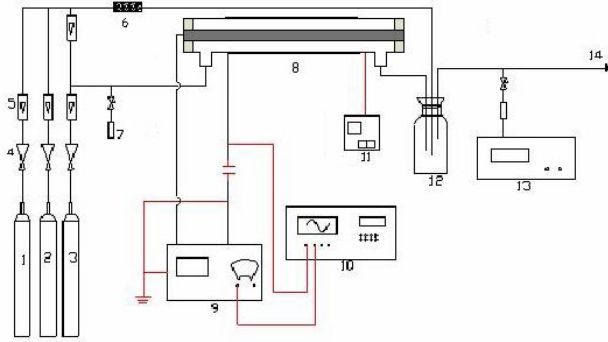
1 Introduction

Ozone(O₃) is a kind of strong oxidant. Its oxidation reduction potential is 2.07V, only second to F₂[1]. O₃ is widely used in disinfection, sterilization, decoloration and deodorization and so on [2-4] because it will decompose to O₂ without secondary pollution. At present, the main method to produce O₃ is DBD method[5]. DBD is a kind of non-equilibrium discharge which is uniform, stable and diffuse. Insulation dielectric is inserted into the discharge space in DBD. It is one of the main ways to produce non-thermal plasma at normal temperature and pressure. German scientist Siemens used coaxial cylindrical reactor to produce O₃[6] for the first time.

In view of recent serious situation for air pollution, scientific researchers did a lot of work to control air pollution. Non-equilibrium plasma method could remove SO₂, NO_x, respirable particulate matter, heavy metal, volatile organic compounds and so on simultaneously, so it has been investigated widely. The existing DBD flue gas control technology is like this: put flue gas into reactor to discharge, then it will produce many kinds of active species such as OH, N, HO₂, O and so on. These strong oxidative species will oxidize NO and SO₂ and remove otherwise. In this paper, the removal experiment was carried out on the experimental tab built by our study team. Firstly, DBD method was used to obtain O₃, then blend it with the flue gas, SO₂ and NO are removed because of the strong oxidizability of O₃. Finally, the feasibility study was done.

2 Experimental Setup

The sketch map of experimental setup is shown as below:



1-O₂ bottle; 2-N₂ bottle; 3-N₂/NO bottle; 4-pressure reducing valve; 5-flowmeter; 6-mixing gas bottle; 7-DBD reactor; 8-high voltage power; 9-digital oscilloscope; 10-temperature controller; 11-flue gas analyzer.

Fig. 1. The sketch map of experimental setup

After going into pressure reducing valve, the needed concentration for the gases in bottles would be obtained after pass the rotameter. Put three kinds of gases into mixing gas bottle to get the simulated flue gas. Put O₂ into reactor, the plasma will be produced because of the applied voltage, then the plasma reacts with O₂ to produce O₃, after that, mix the simulated flue gas and O₃, change NO to NO₂ to utilize strong oxidizability of O₃. Finally the reacted flue gas is exhausted to air.

The high voltage power used in this experiment is CTP-2000P high-frequency power. The turning range of voltage is 0-30kV, frequency is 0-20kHz, central frequency is 10kHz. The current and voltage waveforms are recorded by digital oscilloscope (Tektronix, Tds2024). The flue gas at inlet and outlet is measured online with 350Pro flue gas analyzer, the concentration of single gas in flue gas such as NO, NO₂, SO₂ could be obtained on display panel.

3 Parameter Definition

(1) NO removal efficiency η_{NO} :

$$\eta_{NO} = \frac{C_{in}(NO) - C_{out}(NO)}{C_{in}(NO)} \times 100\% \quad (1)$$

η_{NO} is the removal rate of NO, $C_{in}(NO)$ is density of NO at the entrance, $C_{out}(NO)$ is for that at the exit.

(2) Input power P_{in} : The power applied to reactor, calculated by Lissajous graphic method.

(3) Input energy density $\mathcal{E}$:

$$\mathcal{E} = P_{in} / V \quad (2)$$

(4) Ozone production $V(O_3)$:

As is known from references [7-8], the formation processes of O_3 are shown as below:



Where, M represents other molecules or intermediate induced matter. It can be known from equation (3) and (4) that O_3 is obtained by O_2 . In this experiment, O_2 is divided into O_2 in simulated flue gas and O_2 in reactor to produce O_3 . Assume the flow of O_2 into DBD reactor is $V(O_2)_{reduction}$. So :

$$2V(O_3) = 3V(O_2)_{reduction} \quad (5)$$

(5) O_2 variable quantity $V(O_2)_{change}$:

As is known from references [9], the main reaction in decomposition of O_3 is:



Assume the flow of O_2 produced by equation (6) is $V(O_2)_{production}$. As is known in equation (5) and (6):

$$V(O_2)_{change} = V(O_2)_{reduction} - V(O_2)_{production} \quad (7)$$

$V(O_2)_{change}$ can be obtained by measuring the volume fraction of O_2 which is shown on the display panel of flue gas analyzer. $V(O_2)_{reduction}$ could be gotten in equation (7). At last, $V(O_3)$ can be obtained in equation (5).

4 Experimental Results

Double layer reactor is used in this experiment. The inner electrode is high voltage electrode, its diameter is 3mm, the size of inner dielectric layer is 4×6mm, The length of reactor is 400mm. the dielectric material is quartz. The environmental temperature is 18°C. The compositions of simulated flue gas contains N_2 (10L/min), O_2 (0.8L/min) and NO (0.054L/min). The concentrations of O_2 into reactor are 0.56L/min, 0.8L/min and 1.04L/min, respectively.

1) Condition 1 (0.56L/min)

The initial concentration of NO is 500ppm. When the energy density is 26.95J/L, the removal rate of NO is 91.6%.

2) Condition 2(0.8L/min)

The initial concentration of NO is 483ppm. When the energy density is 20.5J/L, the removal of NO is 95.2%.

3) Condition 3(1.04L/min)

the initial concentration of NO is 470ppm. When energy density is 15.23J/L, the removal of NO is 98.5%.

The change curve of removal rate for NO with power at three conditions is shown as below:

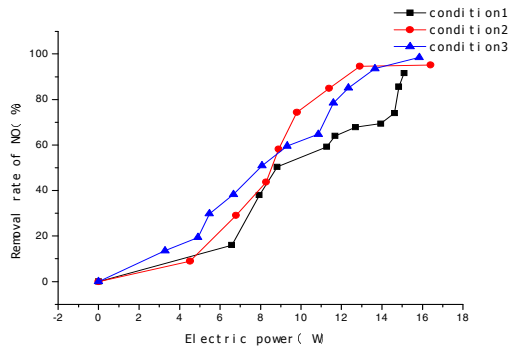


Fig. 2. The change curve of removal rate for NO with electric power at three conditions

As is shown in Figure 2, there is no obvious variation trend for NO removal rate at different conditions when the input power is the same.

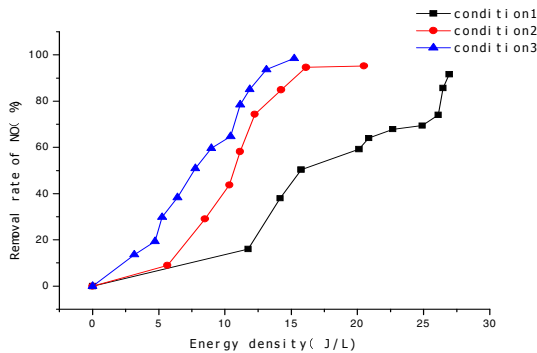


Fig. 3. The change curve of removal rate for NO with energy density at three conditions

As is known in figure 3, with the same input energy density, when the input flow of O_2 increases, the NO removal rate also increases obviously.

The production of NO_2 at three conditions would be obtained by flue gas analyzer. In condition 1, when power is 15.09W, the production of NO_2 is 365.4ppm, In condition 2, when power is 16.4W, the production of NO_2 is 284.4ppm, In condition 3, when power is 15.84W, the production of NO_2 is 237ppm, The change curve of production of NO_2 with input power at three conditions is shown as below:

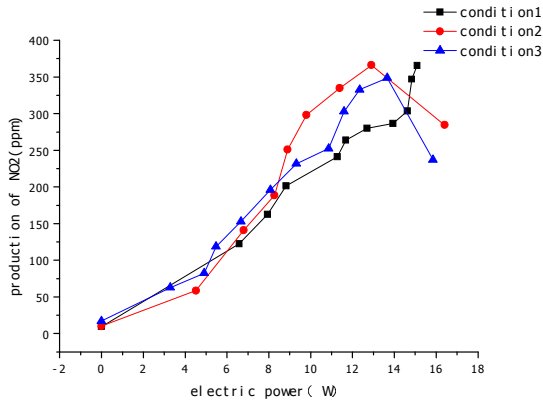


Fig. 4. The change curve of production of NO_2 with electric power at three conditions

As is shown in Figure 4, there is a monotone increasing trend for the production of NO_2 with the input power in condition 1. Nevertheless, in condition 2 and condition 3, the production of NO_2 increases first and then reduces.

5 Experimental Analysis

In this experiment, the main way to remove NO is reacting with O_3 to produce high valence NO_x . The primary chemical equation is shown as below:



Where NO_x may be NO_2 , NO_3 or N_2O_5 and so on. When the flow of O_2 into reactor increases from 0.56L/min to 1.04L/min, the stay time of gas in reactor will reduce, it will hinder the generation of O_3 ; however, the production of O_3 will increase with the growth of volume flow in unit time. Moreover, the impact of the latter is larger than the former. So the total production of O_3 will increase, but the newly increased O_3 will react with NO_2 to generate higher valence NO_x , it will not oxidize NO. Because of that, there is no obvious variation trend for NO removal rate at different conditions when the input power is the same.

As is shown in Figure 3, the removal rate of NO will improve with the growth of flow of O_2 which goes into reactor as the input energy density is the same. For

different flows, at same energy density, when the flow is larger, the power is higher. It is easy to understand that the power is higher, the removal rate of NO is higher.

As is shown in Figure 4, there is monotone increasing trend for the production of NO₂ with the input power in condition 1. nevertheless, in condition 2 and condition 3, the production of NO₂ will increase firstly, then reduce. The reason is that NO₂ will be oxidized to NO₃ or N₂O₅ with the increase of input power, the specific chemical equations are shown as below:



In condition 1, the production of O₃ is small, so NO will be oxidized to NO₂. However, in condition 2 and 3, because of the growth of O₃, part of NO₂ will be oxidized, then make the total production of NO₂ will increase firstly, then reduce.

6 Conclusion

In this paper, ozone is generated by DBD method, then NO is removed because of strong oxidizability of ozone. The impact of ozone for NO removal was studied by changing the concentration of O₂.

(1) With the same discharge power, the impact of O₂ into reactor is small for NO removal.

(2) With the same input energy density, if the concentration of O₂ into reactor increases, the removal rate of NO will improve.

(3) Because NO₂ will be oxidized to higher Oxides, in the condition of high O₃ concentration and discharge power, the production of NO will reduce.

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Research on the Effect of Adding O₂ to DBD Method for Removing NO

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Abstract. In order to know the effect of O₂ on the process of removing NO by using dielectric barrier discharge(DBD) method, a home-made cylinder reactor was used to remove NO from the simulated flue gas, then the effect of NO removing-rate and DBD energy consumption were also given; Related chemical kinetics simulations were motioned. The experimnet results showed that increasing the volume of O₂ restrained the NO removing-rate and enhanced the formation rate of NO₂. The simulations presented that the reaction rate of $N+NO \rightarrow N_2+O$ reduced which lead to the approximate balance of the formation and breakdown of NO. Therefore, adding O₂ inhibit removing rate of NO by DBD.

Keywords: Dielectric barrier discharge, NO, Chemical kinetics simulation, plasmas.

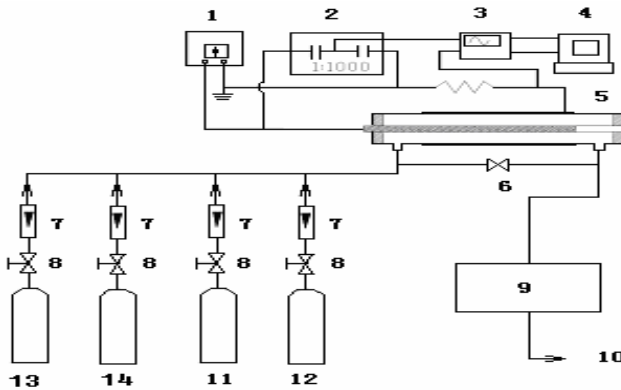
1 Introduction

DBD (Dielectric Barrier Discharge) is a kind of discharge reactor which has insulating medium in it, it is called non-equilibrium gas discharge. Due to an electrode in it, it can form stable discharging under atmospheric pressure[1]. The principle of DBD removing pollutants is: the high-energy electron produced by DBD is collided with neutral gas molecule, then excitation, dissociation and ionization. This process produce a large amount of free radicals, excited molecules and atoms.

The advantages of dielectric barrier discharge reactor are: high working pressure, wide working frequency, avoiding instrument corrosion, easily regulating physical parameters, simple structure, low cost and easily maintenance and operation[2]. There are some factors effect removal efficiency of DBD reactor include the properties of medium material, discharging gap, voltage frequency and electrode materials[3-4], additives and adding gas in DBD reactor [5-7], humidity and temperature of the flue[8]. Oxygen is added in flue gas in experiment to analyze the NO removing rate and energy consumption.

2 Experiment

A schematic diagram of DBD plasma experiment is shown in Fig.1. The simulated flue gas, kept at room temperature, was configured by controlling the gases flow, then it fed into the DBD reactor. The concentrations of NO, NO₂, and O₂ in the gas stream entering or exiting from the reactor are monitored by using a gas analyzer (Testo 350-Pro). The DBD reactor is a concentric cylinder double dielectric-barrier discharge reactor, stainless steel inner electrode which external diameter is 3mm, connects with external AC voltage, inner dielectric quartz inside diameter is 4mm, thickness is 2mm, outer dielectric quartz outside diameter is 20mm, thickness is 4mm, the reactor's length is 400mm, a layer of copper nets cover outer dielectric surface as groundig electrodes.



1—power supply; 2—voltage-dividing capacitor; 3—oscilloscope; 4—computer; 5—DBD reactor; 6—disconnecting valve; 7—rote meter; 8—reducing valve; 9—flue gas analyzer; 10—vent; 11—NO/N₂; 12—N₂; 13—O₂; 14—Ar.

Fig. 1. Schematic diagram of DBD plasma experiment

Power measurement method applied in this study is voltage-charge lissajous figures method. The formula is as follows:

$$P = fC_m k_x k_y kA \quad (1)$$

A₁- parallelogram area (m²); A₂-interface area (m²); A-the ratio of A₁ and A₂, K_x-X axis sensitivity; k_y-Y axis sensitivity; k- variable ratio of voltage divider; f - voltage frequency (Hz).

3 Experimental Result

In order to guarantee combusts completely, excess air coefficient was 1.15-1.25. The export smoke oxygen content is about 6%. This experiment also consider actual flue gas oxygen.

Table 1. NO removal rate under different power changes

working condition	gas composition	gas flow number (L/min)	total flow number(L/min)	temperature (°C)
1	N ₂ /NO/Ar	N ₂ =10,NO=0.052,Ar=0.08	10.132	25
2	N ₂ /NO/O ₂	N ₂ =10,NO=0.054,O ₂ =0.8	10.854	25
3	N ₂ /NO/O ₂ /Ar	N ₂ =10, NO=0.054,O ₂ =0.8,Ar=0.18	11.034	25

As shown in figure 2, when there is no oxygen in gas, the NO removal rate is close to 100% when the input power is 140W, while the other two groups which contain oxygen NO removal rate is only 20%. Therefore, adding O₂ to inhibit removing rate of NO using DBD. The reason of adding O₂ can inhibit removing rate of NO are as flows [9]: on one hand, adding O₂ can reduce velocity and density of high-energy electron, also make the discharge current weakened. Reducing electron density can directly cause NO conversion reduction. On the other hand, NO can be generated by O₂, and this part of O₂ can also affect the high-energy electron density. Finally, adding O₂ can occupy dielectric layers of NO adsorption bits, so when the gas contains oxygen, NO removal rate is lower. The higher NO initial concentration, the more O₂ produced and the NO removal rate will lower.

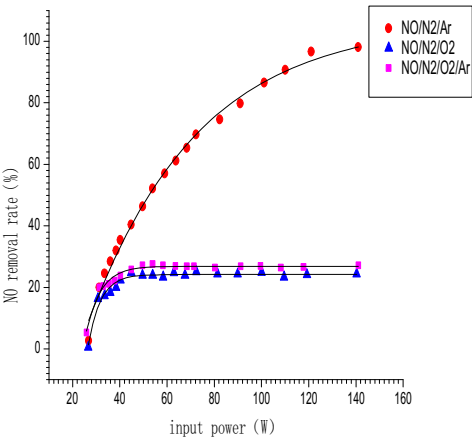


Fig. 2. The relationship between input power and NO removal rate under different kind of gas condition

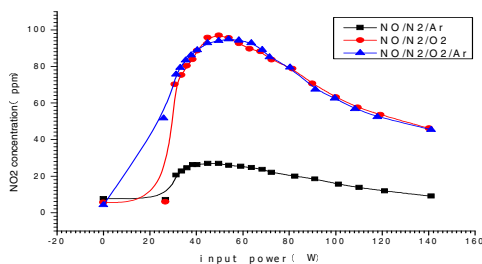
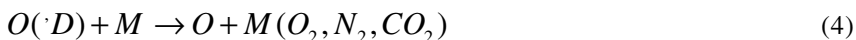


Fig. 3. The relationship between input power and NO_2 concentration under different gases condition

Figure 3 shows that when there is no oxygen in gas, the concentration of NO_2 is very little, the highest concentration of NO_2 is 27ppm. When gases contain O_2 , the outlet of reactor NO_2 concentration can be as high as 97ppm.

When adding O_2 in DBD reactor, involve reactive as follows:



The total reactions are as flows:



At the beginning of this process, reaction (3), and (4) produce O and $\text{O}(\cdot\text{D})$, it not only oxidize NO through reaction (5), but also produce O_3 through reaction (6). In oxygen-enrich environments, NO will be oxidized into NO_2 through reaction (5) and (7). The total reactions (8) will turn NO into NO_2 .

Figure 4 shows In anaerobic conditions, when input energy density is 614J/L, the removal rate of NO is as high as 98%, the removal rate of NO will decline as the input oxygen increasing, when oxygen flow reach 560mL/min, the removal rate of NO is only about 23%, it is because adding oxygen will increase the number of O , and it can inhibit the consumption of NO , so although increase energy input, NO will still cannot be removed. Figure5 shows that with the increase of O_2 concentration in reactor, NO_2 will increase as well.

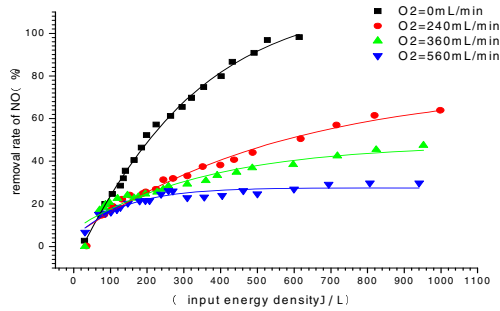


Fig. 4. NO removal rate under different concentration of O₂

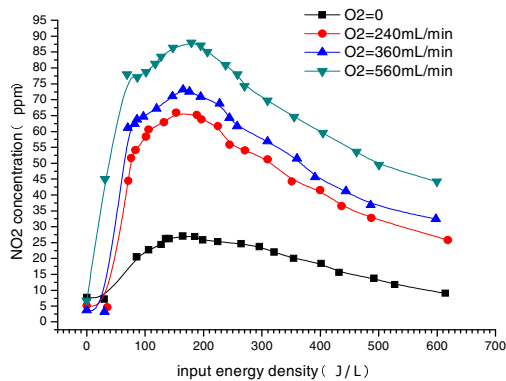


Fig. 5. Relationship of export NO₂ concentration under different oxygen flow

4 Simulation Results

Our experiment use CHEMKIN Plasma Plug Flow Reactor for simulation. Plasma Plug Flow Reactor model is mainly used for various chemical dynamics reaction process. This model has some advantages as follows: first, the fluid in the shaft upwards does not mix, it can assure that the reactants will react thoroughly; Second, the control equations for the model is First-order ordinary differential equations, and it occupied a shorter time, Third, there is no limit on mass transfer.

Quality continuous equation:

$$\rho u \frac{dA}{dx} + \rho A \frac{du}{dx} + uA \frac{d\rho}{dx} = \sum_{m=1}^M a_{i,m} \sum_{k=1}^{k_g} S_{k,m} W_k \quad (9)$$

ρ - density (g/cm³); u - axial velocity (m/s), A - area of flow direction (m²).

Gas species conservation equation:

$$\rho u A \frac{dY_k}{dx} + Y_k \sum_{m=1}^M a_{i,m} \sum_{k=1}^{k_g} S_{k,m} W_k = W_k \left(\sum_{m=1}^M s_{k,m} a_{i,m} + \omega_k A \right) \quad (10)$$

Y_k - quality score of k , ω_k - mole producing rate of chemical reaction components, W_k - molecular weight of k .

Energy equation:

$$\begin{aligned} & \rho u A \left(\sum_{k=1}^{k_g} h_k \frac{dY_k}{dx} + \overline{C_p} \frac{dT}{dx} + u \frac{du}{dx} \right) + \left(\sum_{k=1}^{k_g} h_k Y_k + \frac{1}{2} u^2 \right) \sum_{k=1}^M a_{i,m} \sum_{k=1}^{k_g} S_{k,m} W_k \\ & = a_e Q_e - \sum_{m=1}^M a_{i,m} \sum_{k=K_0}^{K_b} s_{k,m} W_k h_k \end{aligned} \quad (11)$$

h_k - enthalpy of k (J/kg), $\overline{C_p}$ - the gas average specific heat (J / (kg, K)); T - gas absolute temperature (K), Q_e - the system wall and gas exchange heat flow (J).

Kinetic energy equations:

$$A \frac{dP}{dx} + \rho u A \frac{du}{dx} + \frac{dF}{dx} + u \sum_{m=1}^M a_{i,m} \sum_{k=1}^{k_g} S_{k,m} W_k = 0 \quad (12)$$

$$\frac{dF}{dx} = a_i \frac{1}{2} \rho u^2 f \quad (13)$$

$$f = 0.0791 R_e^{-0.25} \quad (14)$$

Through dynamics simulation, the most important chemical formulas are as flows:



Their response speeds change as gas retention time is shown in figure 6.

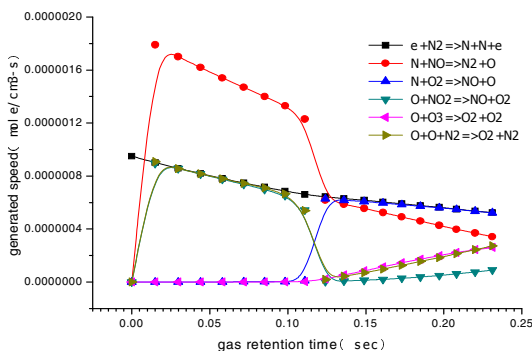


Fig. 6. Adding oxygen conditions, the main reaction generated speed change with gas retention time

When there is oxygen in gases, the reaction (16) affect most at first 0.0125s, reaction (18) and reaction (20) have the same reaction rate, as a leading position. After 0.0125s the reaction rate of reaction (17) will rise. Adding O will promote forward reaction rate of reaction (18) and reaction (20). At the beginning, reaction (16) makes NO consumes quickly and largely, but with the reduction of NO, the reacting rate of reaction (16) will reduce, then the consumption of NO will keep balance with the generated NO produced by reaction (17) and reaction (18), so the value of NO will not decline obviously, but maintain in a certain constant.

5 Summary

(1) The experiment results show that, adding oxygen will decline the NO removal rate and increase the concentration of NO₂ obviously. The value of NO will not be decline obviously, but maintain in a certain constant.

(2) The simulations presented that the reaction rate of $N + NO \rightarrow N_2 + O$ reduce which lead to the approximate balance of the formation and breakdown of NO. Therefore, adding O₂ inhibit removing rate of NO using DBD.

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Using Rough Set to Build Domain Ontology of Knowledge Information System

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Abstract. Previous studies of knowledge management have largely cantered on acquisition, management and sharing of knowledge within an enterprise. The role of this ontology is to provide a shared vocabulary and semantics between domain knowledge and vision. This ontology is a guide, which provides a vocabulary for the visual description of domain classes. Rough set theory is an extension of classical set theory and begins by relating certain information to all the objects under consideration. The paper proposes the method of constructing ontology knowledge information system based on rough concept in order to constructing the ontology model of knowledge management. The experimental results indicate that the rough set building ontology algorithm achieves significant performance improvement.

Keywords: rough set, knowledge information, domain ontology.

1 Introduction

A recognized solution to the class imbalance problem is to take into account the a priori knowledge of class distribution at the data or algorithmic level. The aim of such data analysis techniques is to use the collected data for training in a learning process, and then to extract a hidden pattern by model construction. Therefore, it becomes a pivotal issue on ontology application to build ontology. But this field is still being discussed today. As one of the most important issues in rough set theory, uncertainty of a set has been widely studied[1]. Most systems for automated content generation work as follows: the system sequentially processes a small to moderate size set of mostly relevant documents. These measures include granulation measure, information entropy, rough entropy, and knowledge granulation, and have become effective mechanisms for evaluating uncertainty in rough set theory.

Ontology-based information systems can retrieve pages that refer to precise semantics, not just keywords, and can greatly increase the rationality of query responses. Ontology is an agreement about a shared conceptualization, which includes frameworks for modelling domain knowledge and agreements about the representation of particular domain theories. Knowledge management approaches are generally divided into personalization approaches that focus on human resources and communication, and codification approaches that emphasize the collection and organization of knowledge. To support study management and focused analyses,

database queries must be written to extract subsets of data into specialized tools for those tasks. Rough set has been compared with other techniques. This includes comparison of performance of rough set and discriminates analysis. In the knowledge-based economy, where knowledge assets take central stage, whoever owns knowledge and can create knowledge from existing knowledge will enjoy absolute advantages over the business competition[2]. Rough set theory is a powerful mathematical tool proposed by Pawlak and for dealing with inexact, uncertain or vague information, and a large number of studies have been directed to its development and applications. Temporal constraints among the timing and sequence of these activities are fundamental to the descriptions of protocol entities. RST has been successfully devoted to problems with vagueness and uncertainty of information and it has provided many exciting resulting results in a considerably wide range of fields, such as location services.

Finally, ontology knowledge information model is proposed based on integrating of rough set model and ontology. Based on established standards for knowledge representation and temporal-relational methods, we have implemented an ontology-based architecture for the deployment and execution of its software components. The domain ontology model of knowledge information system is built combined with knowledge of domain expert, and original ontology model of the knowledge management by way of core ontology in order to enhance system robustness and antinoise.

2 Rough Set Model

The rough set theory, introduced by Pawlak in the early 1980s, is a formal mathematical tool to deal with incomplete or imprecise information. Rough set theory (RS) has been a topic of general interest in the field of knowledge discovery and pattern recognition. Machine learning algorithms are known to degrade in performance when faced with many features (sometimes attributes) that are not necessary for rule discovery. Rough set theory is a new mathematical approach to imprecision, vagueness, and uncertainty in data analysis, which was first introduced by Pawlak in 1982.

2.1 Knowledge Reduction Based on Rough Set

Rough set theory is an extension of classical set theory and begins by relating certain information to all the objects under consideration. Objects with the same characteristics cannot be distinguished from each other, and this feature of indiscernibility forms the mathematical basis for rough set theory[3]. A context is a triple (X, M, I) , where X and M are two finite sets called objects and attributes, respectively, and I is a binary relation between X and M . In particular, for $x \in X$ and $m \in M$, denote xIm to express that an object x is in a relation I with an attribute m . Given two sets $A \subseteq X, B \subseteq M$, we define Eq. 1.

$$X_i \subseteq U, \quad X_i \neq \Phi, \quad X_i \cap X_j = \Phi, \quad UX_i = U, (i \neq j, \text{ and } i, j = 1, \dots, n) \quad (1)$$

Let U denote a finite non-empty set, called the universe; the set $R_1 = \{X_1, X_2, \dots, X_n\}$ which satisfies Eq. (1) is called the classification or equivalence relation of U , and X_i

is called an equivalence class of the equivalence relation R_1 . That is, given the set of attributes $A \subseteq Q$ and objects $x, y \in U$, then x and y are indiscernible by A if and only if $f(x, a) = f(y, a)$ for every $a \in A$. Let Eq.2.

$$\begin{aligned} \underline{A}X &= \{x \in U : [x]_A \subseteq X\}, \\ \overline{A}X &= \{x \in U : [x]_A \cap X \neq \emptyset\}. \end{aligned} \quad (2)$$

Where $|X|$ is the cardinality of X and $c(X, Y)$ is the relative classification error of the set X with respect to set Y . An information table is a knowledge expressing system which can be used as an important tool to represent and process knowledge in machine learning, data mining and many other fields. It provides a convenient way to describe a finite set of objects called the universe by a finite set of attributes. The $BN_A(X)$ consists of objects that do not certainly belong to X on the basis of A . A set X is said to be *rough* (respectively *crisp*) if its $BN_A(X)$ is non-empty (respectively empty).

The upper approximation of $X \subseteq U$ by R is the union of all equivalence classes E of equivalence relation $R \in \text{IND}(P)$ which have a non-empty intersection with X is defined as Eq. 3.

$$\text{IND}(P) = \{(x, y) \in U \times U : \forall_a \in p, a(x) = a(y)\} \quad (3)$$

With the accuracy measure we can know the range of the boundary, but not its structure, on the other hand, the topological classification of the rough set gives us insight into the structure of the boundary, but nothing about its range. In the following, we first give the definitions of dispensable attribute and indispensable attribute in the concept lattices.

The concept of set approximation can be extended to approximation of a classification. Let $Y = \{Y_1, Y_2, \dots, Y_n\}$ be a classification (or partition) of U , and this classification is independent of attributes in Q . The main reason for such a definition of the generalized dominance principle is that the precipitations of data should not decrease lower approximations of decision classes which contain consistent knowledge for the considered decision table.

Table 1. Formal context U

U	u1	u2	u3	u4	u5	u6	u7
u2	$\emptyset$	a,b		c			
u3	b,c	b,c			$\emptyset$		
u4	b	b, d	c,d		d	$\emptyset$	
u5	a,b,c,d	a,b,c	$\emptyset$	a,b,c,d			a,c
u6	a,b,c	a,b,c,d	$\emptyset$	a,b,c,d	$\emptyset$	$\emptyset$	
u7	$\emptyset$	$\emptyset$	a,b,c,d	a,b	c,d	c,d	
u8	a,b	a,b	$\emptyset$	a,b	a	$\emptyset$	$\emptyset$

Let P and Q be equivalence relations of universe U , then the P -positive region of Q is defined by the union of all the objects of U which can be classified as the equivalence class of U/Q by the knowledge U/P . Table 1 gives a formal context with $U=\{u1, u2, u3, u4, u5, u6, u7, u8\}$, $C=\{a, b, c, d\}$, $D=\{e\}$.

The reduction of attributes is to eliminate some irrelevant or redundant attributes without decreasing the quality of approximation of an information system as the original set of attributes. The indiscernibility relation of a set of attributes Q remains unchanged when redundant attributes are removed. As we all know, selecting attributes should have large cover rate and higher occupancy. So selecting attributes should contain as many instances as possible; should contain as little features as possible if they contain the same number of instances.

2.2 Reduction of Knowledge Rule Extraction Based on Rough Set

Besides, knowledge or attribute reduction is one of the kernel parts of rough sets, and it can efficiently reduce the redundancy in knowledge base or attribute set. The decision-theoretic models systematically calculate the parameters based on a set of loss functions according to the Bayesian decision procedure. An information table represents all available information and knowledge. That is, objects are only perceived, observed, or measured by using a finite number of attributes[4]. The physical meaning of the loss functions can be interpreted based on more practical notions of costs and risks. Given an information system, rough sets can generate decision rules for objects of known classes, or predict classes to which new objects belong. We selected these two algorithms to compare two different perspectives of decision rules. An object that *satisfies* (or *is covered by*) the condition part of the rule is assigned to decision classes suggested by the decision part of this rule. Decision rules induced from the set of reference objects U can explain DM's preferential policy and can give recommendation for future classification decisions.

Step 1: The condition part is constructed in such a way that $r_q=l(y,q)$ or $r_q=u(y,q), q \in R \subseteq P$, depending on the type of rule.

Step 2: Choose the best attribute y , i.e. with the largest $\forall y \times M_p$, let $Y = Y - y$, $R = R \cup y$, then using a rule reduction algorithm to reduce F_L .

3 Knowledge Information System Based on Ontology

Enterprises are getting more knowledge intensive, and the integration of various types of knowledge becomes a challenge. The information and knowledge is in different formats, e.g., electronic documents, databases, and hardcopy documents, scattered in various systems such as Product Lifecycle Management (PLM), Enterprise Resource Management (ERP), and Office Automation (OA) systems. Ontology-based knowledge management (KM) as follows: "For KM systems in enterprises, ontology can be regarded as the classification of knowledge".

Ontology is a conceptualization of a domain into a human understandable, machine-readable format consisting of entities, attributes, relationships, and axioms. Ontology are increasingly considered a key technology for enabling semantics-driven knowledge processing. Both knowledge representation and machine learning

techniques are involved in the categorization process. The paper offers a methodology for building ontology for knowledge sharing and reusing based on rough set. Considering the cognizing, structure of knowledge and ontology, a method based on the concept map is put forward here, which is extended to an ontology construction tool. Results of this study can facilitate exchange of knowledge and knowledge-related technologies between enterprises.

4 Constructing Ontology Knowledge Information System Based on Rough Set

According to the goal of ontology, the pivotal problem of ontology constructing is to find the concepts and relationship among concepts after confirming the field, but these are connotative in the brain or store the file of this field in e-business. The primary content of this dissertation is to apply rough set technology to obtain all connotative concepts and hierarchy of them automatically from the designated data, which is not under the influence of developer.

In this paper, we apply the theory of rough set concept lattices to automatically construct the concept hierarchy of ontology in knowledge management and to match up the binary relation matrix of documents and terms to express the independence, intersection and inheritance between different concepts to form the concept relationship of ontology. The goals of automatically constructing ontology in our research will help the information classification systems and ontology extraction for knowledge information.

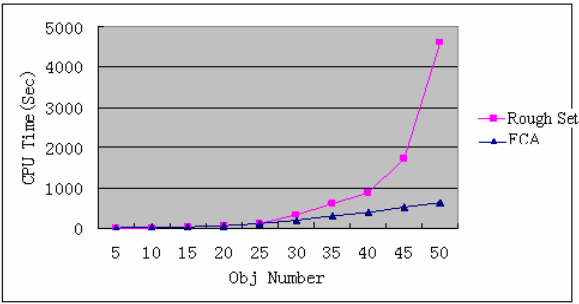


Fig. 1. Constructing ontology object numbers compared rough set with FCA

Experimental studies are done with rough set and FCA in constructing ontology knowledge information. Fig. 1 describes the method of building ontology knowledge management information compared rough set with FCA. Rough set based decision algorithm does not always ensure to reach the conclusion with the given features, but accommodates the decision making by using minimal essential attributes. By applying rough set theory, we were able to generate a decision algorithm and hence helped to overcome the problems of the expert's knowledge by using the core part of the knowledge.

5 Summary

The paper presents the method of constructing ontology knowledge information system based on rough concept in order to constructing the ontology model of knowledge management. We compare the rough set method with the FCA methods for class obtain object number learning in knowledge information.

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Finite Element Analysis of Tractor Diesel Engine Connecting Rod

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Abstract. In this paper, with the ANSYS, stress distribution and safety factor of connecting rod were analyzed by using 3D finite element method. The results show that the inner surface of the transition location of big end and connecting rod shank is the exposed destructive position at maximum stretch condition. Maximum stress value is 118 MPa. Safety factor is 2.99. The exterior surface of the transition location of small end and connecting rod shank is the exposed destructive position at maximum compression condition. Maximum stress value is 127 MPa. Safety factor is 2.77.

Keywords: Finite Element Analysis, Connecting Rod, Stress Distribution, Safety Factor.

1 Introduction

Connecting rod is one of the important driving parts of diesel engine. It bears various complex load of periodic change. If it isn't strong enough, endurance failure of connecting rod would be produced easily. So much so that connecting rod fracture. It will lead to engine fault as well as serious outcome. As an effective analysis method, finite element analysis has been used widely in the design of connecting rod [1-7].

With the rapid development of agricultural mechanization, agricultural machinery is applied more and more widely. Tractor diesel engines are the main machinery types. In this paper, with the ANSYS, stress distribution and safety factor of connecting rod of tractor diesel engine were analyzed by using 3D finite element method.

2 Model Building

The material of connecting rod is 45 steel. Main performance parameters are shown in Table 1.

Table 1. Main performance parameter

Young's modulus [N/m ²]	Poisson's ration	Breaking point [MPa]	Yield limit [MPa]
2.1e11	0.3	624	377

Building accurate and reliable calculating model is one of the key steps of analysis with finite element analysis. During the process of analysis, the finite element analysis model should be built according to the real one as much as possible. However, if the structure of the object is complex, it can be very difficult, even impossible to build the calculating model in accordance with the real one. Therefore, approximate simplification is necessary. In this paper, big end of connecting rod is simplified. Bearing shell, bushing and bolts of connecting rod are ignored. Big end cover and body of connecting rod are taken as a whole model. In order to avoid the big difference of sizes of finite element mesh which would decrease element quality and calculation accuracy, simplifying treatment is done to the little beveling and circular beads that hardly affected the strength of connecting rod.

In order ensure calculation accuracy, 10-node tetrahedron element SOLID92 is employed. The method of dividing model is free mesh dividing. As this method is free of manual control, it is necessary to repair the result of mesh dividing. So stress concentrated parts, such as the transition location of small end and connecting rod shank, the transition location of big end and inner sides of I-shaped cross-section of connecting rod shank, are checked. After reparation, there are 46074 meshes on the finite element model of connecting rod. The mesh dividing of connecting rod is shown in Fig.1.

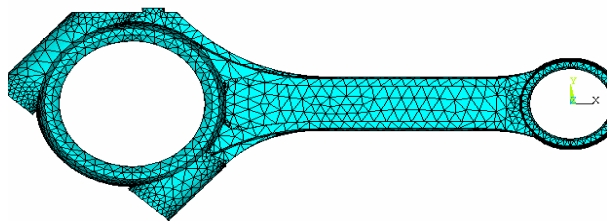


Fig. 1. Mesh of connecting rod

3 Applied Loads

While connecting rod is work, its periodic external force consists of two parts. One is gas combustion pressure transformed by piston crown, which compresses connecting rod. The other is inertia force caused by high-speed moving of piston-connecting rod, which stretches connecting rod. Therefore, during the process of analysis, the main load is maximum combustion pressure, inertia force of piston unit and inertia force of connecting rod unit.

① combustion pressure

Combustion pressure is the gas pressure caused by gas combustion. It presses piston, which will transform the force to small end of connecting rod by piston pin. Gas combustion pressure can be worked out by Eq. 1.

$$F = P_g \frac{\pi D^2}{4} \quad (1)$$

Where P_g is manometer pressure of cylinder and D is diameter of cylinder.

② inertia force of piston unit

Piston unit consists of piston, piston ring, piston pin and piston pin circlip. The mass of piston unit is mass summation of all the parts. Inertia force of piston unit works on piston pin. And it transforms inertia force to connecting rod. The inertia force can be worked out by Eq. 2.

$$F_1 = m_p R \omega^2 (1 + \lambda) \quad (2)$$

Where m_p is mass of piston unit, R is radius of crank, ω is angular velocity of crank and λ is crank link ratio.

③ inertia force of connecting rod unit

Connecting rod unit consists of connecting rod shank, big end cover, bearing shell, bolt and bush. The mass of connecting rod unit is made up of these parts. In order to simplify calculation, the mass of the connecting rod which makes complicated planar movement is divided into two parts. One part concentrates on small end of connecting rod, which is considered to make movement with piston. The other part concentrates on big end of connecting rod, which is considered to make rotary motion with crank. So inertia force of connecting rod consists of reciprocal inertia force on small end and rotary inertia force on big end.

The reciprocal inertia force of small end is calculated by Eq. 3.

$$F_2 = m_1 R \omega^2 (1 + \lambda) \quad (3)$$

The rotary inertia force of big end is calculated by Eq. 4.

$$F_3 = m_2 R (\omega \lambda)^2 \quad (4)$$

Where m_1 is mass of small end of connecting rod, m_2 is mass of big end of connecting rod, R is radius of crank, ω is angular velocity of crank and λ is crank link ratio.

The analysis of connecting rod consists of two conditions, the maximum stretch condition and the maximum compression condition. The load is applied to inner surface of big end and small end. Distributed method is second-degree parabola in axial direction and cosine in radical direction.

Safety factor is calculated by equation (5):

$$n = \frac{\sigma_{-1Z}}{\frac{\sigma_a}{\varepsilon_\sigma} + \varphi_\sigma \sigma_m} \quad (5)$$

Where σ_{-1Z} is yield limit, σ_a is stress amplitude, ε_σ is surface roughness, φ_σ is fatigue life factor and σ_m is mean stress.

4 Results and Discussion

Stress distribution and deformation of connecting rod at maximum stretch condition are shown in Fig.2 and Fig.3. The results show that the inner surface of the transition location of big end and connecting rod shank is the exposed destructive position at maximum stretch condition. The value of stress is big at connecting rod shank, but stress distribution is equably. Maximum stress value is 118MPa. Maximum deformation value is 0.577×10^{-3} . Safety factor is 2.99.

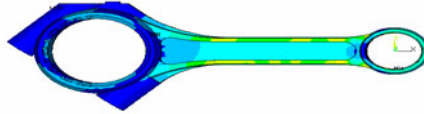


Fig. 2. Stress distribution of connecting rod at maximum stretch condition

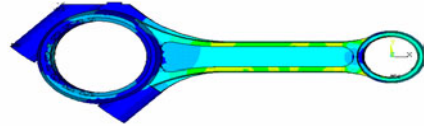


Fig. 3. Deformation of connecting rod at maximum stretch condition

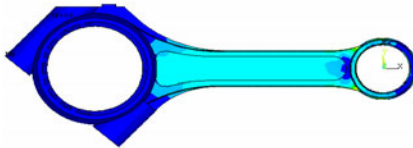


Fig. 4. Stress distribution of connecting rod at maximum compression condition

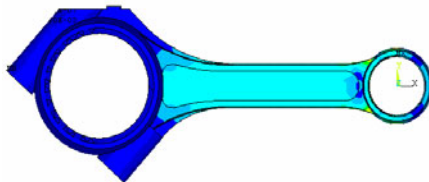


Fig. 5. Deformation of connecting rod at maximum compression condition

Stress distribution and deformation of connecting rod at maximum compression condition are shown in Fig.4 and Fig.5. The results show that the exterior surface of the transition location of small end and connecting rod shank is the exposed destructive position at maximum compression condition. Maximum stress value is

127 MPa. Maximum deformation value is 0.62×10^{-3} . Safety factor is 2.77. To the whole connecting rod, its safety factor is 2.77, which is bigger than the required value 1.5 of connecting rod design. Therefore, connecting rod satisfies the design requirement.

5 Conclusions

At maximum stretch condition, the inner surface of the transition location of big end and connecting rod shank is the exposed destructive position. The value of stress is big at connecting rod shank, but stress distribution is equably. Maximum stress value is 118MPa. Maximum deformation value is 0.577×10^{-3} . Safety factor is 2.99.

At maximum compression condition, the exterior surface of the transition location of small end and connecting rod shank is the exposed destructive position. Maximum stress value is 127 MPa. Maximum deformation value is 0.62×10^{-3} . Safety factor is 2.77. To the whole connecting rod, its safety factor is 2.77, which is bigger than the required value 1.5 of connecting rod design. Therefore, connecting rod satisfies the design requirement.

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Research on Key Technology of Collaborative Virtual Maintenance Training System in Large-Scale Complex Equipment

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Abstract. Aiming at the complexity of complex equipment and the difficulty of actual equipment training, the key technologies of collaborative virtual maintenance (CVM) with multi-operators are studied to design and develop the training system. The maintenance models are designed optimally and simulated according to the hierarchical structure, dynamic characteristic and fault mode of system. The mechanism of mapping transformation and interactive communication of the heterogeneous data between different models and the collaborative processing method of the state parameters are studied. The operation cooperation, motion coordination and collaborative motion simulation of multi virtual staffs are also studied. Then the simulation supporting platform with better generality, extensibility and real-time is developed, which provides the technical support and solution for the development of more immersive, perceivable and informational CVM environment and training system.

Keywords: Collaborative Virtual Maintenance, Training System, Complex Equipment, Maintenance Model, Heterogeneous Data, Simulation Supporting Platform.

1 Introduction

As the large-scale complex equipment has complex construction and high integration, which is composed of mechanic-electronic-hydraulic integrated system (MEHIS), the operation process of maintenance is quite complicated and difficult. It will cause the burdensome expenses and unexpected damage when taking the maintenance training with actual equipment. So considering the complexity of maintenance operation and difficulty of actual training, the technologies and methods of CVM are applied to take the maintenance training for multi-operators according to the maintenance task requirements and concrete implementation regulation of the equipment. And the key technologies of collaborative virtual maintenance training system (CVMTS) are studied to build a more immersive and interactive virtual maintenance environment (VME).

Based on the requirement analysis of collaborative maintenance training of the large-scale complex equipment, the maintenance task model, maintenance operation model and maintenance instruction model are designed and developed optimally

according to its hierarchical structure, dynamic characteristic and fault mode. The strategy of interactive communication and distribution management for all kinds of data and information and the method of information compensation, synchronous calculation and collaborative process for the state parameters are studied and created to accomplish the mapping transformation and interactive communication of the heterogeneous data between different models. The time synchronization mechanism for input cooperative operation and action coordination control of the trainees in different work stations is studied to perform the cooperative operation, action coordination and collaborative motion simulation of the virtual maintenance staffs. Then the simulation supporting platform of collaborative virtual maintenance (SSPCVM) with better generality, extensibility and real-time is designed and developed, which provides the technical support and solution for more immersive, perceivable and informational CVMTS.

2 Modelling of CVM

As the purpose of maintenance is to detect and repair or replace the fault components to make the equipment work normally. The maintenance training contents should take both the fault diagnosis training and assembly training of components into consideration. So the modelling of CVM is based on the fault modelling and the simulation of corresponding fault detection and diagnosis.

Fault Modelling of the Complex Equipment. As the MEHIS of complex equipment has such characteristics as hierarchy, relativity, nonlinearity and uncertainty, it is very difficult to establish the precise archetypal system model. In order to simulate all kinds of faults of equipment and the process of their detection, diagnosis and elimination, the mixed modelling and simulation method based on combined multi-resolution is applied to establish the fault simulation model [1-2]. Its main idea is that: use the multi-resolution modeling in different subsystems with the same type while use the mixed modelling method in the ones with the different type, design and select the time and space resolution for each subsystem optimally and properly to establish the models of subsystems with different resolution and the interconnected models between them, then analyze the effect and influence of each component in different fault mode according to the static and dynamic characteristics and fault mode of the equipment to define the physical state parameters and their change law. The process of fault modelling and simulation of complex equipment is displayed in Fig. 1.

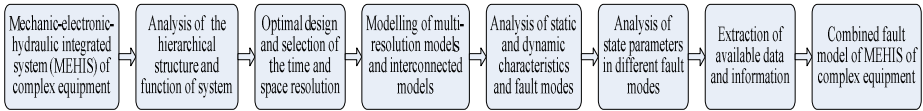


Fig. 1. The Flow Chart of Fault Modelling and Simulation of Complex Equipment

Simulation of Fault Detection and Diagnosis. The large-scale complex equipment that includes many complicated factors such as nonlinearity, time-varying and

uncertainty induces the correlation between each fault phenomenon and its causation complicated and strongly nonlinear with high dimensionality. And it causes the correlative simulation and modelling such as mathematical modelling, physical modelling and motion modelling etc., and the validation of simulation results' reliability and accuracy quite difficult. So the techniques of fuzzy theory, fuzzy identification and pattern recognition are applied synthetically to perform discrete processing of conditional attributes, calculation of attribute reduction, acquisition of fuzzy training sample set and training of fuzzy multi-class support vector machines (SVMs) model based on the rough set and fuzzy multi-class SVMs [3-4]. And the fault diagnosis model is established to identify and classify the simulation fault samples, as shown in Fig. 2. Then the process of injection, detection, location and analysis of fault is simulated to train the skill of fault diagnosis for trainees.

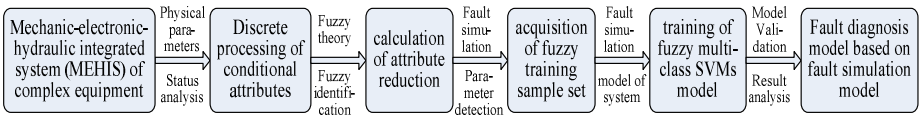


Fig. 2. The Establishment Process of Fault Diagnosis Model Based on rough set and fuzzy multi-class SVMs

CVM Modelling of the Complex Equipment. The modelling process of CVM is displayed in Fig. 3. Firstly the collaborative maintenance task model is established based on the fault injection and simulation that can simulate fault phenomenon, and the fault detection, diagnosis and analysis of fault model that can define the current fault components and corresponding fault information. Accordingly the maintenance task of each operator in different workstation is assigned with the database and information processing technique according to the maintenance task requirements and concrete implementation regulation of the complex equipment. Secondly the maintenance operation model is established according to the concrete maintenance workflow and implementation steps of each workstation to simulate the collaborative and cooperative maintenance process of each trainee, and the validity of the training process is also normalized and examined [5-6]. Finally the expert system and maintenance instruction model is developed according to the technical standard and experiential knowledge of the maintenance operation of the complex equipment to teach and instruct the current operation for each tainee.

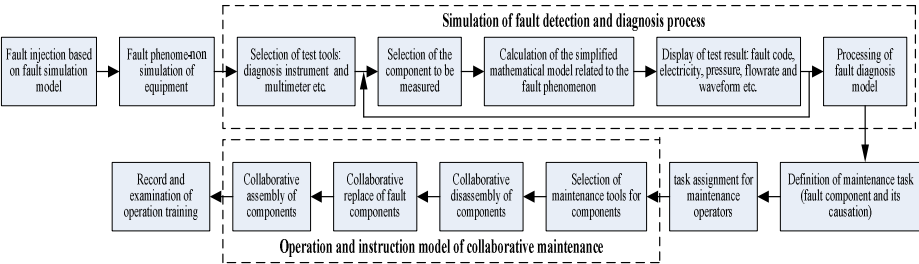


Fig. 3. The Flow Chart of CVM Modelling of the Complex Equipment

3 Interactive Communication and Collaborative Processing of Heterogeneous Data

The CVM modelling of complex equipment include entity 3D model, mathematical model, physical model, motion model and human-computer interaction model, which have different data forms. So the data information, underlying database and interactive information in the system have different content structure and knowledge representation. In order to ensure the accuracy and reliability of operation training of collaborative maintenance, the heterogeneous data is converted into unified data template by mapping transformation, and the unified data is invoked dynamically to reckon the values of required state parameters at the current time by information compensation, then the calculation results are transferred and interacted reliably among different models by the strategy of data distribution management.

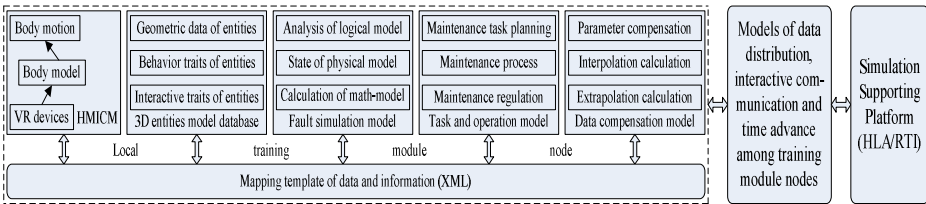


Fig. 4. The sketch map of structure and workflow of the data processing for each local training module

The structure and workflow of the data processing for each local training module is displayed in Fig. 4. Firstly the required data and information are transformed by mapping template or model with Extensible Markup Language (XML). The template is described in the format of XML including the information such as name, handle, type, state, attributes and their values, description and so on. Secondly the values of required state parameters obtained from different models in local module are compensated by interpolation and extrapolation method to reckon the optimal values at the current time. Meanwhile the reckoned values are assigned to the corresponding state parameters for further analysis, calculation and interaction. Then the functional services provided by HLA/RTI such as time management, declaration management, object management and data distribution management are applied to establish the strategy of interactive communication and collaborative processing for all the data and information among the models, which makes the communication and processing accurate and reliable [7]. Finally the time synchronization mechanism is applied to calculate synchronously and process collaboratively the values of state parameters that received asynchronously from different modules in the system with the simulation supporting platform. And the updated information and parameters are distributed and returned back to corresponding module nodes for the next step of simulation.

4 Human-Computer Interactive Control and Collaborative Motion Simulation

The human-computer interactive control model (HCICM) for the CVM not only includes the time synchronisation mechanism which implements the input operation cooperation and action coordination control of the real maintenance trainees, but also takes the real-time interaction control of the virtual maintenance staffs and their operation cooperation, action coordination and collaborative motion during the simulation process into consideration. There are many successful cases and mature methods about human-computer interaction control and motion simulation for single virtual staff [8-9]. However the relevant research results and concrete implements about the CVM are quite lacking. So the efficient approach of collaborative maintenance operation and coordination that applicable to large-scale complex equipment for multi-trainees in different work stations is studied according to the concrete demands of maintenance regulation.

In the process of CVM, the space position, body posture, hand action and operation instruction of the operators are transferred as the digital signals to the HCICM by VR devices such as motion capture system, position tracking equipment, data gloves and space mouse and their API functions under the standardized interface protocol. Based on the calculation, analysis and decision-making for the input digital signals with the HCICM, the real-time control of motion simulation and interactive operation of each virtual maintenance staff is accomplished.

In order to ensure the accuracy and reliability of the human-computer interactive control and collaborative motion simulation in the process of CVM, the strategy of interactive communication and distribution management for the data and information and the time synchronization mechanism are also applied to make each module for maintenance operation can receive the status information of the others in time. Meanwhile the irrational operation requests are restricted by the strategy of human-computer interactive control. The techniques of HLA/RTI and virtual reality and the

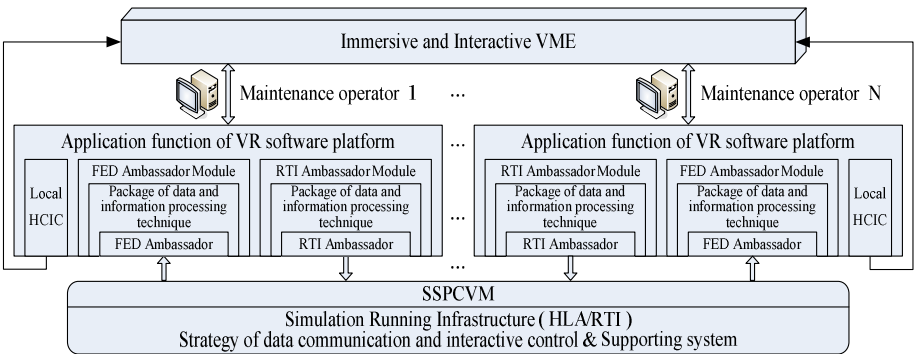


Fig. 5. The Technique Framework of CVM for Multi-Operators Modules and VME

theory of virtual maintenance are applied to analyze and design the interactive operation modes, motion constraint relationships and physical response characteristics between the virtual staffs and the entity models such as components and spare parts of equipment and maintenance tools. And it provides technique support for the establishment of VME with better fidelity and third dimension. Accordingly the simulation process of collaborative detection, diagnosis and maintenance of faults and the corresponding training methods for multi-operators are studied to explore the efficient approach of fostering and improving their ability of fault elimination and maintenance implementation in the locale. The technique framework of CVM for multi-operators modules and VME is displayed in Fig. 5.

5 SSPCVM Supporting the Coupling of Multidomain Software

The purpose of SSPCVM is to provide a running supporting infrastructure with better generality expansibility and real-time for the collaborative maintenance training of large-scale complex equipment. The technique domain involved is quite extensive and the interactive communication of data and information is quite complicated, which makes the design of SSPCVM quite difficult. So it is essential to design the standardized interface modules of the modelling and simulation software in different domain to implement the interactive communication of heterogeneous data and information, according to the coupling and relevance of all kinds of simulation models in complex system. And then actualize the organic combination and seamless splice between all the functional modules and SSPCVM to ensure the real-time, accuracy and reliability of the process and result of CVM simulation for the large-scale complex equipment.

Aiming at these problems involved in the development of SSPCVM, the idea of modularized design and combined hierarchical structure are applied to develop the general framework of SSPCVM based on the technique of HLA. With a series of universal and mutually independent supporting service programs provided by HLA/RTI, each module node with modularized design can be developed independently according to the specific simulation function [7]. Then the simulation applications in different domain are integrated organically by the simulation platform by inserting the extended program compiled by users into the corresponding module node, which can implement the data communication, state parameter update and interactive operation control of the nodes and their function modules to establish the shared mechanism of maintenance resource information and the mechanisms of sending/receiving and reflecting/updating for all parameters and interactive information in the VNE. Meanwhile VR technique and relevant software development platform are applied to establish the more immersive, perceivable and informational environment and training system of CVM, and design the setting and feedback mode of all kinds of physical and vocal effects in the maintenance process. The general structure of SSPCVM is displayed in Fig. 6.

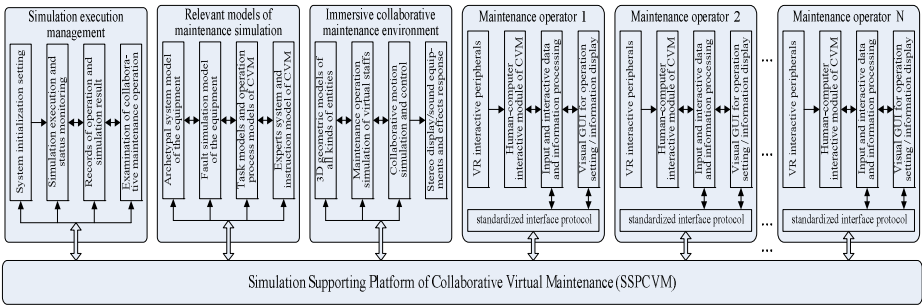


Fig. 6. The General Structure and Function Constitution of SSPCVM

As the CVMTS based on SSPCVM is designed and developed on basis of HLA/RTI, with the provided service of federation management, it can manage and control the process of scheme design, integration test, simulation running and result analysis to ensure each link is controllable. And it is convenient for the acquisition and analysis of simulation data so as to perform the optimization, VV&A and improvement of the models and platform in time. The generality and extensibility possessed by SSPCVM can accomplish the larger-scale, distributed and whole lifecycle simulation of CVM according to its complexity degree by multi-granularity distribution.

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Study of the Optimal Water Resources Allocation Scenarios in Pingxiang City

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Abstract. The paper evaluates the quality, quantity, development and management of water resources in Pingxiang City. It analysis the water resources demand of every areas in different periods by economic development planning and possible development of super-normal conditions. We also establish the Pingxiang City water resources optimal distribution model by large scale system, optimization theory and node analysis. The paper simulates and analysis the water resources demand in different period and areas, formulate a sustainable development water resources allocation scenarios. We also optimal allocate the water resources of Pingxiang City in 2015 and 2020. The method and conclusion can provide a scientific decision-making of scientific project planning, water saving and regulation for Pingxiang City.

Keywords: water resources, water allocation, optimization, node analysis, large scale system.

China is a water scarce country, the total amount of fresh water resources 2.8 trillion m^3 . It only account for 6% of total global water resources, rank fourth in the world, but per capita is only 2300 m^3 , only 1/4 of the world average water resources occupancy. Water resources shortage has seriously restricted the sustainable development of China's national economy. Therefore, we must implement the sustainable development of water resources, construct an adjustment mechanism which combination the market mechanisms and national macro command, optimal allocation water resources. So the limited water resources can match our social and economic development as possible.

Rational allocation of water resources is to study how to use water resources efficiency and equity, including water resources development, utilization, protection and management. With the increase of population and socio-economic development, the development of water resources is very high, the shortage of water is very strict, water supply and demand conflict is more and more prominent. How to allocation water resources reasonable, improve water use efficiency in every sections, solve the water use conflict become an urgent problem. Rational allocation the water resources can ease the water shortage problem in a certain extent. It also has a very important significance of sustainable development and utilization of water resources.

This paper analysis and study the water resource allocation scenarios of Pingxiang City based on investigation and exploitation of water resources quantity and quality.

The scenarios can also meet the economic and social sustainable development, ecological environment improvement and protection. It also provide a scientific decision-making of scientific project planning, water saving and allocation for Pingxiang City. The water allocation scenarios can promotion and protection the population, resources, environment and economy harmony development in Pingxiang City.

1 Basin Overview

1.1 Location

Pingxiang City is located at longitude 114°01'-113°37', latitude 27°45'-27°22', the study area include Shangli County(SL), Luxi County(LX), Lianhua County(LH), Anyuan District(AY), Xiangdong District(XD) and Pingxiang Economic Development Zone(PXEDZ). The total area of Pingxiang City is 1483km². Which Anyuan area is 186km², Pingxiang economic development zone is 52km², Shangli County 360km², Xiangdong 568km², Luxi County 255km², Lianhua County 62km².

1.2 Hydrological and Meteorological

Pingxiang City is located in the subtropical monsoon climate zone, where the weather type is subtropical humid monsoon climate. Which the climate characteristic is four distinct seasons, mild, abundant sunshine and rainfall, short frost period and long growth period of crops. The annual average precipitation is 1594mm in planning zone, annual mean temperature is 17.2 °C. The maximum and minimum temperature in the area are 41°C and -9.3 °C. The annual average evaporation is 1319mm, maximum annual evaporation is 1488.8mm, and minimum evaporation is 1058.5mm. The maximum evaporation occurs in June to August, it account for 44.7% of every year. The minimum evaporation occurs in December to February in next year, it only account for 9.6% of every year. The annual average wind speed in this area 1.5m/s, and the maximum wind speed 16m/s. Every season the wind direction change is not obvious, the most common wind is northeast direction.

In addition, there is the limestone which developed from limestone soil in the hilly areas, yellow brown soil distributed in 1200 to 1500m sea level in the mountains, and mountain brown soil, mountain meadow soil and so on in the higher mountain.

2 Research Status of Water Resources Optimal Allocation

In 1940s, Bertalanffy proposed the concept of general system theory. From that time on, people study water resources use system theory. They construct water resources system model and find the optimal solution in theory [1,2]. The methods discrete dynamic programming, incremental dynamic programming, and differential dynamic programming and so on that developed from dynamic programming have a good adaptability and ability to solve that problem[3~7]. The large-scale production system and scientific system are consist of many parts, the relationship between every part is very complex, so, we need to establish a scientific method and program to settle the

complex problem. To settle the problem, investigators promote system engineering method and use the method in many aspects. It also promotes water resources system engineering. Form then on, the system engineering became a useful tool in water resources problem [8~10]. Then, large scale system, multi-object, optimal theory is becomes new ways to settle water resources problem [12]. The water allocation results mostly qualitative describe the distribution principle [16,17], only few studies quantitative analysis and design a guide line system of water rights[18,19]. But the quantity of guide line is so many that it get more difficulties in practices.

3 Water Supply and Demand Balance Analysis

We analysis the water supply and demand balance of planning zone base on forecast the water supply capacity and water demand of study zone, as shown in Fig. 1. The supply-demand balance results in the study area shown that, the water can meet the basic needs of study zone in 2015, but there are local water shortages, especially in the area of developing zones and Anyuan, can reaching to 84.3 % and 56.9%. The Anyuan and developing zones water shortages rates are 86.1% and 62.8% in 2020. When the guarantee rate of water supply is 95%, the rates are 84% and 48.1% of Anyuan and developing zones in 2015, 86.2% and 62.9% in 2020.

We can see form the analysis that the local water shortage is very serious in the study zone. Therefore, we must not only take active measures to increase water supply capacity, but also continue to enforce water-saving programs, to control the growth of water demand effectively. We must make full use of local water resources, develop water reuse projects, mine drainage and rainwater reuse project, to achieve water supply and demand balance in the next planning period of the study area and support economic-social development in the study zone.

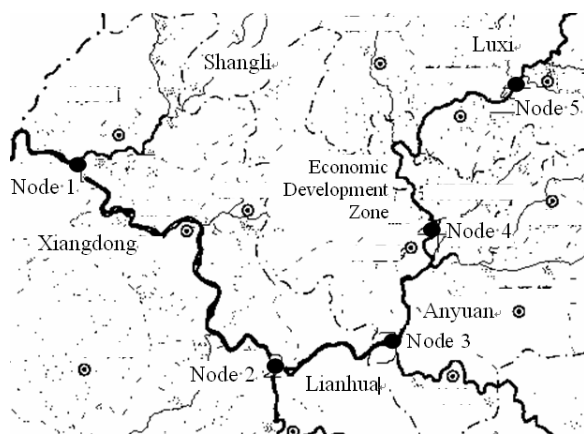


Fig. 1. The water system position of Pingxiang City planning zone

Table 1. Water supply-demand balance analysis of study zone in normal and low flow year

Year	Administrative Districts	P=50%				P=95%			
		Water Supply	Water Demand	Water Shortage	Water Shortage Rate	Water Supply	Water Demand	Water Shortage	Water Shortage Rate
2015	Shangli	7408	8033.58	625.6	7.8%	7408	8914.72	1506.7	16.9%
	Luxi	11310	3843.46	-7466.5	-194.3%	11310	4533.71	-6776.3	-149.5%
	Xiangdong	28356	18979.23	-9376.8	-49.4%	20356	23017.74	2661.7	11.6%
	Anyuan	6509	15107.83	8599.3	56.9%	6509	12542.01	6033.5	48.1%
	PXEDZ	938	5959.28	5021.3	84.3%	938	5878.23	4940.2	84.0%
	Lianhua	2034	357.95	-1676.1	-468.2%	2034	522.05	-1512.0	-289.6%
	Total	56555	52281.33	-4273.2	-8.2%	48555	55408.47	6854.0	12.4%
2020	Shangli	9097	8547.87	-549.1	-6.4%	7408	8203.48	795.5	9.7%
	Luxi	11310	3929.93	-7380.1	-187.8%	11310	3942.43	-7367.6	-186.9%
	Xiangdong	28356	19406.73	-8949.3	-46.1%	28356	19457.46	-8898.5	-45.7%
	Anyuan	6509	17485.57	10977.1	62.8%	6509	15195.44	8686.9	57.2%
	PXEDZ	938	6771.15	5833.2	86.1%	938	6002.11	5064.1	84.4%
	Lianhua	2034	893.81	-1140.2	-127.6%	2034	372.47	-1661.5	-446.1%
	Total	58244	57035.07	-1208.4	-2.1%	56555	53173.40	-3381.1	-6.4%

4 The Model of Water Allocation and Compute Programs

4.1 Model Construction Method and Compute Theory

We can compute the water supply capability of water storage project in every period based on node analysis, and then analyze the extent that the water supply meets the water demand. The node arrangement is shown in Figure 1. We must clearly confirm the proportion of water demand on industry, agriculture and live in the study zone which controlled by nodes. It can provide evidences for establish water saving scenarios and conform the water shortage type. If the water shortage is caused by the project, we should increase the water supply project. If the study zone has little water, we should enforce water saving policy, adjust industrial structure and change the distribution of production. When the water shortage caused by pollution, we should increase environmental protection efforts, strengthening the treatment of pollution sources.

Five nodes were set in the Ping water system according to the standard. The study zone can be divided into six water use areas by partition principle. We allocate the water from downstream according to water resources demand. Water demand mainly includes agriculture, industry, ecology and life. Water sources mainly include upriver water and interzone water. The main compute method as follows:

(1) Use ration method to compute the industry, living and agriculture water demand. Ecological water use for the river is 90% of minimum flow in the guarantee rate according to the standard.

(2) Water of each month in every district includes water that adjusts by water supply projects and the plus of earth's surface water every day in other area.

(3) From the downstream river, the total water demand of every node is the plus of every water users' water demand. The water that need from upriver is the total water demand subtracts the water from the district. At last, we can get the water that need from the upriver of the fifth node. Then compare the date in the guarantee rate to coming water, we can get the surplus and deficiency of the water resources. We also get the water resources surplus and deficiency of each nodes and the valley.

(4) Analysis every nodes, we can get the water demand and supply between each nodes. If $Q_{supply} > Q_{demand}$, then the water supply can meet the water demand, can reach to the demand and supply balance. If $Q_{supply} < Q_{demand} < Q_{total}$, the area run short of water saving projects, we could construct saving projects to solve the contradiction. If $Q_{demand} > Q_{total}$, the area run short of water resources, we must through save water, adjust industry structure and attemper water from other area to ease the conflict.

4.2 The Compute Program

The water resources allocation program is constructing through nodes control, compute from downstream to upstream in turn. Compute program conclude water demand of each nodes, coming water in every areas and ecological water demand in the river. At last, we can get the water resources surplus and deficiency in the study zone.

4.3 Water Resources Allocation Scenarios

The water resources allocation scenarios show that the water shortage in the third and fourth node is very serious. To exhibit the demand and supply change more intuition, we make the water allocation results in the study zone into drawing in the rate 50% of 2015 and 2020, as shown in Fig. 2 and Fig. 3.

The water allocation scenarios show that the water shortages are in certain seasons and local areas. Most zones run short of water must increase saving projects, some areas water shortage are caused by pollution and resources scarcity.

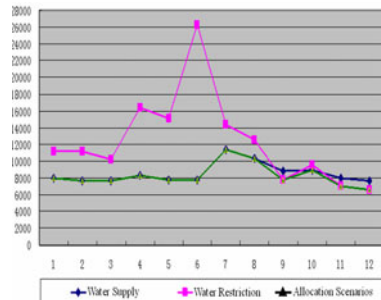
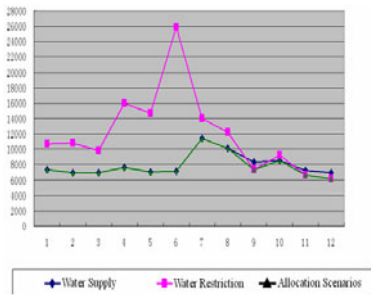


Fig. 2. water allocation scenario of 2015(50%) **Fig. 3.** water allocation scenario of 2020(50%)

(1) The distribution of water users is asymmetry. The water users mostly centralize in the third and fourth node and the population is very coarctation, the industry level is higher than other zone. The water use proportion of industry is very high. Water shortage of some local areas in study zone is very serious. The water shortage mostly happens in July to October. The water shortage can reach to 1319 ten thousand m^3 ,

(2) Uneven distribution of the rainfall, short of water saving projects, water adjust capacity of the reservoirs are very small and water supply capacity in practice have a great gap of the ideal capacity are the disadvantages of the water allocation scenarios study zone. So, the water was wasted in the flood season, run short of water in the low water period. The water shortage in some seasons in the study zone is very serious.

(3) In the water allocation scenario study zone, water waste is very serious. The coefficient of water irrigation in agriculture is very low. There is a big gap of the water recycling rate in industry compare to developed country. So, we must strengthen the water conservation.

5 Conclusions

Water allocation is one of the most important researches in the initial water right allocation. However, the initial water allocation research is a relatively new subject, and there is no fixed pattern in this area. The paper began with the investigation of the study valley, then analysis and deal with the date, get some theoretical innovations in the water allocation area, also make scientific analysis to the water allocation scenario form qualitative to quantitative. The water allocation scenario of Pingxiang City not only realizes the water resources optimal allocation, advance water saves of water users, improve water use efficiency and benefit, but also achieve the rational development and protection of water resources. The ultimate goal of allocate the initial water rights, construct the water rights system is maintenance the health of the river, realize the sustainable use of water resources. We also hope that through the work, not only get a water allocation scenario, more importantly, it can embodies the concept of a forward-looking strategy for water resources, but also establish a sense of water resources and make a guidance of water resources management.

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Node Wake-Up Scheduling Mechanism for Delay Tolerant Networks

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Abstract. In the delay tolerant networks (DTNs), nodes often be in the long disconnected state. Therefore, how to design an effective node wake-up scheduling pattern and keep the existing network connectivity is an important issue. In this paper, a delay tolerant networks wake-up scheduling policy is proposed, referred as WSP. The policy studies the relationship of wake-up scheduling key parameters. Moreover, WSP controls the wake-up period intervals to ensure the effective data throughput of node. The simulation results show that our policy can reduce the power consumption of node under the premise of effective data delivery ratio. In addition, WSP has good adaptability with delay tolerant networks.

Keywords: delay tolerant networks, MANET, wake-up scheduling mechanism.

1 Introduction

Recently, many researchers focus on delay tolerant networks [1, 2]. The nodes contact opportunities are one of the most important resources because of the weak connectivity in DTN. In this context, how to design node effective wake-up scheduling mechanism under the premise of weak contact opportunity becomes an important issue. At present, most of the wireless nodes can run in two different radio frequency modes: low-frequency short-range model and high-frequency long-range mode. In this structure, the low-frequency mode usually is used to scan and monitor neighbor nodes. And when peer node is discovered, node can “wake up” to enable the high-frequency mode which is used to establish a connection and transmit data effectively. Existing researches [3-6] show that low-frequency mode can save a lot of nodes energy compared to high-frequency mode. For example, paper [3] points that node can save energy and extend its life cycle through the appropriate switching frequency operation mode. And J. Sorber etc. adapt different priority scheduling model according to different scenarios and disable wireless RF node to enter sleep mode in some inapplicable scenes. Their purpose is to maintain the life cycle of the node as long as possible. Overall, the main idea of wake-up scheduling mechanism is to use low-frequency scan mode as much as possible and control the use of high-frequency mode cycle time. The classical mobile Ad Hoc Networks (MANETs) have good connectivity. Therefore, it does not break the network connectivity when a single or small number of nodes be in the sleep state. However, it has poor

connectivity characteristic in delay tolerant network. Thus, nodes wake-up scheduling mechanism design must consider ensuring the efficient data communication as an important factor. For this problem, this paper proposes a node wake-up scheduling policy in delay tolerant network (WSP). This policy adopts available bandwidth as lower bound of the network performance and analysis the relationship of key parameters in sleeping scheduling mechanism. Moreover, WSP adjusts the sleeping cycle length and the number of wake times dynamically. Simulation shows that WSP gets good balance between data communication efficiency and power consumption.

2 WSP Design

In WSP, each node runs its own wake-up scheduling independently. Node sends an inquiry packet within each wake up window time (W) to discover neighbor node in communication range. It is shown as Fig.1. The wake up interval period (P_w) is time period between two consecutive wake-up windows. In communication stage, node sends the data queue in cache to target node which is discovered in scan inquiry stage. It is important that node has enough time to send an inquiry control packet during the W period. We adopt IEEE802.11 as MAC layer protocol. Therefore, the $W_{\min}$ value is about 10 ms [7]. The P_w value is key parameter of the sending performance and power consumption. It can save power effectively when the P_w is long. However, it will miss some contact opportunity with neighbor node and leads to the performance degradation. This phenomenon will affect the overall network performance, especially in the case of weak connectivity in delay tolerant network. Thus, the P_w setting principle of WSP is that keeping as many contact opportunities as possible with neighbor nodes in scan query stage to ensure sending performance. In this context, WSP reduces node energy as much as possible.

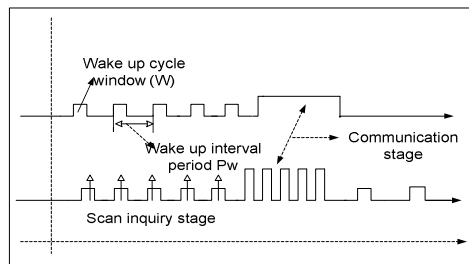


Fig. 1. WSP node communication process

Based on the above design principle, the WSP supposing rate α indicates the number of nodes interact with neighbors during per unit time interval. The α value can be gotten by the history contact record in node itself. The WSP assumes that the α follows the Poisson distribution [6]. Thus, the two node contact moment t in the P_w interval follows: $t \sim P(0, P_w)$. A node contact can be discovered if the contact period length C_{ij} longer than the next wake-up interval length, in other words, $C_{ij} > P_w - t$. The WSP call the contact as available contact. It is shown as Fig.2. Let the $E_{ij}(P_w)$

denotes the mathematical expectation of valid contact period within Pw . So, the Pw value must satisfied with the follow equation (1):

$$\alpha * E_{ij}(Pw) * L > S_{data} \quad (1)$$

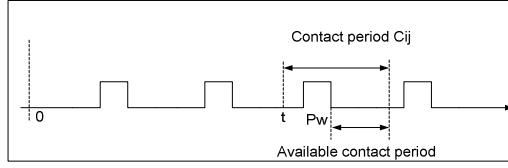


Fig. 2. The available contact period based on Pw

In equation (1), the L is the node 'real' valid bandwidth for sending data, in other words, the L does not include the overhead of exchanging inquiry scan packet etc. S_{data} denotes the total amount of data to be transmitted in node cache. We discuss how to get the L and $E_{ij}(Pw)$ in the follow.

Calculation of the valid bandwidth (L). As mentioned before, the L excludes the some overhead. Let the k denotes the data packet size, the L' denotes the theoretical bandwidth. Thus the total delay for sending a packet is $T_{delay} + k / L'$, the T_{delay} includes access latency and data queue latency etc. Therefore, the L can be gotten by:

$$L = L' * \frac{k / L'}{k / L' + T_{delay}} \quad (2)$$

In equation (2), the T_{delay} is closely related to the specific MAC layer protocol. For example, the WSP adopts the IEEE 802.11 protocol as MAC layer protocol. Then the T_{delay} value can be calculated approximately as follows:

$$T_{delay} = T_{backup} + T_s \quad (3)$$

In equation (3), the T_{backup} is average back off time, T_s is the time of switching wireless channel in confliction. The T_s value can be calculated approximately as follows:

$$T_s \approx RTS + SIFS + CTS + SIFS + SIFS + ACK + DIFS \quad (4)$$

In equation (4), all parameters are 802.11MAC layer protocol communication parameters, their values are shown in Table 1 as follows:

And the T_{backup} value can be calculated approximately as follows:

$$T_{backup} \approx \frac{w_{min} * \theta - 1}{2p}, \theta = \frac{P - 2^m(1-p)^{m+1}}{1 - 2(1-p)}, p \approx \frac{(w_{min} + 1)^2}{(1 + w_{min})^2 + 2w_{min}(n-1)} \quad (5)$$

From the above these equations, the L value is about $0.7 L'$

Calculation of the valid contact time period. As mentioned before, the contact can be regard as valid contact when contact period lengths C_{ij} longer than the next

wake-up interval length. In other words, the node can send data packet when $C_{ij} - (P_w - t) > 0$. Therefore, the mathematic expectation of valid contact period can be calculated as follows:

$$E_{ij}(P_w) = \int_0^{P_w} \frac{C_{ij} - P_w + t}{P_w} dt \quad (6)$$

Table 1. IEEE 802.11 parameter value

Communication parameter	Default value
MAC header	34 bytes
ACK	30 bytes
Slot time	16us
SIFS	8us
Wmin	16
DIFS	16us
Data rate	1 MB /s

In addition, it can be further divided into two situations about the contact that the period length shorter than the interval between two wake-up cycle.

(I) There is not overlap with the inquiry window. In this situation, it means that there is not valid contact.

(II) There is overlap with the inquiry window. In this situation, it means that the contact can be discovered. And the valid contact length equals to the contact length subtract the contact length of scan window. And the mathematic expectation of valid contact period can be calculated as follows:

$$E_{ij}(P_w) = \int_{P_w - C_{ij}}^{P_w} \frac{C_{ij} - P_w + t}{P_w} dt \quad (7)$$

From the above discussion, the expectation of a node valid bandwidth is $\alpha * E_{ij}(P_w) * L$ in WSP. And the valid bandwidth value must be satisfied with the equation (1). The P_w value takes the maximum value of collection that meets the (1) equation relationship.

3 Simulation

This section gives the simulating result based on NS2 platform [8]. We adopt IEEE802.11 as MAC layer protocol. The simulation parameters setting are shown in Table.1. In 1500m×150m area, there are two types of nodes: mobile nodes and static BT-AP nodes. BT-AP nodes are randomly located in area. Mobile nodes move randomly in area without stop. The data communication uses the CBR data flow and a packet size is 1024 bytes. There are two performance metrics: data delivery ratio and power consumption. The simulation repeats 20 times, and their average value is obtained as result.

The left part of Fig.3 shows the comparison of data delivery ratio. There is almost no difference in delivery ratio comparison when the traffic load is small. Due to the weak connectivity of the network, performance of both has declined when the traffic load increases (Range in 80-120). The WSP performance has slight worse than the normal network because of the impact of wake-up scheduling interval. However, the decrease range is not large, about 5%. The right part of Fig.3 shows the comparison of energy consumption. We can see that the WSP power consumption significant lower than the normal nodes. Especially in the case of large traffic loads, WSP reducing energy consumption about 30% because it adjusts the sleeping cycle length and the number of wake times dynamically.

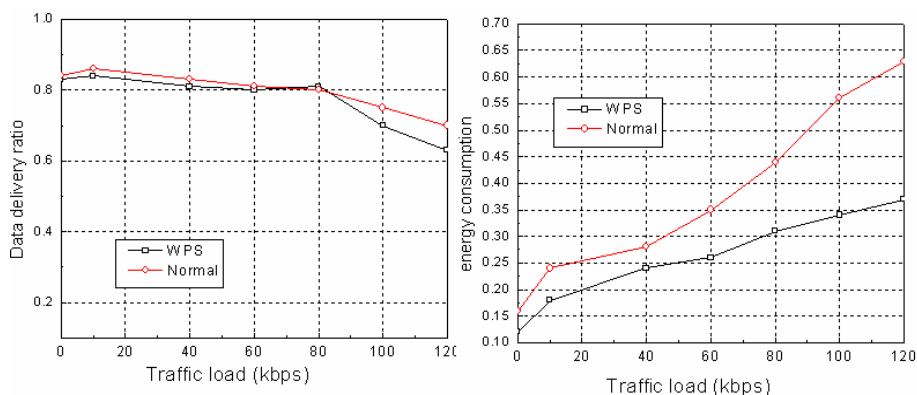


Fig. 3. The comparison of data delivery ratio (left) and power consumption (right)

4 Summary

This paper proposed the node wake-up scheduling policy referred as WSP. It analyzes the relationship of the key parameters in wake-up scheduling policy based on the weak connectivity of DTNs. The WSP ensures the valid transmission bandwidth of node. On this basis, it adjusts the sleeping cycle length and the number of wake times dynamically for saving power consumption. The simulation results show that WSP achieves good balance between data communication efficiency and power consume of node.

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Shanghai Hangzhou Bay North Shore Water Environment Impact Assessment Based on Grey Recognition Model

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Abstract. Water environment in coastal area has been a hot spot for coastal ecological environment research of our country. Based on grey recognition mode, this Paper analyzes the water environment quality of Shanghai Hangzhou Bay north shore coastal artificial bathing place in the spatial-temporal perspectives and researches the influence of coastal artificial bathing place construction on costal water environment. The research results reveal that: Coastal artificial bathing place is beneficial for protecting and improving coastal water body environmental quality and different management modes on coastal artificial bathing place present different temporal features on protection of coastal water body; in tourist peak season, environmental management improves the surrounding water environmental quality of artificial bathing place; in the same coastal artificial bathing place, tourist activities cause different levels of influences on water body environment due to different adopted water body purifying technologies.

Keywords: grey relational recognition model, water environment impact, coastal tourist activities, Hangzhou Bay north shore artificial bathing place.

1 Introduction

China has a long coastline. As economy and society develop rapidly, coastal area has been an important area for human exploitation activities. Coastal area is located in the transitional zone of marine and continental area, its ecological system is vulnerable and instable, so improper human exploitation activities usually cause severe negative effects on the ecological system of coastal area and aggravate the complexity, diversity and uncertainty of ecological scenery evolution in coastal zone. Hence the ecological safety and sustainable development of coastal area have drawn great attention of human beings [1]. The wetland water environment ecological system is an important part of ecosystem. However, most current foreign and domestic impact research related to wetland water environment, especially the assessment research on sea water environment are only simple water environmental quality assessment,

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which are basically simple assessment according to water environment quality testing and lack of analysis on water environmental influential and driving factors and correct assessment methods on water environment testing indexes. [2,3].

2 Materials and Methods

A Selection of Sampling Area

Located on the south edge of Yangtze River Delta, Hangzhou Bay north shore is a hot spot for current littoral zone wetland ecological system research. The Paper selects the research zone at Fengxian Blue Sea and Golden Sand Water Park on the north shore of Shanghai Hangzhou Bay, Fengxian Coastal Tourist Zone and Jinshan City Sand Beach. As the three areas have different tourist development ways and management way, their development has different changing mechanism on ecological environments and their ecological environments have different responses as well.

B Calculation of Grey Recognition Model

As to water environment assessment, at present, such as comprehensive pollution index[4], Nemero pollution index[5] are adopted to make a composite environmental assessment. Hence, some scholars led by Shi Xiaoxin[6] were based on grey relation degree, took the defined relation degree dissimilarity as measure, considered water quality composite indexes, and created a new water environment assessment grey-mode recognition model[7].Based on grey-mode recognition model this paper improve the model to assess the coastal water environment of Hangzhou Bay north shore artificial bathing place as follows:

1) Grey recognition model

$$u_{jt} = \frac{1}{\sum_{k=1}^c \left| \frac{1 - \sum_{j=1}^m \omega_j \xi_j(a_j, b_t)}{1 - \sum_{j=1}^m \omega_j \xi_j(a_j, b_k)} \right|^2} \quad (1)$$

u_{jt} : The j^{th} water body sample belongs to the grey subordination degree of the t^{th} level of water;

$\xi_i(a_j, b_t)$: relational coefficient of the i^{th} index of a_j and b_t ;

ω : Cluster Weight;

a, b : Normalized value of water quality indexes, $j = 1, 2, \dots, n$; $t = 1, 2, \dots, c$.

$$\xi_i(a_j, b_t) = \frac{\min_t \min_i \Delta t(i) + \rho \max_t \max_i \Delta t(i)}{\Delta t(i) + \rho \max_t \max_i \Delta t(i)} \quad (2)$$

ρ : identification coefficient, $0 < \rho < 1$, usually takes $\rho = 0.5$

2) Composite Index of Grey Recognition Model

$$GC = U_{jt} \times s \quad (3)$$

GC: composite index for water quality assessment, the value of GC is usually set between 1~c. S is water quality standard matrix.

3 Results and Discussion

A Water Environment Quality Assessment Result of Hangzhou Bay Artificial Bathing Place in Summer and Winter

1) Water environment index monitoring method and index testing

The collection of research water sample this time adopts lateral even stationing method and makes water quality testing according to international standards [8]. The testing indexes mainly include: 10 indexes of water temperature, PH value, Turbidity, conductivity, salinity, dissolved oxygen, total nitrogen, total phosphorus, COD and ammonia nitrogen. In Fengxian, 24 water sampling spots are set. The sampling is comprised of 2 stages. One is at the tourist peak season in summer and the other is at tourist slack season in winter. In Fenxgian, Spot 1~17 are in coastal artificial bathing place; spot 18 and19 are at background area; spot 20~24 is at the enclosed water area of Fengxian tourist gulf ; Jinshan spot 1~7 are at non-open water area; spot 8~21 are at coastal artificial bathing place; spot 22, 23 and 24 are at background area.

2) Water Quality Assessment Results by Grey Recognition Model

According to the 10 indexes [9], finally select DO, COD, TN and TP that are comparatively higher relational with tourist activities to make water quality composite assessment. According to testing results, the water quality indexes of the research area are all between level 2 and level 3. The composite assessment results GC(dimensionless) and δGC ($\delta GC= GC_2-GC_1$) are as shown in Table 1 and 2:

Table 1. The result of evaluation of water quality (Point 1 to 12)

Number Area		1	2	3	4	5	6	7	8	9	10	11	12
Feng xian GC	GC ₁	2.5 22	2.52 9	2.53 3	2.54 0	2.54 1	2.55 2	2.52 4	2.50 7	2.51 6	2.49 6	2.49 0	2.55 2
	GC ₂	2.4 53	2.52 7	2.50 7	2.55 1	2.54 5	2.53 9	2.54 4	2.50 6	2.48 5	2.53 3	2.52 1	2.50 4
	δ GC	— 0.0 69	— 0.00 2	— 0.02 7	0.01 1	0.00 4	— 0.01 2	0.02 0	— 0.00 1	— 0.03 1	— 0.03 7	— 0.03 1	— 0.04 8
	GC ₁	2.4 97	2.53 1	2.53 9	2.52 9	2.52 1	2.53 5	2.54 2	2.47 9	2.54 0	2.53 8	2.53 3	2.48 2
Jins han GC	GC ₂	2.5 34	2.53 7	2.53 6	2.54 2	2.54 0	2.53 7	2.53 5	2.52 8	2.54 2	2.53 8	2.51 3	2.54 6
	δ GC	0. 03 7	0.0 07	— 0.0 3	0.0 13	0.0 19	0.0 03	— 0.0 07	0.0 49	0.0 02	0.0 00	— 0.0 21	0.0 65

Table 1. The results of evaluation of water quality (Point 13 to 24)

Number Area		13	14	15	16	17	18	19	20	21	22	23	24
Fen g xia n GC	G	2.532	2.52	2.57	2.52	2.52	2.54	2.51	2.49	2.48	2.4	2.5	2.4
	C ₁		5	0	7	4	9	5	1	9	84	59	94
	G	2.537	2.49	2.49	2.48	2.49	2.59	2.58	2.56	2.51	2.5	2.5	2.5
	C ₂		2	3	2	0	5	0	7	7	66	68	46
Jin sha n GC	δ		—	—	—	—	0.04	0.06	0.07	0.02	0.0	0.0	0.0
	G	0.005	0.03	0.07	0.04	0.03	6	5	6	7	82	08	52
	C		3	7	5	4							
	G	2.507	2.53	2.51	2.49	2.52	2.55	2.53	2.55	2.55	2.4	2.4	2.5
GC	C ₁		6	8	5	8	6	0	2	1	86	88	18
	G	2.551	2.51	2.54	2.55	2.55	2.53	2.52	2.54	2.49	2.5	2.5	2.5
	C ₂		7	3	4	2	9	2	4	8	75	62	66
	δ		—	0.02	0.06	0.02	—	—	—	—	0.0	0.0	0.0
C	G	0.045	0.01	5	0	4	0.01	0.00	0.00	0.05	89	74	48
	C		96				7	8	8	3			

B Water Environmental Quality Change Features of Hangzhou Bay North Shore Artificial Bathing Place in Summer and Winter

GC value has a negative correlation with water body quality and corresponds to water environment quality level. As shown in Table 1&2, a negative value means the second water quality is better than the first water quality, while a positive value means that the second water quality is worse than the first water quality. The results are shown as follows:

1) The water quality keeps at level 2 and 3 in winter and summer. The standard-exceeding situation of water quality has not been found

According to national sea water quality standard (GB 3097-1997), the type 2 and type 3 water are suitable for marine activities for human body directly contacting sea water in aqua-cultural area.

2) In temporal perspectives, in different research areas, the water quality changes in summer and winter are different

Fengxian Blue Sea and Golden Sand has its water quality in winter better than in summer and the water sampling spots with δGC smaller than 0 account for 65% ; the water quality in background area and Fengxian tourist Bay in winter is worse than in summer and the water sampling spots with δGC larger than 0 account for 100% ;

The water quality of Jinshan City Sand Beach in winter is worse than in summer and the water sampling spots with δGC greater than 0 accounted for over 55%; in background area, the water sampling spots with δGC greater than 0 account for 100%. It's because in winter Fengxian Blue Sea and Golden Sand is closed to protect the

water body environment in this area, while Jinshan City Sand Beach is open to the public and lacks of effective maintenance on water body, so its water body environmental quality deteriorates.

4 Conclusions

A. Coastal Artificial Bathing Place is Beneficial for Protecting and Improving Coastal Water Body Environmental Quality. Different management modes on coastal artificial bathing place present different temporal features on the protection of coastal water body.

According to the research results, coastal artificial bathing place has had its coastal water environment protected due to its reasonable sea water artificial purification and solid waste clearing. The water quality of Fengxian Blue Sea Golden Sand artificial bathing place in winter is better than in summer, because in winter the coastal artificial bathing place is closed to effectively protect water body environmental quality due to its corporate contracting management mode ; Jinshan City Sand Beach is a public place, it only takes closed management and charges in tourist peak season, in winter it's open to the public for free, so it lacks of effective water body purification and the water quality in this area thus deteriorates in winter.

B. Environmental Management in Tourist Peak Season Improves the Water Environmental Quality Surrounding the Artificial Bathing Place.

According to the research on the non-open water area in background area and Fengxian Tourist Area, compare the water quality of coastal artificial bathing place in winter and summer from the temporal perspectives, in the surrounding areas of Fengxian and Jinshan coastal artificial bathing place, to ensure tourists' safety in coastal tourism and the beauty of the scene, the administrative departments strengthen effective environmental management measures, which make the environmental quality of coastal area in tourist peak season better than in slack season.

C. In the Same Coastal Artificial Bathing Place, with Different Water Body Purification Technologies, the Tourist Activities have Different Levels of Impact on Water Body Environment.

According to related surveys, Fengxian Blue Sea and Gold Sand adopts sea water physical purification technology. It mainly adopts physical sedimentation method to remove the sediment in sea water, and make water body purification with chemical methods; Jinshan City Sand Beach uses physical sedimentation method to get rid of the sediment in sea water, and then adopts biological algae purification technology to purify the sea water. Therefore, due to the difference of purification measures, the water quality of Fengxian coastal artificial bathing place is worse than in background area and the non-open water area, while the situation of Jinshan City Sand Beach is the contrary of it.

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Views on the Energy Efficiency Service Industry in China

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Abstract. The implementation of energy efficiency projects has fallen far short of the potential due to a number of barriers in China. Energy performance contracting (EPC) implemented by energy service companies (ESCOs) has been recognized as an important mechanism to overcome these barriers. However, the growth of the energy efficiency industry has been slow. This paper aims to promote a number of policy initiatives to foster the development of the ESCO industry in China. Firstly, the paper reviews and analyses the development and the current status of ESCO industry in China. Further, key barriers to the development of ESCO industry in China are identified in this paper. Based on the review and the analysis, a long-term strategy to foster the growth of a viable energy services industry in China is formulated. A set of policies that help remove market and institutional barriers to the investment in energy efficiency projects are suggested. This paper provides information to policymakers and industry participants on ESCO market development, growth and capabilities.

Keywords: Energy service, Energy efficiency, performance contracting.

1 Introduction

The rapid development of the Chinese economy over the past decades has led to significant growth in China's energy consumption and greenhouse gas (GHG) emissions. Between 1980 and 2009, China's energy consumption more than trebled from 602 million to 3.0 billion tons of coal-equivalent [1]. China's GHG emissions were about 12% of the global total, ranked second behind only the US [2] and current overall level of energy efficiency remains far behind those observed in other developed economies. Chinese government has put high emphasis on the problem of energy consumption and environmental pollution, and has put the project of energy conservation and emission reducing into practice. China has mapped out its long-term energy efficiency schemes. According to the latest national development plan (the 12th five-year guidelines), China sets the goal of reducing the amount of energy per unit of GDP by 16 percent between 2011 and 2015.

China is placing emphasis on developing regulations, policies, and incentives to encourage increased energy efficiency in industrial sector, transport sector, and building sector. However, the actual implementation of energy efficiency projects has fallen far short of the potential due to a number of barriers in China [3]. From the mid of 1970's, a market-based energy conservation mechanism of "EPC" had been developing step by step in market economy countries. As a result, the "Energy

Service Company” that operates based on this mechanism, which is referred to as ESCO overseas and EMCo in China, began developing rapidly. Nowadays, EPC has been proposed as an important mechanism to overcome some of the barriers and ESCOs are expected to play an important role in promoting energy efficiency in China. However, the growth of the ESCO industry has been particularly slow in China due to a number of regulatory and institutional barriers.

This paper reviews and analyses the development and the current status of ESCO industry in China. This paper further identifies barriers to the development of a viable ESCO industry in China. Based on the review and the analysis above, a long-term strategy to foster the growth of a viable energy services industry in China is formulated. A set of policies that help remove market and institutional barriers to the investment in energy efficiency projects are suggested.

2 Review of China's Energy Service Market

China has been working with the World Bank (WB) and the Global Environmental Facility (GEF) to promote the ESCO business model in China since 1997. The WB/GEF China Energy Conservation Project aims to introduce market-based mechanisms for energy conservation in China. Phase I of the WB/GEF Project helped China to establish 3 Energy Management companies (EMCs) to demonstrate the applicability of the ESCO business model in China. Up to the end of Year 2005, the 3 pilot EMCs have implemented 423 energy efficiency projects and the total investment is about 1.17 billions and the gross energy saving benefits are near 1.5 billion RMB Yuan [4]. The average payback period for these projects is 1.3 years. These projects demonstrate huge potential of energy savings [5]. The successes of Phase I provided compelling evidence for the fact that EPC does indeed suit China's young market economy.

In 2004, building on the success of the 3 EMCs, Phase II of the WB/GEF Project aims to foster a host of new EMCs and the development of an ESCO industry in China. EMCA, officially registered in 2003, is the implementing agency of the EMCo Service Component of the WB/GEF Project Phase II. The mission for EMCA is to promote the sustainable development of ESCO industry and to support the fast and healthy growth of ESCO in China. In order to address the financing difficulties for emerging EMCs, Guarantee Facility is developed, which is designed to leverage lending from domestic commercial banks to create a large pool of capital for energy efficiency projects. The WB/GEF guarantee Facility (funded by GEF at US \$22 million) is managed by China Economic and technical Investment Guarantee Corporation and operates on a commercial basis. The Guarantee Facility will be the first risk-taker in case the cash flows from the energy efficiency projects are insufficient to cover loan payments to the lenders. This arrangement greatly reduces the risk to lenders, thus making it easier for banks to make loans to EMCs for energy efficiency projects. Phase II of the WB/GEF Project overcome the financing barriers and thus help create a more attractive business environment for EMCs.

3 Overview of China's ESCO Industry

ESCOs are businesses that offer improvements in end-use energy efficiency by combining engineering expertise with financial services [6]. During the 11th five-year period, China's energy services industry goes through rapid growth and consolidation. The number of EMCA's members, distributed in more than 20 provinces, has increased 5-fold. EMCA members include EMCs, energy conservation center, financial institutions, advisory bodies, et al. Energy services industry has become an important force for energy conservation in China.

By the end of 2010, total Energy Services Company increased from 80 to more than 800 and employees increased from 1.6 million to 18 million. The scale of energy service industry grew by about 16 times, increasing to 84 billion from 4.7 billion. EPC project investment increased from 1.3 billion to 29 billion. Compared with developed countries, ESCO activity in China shows that the development of the ESCO industry is still in its infancy [7]. In China, ESCO projects cover a wide variety of services and products. The main service areas include: energy efficient lighting, heating networks, boiler retrofit, central air conditioning, integrated power saving, heat pump projects, variable frequency/variable speed drive projects, combustion of (waste) gas for electricity production, waste heat recovery, and heat and cold storage. Lighting and heating, ventilating and air conditioning (HVAC) measures are by far the most common ESCO projects, and the largest total investment is in boiler retrofit.

4 Performance Contracting Business Models Used in China

Performance contracting is a core part of an ESCO's business plan. There are 3 types of performance-contracting typically used in China: shared savings, guaranteed savings, and outsourcing energy management.

The shared savings structure is a good introductory mode for developing markets because the customers assume no risk; however, it limits long-term growth and competition of the ESCO and financing industries. According to the EMCA, it is the mainstream of EPC in China. The majority of shared savings contracts are signed by buildings in China. Typical contracts last for 4.5 years with a maximum of 10 years.

Under a guaranteed savings model, the customer assumes "business risk" (market risk), the ESCO assumes performance risk, and the bank holds the credit risk. In China, market distribution of guaranteed savings is mainly in industries. The characteristic of this sector is that the project is usually 10 year-span, maximum is 15 years. The market share of guaranteed saving has been increasing recently.

Outsourcing energy management is developed in China based on its actual situation. Outsourcing of energy management is mainly done by commercial buildings such as hospitals, hotels, and super markets. This market sector is expected to grow rapidly.

Findings from third-party assessment agencies show that when non-EMCA-member companies implementing energy conservation projects, 60% of customers tend to EPC mechanism, and of these customers, 65% of which tend to the shared savings model, see Fig.1 and Fig.2 [5].

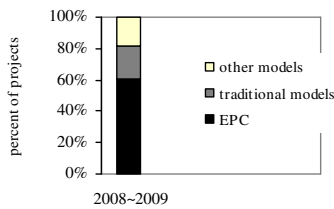


Fig. 1. Energy conservation market by business model

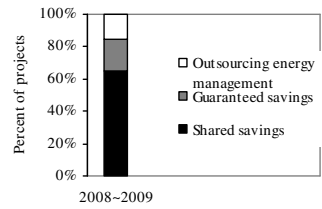


Fig. 2. China ESCO market by contract type

5 Barriers to the Development of ESCO Industry in China

In China, several barriers prevent the full development of the ESCO industry. Key barriers that inhibit the development of ESCO industry are summarized below.

(1) Low awareness, lack of information and understanding of the opportunities that energy efficiency offer because energy savings are “not seen” and there is lack of information and understanding of how EPC works [8]. Low energy price, lack of motivation, and limited confidence in ESCOs also cause low awareness at the demand side of the market for energy services. Energy is a small fraction in total costs and hence low priority when energy efficiency projects compete with core business investments.

(2) Limited understanding of energy efficiency and performance contracting by financial institutions. Sustainable project financing is lack due to conservative lending practices and limited experience with energy efficiency project financing within the banking sector [9]. Actually, the scarcity of project financing is caused by the gap between traditional corporate “asset based” lending and the special financing intricacies of energy efficiency projects requiring “cash-flow based” lending.

(3) Measurement and verification protocols for assuring performance guarantees are not understood because China is lack of uniform standards and third-party evaluation agencies.

Limited government support for energy performance contracting, especially in residential sector where local banks and private investors are reluctant to participate is also an important barrier to the development of EPC and ESCO industry.

6 A Possible Strategy to Foster the Development of the ESCO Industry in China

Several types of strategic actions are needed for fostering the development of the ESCO industry in China. The first action is to increase information about energy-efficiency projects, financing opportunities, and services offered by ESCOs. As mentioned above, there is a lack of information by the end-user on ways to improve energy efficiency (e.g., in public buildings). The same lack of awareness and interest

is also present in financial institutions because China has not been a culture for third-party project financing. To move in this direction, government may establish demand-side based incentives to increase the end-user's awareness of energy efficiency. ESCO Committee of China Energy Conservation Association may create a comprehensive list of EMCo, including a description of their projects, capabilities, and illustrative case studies. The list could be available at national and local energy agencies. Another important measure is the organization of training courses for energy managers of companies, making them aware of EMCo activities, EMCo-type projects, and measurement and verification methods and procedures for measuring energy savings.

A second action is to standardize contracts and proposals and measurement and verification (M&V). The development of standard procedures for M&V of savings as well as for standard contract terms can help end users, EMCo, and financial institution better understand performance contracting. However, the development of standard contracts may be an elusive task. Rather than developing a single standard energy services agreement, developing standard contract provisions that could be adapted for use in different types of energy projects may be useful.

A third action is to promote energy performance contraction in government buildings. Government-owned property is a major energy user and can represent a significant proportion of the potential ESCO market.

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Problems and Solutions of Information Science Education in China

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Abstract. Personnel education in the field of information science has reached a considerable scale in Chinese universities and colleges, but there exists a contradiction between higher education and market requirement, many graduates from higher school don't meet the demands of enterprises. This contradiction is investigated according to recent data from human resource markets and government departments. In order to make information science educations to cater to social requirements, trends of information industry in recent years in China are discussed; the composition of human resource in this industry is investigated, and some solutions to overcome the contradiction are suggested.

Keywords: Information science, Education, Graduate.

1 Introduction

Information science education involves many specialties in higher school; typical specialties include Computer Science and Technology, Software Engineering, Automatic, Communication Engineering, Microelectronics, E-commerce, Information Management and Information System, and so on. Personnel education and training in China have reached a quite large scale in recent years. We take Software Engineering (SE) as an example here. In 2008 the number of undergraduate students in colleges and junior college majoring in SE are 131 thousands and 359 thousands separately, then the total is 491 thousands, if we take those students majoring in SE related specialties into account, the total number is 3150 thousands; The graduates from SE and relevant majors in 2008 are composed by 38.5 thousands graduate students, 389 thousands college students and 430 thousands junior college students.

The universities, colleges, junior colleges and training schools today are beset with a contradiction between supply and demand for students majoring in information science. On the one hand there are too many graduating students find it is very difficult to find a job; on the other hand employment companies are not satisfied with the current education pattern and feel difficult to find personnel who are qualified for information industry.

We investigate the cause of the problem and give some suggestions to solve this problem in this paper. The rest of this paper is composed by following sections: the

contradiction between graduating students' supply and demand, analysis of personnel demand in information industry, imperfection of present personnel structure and some measures to overcome this.

2 The Supply and Demand Contradiction of Graduating Students

Chinese college graduates' employment annual report (2010)[1], the blue book of employment from MyCOS Institute was published by Social Sciences Academic Press (China) in 2010. They surveyed and analyzed the 2009 university graduates in the job flows, employment and income, ability to work, employment and education equity. According to data in the report, the total unemployment number is 103.8 thousands for the graduates from the top 10 majors with the most unemployed, which account for 33 percent of the total graduates. 8 majors belong to the most unemployed for successive three years (2007-2009), Computer Science and Technology is ranked in second place among them. In addition, according to data from educational departments, there are totally 3150 thousands students majoring in Computer Science and technology, Software Engineering and relevant specialties (where junior colleges and training colleges are taken into account), which we have mentioned in previous section. The number of graduates of such majors in 2007 is 800 thousands.

But on the other hand, qualified personnel in Information Science are badly needed. We also take Software Engineering as an example to explain this situation. The problem that personnel in software is in short supply confines the development of software industry in China, short of software personnel supplies is reported widely in recent years. In contrast with the layout of the Eleventh-Five Year Plan for software industry, the scale of software personnel education is still on the low side. According to the plan of Education Department and Commerce Department, we have to bring up 1200 thousands personnel for software industry and outsourcing service, among them an extra 1000 thousands college students are required. Tendency of personnel demanding in 2010 released by a main website on advertising job offers indicates that computer software is the No.1 among the industries where personnel are badly needed.

Numbers of graduates majoring in information science can not find a job in the personnel market, while numbers of enterprises can not find right employees at the same time, this forms embarrassed situation.

3 Personnel Demand in Information Industry

From the data in above we can find that colleges and universities play key roles in information science education. Usually colleges and universities in China emphasize the foundations and theories during education, students are well educated with complete knowledge of certain field, graduates are suitable for science research. If we compare the syllabuses and textbooks from different universities, colleges and even higher vocational colleges, we can find most of the schedules seem to look alike, although these schools and their students are in different levels in fact. With the development of higher education successively in so many years, a great deal of

graduates suitable for theory researches are provided for the market to get a job. This leads to the intense competition for some limited posts, even the information industry in explosion cannot absorb so many personnel with great similarities, at the same time, it is difficult to find enough graduates for some other places such as software service.

To educate students with a market-oriented objective in mind, we must make clear the development trend of information industry. For example, according to the planning for software industry of the Eleventh-Five Year Plan, the developing focus of software industry is classified into 7 types, which can be further boiled down to following three types: foundational software, application software and software service.

(1) Foundational software refers to the development and application of reliable network application environment oriented operating system and database management system, middleware, office software and development environment, foundational software for security, intelligent software for Chinese information processing and other foundational software.

(2) Application software refers to the development and application of software for the fields including e-government, e-commerce, e-health, e-manufacturing, rural informationization, city and community informationization, enterprise informationization, logistics informationization and long distance education. This also includes development and application of embedded software and operating system for mobile communication, automobile electronics, digital television and information security. Another field related here is the digital industry of animation, cartoon and game, which speeds up the fusion of culture industry and information industry.

(3) Software service includes the construction of software service and e-business platform, and service personnel training.

For the education of personnel for software industry, we must aim at the above directions. Under current economic circumstance in China, training of fusional personnel in informationization and industrialization should be paid special attention to. Manufacturing is one of the pillar industries with extensive influence; it drives the development of a chain of related industries. Informationization is a key resort to realize upgrading of manufacturing industry. The design and technology innovation in manufacturing should be supported by special background in this industry, so for students in this area synthesized education covering information technology and professional knowledge should be stressed, some of the important courses may include Computer Integrated Manufacturing System (CIMS), Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE), Computer Aided Project Planning (CAPP), and so on.

4 Imperfection of Present Personnel Structure

Personnel is the most important resource for industry development, so it is a project of vital and lasting importance to cultivate a lot of qualified personnel, the group should be of reasonable structure composed by those who are not only familiar with market but also with different professional background.

Employees in software industry usually follow one of the two routines in their career development: the first type run the way of programmer, software engineer, team leader, project manager, department manager; the second run the way of programmer, software engineer, senior engineer, system analyst, technical director.

Personnel resource configuration of mature software industry should be a pyramid, system analysts, technical directors and department managers are in the top of the pyramid working as the soul of a enterprise, project managers and software engineers compose the middle part of the pyramid working as the backbone, a great deal of programmers is the foundation to write programs. A reasonably structured team with an elaborate division of personnel helps for scientific management and making full use of human resource.

However the main force of the software industry in China is composed by employees who are well educated with specialized theories, although they lack practical experience when left university, they can compensate that very soon in their work and step into the rank of engineers in short time, but under current situation in China, it is difficult for them to advance further. Too many engineers playing the role of programmers and the lack of high level talented person is still keeping a serious problem in information industry.

5 Some Measures

Specialty foundation is the stress of current education in colleges and universities, while practical engineering application is relatively less involved, or not enough at least. The graduates usually feel out of place at the new place since they are unfamiliar with project organizing, production flow and many things else. Knowledge in information science renews quickly, so it more important to provide continuation education and on-the-job training for employees compared with other industries, but many minor enterprises don't like to do this because of cost and time, they hope the personnel they employed satisfy their requirements directly, this in fact create a gap between higher education and real work.

So even the higher education today is not perfect really today, it's unfair to claim colleges and universities should account for this independently. It is in fact impossible for higher education to foster abilities desired by enterprises separately, such abilities includes study, communication, cooperation, organization and other occupational qualities, even career experience.

It's important to establish a sound system for personnel education in information science, a hierarchical scheme is suggested. High-level universities take charge of culturing researching talent with preferable theoretical principle, ordinary universities and colleges take charge of culturing engineers. Higher vocational education should be strengthened to bring up popular personnel for ordinary post where advanced knowledge or technology is not required, and strong enterprise or organizations are encouraged to providing specific training aiming at certain products, technologies or transactions. By above methods, a relatively sound train and education system for personnel of different levels can be established.

6 Summary

Some researches indicate technology diffusion contributes more than technology innovation, this show not only scientists to invent new technologies are demanded by the society, but also personnel to apply new technologies are badly wanted. Application software for a certain industry possesses distinct characteristics of that industry, the production flow and management industry have different needs and emphases, so it impossible to solve all problems using one universal software such as an fixed ERP system, it is necessary to develop or alter systems in conjunction with employees in that industry. To bring up personnel with both information science knowledge and certain industry knowledge is an important direction of higher education, this is the method to break the impasses that the software engineers know nothing about the industry and the industry engineers know nothing about software.

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Factors Influencing Bilingual Teaching on Computer Science

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Abstract. Bilingual teaching on computer science is widely accepted in different universities. As an important item of the education reform, bilingual teaching faces some problems in the practice, and these problems have to be solved so as to improve teaching effect. According to author's experience of bilingual teaching practices in the past years, three factors including students, teachers and courses are analyzed in detail, and these factors influence the practical result of bilingual teaching greatly. Some answers are given to solve these problems. Research in this paper helps to popularize bilingual teaching on computer science scientifically.

Keywords: Bilingual Teaching, Student, Teacher, Course.

1 Introduction

The word bilingualism in China usually refers to Chinese and English, this is decided by the fact that Chinese is the native language and English is an all-purpose language in the world today. The intention and meaning of Bilingual Teaching in China is to cultivate students' ability to use and understand English comprehensively, and to improve students' professional knowledge by introducing original edition textbook. Bilingual teaching is a key measure to culture students linking up to the world and to make them to be innovative and complex talents. In the document "Some opinions about enhancing undergraduate teaching and improving quality" released by Education Department in 2001, teaching by foreign language including English is encouraged, universities should create proper conditions for teaching common course and professional course in English in undergraduate course education. With the gradual popularization of bilingual teaching, it is proved to be feasible, but there exist some problems to be solved.

In order to improve bilingual teaching, we have to research the factors which influence the effect of teaching, in this paper we mainly research those related to the teaching of computer science. We describe the effect of bilingual teaching using following function

$$Y=f(x_1, x_2, x_3) \quad (1)$$

where

x_1 is the student factors,

x_2 is the teacher factors,

x_3 is the course factors.

The three factors above cover the different aspects of bilingual teaching and influence each other. According to bilingual teaching experience of author in the past years, we analyze existing problems at different angles by method of decomposition, and give some corresponding solutions for different problems.

2 Student Factors

Basic point of departure for bilingual teaching is to train students more effectively. Student is the main participant and object of bilingual teaching, so students' English level and acceptance degree for bilingual teaching decide whether this reform can be successful or not. The student factors are described by following function:

$$x_1 = f_1(z_1, z_2, z_3) \quad (2)$$

where

z_1 : subjective factors, in which learning initiative is the major, they are the key factors of students;

z_2 : objective factors, in which learning capacity and foundation is the major, they can change with the changing of z_1 ;

z_3 : objective factors, in which English level is the major, they can change with the changing of z_1 . It means such factors can be changed by one's endeavor. The factor of English level can be classified as learning capacity; it is listed independently here because it is of particular importance in bilingual teaching.

Although bilingual teaching is suggested for undergraduate courses by the Department of Education, degree of appropriateness is diverse from each other in different universities. Currently the evaluation of a student's English level is based on his score of College English test IV and VI. Statistics shows usually the higher a student's score is, the more willing the student shows to accept bilingual teaching, this indicates the acceptance of bilingual teaching has direct relationship with students' English level. Students passed CET IV sometimes still feel difficult for some professional courses. Usually English level of students in high level universities is better than those in other common universities because their sources of students are better; another reason is brought by the difference of learning climate in universities. Local university, especially some recently founded colleges; their students' knowledge quality including English level is not as good as that of famous universities. So it's not strange some famous universities have a very high proportion of bilingual teaching or even teaching in English at all, while in some local universities bilingual teaching is rather difficult.

Since the acceptance of bilingual teaching has direct relationship with students' English level, it is necessary to classify students into different classes before beginning a bilingual teaching course. Whether to take bilingual teaching or not

should take many factors into account, these include university itself, specialty, grade and so on, there exists no uniform standard. If possible, it would be better to provide a choice between bilingual teaching and teaching in Chinese, the students can decide whether to choose a bilingual teaching course or not. For some common courses of different majors, such as Operating System, Data Structure, Computer Networks for both Computer Science and Software Engineering, the students from different majors can be put together for flexibility. It is suggested that students should be allowed to change to the other class with different teaching method.

Improving students' English level and acceptance degree is the key for promoting bilingual teaching, they are also the most difficult things to do and decide the success or failure of bilingual teaching, and so mobilizing students' learning enthusiasm sufficiently is stressed in the notice of Education Department.

3 Teacher Factors

Teacher is the second important factor for bilingual teaching. Besides the requirements for ordinary teachers, bilingual teaching set an even higher demand for teacher in the aspects of language and teaching method. Teacher factors are described as following function in equation (3).

$$x_2 = f_2(v_1, v_2, v_3) \quad (3)$$

where

v_1 is the subjective initiative of a teacher, namely activeness of him to adapt bilingual teaching;

v_2 is the objective factors mainly referring to teacher's English level;

v_3 is the objective factors including the teaching level and techniques of a teacher.

Activeness of a teacher to adapt bilingual teaching is the precondition to do it well. How to make teachers active to teach bilingually concerns the question of policies, this concerns the environment factors which are not discussed in this paper. Teaching level and techniques of a teacher are important to all his courses, form the preconditions of effective instruction. In a bilingual teaching course, students are more easily distracted. The process of acceptance knowledge, including those from textbook, teaching material and teacher's explanation, is accomplished by translating from English to one's native language, this exacts the closest attention. If a student get a little carried away, it's not so easy to get the teacher's rhythm as that in a Chinese teaching course, this will bring frustration response and make him absent-minded further. So it is really important to use interactive instruction model, this helps to make students feel interesting and active. Group discussing, classroom questioning and designing courseware with utmost care help to relieve the problem.

It is suggested to use simple sentences and frequently used words, too complex sentences should be avoided. English is recommended to explain common knowledge, but it is better to use Chinese and English together to explain important concepts and terms, as for some difficult and abstract contents, native language is the best choice. The teaching process should not be restrained by regulations about the

ratio of English from different policies, the native language should be used more frequently for those students who are not good at English, but for those who are good at English, even all in English is possible.

Successful practice of bilingual teaching requires qualified teachers, by training and introduction in recent years, key universities mostly possess a group of preferable bilingual teachers, but it is not true in local universities, most of the doctors graduated and introduced into universities in recent years are unnecessarily suitable candidates for bilingual teachers. Of course training and introduction are still measures to solve this problem. The first way of personnel introduction is selecting those who are good at English from famous domestic universities, the second is introducing abroad, but for computer science it is not easy to introduce the best men. According to recent data, the Chinese graduating from USA with doctor's degree in computer science is only about 75 annually, not to say those who have returned to China [1]; it is still difficult for a local university even to take those masters from famous universities into account. Another effective way to solve this problem is talents exchanging, we can invite teachers from cooperative universities for short term courses. Since the bilingual teachers are in great demand, it is necessary to train young teachers specially.

4 Course Factors

Course factors include items such as whether a specific course is suitable for bilingual teaching or not, we use the following expression (4) to describe these:

$$x_3=f_3(u_1,u_2) \quad (4)$$

where:

u_1 is the aptness for bilingual teaching of a course, this relates to subject, course, condition or state of a certain country;

u_2 is textbook or teaching material related factors, mainly refer to the rationality of the textbooks, including level, difficulty and quality.

Aptness for bilingual teaching is limited. Hong Kong Chinese University brings forward three principal requirements for teaching languages [2]: for universal courses in natural science, cultural difference is not apparent, English is used internationally, so teaching in English brings the benefits of direct and accuracy; for courses concerning Chinese culture, society and history, Chinese is the best choice; for courses related to local culture, society and politics, Guangdong Language can be used.

Above rules are reasonable. It is suggested to take following items into account for bilingual teaching in universities in mainland of China:(1)If the course belongs to a subject researched internationally, so teaching bilingually or completely in English can promote exchange and help students to learn international trends in this field;(2) If the course belongs to a lagging subject compared with other countries, introduction of original edition textbooks and bilingual teaching help to narrow the gap and average up the level of students education;(3)Courses are geared to international standard, such as finance and law. As for some Chinese characteristic courses such as Chinese medicine, they are closely related with our culture or politics with less

interaction with the others, it is difficult to carry out bilingual teaching and in fact the influence is not significant.

5 Summary

Although 50 percent of foreign language teaching is required for a course to be regarded as bilingual teaching in undergraduate teaching assessment, universities should not be restricted by this, all in all the aim of bilingual teaching is helping students to learn knowledge more effectively, it is unsuitable to draw a line for students with different English levels. The other question is quality monitoring for bilingual teaching should be enhanced, the opening, management and evaluation of bilingual teaching courses should be improved further. Generally more bilingual teaching courses can be set in key universities, while in common universities less bilingual teaching courses should be set. Bilingual teaching should not be limited to undergraduate courses, in the view of student quality, demand from study and research, graduated students especial doctor students should be the main force to accept bilingual teaching.

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Assessment of Yield Variability by Linear Regression Model

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Abstract. A long-term experiment was started in early 1990s and continued until 2008 to study the effects of crop rotation and chemical fertilization on the yield and yield stability of maize (*Zea mays* L.). The results indicated that the yield of maize was higher in the cropping system of soybean-maize rotation than that in maize monoculture. The yield of maize under the treatments without fertilizer N increased significantly in the crop rotation system. This observation can be explained by residual nutrients after legumes. The rotation effect would be diminished by balanced nutrient supply. Maize yield increased significantly under N fertilization treatments and was even higher under the treatments of N combined with P (NP) and NP plus K (NPK). The stability analysis showed that stability of maize yield of soybean-maize rotation was significantly improved compared to maize monoculture, and higher stability could be obtained in NP and NPK treatments regardless of crop sequences, which can be attributed mainly to balanced macronutrients supply.

Keywords: Long-term trail, Yield variability, Crop rotation, Dryland maize yield.

1 Introduction

The yield as well as the yield stability is the most important targets to evaluate a cropping system[1]. The researches showed that the yield stability was significantly influenced by agricultural practices and the environment, especially fertilization, seed genotype, tillage, precipitation, accumulated temperatures, pests, and diseases[2]. The common approaches to stability analysis were environmental variance parameters, regression[3] and the fluctuation of production about a long-term average or the fluctuation of production about a long-term trend can be assessed by the long-term experiments. To some extent, long-term experiments are indispensable in investigations on the stability of crop production, predicting soil carrying capacity and assessing system sustainability[4].

The objectives of this work were (i) to assess the yield-increasing effects of different fertilization and crop rotation and (ii) to evaluate the yield stability under various fertilization treatments and rotations by the regression analysis.

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2 Methods

Experimental Site, Design and Treatments. A long-term field experiment has been conducted since 1990 in the Institute of Applied Ecology, Chinese Academy of Sciences (41°32' N latitude, 123°23' E longitude). The mean annual temperature of 7.0-8.0 °C. Its annual precipitation is about 680 mm. The soil of the experimental field is alfisol soil. The initial properties of the surface soil (0-20 cm depth) were shown in table1.

Table 1. Initial physical and chemical properties of test soil

organic matter [g/kg]	total nitrogen [g/kg]	total P [g/kg]	total K [g/kg]	available P [mg/kg]	available K [mg/kg]	pH
20.9	1.13	0.44	16.4	10.6	88.0	6.5

The experiment had 8 treatments: no fertilizer (CK), N, P, K, NP, NK, PK, and NPK treatments. N, P, and K fertilizers were applied at the rates of 150, 25, and 60 kg/ha/year in the form of urea, double superphosphate, and potassium chloride, respectively. Each plot area was 162 m², with a buffer zone of 1.0 m. Initially, in 1990, the experiment was started with a soybean-maize-maize 3-year rotation. Then there were two crop sequences for maize per year that the forecrop was maize or soybean, respectively, namely maize monoculture and soybean-maize rotation. Each treatment consisted of 3 replications.

Data Analysis. Maize grain yield data was subjected to analysis of variance (ANOVA) followed by Duncan’s multiple range test for multiple comparisons of paired means of treatments.

Stability Analysis. The regression method of stability analysis was applied as described by Finlay and Wilkinson [5]. The regression model can be written as

$$y_{ij} = \mu_i + \beta_i u_j + d_{ij}$$
(1)

where μ_i is the mean (expected value), i.e. the systematic effect of the i th treatment; β_i is a regression coefficient corresponding to the i th treatment; u_j is an effect of the j th environment and d_{ij} is a random deviation from the regression line. Finlay and Wilkinson[5] suggested that slopes with $b_i < 1.0$, where b_i is an estimate of β_i obtained by regression onto the environmental mean, indicated better adaptation to poor environments, whereas slopes with $b_i > 1.0$ were best used in superior environments. A cropping system with an estimate of $b_i = 1$ showed an average response to environmental conditions.

3 Results

Yield Response. The effects of crop rotation and fertilization on the grain yield of maize over the years 1991-2008 are summarized in Table 1. Application of N fertilizer significantly increase maize yield over the other treatments, and comparison

of treatments revealed that the average yields of maize under combined application of N with P or K were significantly higher than those in control and N, P or K alone. It can be also seen that the yield of maize in monoculture was always lower than in soybean-maize dicultrue except NPK treatment, especially without N fertilizer. The yield-increasing effect of crop rotation was greatest in the PK treatment, followed by the CK and P, with the poorest effect for the NPK.

Table 2. Effect of fertilization and rotation on grain maize yield (1991-2008)

Treat- ments	Yield response [t/ha]		Increase yield [t/ha]		Yield-increase rate [%]	
	Monocul- ture	Soybean- maize	Monocul- ture	Soybean- maize	Monocul- ture	Soybean- maize
CK	3.302Aa	4.494Ba	-	-	-	
N	5.641Ab	5.866Abc	2.339	1.372	70.85	30.53
P	3.688Aa	4.849Bab	0.386	0.355	11.70	7.89
K	3.438Aa	4.493Ba	0.136	-0.001	4.12	-0.03
NP	6.569Abc	6.698Acd	3.268	2.203	98.96	49.02
NK	6.205Ab	6.529Acd	2.903	2.034	87.91	45.26
PK	3.678Aa	5.087Bab	0.377	0.593	11.40	13.19
NPK	7.482Ac	7.477Ad	4.180	2.983	126.60	66.36

Note: Data followed by the same letter (lowercase for different treatment and uppercase for different rotation) do not differ significantly at the $P \leq 0.05$ level.

Stability Analysis. On the whole, the treatments without N fertilizer differed markedly from the remaining treatments. In soybean-maize diculture the better adaptation to poor environments of CK compared with monoculture can be interpreted as the rotation effect. Since both slopes of control treatment was less than 1.0 (Table 2), yield was not responsive to a superior environment. The slopes of all treatments in soybean-maize rotation were closer to unit than those in monoculture, indicating more stable. The highest yield in all environments was achieved in NPK treatment.

In the maize monoculture there was no difference in stability between CK and K, and the difference between CK and P in high-yield smaller than in low-yield conditions. In the soybean-maize system, CK, P, K and PK treatments were showed better adaptation to poor environment, and similar to the relevant treatments in monoculture system. The treatment N indicated a good adaptation in superior

environments and its yield level was higher up to an environment mean of 5.0 t/ha and 5.7 t/ha in the monoculture and soybean-maize diculture, respectively. Yields under NP, NK and NPK treatments have improved markedly in all environments and their yield levels were higher than environment mean yield. The highest yield stability was observed under NP and NPK treatment regardless of various cropping systems.

Table 3. Linear regression parameters of grain yield on the environmental mean

Treat- ments	Intercept		Slope		R ²	
	Monocul- ture	Soybean- maize	Monocul- ture	Soybean- maize	Monocul- ture	Soybean- maize
CK	-1.456	-0.235	0.841	0.902	0.746***	0.767***
N	-0.320	-0.375	1.192	1.093	0.731***	0.794***
P	-0.529	-0.713	0.783	0.951	0.668***	0.816***
K	-1.095	-0.649	0.820	0.914	0.721***	0.837***
NP	1.924	0.701	0.944	1.034	0.701***	0.874***
NK	-0.389	-0.230	1.319	1.188	0.723***	0.852***
PK	-0.342	0.277	0.780	0.876	0.534**	0.790***
NPK	2.214	1.224	1.073	1.049	0.803***	0.800***

Note: **Significant at $P \leq 0.01$; ***Significant at $P \leq 0.001$.

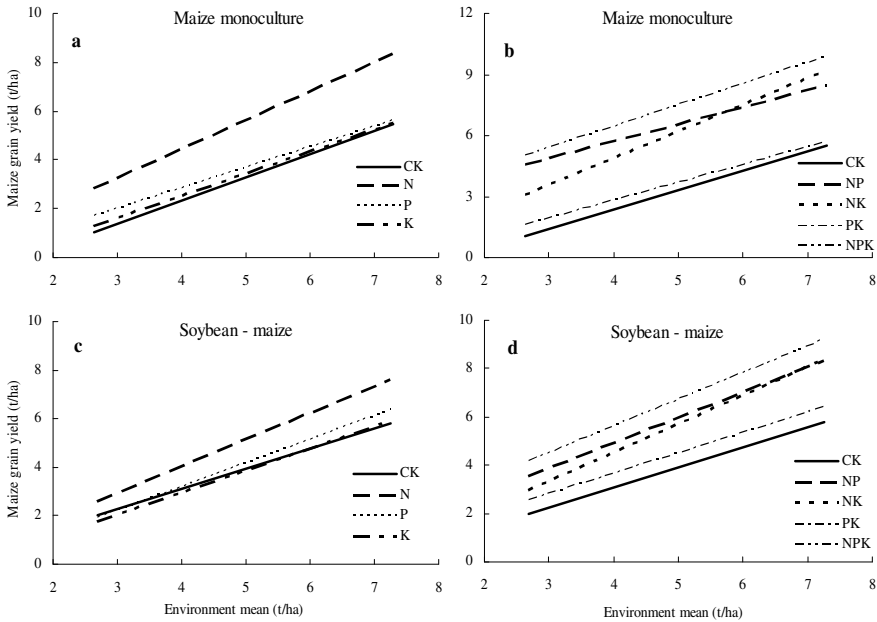


Fig. 1. Stability analysis of maize grain yield under different fertilization treatments in soybean-maize rotation systems and maize monoculture systems

4 Conclusions

Fertilizer N, P and K were used more efficiently in fully balanced than in imbalanced fertilizer treatments. The yield-stabilizing effect of crop rotation was mainly due to the residual soil fertility after soybean. Then the N-fixing effect of legume was also important for maize production. Under CK, PK, and single mineral fertilizer treatments, maize yield decreased and yield stability was poor. Balanced nutrient supply and appropriate cropping management practices were essential for the achievement of high yield and yield stability.

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Effect of Different Land Use on Activity and Composition of Ammonia-Oxidizing Bacteria in an Alfisol Soil

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Abstract. The effects of long-term (19 years) different land use on activity and composition of ammonia-oxidizing bacteria (AOB) were detected. The result showed that the potential nitrification rate in soils (RM, NPK+RM, Mowed, Fallow) was significantly higher ($P < 0.05$) than the CK and NPK treatments, indicating that long-term applications of recycled manure and return by plant residue both significantly increased the activity of AOB. However, the application of NPK did not enhance soil potential nitrification because of decreased pH. Fingerprints from DGGE showed that each treatment exhibit distinctly different DGGE patterns. Non-agricultural plots showed an increase in the diversity of the AOB community compared to CK, RM and NPK treatments, implying that agricultural practices, especially tillage, have an adverse effect on the soil AOB community. A phylogenetic analysis showed that most of the DGGE bands derived from all plots belonged to *Nitrosospira* cluster 3.

Keywords: Ammonia-oxidizing bacteria (AOB), land use, nitrification, PCR-DGGE.

1 Introduction

As the first step in the nitrification process, ammonia oxidation plays a central role in the global cycling of nitrogen. In many agricultural systems, most ammonia oxidation is carried out by ammonia-oxidizing bacteria (AOB) [1, 2]. All known AOB belong to two monophyletic groups: the γ -subdivision of the division *Proteobacteria* and the β -subclass of *Proteobacteria*, which is divided into two genera characterized by *Nitrosomonas* and *Nitrosospira* [3].

Using the corresponding 16S rRNA gene, phylogenetic analysis has indicated the existence of at least seven distinctive clusters defined by Stephen *et al* [4]. The distribution of clone sequences among these clusters is related to the environments from which they were obtained. Various studies have shown that the community structure of AOB shifts in response to fertilization [5, 6], soil pH [7], vegetation types [8] and temperature [9], but little is known about contrast between agricultural and non-agricultural practices on the activity and composition of soil AOB. Our objective was to explore the long-term effects of different land use on the composition and activity of soil AOB, and assess the relationship between the activity and diversity of AOB and properties of the soil.

2 Material and Methods

2.1 Field Site

The experiment was initiated in 1990 at Shenyang Ecological Experimental Station, which is located in lower reach of Liaohe River Plain, 41°32'N and 123°23'E. The climate is temperate, sub-humid continental, with mean annual temperature of 7.5°C and mean annual precipitation of 700 mm. The soil is alfisol, which is the primary soil type used for agricultural production.

The field experiment was 3-course rotation with soybean-corn-corn. There were four treatments in the agricultural system: no fertilizer (CK), recycled manure (RM), NPK fertilizers (NPK), and NPK fertilizers plus recycled manure (NPK+RM). The N, P, and K fertilizers were applied at 150, 25, and 60 kg ha⁻¹ year⁻¹ in the forms of urea, double super phosphate, and potassium chloride, respectively. Each plot was 162 m² in size with a protective zone of 2.0 m in width. The recycled manure was from feeding-composting cycles, in which 80% of harvested seeds, 100% of soybean straws, and 50% of corn stalks were returned to the original treatment. There were three categories in the non-agricultural system: bare land, mowed in October each year (mowed land), and abandoned land (fallow land).

In April 2008, soil samples were collected at a depth of 0 to 20 cm. For each plot, soil samples were collected from 6 points and then mixed to make a composite bulk sample. Each sample was divided into two sub-samples. The first sub-sample was fresh soil samples were used for the analysis of potential nitrification. The second sub-sample was stored at -20 °C for DNA extracton.

2.2 Potential Nitrification

Soil potential nitrification was determined according to the method of Hayatau and Kosuge [10].

2.3 PCR-DGGE and DNA Sequencing

DNA was isolated by the UltraClean Soil DNA kit (MoBio, Solana Beach, CA, USA). GC clamped CTO 189f-ABC/CTO 654r [11]. The PCR reaction mixture (25 ml) consisted of 1 µL of each primer (50 pmol µL⁻¹ each), 2 µL of 2.5 mmol L⁻¹ dNTP mixture, 2.5 µL of 10 × *Ex Taq* buffer (20 mmol L⁻¹, TaKaRa), 1µL of template DNA and 0.2 µL of 5 U µL⁻¹ *Ex Taq* DNA polymerase (TaKaRa). Amplification was performed using an initial denaturation step at 94 °C, 30 cycles of 30 s at 94°C forat 94°C 30 s, 30 s at 55°C for 30 s, and 90 s at 72°C, followed by a final extension at 72 °C for 10 min.

Following the PCR products were separated by DGGE gels using a D-Code system (Bio-Rad Laboratories, Hercules, CA, USA). The PCR products were loaded onto polyacrylamide gradient gels with a denaturing gradient of 30% to 60% (100% denaturant contains 7 mol·L⁻¹ urea and 40% deionized formamide). The gels were run for 5 h at 200 V and 60 °C in 1.0×Tris-acetate-EDTA buffer. After DGGE, the gels were stained with SYBR Green I nucleic acid gel stain for 30 min and photographed under ultraviolet (UV) illumination. Fifteen DGGE bands were chosen for sequencing

and phylogenetic analysis. The nucleotide sequences obtained in this study have been deposited in the GenBank database under the accession numbers: GQ281013-GQ281027.

2.4 Statistical Analysis

The obtained sequences were compared with sequences available in the National Center for Biotechnology Information (NCBI) gene database using a Basic Local Alignment Tool (BLAST) search (<http://www.ncbi.nlm.nih.gov/BLAST/>). MEGA 3.1 software was used to construct a phylogenetic tree.

All statistical analyses were performed using SPSS version 13.0, and one-way analysis of variance (ANOVA) followed by S-N-K test was used to check for quantitative differences between treatments. $P < 0.05$ was considered to be statistically significant.

2.5 Results and Discussion

Soil Potential Nitrification

The potential nitrification of soils (RM, NPK+RM, Mowed, Fallow) that received additional inputs from recycled manure or plant residue was significantly higher ($P < 0.05$) than the CK (Fig. 1). This information might suggest that non-tillage or plant residues would result in an increase of AOB quantity, and therefore enhance potential nitrification of the soil [12, 13]. However, there was no obvious difference between CK and NPK, RM and NPK+RM, NPK+RM and Bare, respectively, which is likely due to the reduced pH of soil from 6.40 to 5.61 after the long-term application of N fertilizer. Several studies have reported that low pH in soil restrains soil potential nitrification [14, 15].

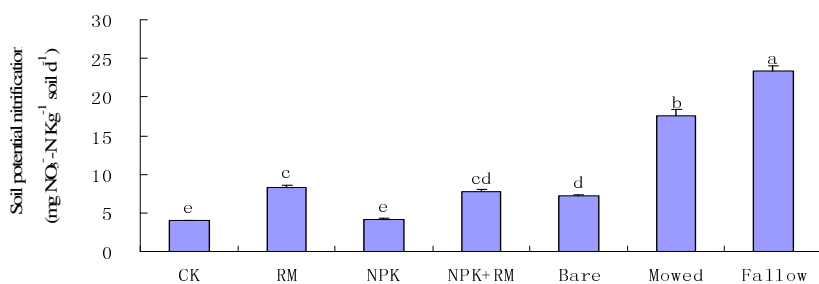


Fig. 1. Soil potential nitrification under long-term different land use. Bars topped by the same letter indicate no significant difference in values ($P < 0.05$).

2.6 Community Analysis of AOB

A significant difference in the DGGE patterns was observed between fertilized treatments and CK treatment (Fig. 2), which suggests that the fertilization causes abrupt change in the AOB community. Moreover, there were significant differences

between recycled manure treatments (RM and NPK+RM) and deficient-RM treatments (CK and NPK), respectively. Similar results have also been reported by Chu *et al* [16] and He *et al* [17]. Non-agricultural treatments showed an increase in the diversity of the AOB community compared with CK, RM and NPK treatments. Agricultural practice, especially tillage, has an adverse effect on the soil AOB community [23].

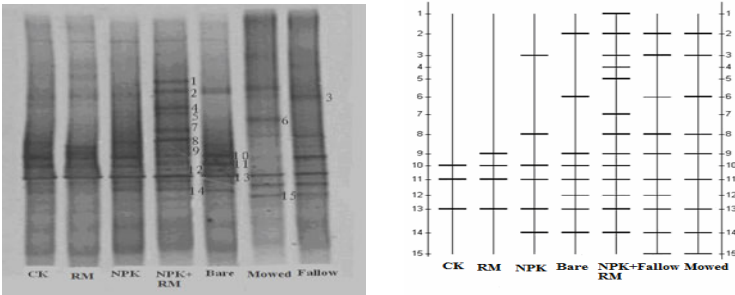


Fig. 2. DGGE fingerprint of AOB retrieved from soils after long-term different land use. The excised bands are numbered.

A phylogenetic analysis showed that most bands fell within *Nitrosospira* except for bands 1 and 2, and no *Nitrosomonas* species were detected in our soil (Fig. 3), which was consistent with the conclusion of Kowalchuk *et al* [18]. Interestingly, these bands were affiliated with *Nitrosospira* cluster 3 only. Some studies have demonstrated that *Nitrosospira* cluster 3 corresponds with high ammonium nitrogen concentration in soil [19, 20]. Consequently, the observation of *Nitrosospira* cluster 3 in all treatments might be caused by the elevated ammonium nitrogen concentrations.

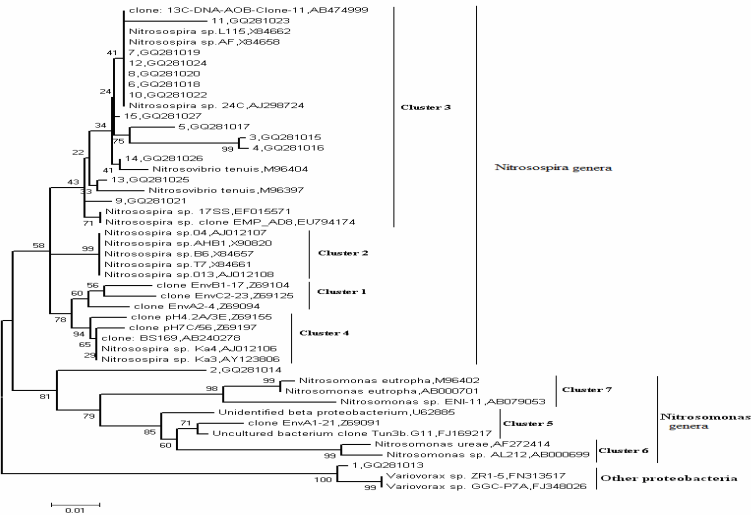


Fig. 3. Phylogenetic tree based on partial 16S rRNA sequences retrieved from the DGGE bands.

No correlation was found between the composition of AOB and its potential activity ($r = 0.329$, $P > 0.05$), indicating that the shifts in AOB community did not significantly affect the change in potential nitrification, which was consistent with previous observation [21]. This outcome might be explained by the high abundance of AOA in our soils. Furthermore, recent studies also showed that AOA could substantially contribute to ammonia oxidation [22]. Therefore, a further study on AOA is needed to elucidate the functions of AOA in the soil of our different land use systems.

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Research on Optimization of Random Storage Capacity with Analysis of Scientific Materials in Logistics System

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Abstract. As a system, the storage capacity and its space redundancy of warehouse are significant in logistics park. At present, more researches are focused on the how to expand the path capacity to meet the fast incremental of cargo in/out the park. However as one of the most important issue of the key operation, the optimization of storage capacity should be further studied. The problems and methods of solving problems are put forward through the capacity distribution and capacity redundancy based on the system engineering. Assume that the capacity of warehouse is random and obey $N(\mu, \sigma^2)$, we set up the mathematics mode based on the different paths and use of the genetic algorithm to solving the mode. The result of the example indicates that the algorithm and mode are effective to such problems.

Keywords: Random Storage Capacity, Logistics System, Optimization.

Introduction

It is necessary to research on reservation of the storage capacity of the logistics park, specifically, reserving the storage capacity in system is one of the effective methods of improving the system reliable. In reality, the two methods can be used, one is parallel, the other is reservation. The paper set up the mathematics mode based on capacity reservation rather than parallel. Reservation problems based on certainty are often simple, however, the capacity reservation is random and the problems will be more complicated, the following the method is given.

Mathematics Description

As we all now that the better way to improve the system reliability is to provide the every component redundancy. In process of reservations of system, when one warehouse is no spare space, the other can be added effectively. However the reservation cost is different and random, the optimal destination is to make decision for every warehouse reasonable to redundancy reservation ability based on the certain cost.

Based on the analysis above, we consider the optimal problem of the logistics system contain n components. Assume that is the i th best one of warehouse

reservation capacity, then the process of the optimization is searching the optimal solution to make the logistics system optimal.

1 Problem Description and Abstraction

To a certain decision variable x , warehouse i 's redundancy reservation variable j and its reservation capacity is a random variable, use of matrix express following:

$$\mu = \{\mu_{11}, \mu_{12}, \dots, \mu_{21}, \mu_{22}, \dots, \mu_{n1}, \mu_{n2}, \dots\}$$

That is:

$$\mu = \begin{cases} \mu_{11}, \mu_{12}, \dots, \mu_{1m} \\ \mu_{21}, \mu_{22}, \dots, \mu_{2m} \\ \dots \\ \mu_{n1}, \mu_{n2}, \dots, \mu_{nm} \end{cases} \quad \begin{array}{l} \text{So, the different type } i \text{ (based on the different cargo} \\ \text{reservation needs) of reservation capacity and whole} \\ \text{logistics system also is random, respectively.} \end{array}$$

$$R_i(x, \mu) = \max_{1 \leq j \leq x_i} \mu_{ij}, \quad i = 1, 2, \dots, n$$

So, the reservation capacity of the whole system is decided by every state of the all components.

Assume that k_{ij} is the j th redundancy reservation in the i th cargo reservation, k_i then is the state of the i th reservation. We can easily get the idea that the state of i th reservation is decided by the state of k_{ij} .

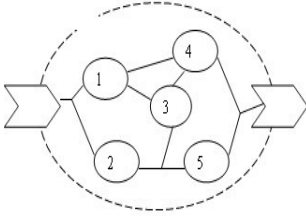
The following we consider the system of that.(pic 1)

2 Process of Cargo Flows in Logistics System

As a system, to simplified the problem, assume that the flows is from left to right and reservation type in warehouse is difficult, in another words, a certain cargo must be reserved by a certain fixed reservation location. So to a certain goods and its' flow is fixed.

Pic 1 indicates a general layout of a logistics system. Assume that the pathways of the net is from the left to right, we can get the possible pathways from left to right:

$$\eta(k) = \max \{k_1 k_4, k_1 k_3 k_4, k_2 k_3 k_4, k_2 k_5, k_1 k_3 k_5\}$$



Pic. 1. Logistics system and its warehouse layout.

2. Description of cargo flows in logistics system

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$$\eta(k) = \max \{k_1 k_4, k_1 k_3 k_4, k_2 k_3 k_4, k_2 k_5, k_1 k_3 k_5\}$$

If the warehouse 1 contain {A,B,C,D} four types reservation locations, warehouse 2 contain {A,C,D,E} four types reservation locations, warehouse 3 contain {A,D} two types, warehouse 4 contain {B} one type, warehouse 5 contain {A,B,D} three types, so we can easily get the possible routes following:

$$\eta(k)^* = \max \{k_1 k_3 k_4, k_2 k_3 k_4, k_2 k_5, k_1 k_3 k_5\}$$

Assume that the reservation location is random and obey $N(\mu, \sigma^2)$, the pic2 indicate a certain warehouse reservation capacity is normal distribution $N(\mu, \sigma^2)$.

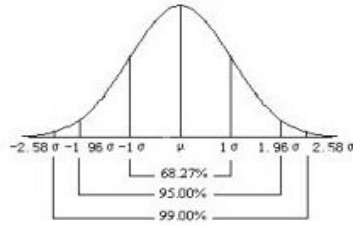
3 Mathematics Mode Established

Obviously the bigger mathematical expectation $E(R_i(x, \mu))$ is, more stable the system is.

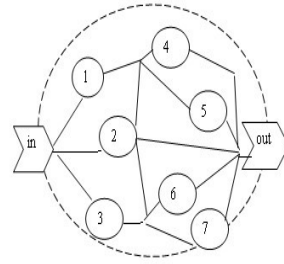
Assume that every reservation cost c_{ij} is different and its reservation capacities obey the $N(\mu, \sigma^2)$, p_{ij} is the reservation time (random variable) and the s_{ij} is the reservation area. So, we can get the mathematics mode:

$$\min E\{R_i(x, \mu)\}$$

$$\text{s.t.} \begin{cases} \sum_{i,j \in \{\eta(k)\}} c_{ij}(x_j) \times s_{ij} \leq C \\ p_{ij} \propto (\mu, \sigma^2) \end{cases}$$



Pic. 2. Reservation capacity $N(\mu, \sigma^2)$



Pic. 3. a certain warehouse layout in logistics system

4 Problem Solving Based on Genetic Algorithm

Firstly we must solve how to estimate the whole system's expected reservation capacity.

Generally, because of the structure of logistics system is relatively complex, it is difficult to calculate the mathematics expectation $E(R_i(x, \mu))$. According to the reference [1], we can use of the dichotomy method to solve the similar question.

Algorithm is following,

Step 1: given the upper bound and lower t_1, t_2 , let every u accord with $\eta(k(t_1)) = 0$ and $\eta(k(t_2)) = 1$;

Step 2: let $t_0 = \frac{1}{2}(t_1 + t_2)$;

Step 3: if $\eta(k(t^*)) = 1$, then let $t_2 = t^*$, otherwise $t_1 = t^*$;

Step 4: loop until $|t_2 - t_1| < \varepsilon$;

Step 5: $R_i(x, \mu) = \frac{1}{2}(t_1 + t_2)$.

Secondly, we use of the genetic algorithm to solve the random problem.

Generally, the steps of GA as followed:

Step 1: Input *pop-size* parameters, p_c and p_m

Step 2: Produce initially *pop-size* chromosomes

Step 3: Crossover and mutation of chromosomes.

Step4: Calculate the all chromosomes' target numerical.

Step 5: According to Target Numerical, Calculate every chromosomes' fitness.

Step 6: Reproduce the next generation according the roulette wheel selection.

Step 7: Repeat step 2 and step 5 until all conditions have meet.

In algorithm, to convergence rapidly, we can use of the following method[1] to crossover:

$$V_1 = (x_1^{(1)}, x_2^{(1)}, \dots, x_n^{(1)}), V_2 = (x_1^{(2)}, x_2^{(2)}, \dots, x_n^{(2)})$$

Generate the random variables in $[0,1]$ as crossover point, note n_1, n_2 , and $n_1 < n_2$, then crossover the part of $[n_1, n_2]$ corresponding the chromosomes in $[V_1, V_2]$, so the son-generation can be produced:

$$V_1^1 = (x_1^{(1)}, x_2^{(1)}, \dots, x_{n_1-1}^{(1)}, x_{n_1}^{(2)}, \dots, x_{n_2}^{(2)}, x_{n_2+1}^{(1)}, \dots, x_n^{(1)}),$$

$$V_2^2 = (x_1^{(2)}, x_2^{(2)}, \dots, x_{n_1-1}^{(2)}, x_{n_1}^{(1)}, \dots, x_{n_2}^{(1)}, x_{n_2+1}^{(2)}, \dots, x_n^{(2)})$$

Through the above improved method, we can solve the mathematics mode based on the random reservation in logistics system.

5 Example Analysis

There is a large logistics park with 7 cargo warehouses and assume every contains every reservation location type. Logistics location layout pic 3 is following:

Assume that all the warehouse lay in a certain logistics system and all it has 7 types reservation locations, warehouse 1-7 is obey normal distribution such as:

$$\Omega(289, 21^2), \Omega(391, 30^2), \Omega(311, 23^2), \Omega(350, 26^2) \\ , \Omega(378, 21^2), \Omega(281, 44^2), \Omega(276, 33^2)$$

Assume decision variable is $x, x = (x_1 - x_7)$

x_i is the i th warehouse's redundancy reservation capacity.

We know the cost of the warehouse's reservation, that is $\{33, 41, 64, 71, 49, 33, 52\}$;

So according to the mode we established, we can get the reservation cost as following:

$C(x) = 33x_1 + 41x_2 + 64x_3 + 71x_4 + 49x_5 + 33x_6 + 52x_7$ if we can only pay within 1000 RMB, then

$$C(x) \leq 1000$$

The direction of Logistics system is from left to right, and we can define the possible route to maintain the system work well.that is:

$$\eta(k) = \max \{k_1k_4, k_1k_5, k_2k_4, k_2k_5, k_2k_6, k_2k_7, k_3k_6, k_3k_7\}$$

According to the genetic algorithm we can get he result:

The system's optimal reservation capacity is $E=685.23$, the total cost $C=891.6$;

Every warehouse's the best redundancy reservation capacity is

$\{21.25, 29.32, 41.44, 28.32, 65.32, 24.98, 41.02\}$

1. Every optimal solution is fit with the conditions.
2. The reservation capacity is fit with the operational situations of large logistics system.
3. All solutions is less than capacity such as the cost is less than the total cost. The reservation capacity of every warehouse is factual situation. The redundancy capacity reservation problem exist in every logistics and more important especially in larger logistics parks. The type question is significant for operation.

6 Conclusion

The paper uses of the theory of random and genetic algorithm, through the factual operation problems in logistics park and abstract the specific process to general mathematics mode. The paper define the capacity random to make such problems more representative. Through the example's analysis, it indicates that the model and algorithm have its' value to apply. But some researches should be taken.

1. Further studies on capacity with fuzzy parameters, the related problems can be implied and should greatly improve the efficiency of logistics center and service level.
2. To transportation capacities, the paper does not involve, so further studies on associated research should be taken.

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Recognition of Tea Taste Signal Based on Rough Set

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Abstract. The discretization method of continuous attributes based on decision attributes which is discussed in document [3] can't consider some special breakpoints very carefully. The modified algorithm on discretization given in this paper will improve the recognition accuracy and decrease the number of breakpoints. Experiment one gives the result about recognition of tea taste signal based document [3]'s algorithm. Experiment two gives the result about recognition of tea taste signal based on modified algorithm on discretization method. By comparison with experiment one and experiment two testified the superiority of algorithm in this paper.

Keywords: rough set, discretization, region division, breakpoint selection, taste recognition.

1 Introduction

The rough set theory was developed by Z. Pawlak for classificatory analysis of data tables. It is a mathematic theory mainly used to analyze the indefinite data [1,2].

The rough set theory only can process discretized data. So it is very important for a decision system to discretize its continuous attributes[3]. The algorithm of this paper improves the recognition accuracy and decreases the number of breakpoints by selecting breakpoints more subtly.

2 Conception of Discretization

2.1 Discretization Description

The decision table is the knowledge expression system such as $S = (U, A, \{V_a\}, f)$ which owns the condition attribute and the decision attribute. For $\forall x \in U$, there is a

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list $C(c_1(x), \dots, c_n(x)), D(d_1(x), \dots, d_m(x))$, which is called region, where U is a non-null limited set. A is an attribute set defined as a non-null limited set. V_a is a value set where $a \in A$. $f: U \rightarrow V_a$ is a single mapping which enables any one of elements in discourse domain U own a unique value in V_a when the attribute of the element is a . $A = C \cup D, C \cap D = \Phi; \{c_1(x), \dots, c_n(x)\}$ is defined as a condition attribute set. $\{d_1(x), \dots, d_m(x)\}$ is defined as a decision attribute set.

For any one of breakpoint sets $\{(a, c_1^a), (a, c_2^a), \dots, (a, c_k^a)\}$ in the value set $V_a = [l_a, r_a]$, P_a is one of classifications in V_a , which can be defined by

$$P_a = \{[c_0^a, c_1^a), [c_1^a, c_2^a), \dots, [c_{k_a}^a, c_{k_a+1}^a)\} \quad (1)$$

l_a and V_a are given by

$$l_a = c_0^a < c_1^a < \dots < c_{k_a}^a < c_{k_a+1}^a = r_a \quad (2)$$

$$V_a = \{[c_0^a, c_1^a) \cup [c_1^a, c_2^a) \cup \dots \cup [c_{k_a}^a, c_{k_a+1}^a)\} \quad (3)$$

Therefore, we can define a new decision table $S^P = (U, A, V^P, f^P)$ for any $P = \bigcup_{a \in A} P_a$. Where $f^P(x_a) = i \Leftrightarrow f(x_a) \in [c_{a,i}^a, c_{a,i+1}^a)$.

For $x \in U, i \in \{0, \dots, k_a\}$, the old decision system will be replaced by a new one after discretization [2] and [12].

2.2 Significance of Attribute

The significance of attribute can reflect the importance of attribution for decision.

Definition 1: $M_a = \frac{1}{n} \sum_{i=1}^n \frac{1}{l_i}$ is the significance of a attribute in a decision system, where $a \in A$, n is the base number of $V_a \{V_{a,1}, \dots, V_{a,n}\}$, l_i is the number of possible values for the decision attribute when the value of the attribute a is $V_{a,i}$ [3].

3 The Algorithm of Discretization for Continuous Attributes

3.1 Discretization Algorithm

Let $S = (U, A, \{V_a\}, f)$ be a decision table. The process of discretization is going on following steps.

Step 1. Organize the sample set into the system. Generate initial decision system S_0 .

Let $S_1 = S_0, S_2 = S_0, i = 2$;

Step 2. Discretize every continuous attribute in S_1 with FCM. Calculate the significance for each condition attribute according to definition 1, and sort all condition attributes on their significance in descending order to $c_1, \dots, c_n$;

Step 3. Copy the attribute column of c_1 in S_1 to the attribute column of c_1 in S_2 ;

Step 4. Discretize c_i with the second discretization method in 3.2 section;

Step 5. if all decision attributes of C_{i-1} are consistent or all condition attributes being discretized already, algorithm finishes, or else $i = i + 1$, repeat **Step4**. C_{i-1} is the attribute set of $c_1, c_2, \dots, c_{i-1}$.

3.2 Region Division

The discretization refers to a division of attribute region. If the region is divided too thin, it may lead to over-fitting to training data and increasing of decision rules [6]. On the contrary, it will bring out unclear classification along with contrary rules. The whole region division will be divided into two stages as following.

3.2.1 Combination of Intra-group

Suppose $S_0 = (U_0, A, \{V_a\}, f_0)$ to be the initial decision system and $S_2 = (U_2, A, \{V_a\}, f_2)$ to be the decision system after discretizing. c_i , the attribute of S_2 , is to be discretized, $C_{i-1} = (c_1, \dots, c_{i-1})$ is the discretized attribute and $V_{C_{i-1}}(v_{c_{i-1,1}}, v_{c_{i-1,2}}, \dots, v_{c_{i-1,k}})$ is the corresponding attribute value to $C_{i-1} = (c_1, \dots, c_{i-1})$, where k is the potential value number of C_{i-1} . Let the record set be X_j when C_{i-1} owns $v_{c_{i-1,j}}$. Other attributes of X_j need not to be discretized if the decision attribute value is unique when C_{i-1} is given by $v_{c_{i-1,j}}$, or else gather all decision attribute values $D_j(d_{j1}, d_{j2}, \dots)$ of X_j and find out the interval $reg_j(reg_{d_{j1}}, reg_{d_{j2}}, \dots)$ of c_i corresponding to each decision attribute value $d_{j1}, d_{j2}, \dots$ in S_2 (i.e., if d_{jp} is the value of a decision attribute in X_j and the corresponding c_i attribute value set is $\{0.1, 1, 4, 2.5\}$, the $reg_{d_{jp}}$ is $[0.1, 4]$). For any double intervals a and b in reg_j (shown in Fig. 1), divide them again if there existing an intersection between them and transform them into a', b', c' , ultimately generated intervals are $reg_{j1}, reg_{j2}, \dots$ which are sorted by the left end point of

each interval in ascending order. So reg_j is the interval sequence $reg_{j_1}, reg_{j_2}, \dots$. We can get $REG(reg_1, reg_2, \dots)$ of c_i with above method. Suppose α is a really tiny value. If the left end point of the new interval is from the right end point of some one old interval its value multiplies α times. For example, the left end point of c' in the left figure of Fig. 1 is this kind situation. If the $reg_{d_{jp}}$ is an isolated point we will turn it into an interval. Suppose the isolated point's value be x . The interval will be $[x * (1 - \alpha), x * (1 + \alpha)]$.

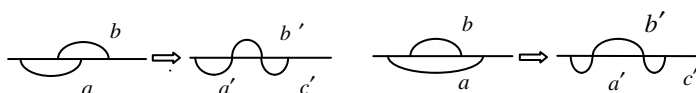


Fig. 1. Redivision of Intersection between a and b

3.2.2 Combination of Inter-group

Combine all intervals in $REG(reg_1, reg_2, \dots)$. There are not inconsistent data because values of C_{i-1} for each $reg_1, reg_2, \dots$ are different. So we try our best not to increase any new interval in conditions of not raising inconsistent data during sequential combining. Suppose reg_1 to be the initial value of $reg - end(reg - end_1, reg - end_2, \dots)$. Firstly combine reg_2 into $reg - end$, and then remainders of $REG(reg_1, reg_2, \dots)$ in turn. For any two adjacent intervals, not existing common end point between them, replace two contiguous end points of them with the middle point of segment that is formed by two contiguous end points. The middle point becomes a breakpoint of interval division. we can generate interval divisions of c_i finally. Let reg_x be any interval set of REG . How to combine reg_x with $reg - end$ is described as following. Combine $reg_{x_1}, reg_{x_2}, \dots$ of reg_x with $reg - end$ in turn, where $reg_{x_1}, reg_{x_2}, \dots$ are sorted by the left end point of each interval in ascending order. For any reg_{x_j} , there are four different situations (shown in Fig. 2) when describe the relationship between reg_x and a pair of intervals $reg - end_k$ and $reg - end_{k-1}$ in $reg - end$. Firstly set the label not to be updated for each interval in $reg - end$ before reg_x being combined. Suppose $reg - end_{end}$ to be the right end interval of $reg - end$. Each interval is described as $reg_{x_j} = [l_j, r_j]$, $reg - end_{k-1} = [l_{k-1}, r_{k-1}]$, $reg - end_k = [l_k, r_k]$, $reg - end_{end} = [l_{end}, r_{end}]$. We label every interval

with $flag$ (e.g., reg_{x_j} is not updated if $flag(reg_{x_j}) = 0$, or else $flag(reg_{x_j}) = 1$). Four different situations of combining reg_x into $reg - end$ are described as following.

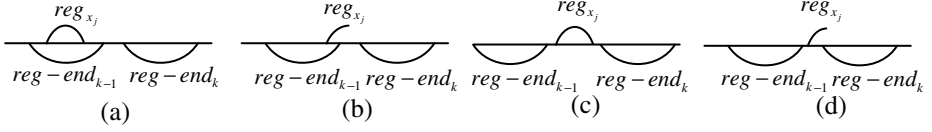


Fig. 2. Situations of Combination reg_{x_j} into $reg - end$

(a) Let $flag(reg - end_{k-1}) = 1$ if $flag(reg - end_{k-1}) = 0$, or else divide $reg - end_{k-1}$ into $[l_{k-1}, l_j)$ and $[l_j, r_{k-1}]$, number all intervals of $reg - end$ again sorting by the left end point of each interval in ascending order. The interval $[l_j, r_{k-1}]$ will be the interval k and set $flag(reg - end_k) = 1$. There isn't $reg - end_{k-1}$ when $k = 1$, so update $reg - end_k$ with $[l_j, r_k]$ and set $flag(reg - end_k) = 1$

(b) Update $reg - end_{k-1}$ with $[l_{k-1}, r_j]$, that is $r_{k-1} = r_j$, if $r_j \leq l_k$. At the same time, divide $reg - end_{k-1}$ into $[l_{k-1}, l_j)$ and $[l_j, r_{k-1}]$ with the left end point of reg_{i_j} if $flag(reg - end_{k-1}) = 1$, number all intervals of $reg - end$ again sorting by the left end point of each interval in ascending order. If $r_j > l_k$ and r_j belongs to some one interval of $reg - end$, label the interval to be updated.

(c) If $flag(reg - end_{k-1}) = 0$, update $reg - end_{k-1}$ with $[l_{k-1}, r_j]$, or else update $reg - end_k$ with $[l_j, r_k]$ and set $flag(reg - end_k) = 1$.

(d) Update $reg - end_k$ with $[l_j, r_k]$. If the right end point of reg_{x_j} belongs to some one interval of $reg - end$, label the interval to be updated, or else label the left neighbor interval to the right end point of reg_{x_j} in $reg - end$ to be updated. If $k - 1 = end$ (i.e., $reg - end_{k-1}$ is the right end interval of $reg - end$), insert reg_{x_j} into the right end interval position of $reg - end$ directly.

4 Experiment Results

We used taste signal data about tea as our test data shown in table1 [7]. It is the output signal of taste sensor after principal component analysis. Four times' independent experiments were done on five kinds of tea. Our experiment is based on Matlab7.0.

Table 1. Taste signal data of tea

NO.	PC1	PC2	Sample name	NO.	PC1	PC2	Sample name
1	0.1566667	0.179	The sixteenth tea	11	0.1766667	0.162	Tie Guanyin tea
2	0.1583333	0.180	The sixteenth tea	12	0.1766667	0.163	Tie Guanyin tea
3	0.1333333	0.183	The sixteenth tea	13	0.1316667	0.174	Coarse tea
4	0.1500000	0.184	The sixteenth tea	14	0.1283333	0.167	Coarse tea
5	0.1866667	0.128	Green tea	15	0.1400000	0.171	Coarse tea
6	0.1850000	0.140	Green tea	16	0.1433333	0.169	Coarse tea
7	0.1750000	0.169	Green tea	17	0.1100000	0.177	Golden oolong tea
8	0.1750000	0.171	Green tea	18	0.1116667	0.178	Golden oolong tea
9	0.1650000	0.183	Tie Guanyin tea	19	0.1166667	0.176	Golden oolong tea
10	0.1666667	0.185	Tie Guanyin tea	20	0.1200000	0.176	Golden oolong tea

4.1 Experiment One

Use the algorithm of document [3] to test the data. The PC1's significance of attribute is higher then that of PC2. The recognition correction rate is 0.95. The PC1's breakpoint set is {0.1242, 0.1417, 0.1617, 0.1708}. The PC2's breakpoint set is {0.1620, 0.1630, 0.1750 }. The decision table is shown in table 2. The relation between the descrtized value and the interval is shown in table3. The fifth and eighth rules are ambivalent. The fifth rule, which appeared firstly, is the decision rule by the algorithm.

4.2 Experiment Two

Use the algorithm of this paper to test the sample data. Suppose α is 0.001. The PC1's significance of attribute is higher then that of PC2 too. But the recognition correction rate is 1.00. The PC1's breakpoint set is same to that of experiment one. The PC2's breakpoint set is { 0.1620 ,0.1632 , 0.1750 }. The decision table is shown in table4. The relation between the descrtized value and the interval is shown in table5. By comparing with two experiments we may conclude that sample data's

recognition correction becomes higher and the number of decision rules becomes less by breakpoint's dividing subtly.

Table 2. Decision table

PC1	PC2	Dec
3	4	1
2	4	1
5	1	2
5	3	2
4		3
5	2	3
5	3	3
2	3	4
3	3	4
1		5

Table 3. Relation between the discretized value and the interval

Discretized value	PC1 interval	PC2 interval
1	$(-\infty, 0.142)$	$(-\infty, 0.162)$
2	$[0.1242, 0.147)$	$[0.162, 0.163)$
3	$[0.1417, 0.1617)$	$[0.163, +\infty)$
4	$[0.1617, 0.1708)$	
5	$[0.1708, +\infty)$	

Table 4. Decision table

PC1	PC2	Dec
2	4	1
5	1	2
5	3	2
4		3
5	2	3
2	3	4
3	3	4
1		5

Table 5. Relation between the discretized value and the interval

Discretize d value	PC1 interval	PC2 interval
1	$(-\infty, 0.142)$	$(-\infty, 0.162)$
2	$[0.1242, 0.147)$	$[0.162, 0.1632)$
3	$[0.1417, 0.1617)$	$[0.1632, +\infty)$
4	$[0.1617, 0.1708)$	
5	$[0.1708, +\infty)$	

5 Conclusions

This paper proposes a modified discretization method of continuous attributes. It is better to recognize tea taste signal. Sample's recognition accuracy makes further improvement. And the number rule is further reduced.

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Research on Occurrence of Phosphorus in Sediments of Nansihu Lake and Its Main Inflow Rivers Based on Analysis of Scientific Materials

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Abstract. Phosphorus content and its species were studied for the surface sediments of Nansihu Lake and its main inflow rivers, and the core sediments of Dushan Lake and Weishan Lake, using the SMT sequential extraction method. The phosphorus contents in the surface sediment are 465.5-13068.3 mg/kg, with the maximum value in Laoyun River, which was due to the waste water pollution from Jining City. The enrichment factors of organic phosphorus (OP) and NaOH-P are 6.5 and 9.0, respectively. The contents of phosphorus in other surface sediments are relatively lower, and are mainly composed of HCL-P. The enrichment factors of NaOH-P and OP are 1.0-3.7 and 1.3-6.0, indicating a minor human pollution. The phosphorus in the core sediment of Dushan Lake and Weishan Lake are mainly composed of HCL-P and OP. The increasing content of TOC in the core sediments was due to the growth of aquatic productivity and organic matter decomposition during the early diagenesis process, which also induced the increase of OP in the sediments since late 1960s. The higher content of OP and NaOH-P in the sediments of 6-0cm and 5-0cm for Cores DU3 and WS4 also indicated the human contamination since mid 1980s.

Keywords: sediments, phosphorus species, Nansihu Lake.

1 Introduction

Phosphorus in the sediments could translate into dissolved morphology under certain environment conditions, and then lead to secondary pollution when they transferred into superincumbent water again [1]. For shallow lakes, endogenesis release of phosphorus had larger potential ecologic crisis [2]. Hence, it was requisite to study the occurrence character of phosphorus in sediments.

Nansihu Lake located in the southwest of Shandong Province, which was the typical shallow lake in the North China Plain. Its area was 1266km² and the average water-depth was 1.5m, it consisted of four sublakes: Nanyang, Dushan, Zhaoyang and Weishan Lake from north to south. In recent 20 years, the concentration of phosphorus in Nansihu Lake water was growing constantly and the regime of water

environment was deteriorating [3]. Also, the sediments were polluted by phosphorus [4], but the study of occurrence of phosphorus was deficient. The phosphorus content and its species in the surface sediments and the core sediments of Dushan Lake and Weishan Lake were mainly studied.

2 Material and Method

Twenty-two surface sediment samples were recovered from Nansihu Lake and its main inflow rivers in September, 2005, using gravity core sampler: two sediment cores were gathered in Dushan and Weishan Lake (DU3, WS4). According to the maneuverability and precision of sampling, the top 1-cm sediment was sectioned as the surface sample, and the sampling-depth of sediment cores was 1 cm. Sediment samples were measured pH and Eh in-situ. The samples were put in a sealed bag back to laboratories under low temperature.

The modality of phosphorus has divided into five species by SMT sequential extraction method [1], namely: NaOH-P (phosphorus which mainly combined with hydration Al/Fe/Mn oxide and hydroxid), HCl-P (phosphorus which mainly combined with Ca), IP, OP and phosphorus extracted from dense hydrochloric acid (corresponding to TP). This paper extracted and analyzed the content of NaOH-P, HCl-P, OP and TP. In order to detect SMT sequential extraction method and the stability of operation, we analyzed the No.5 and No.13 samples with triple parallelism analysis, respectively, in the course of extraction, and the error was showed in Fig.1.

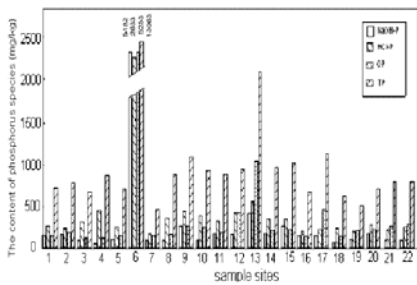


Fig. 1. Composition of Phosphorus species of the surface sediments

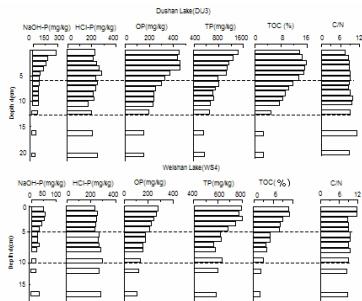


Fig. 2. Composition of phosphorus species, TOC content and C/N ratio in the core sediments of Dushan Lake and Weishan Lake

3 Results and Discussion

The Main Physical Chemistry Index Feature of Sediments

The value of pH and Eh of the surface sediments of Nansihu Lake and its main inflow rivers was 7.00-7.57, -40 - -440mv. The TOC content of surface sediments of its inflow rivers was 1.4%-23.5%, in which surface sediments of Laoyun River had the highest TOC content. The TOC content of surface sediments of Nansihu Lake was

1.1%-16.0%. The TOC content of core sediments of Dushan Lake and Weishan Lake was 3.0%-16.0% and 2.1%-11.0%, respectively. In the core sediments of Dushan Lake, the TOC content of the first period (21-13cm) was 3.0%, the second period (13-6cm) was about 5.4%~10.9%, the third period (6-0cm) had the highest TOC content, which was 13.7%-16.0%. In the core sediments of Weishan Lake, the variety of TOC content could be divided into three periods of 17-11cm, 11-5cm, 5-0cm, the TOC contents were 2.1%, 3.1%-5.4% and 8.0%-11.0%, respectively. The C/N ratio of the surface and core sediments was 7.0-12.1 besides the sediments of Si River had higher C/N ratio (Fig.2).

The Composition Character of Phosphorus Species in Surface Sediments

The sediments of Laoyun River (the No.6 sample) had the highest TP content, which was 13068.3mg/kg. The second one was the sediments of lake inlet of Guangfu River (the No.13 sample), the content of TP was 2085.5mg/kg. The TP content of the other surface sediments of Nansihu Lake and its inflow rivers was 465.5-10874.5mg/kg (Fig.1).

The composition of phosphorus species in surface sediments was of larger variety. OP and NaOH-P gave the priority to the sediments of Laoyun River, accounting for 40.2% and 39.7% of the TP content, respectively. The composition of phosphorus species in the sediments of lake inlet of Guangfu River (the No.13 sample) was resemble to the sediments of Laoyun River, it had the highest OP content which was accounting for 49.0% of the content of TP, and had lower HCl-P and NaOH-P content; The surface sediments of other inflow rivers and Nansihu Lake had the highest HCl-P content, and had lower OP and NaOH-P content.

The Composition Character of Phosphorus Species in Core Sediments

The content of HCl-P in DU3 core sediments was stable, which was 206.3-280.5mg/kg. But the content of OP and TP was gradually increased from bottom to top. The first period (13-21cm) had lower TP content, also HCl-P and OP gave priority to the sediments, which accounting for 36.5%-45.9% and 28.2%, respectively. The TP content of second period (13-6cm) was increased gradually, and the HCl-P relative content was about 30%. Also, the relative content of OP and NaOH-P were 32.3%-37.7% and 5.4%-6.1%, respectively. The third period (6-0cm) had higher TP content, the content of OP and NaOH-P were increased obviously and their relative contents were 39.8%-49.0% and 5.4%-12.7%, respectively. The absolute content of HCl-P was changed little when compared with the two former periods, but the relative content had decreased to 20.8%-31.5%.

The content of HCl-P in WS4 core sediments was stable, too, which was 232.3-294.8mg/kg. The change current of NaOH-P, OP and TP in WS4 core sediments was resemble to the change in DU3 core sediments that was increased gradually from bottom to top, and also could be divided into three changing periods (Fig.2): The TP content of first period (11-17cm) was lower, and the relative content of OP was 19.0%-21.0%. The second period (11-5cm), the relative content of OP had increased to 21.3%-28.5%, and the relative contents of HCl-P and NaOH-P were 41.1%-48.5% and 3.0%-5.3%, respectively. The third period (5-0cm), it had higher TP content, also the relative content of OP had exceeded 30%. Although the relative content of NaOH-P was lower, its absolute content was increased obviously compared with the two

former periods. The change of HCl-P absolute content was little, but the relative content had decreased to 29.1%-34.7% when compared with the other periods.

The accumulation rate of Dushanhu Lake which was 3.5mm/a using the ¹³⁷Cs chronometry [4], and the number was inoculated with the lake average accumulation rate which was 4.0mm/a which calculated from the annual amount of sediment load entering Nansihu Lake [4]. In DU3 and WS4 core sediments, the first period was equivalent to the years before the ending of 1960s; The second period was equivalent to the years from the ending of 1960s to the middle of 1980s, and the third period was equivalent to the years after the middle of 1980s.

4 Discussion

The Embedding Evolvement of Phosphorus in Core Sediment and the Character of Human Pollution

The change of organic materials content in sediments would affect the OP content in the first place. In the second stage, the content of TP, OP and TOC in DU3 and WS4 core sediments had put up accordant increasing trend, but the contents of NaOH-P and HCl-P were stable, which were resemble to the first stage. The results of phosphorus in unit water of Nansihu Lake had showed that the water quality of Nansihu Lake was according to the nation I - II criterion in 1980; In 1982-1984, the concentration of phosphorus in water began to rise, but the water quality was also according to III criterion (Tab.1). It illuminated that the content of phosphorus in Nansihu Lake sediments was not influenced by human pollution before the middle of 1980s, the rise of OP content was in relation to the improvement of lake productivity and the numerous settlement of inorganic phosphorus which was caused by the increase of organic materials content.

Table 1. Concentration (CP, mg/L) of phosphorus (PO₄³⁺-P) in the main inflow rivers and annual flux (FP, ×10³kg) discharged into Nansihu Lake

year	Guangfu River		Laoyun River		Liangjiyun River		Zhuzhaoxi n River		Wanfu River		Dongyu River		Baima River		Si River		Nany ang Lake	
	CP	FP	CP	FP	CP	FP	CP	FP	CP	FP	CP	FP	CP	FP	CP	FP	CP	FP
1980	0.01	0.1	0.03	1.3	0.0	7.8	0.01	7.9	0.01	0.7	0.02	6.7	0.06	1.4	0.01	/	0.01	
1982	0.13	/	0.20	8.5	0.0	7.6	0.05	27.4	0.02	0.8	0.04	17.0	0.07	0.6	0.01	/	0.05	
1983	0.18	/	0.57	24.3	0.0	10.3	0.03	18.0	0.03	1.0	0.05	15.4	0.06	0.1	0.03	/	0.06	
1984	0.17	0.7	0.22	9.2	0.0	9.4	0.03	23.2	0.03	2.0	0.04	14.9	0.1	1.1	0.05	/	0.05	
2000	1.13	113.2	2.41	102.6	0.6	52.6	0.98	49.8	0.37	7.2	0.26	38.7	0.87	2.6	0.2	15.3	0.24	

Since the middle of 1980s, the discharge amount of pollutant was increasing with the rapid development of economy. Until 2000, the annual flux of phosphorus discharged into Nansihu Lake had reached to 382.1 ton, and the concentration of phosphorus had exceed the nation V criterion (Tab.1). Meanwhile, the contents of

NaOH-P in DU3 and WS4 core sediments were increasing gradually, and the content of OP had also reached the highest level.

In the early diagenetic process, a part of organic phosphorus could decompose resolvable molecule organic phosphorus and resolvable phosphate, going with the mineralization decomposition of organic materials. And this made the OP content in sediment decreased from top to bottom gradually. The resolvable component of phosphorus discharged into interstitial water transported and diffused to the overlying water with the driving of concentration gradation, and then generated iron-phosphorus minerals again in the surface sediments with higher oxidation-reduction potential[5]. But the invasive depth of dissolved oxygen in water sediments was generally less than 1-2cm[6], the resolvable component of phosphorus discharged into interstitial water only enriched in the surface sediments in the form of iron-phosphorus minerals. In the other place, the DU3 and WS4 core sediments had higher NaOH-P content in the whole third stage, and its content appeared gradually increasing trend. Hence, the increasing of NaOH-P content in DU3 and WS4 core sediments indicated the character of phosphorus' human pollution since the middle of 1980s. The discharge of human pollution causing the rising of concentration of phosphorus in water, and a part of dissolved phosphorus combined with organic materials and then buried in the sediments. HCl-P was the phosphorus component that more nonreactivity in the sediments and its content was stable in DU3 and WS4 core sediments, which were mainly from clastic rock[1]. It reflected the stable natural input process of the basin.

5 Conclusion

The content of HCl-P in surface sediment of Nansihu Lake and core sediments of Dushan Lake and Weishan Lake was stable, which mainly reflected the character of natural source of basins. The increasing of NaOH-P content was mainly in relation to human pollution. The variety of TP in core sediments of Dushan Lake and Weishan Lake was mainly under the control of OP and NaOH-P contents. The increasing of NaOH-P content in core sediment indicated the character of phosphorus human pollution since the middle of 1980s. The contribution rate to OP increasing by artifact pollution also needed a further study.

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The Alternating Direction Iterative of Static Electric Field for Axial Symmetric Charge Distribution

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Abstract. In this paper, the problems of calculating and solution about axial symmetric electric fields were studied. An accurate theoretic model was established that it can be applied in high-performance numerical calculation. The new calculating method was proposed using Maxwell's equations and calculus under the conditions of static, axial symmetric, contains charge, finite, differentiable and integrable. This new calculating method was called alternating iterative method and its expression form was also given here. The electric field outside of axis can be expressed as each order derivative and one-dimensional integration of electric field which on the symmetric axis and also electric charge. By means of this method, the result is progression form, which is the best form for computer approximate calculation. It's very easy, quick and accurate to carry out numerical calculation by using this method. The calculation method provided in this paper has important theoretical significance and broad prospect of application.

Keywords: alternating direction iterative, charge distribution, static, electric field, axial symmetry.

1 Introduction

The phenomenon and problems in natural world are extremely complicated and manifold. In order to describe these phenomena quantitatively and resolve problems, scientific researchers always try to abstract them into equations of mathematical physics and solve them. Because the problems are very complex and diverse, it is quite difficult to give generally analytic solutions. Therefore, they have given and developed many special solving methods. For instance, to nonlinear problems, scientists have already established mapping deformation method [1], generalized Hirota transformation method [2], wavelet function and quasi-wavelet method [3] and so on.

The electromagnetic fields' transporting, detecting and calculating have also give rise to people's attention, to solve these problems, people propose many special methods. In the process, scientists gave fast multipole method [4], implicit marching-on-in-time method [5], etc.

In natural world, axial symmetric phenomena are very common and important. The solutions for axial symmetric electromagnetic fields are also very common and

important in the theory and practical application of electromagnetic fields. If it is highly axial symmetric, that is, the electric field is only a function of cylindrical coordinates r , it can be solved directly by using Gauss's theorem, loop theorem and axial symmetry. Otherwise, if it is normally axial symmetric, that is, the electric field is relative to both cylindrical coordinates r and z , it is very difficult to get its generally analytic solutions. In this case, we can perform approximate calculation by using computers. Yet, owing to the complexity of problems and improper handling of them at times, the approximate solutions are not easy to approach exact solutions, or it takes a long time to get more ideal approximate solutions, or even it is quite difficult to perform approximate calculation. Along with the high performance of electronic computers in recent years, numerical simulation and analytical calculations of electromagnetic fields have been prosperous. In the process of researches and calculations people have presented many methods, such as sparse-matrix canonical-grid method [6], two-grid method [7], multilevel sparse-matrix canonical-grid method [8], time domain finite difference method [9], impedance approximate method [10], etc.

To optimize algorithm and improve computational efficiency, this paper built a precise theoretical model and gave a computational method with high performance. In the circumstances of the axial symmetric, contains charge and static electric field which is limited, integrable and differentiable on the symmetric axis, this paper gives a new kind of computing method and its results in the series form by using Maxwell equations and calculus. That is, the out-of-axis electric field can be determined by the electric field on the symmetric axis and its different order derivatives. The procedure and results of approximate calculation state that the results in the series form are the most ideal results for computer to perform approximate calculation with extremely high degree of accuracy and quick speed.

The new computing method given by this paper is very important in theory and application since signal detection and calculation is an important part in scientific research and engineering. Along with the progress of science and technology, scientific researchers invented many measuring or detecting devices [11]. They can directly measure or detect signals by using them [12]. On the other hand, the researchers did in-depth theoretical studies in the analysis and presumption of the signal components [13]. In fact, many signals can be described as electromagnetic wave. So the problems become the calculation or detection of electromagnetic wave. As known, in some cases, measuring devices can not reach the regions of some signals because of limitation. So this paper gives a new kind of computing method and results to calculate or detect signals. That is, the electric field on one point can be calculated, detected or presumed with another point. As you know, an electric field can be regarded as a static state approximately if the signal changes slowly. Then, to the static and passive field, there is certain theoretical and applied value for the study how to solve the electric field at one point by calculating or detecting another point. To optimize algorithm and improve computational efficiency, this writer built a precise theoretical model and gave a computational method with high performance. Not long ago, the authors studied the electric field without charge distribution using the method [14-20]. This paper is its further development.

The Alternating Iteration of Static Electric Field for Axial Symmetric Charge Distribution

As is known to all, the differential form of Maxwell's equations is

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad (1)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (2)$$

$$\nabla \cdot \vec{D} = \rho \quad (3)$$

$$\nabla \cdot \vec{B} = 0 \quad (4)$$

We choose cylindrical coordinates r , φ , z , and the z axis is the symmetric axis of the electric field. In the circumstances of vacuum, static state and a charge distribution, applying Maxwell's equations and axial symmetry, the equations of the electric field to follow are

$$-\frac{\partial E_\varphi}{\partial z} \vec{e}_r + \left(\frac{\partial E_r}{\partial z} - \frac{\partial E_z}{\partial r} \right) \vec{e}_\varphi + \frac{1}{r} \frac{\partial(rE_\varphi)}{\partial r} \vec{e}_z = 0 \quad (5)$$

$$\frac{1}{r} \frac{\partial(rE_r)}{\partial r} + \frac{\partial E_z}{\partial z} = \frac{1}{\epsilon_0} \rho \quad (6)$$

From the (5) and (6), we have

$$E_r(r, z) = \frac{1}{\epsilon_0} \frac{1}{r} \int_0^r \rho(r, z) r dr - \frac{1}{r} \int_0^r \frac{\partial E_z(r, z)}{\partial z} r dr \quad (7)$$

$$E_z(r, z) = E(z) + \int_0^r \frac{\partial E_r(r, z)}{\partial z} dr \quad (8)$$

$$E_\varphi(r, z) = 0 \quad (9)$$

$E(z) = E_z(0, z)$ in the (8). The equations (7), (8) and (9) show that the axial symmetric, without charge current distribution and static state electric field $E_\varphi(r, z)$ is identically vanishing. However, because of the mutual nestification of $E_r(r, z)$ and $E_z(r, z)$, none of them can be solved directly. In order to solve $E_r(r, z)$ and $E_z(r, z)$, we suggest the new computing method (alternating iteration method). That is, one should choose a proper initial value and make use of the (7) and (8) to perform alternating iteration. Obviously, approximate solutions are given by the alternating iteration of finite degrees and times. With increasing the degrees and times of alternating iteration, the solutions are more exact. After the alternating iteration of infinite degrees and times, the exact solutions of the out-of-axis electric field can be given. Here, we choose $E_z(r, z)$'s value on the symmetric axis as the initial value, that is

$$E_{0z}(r, z) = E_z(0, z) = E(z) \quad (10)$$

Substituting the (10) into the (7), we can get

$$E_{0r}(r, z) = \frac{1}{\epsilon_0} {}^{(0,1)}\rho(r, z) - \left(\frac{r}{2}\right) E^{(1)}(z) \quad (11)$$

In the (11), $E^{(n)}(z)$ is the n th derivative of $E(z)$ with respect to z , and

$${}^{(m,n+1)}\rho(r, z) = \frac{1}{r} \int_0^r {}^{(m,n)}\rho(r, z) r dr \quad (12)$$

Substituting the (11) into the (8), we get

$$E_{1z}(r, z) = E(z) - \left(\frac{r}{2}\right)^2 E^{(2)}(z) + \frac{1}{\epsilon_0} {}^{(1,1)}\rho^{(1)}(r, z) \quad (13)$$

In the (13), $\rho^{(l)}(r, z)$ is the l th derivative of $\rho(r, z)$ with respect to z , and

$${}^{(m+1,n)}\rho^{(l)}(r, z) = \int_0^r {}^{(m,n)}\rho^{(l)}(r, z) dr \quad (14)$$

Substituting the (13) into the (7), we obtain

$$E_{1r}(r, z) = -\left(\frac{r}{2}\right) E^{(1)}(z) + \frac{1}{2} \left(\frac{r}{2}\right)^3 E^{(3)}(z) + \frac{1}{\epsilon_0} {}^{(0,1)}\rho(r, z) - \frac{1}{\epsilon_0} {}^{(1,2)}\rho^{(2)}(r, z) \quad (15)$$

Substituting the (15) into the (8), we get

$$E_{2z}(r, z) = E(z) - \left(\frac{r}{2}\right)^2 E^{(2)}(z) + \frac{1}{4} \left(\frac{r}{2}\right)^4 E^{(4)}(z) + \frac{1}{\epsilon_0} {}^{(1,1)}\rho^{(1)}(r, z) - \frac{1}{\epsilon_0} {}^{(2,2)}\rho^{(3)}(r, z) \quad (16)$$

The rest may be deduced by analogy. The exact solutions of $E_z(r, z)$ and $E_r(r, z)$ can be given by the alternating iteration of infinite degree. That is

$$E_z(r, z) = E(z) + \sum_{n=1}^{\infty} (-1)^n \left[\frac{1}{(n!)^2} \left(\frac{r}{2}\right)^{2n} E^{(2n)}(z) - \frac{1}{\epsilon_0} {}^{(n,n)}\rho^{(2n-1)}(r, z) \right] \quad (17)$$

$$E_r(r, z) = \sum_{n=0}^{\infty} (-1)^{n+1} \left[\frac{1}{(n+1)!n!} \left(\frac{r}{2}\right)^{2n+1} E^{(2n+1)}(z) - \frac{1}{\epsilon_0} {}^{(n,n+1)}\rho^{(2n)}(r, z) \right] \quad (18)$$

2 Conclusions

According to the study we can get a conclusion below. In the circumstances of the static, axial symmetric, without charge and current distribution, finite, differentiable, and integrable, this paper provides a new kind of computing method (alternating iteration method) and its results in the series form by making use of Maxwell equations and calculus. That is, the out-of-axis electric field can be determined by the electric field on the symmetric axis and its different order derivatives. It has been exact enough, and it is very easy to perform approximate calculation with quite high speed. Therefore, the theory, method and results given by this paper not only are of certain theoretical meaning, but also are of quite great-applied value. Especially to those problems of some out-of-axis areas which are hard to measure or to get exact solutions from other theory, it is easy, quick and exact to solve them when using the alternating iteration method.

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Computation of Pile-Sinking Resistance of Jacked Pile Based on Cavities Expansion Theory

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Abstract. According to the penetration mechanism of jacked pile, a mixed mode of cylindrical-spherical cavity expansion is proposed to simulate the installation process of jacked pile. Soil is assumed as Mohr-Coulomb material and meets the criterion of elasto-plastic deformation. Based on the theory of cylindrical cavity expansion and spherical cavity expansion, a new method is proposed to get the pile tip resistance and skin friction. Then the total penetration resistance of jacked pile is obtained. It is proved that this method is feasible because the values of pile-sinking resistance calculated by the equations with software are consistent with the field tests results.

Keywords: jacked pile; compacting effect; pile-sinking resistance; spherical cavity expansion; cylindrical cavity expansion.

1 Introduction

In recent years, technology of jacked pile has been developed rapidly in China. Before construction, accurately estimate the pile driving resistance is of great significance for the rational design of piles, pile driver selection, and accurate judgment of piles possibility. Currently the calculation of pile resistance is major based on the cone penetration test and the specific geological conditions. The establishment of the empirical equation is proposed with correction coefficient, while the correction factor is of too much reliance on experience and CPT data, regional limitations significantly.

Over the years, scholars and engineers has carried out extensive research around the pile-sinking resistance. Since the cavity expansion theory proposed in 1945, after Vesic (1972 years) [1 ~ 4], the development has been widely used in geotechnical research in the field, but most focus on the effects of soil into piles and so on. In this paper, soil is considered homogeneous, isotropic semi-infinite body. A mixed mode of cylindrical-spherical cavity expansion is used to simulate the process of pile installation. Then the pile tip resistance and side sliding friction can be obtained with the theoretical equations. The results show that this mixed mode is more in line with the actual state than the plane strain axial symmetry assumption used in the cylindrical cavity expansion theory [1].

Driving Mechanism of Jacked Pile.

Jacked pile is a type of pile with soil compaction, different from the non-displacement pile. The pile sinking process is also different from the vibration pile and driven pile. With a large enough pressure on the top of the pile, the resistance of the soil overcome, and the pile sinks to the pre-bearing layer with a specific rate. During the process of pile installation, with the continuous penetration of pile, the increasing volume in the soil of the piles is absorbed by the shallow soil uplift, radial compression of soil, and the ball pore diffusion. The deformation behavior of a large disturbance caused by the lateral compression of pile soil, shallow surface uplift, and lateral pile tip shear strength under compression can be understood as a mixed expansion mode with spherical cavity expansion in the end and cylindrical cavity expansion on the side of the pile.

During the installation process of the pile, there are three main mechanical elements, including the jacking force P , pile-sinking rate V , and pile-sinking resistance Q (the sum of Q_p and Q_s). In order to achieve the intended purpose of successfully completing the pile-sinking, the jacking force should meet the inequality $P \geq \sum Q$ in the whole process [5].

Accurate estimation of pile resistance is important for the rational design of piles, the right choice of pile driver, and the accurately judging of pile-sinking possibility. In general, the initial time of pile sinking, the pressure force needed to overcome end resistance and static side resistance to pile sinking. When the steady-state penetration occurs, pile side resistance was dynamic friction. This paper majorly discusses the calculation of pile-sinking resistance at steady-state penetration of jacked pile.

Theoretical Analysis of Cavity Expansion.

Pile-sinking process of jacked pile has both spherical cavity expansion and cylindrical cavity expansion. In order to facilitate the analysis, introducing a parameter m , for cylindrical cavity expansion of $m = 1$, and spherical cavity expansion of $m = 2$. Cavity expansion in infinite body can be indicated by Figure 1 [6].

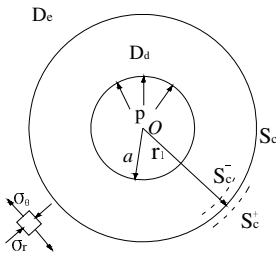


Fig. 1. Sketch of cavity expansion

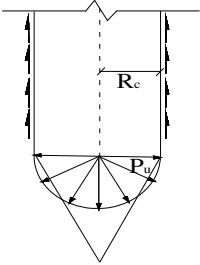


Fig. 2. Sketch of jacking force

When the pressure p (the radial pressure, tangential tension) is small, the surrounding medium of the hole will be in the elastic state; when the p value increases and reaches the value of p_c , the media around the hole will yield, and the damaged

surface S_c will occur. With the increase of p value, the damaged surface S_c expands outward, then the stress on the surface drops, and a circular cylindrical damage zone (plastic zone) D_d is formatted. But other region still is elastic area (D_e). In fig.1, a is column radius of the hole, r_l is the radius of damage zone, p is the internal hole expansion pressure.

Basic Equations. For Mohr-Coulomb material, according to the basic equations and boundary conditions, the final expansion pressure p_u in plastic zone can be obtained [6]:

$$p_u = (2mG\delta + p_0 + \frac{Y_r}{\alpha_r - 1}) \times \left(\frac{1 + \Delta E}{1 + \Delta - (1 - \delta)^{m+1}} \right)^{\frac{m(\alpha_r - 1)}{(m+1)\alpha_r}} - \frac{Y_r}{\alpha_r - 1} \quad (1)$$

Here, $\alpha = \frac{1 + \sin \phi}{1 - \sin \phi}$, $Y = \frac{2c \cos \phi}{1 - \sin \phi}$, $\delta = \frac{Y + (\alpha - 1)p_0}{2(m + \alpha)G}$, c , ϕ , c_r , ϕ_r is the material cohesion, internal friction angle, residual cohesion and residual internal friction angle respectively. Δ is the plastic volumetric strain, can also be described as the consolidation test strain, which can be obtained by iteration method:

① We can assume an average plastic volumetric strain Δ_1 , and calculate the stress state of the plastic zone; ② By the stress state, according to the relationship between strain and stress obtained by triaxial compression test, we can get the modified average plastic volumetric strain Δ_2 ; ③ Check the Δ_2 and Δ_1 value, if the difference between the two is too large, then use the modified average plastic volumetric strain Δ_2 , repeat steps ① and ②, until Δ_n , which value is close to the value Δ_{n-1} . Substitute Δ_n as Δ .

If $c_r = c$, $\phi_r = \phi$, ignoring δ^2 , $m = 1$,

$$p_{u1} = [c \cos \phi + p_0(1 + \sin \phi) + c \cot \phi] \times \left[\frac{(1 + \Delta)E}{\Delta E + 2(1 + \nu)(c \cos \phi + \sin \phi p_0)} \right]^{\frac{\sin \phi}{1 + \sin \phi}} - c \cot \phi \quad (2)$$

If $c_r = c$, $\phi_r = \phi$, ignoring δ^2 , δ^3 , $m = 2$,

$$p_{u2} = \frac{3(1 + \sin \phi)(p_0 + c \cot \phi)}{3 - \sin \phi} - c \cot \phi \times \left[\frac{(3 - \sin \phi)(1 + \Delta)E}{\Delta E(3 - \sin \phi) + 6(1 + \nu)(c \cos \phi + \sin \phi p_0)} \right]^{\frac{4 \sin \phi}{3(1 + \sin \phi)}} \quad (3)$$

Calculation of Pile Penetration Resistance. From the field test data analysis, we can know that pile-sinking resistance is mainly composed by skin friction and tip resistance, shown in Figure 2.

Under normal circumstances, skin friction and tip resistance ratio of total pile-sinking resistance is a variable value. Skin friction and tip resistance to reflect the terms of stratigraphic variations are basically consistent.

Pile Skin Friction. Because of the pile lateral sway, cracks appear between the shallow soil and the pile, coupled with excess pore water pressure in the pore water lubrication, the sliding friction of the pile in this section is very small. Usually, the friction of this area is negligible when we calculate the pile skin friction. The length h_1 of this area is determined by the total buried depth, the initial state of soil, and the nature of soil. The value of h_1 is about $(0.15 \sim 0.3) h$. Here $h_1 = 0.2h$ [7].

According to the related equations of cylindrical cavity expansion theory, the pile side resistance:

$$Q_s = 2\pi R_c \int_{0.2h}^h \sigma_{R_c} \tan \delta dz = 2\pi R_c \int_{0.2h}^h p_{ul} \tan \delta dz \quad (4)$$

Here, δ is the external sliding friction angle of pile and soil, which can be obtained by indoor pile-soil sliding friction test [8] or to take empirical values; R_c is the pile diameter; p_{ul} can be obtained by equation (2).

Pile Tip Resistance. The end of the pile can be modeled as a half sphere. Then the tip resistance can be obtained by the spherical cavity expansion theory:

$$Q_p = p_{u2} \pi R_c^2 \quad (5)$$

Here, p_{u2} is obtained by equation (3).

Pile-sinking Resistance. Pile-sinking resistance is composed of the pile skin friction and tip resistance. If we do not consider the excess pore water pressure force, the total pile resistance can be obtained:

$$Q = Q_s + Q_p \quad (6)$$

Here, Q_s , Q_p are obtained from equation (4), (5) respectively.

Engineering Examples. A layered soil foundation is selected as test sites in Dongying of Shandong province in China. Distribution of soil in site is uniform. Reinforced concrete square piles are used in the test, with the length of 22m and cross-section dimensions of 400mm × 400mm. The major soil parameters are listed in Table 1.

Jacking forces of pile in different depth are recorded during the installation of the pile. We use software to calculate the pile-sinking resistance with the theoretical equations, and the differences between the calculated values and the measured values are shown in Figure 3.

Table 1. Soil calculation parameters of test field

Layer number	Layer name	Depth range [m]	Elastic modulus E_s [MPa]	Poisson's ratio μ	cohesive force c [KPa]	angle of internal friction φ [°]	Dilatation angle φ_{il} [°]	Coefficient of sliding friction
①	silt	0~7.7	5	0.4	36	24.0	2	0.52
②	silty clay	7.7~10.8	6	0.38	86	14.4	0	0.34
③	silt	10.8~15.2	8	0.36	45	28.9	8	0.63
④	silt	15.2~19.6	10	0.35	52	30.1	9	0.66
⑤	silty clay	19.6~27.8			95	13.0		

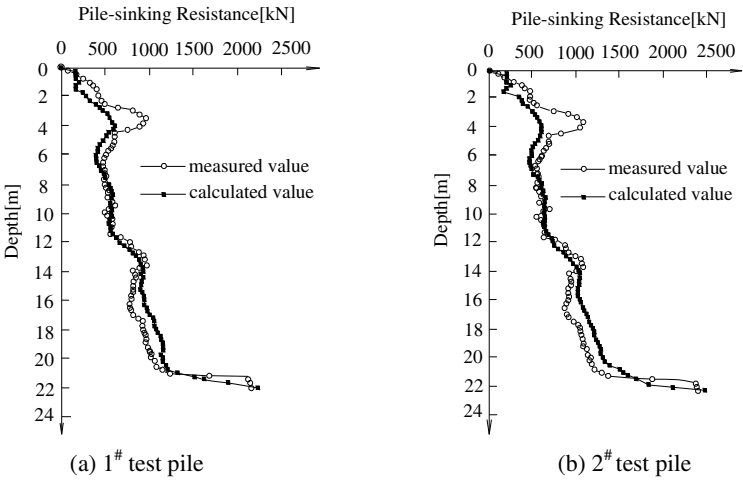


Fig. 3. Comparison between calculated values and measured values

Data can be seen from the figure, the errors of the calculated values are larger when the pile penetration depth is shallower, but with the penetration depth increasing, differences between the calculated values and measured values decrease. The comparative analysis results of other test piles are the same. Through analysis, we can say that within a certain range below the surface, soil is disturbed obviously by external factors such as pile driver moving. The actual values of c , φ have larger errors in this range, which are difference from the survey results. So they have a direct influence on the theoretical analysis accuracy. In contrast, the deeper soil is less

disturbed during construction, so the theoretical values within this range are good agreement with the measured values.

2 Summary

(1) Through the penetration mechanism analysis of jacked pile, a mixed mode of cylindrical-spherical cavity expansion is proposed to simulate the process of pile installation. Compared to the single cylindrical cavity expansion, it is more consistent with the actual state of penetration.

(2) Based on cylindrical cavity expansion theory and the spherical cavity expansion theory, the theoretical equations of the pile-sinking resistance are proposed. Project examples show that pile-sinking resistance values calculated with the equations are consistent with the measured values. It means that the pile-sinking resistance equations based on the mixed mode of cylindrical-spherical cavity expansion are reasonable and feasible.

(3) The theoretical equations provide a theoretical basis for pile-sinking problems. However, due to complexity of the problem, there are still many aspects do not take into account in the theoretical calculation, such as pore water pressure, soil anisotropy characteristics and so on. These problems need to be combined with test data for more in-depth discussions.

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Urban Rail Transit Environmental Impact Assessment Based on Extension Matter-Element Model

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Abstract. Urban rail transit environmental impact level is affected by many factors. In the account of various factors, this paper established an index system for the overall assessment of urban rail transit environmental impact. Based on matter-element model and extension mathematical methods, an extension matter-element model was established to assess the level of urban rail transit environmental impact. Through correlation and level calculation, objective and accurate urban rail transit environmental impact assessment results were worked out. The analysis and computation results showed that this method with simple actual operation can effectively ensure the assessment quality and efficiency.

Keywords: urban rail transit, environmental impact assessment, extension matter-element model.

1 Introduction

In recent years, China's urban rail transit construction has made great progress. However, due to the unreasonable the selection of lines and laying mode, station siting, size, schedule arrangement and others, while significant achievements have been made, some environmental problems have been inevitably caused which restricted its further development[1]. Therefore, it will has positive significance to make in-depth analysis of the environmental impact of the urban rail transit and to promote the urban rail transit environmental impact assessment and control system with the goal to achieve the sustainable development of urban rail transit.

It can be found through searching and sorting domestic and foreign literatures that the urban rail transit environmental impact assessment and research currently mainly focus on the impact on natural environment caused by vibration, noise and water resources damage [2-4] while relatively few research has been made on the urban rail transit comprehensive environmental impact. Urban rail transit environmental impact assessment indexes consist of both quantitative and qualitative indexes so that the

assessment is somewhat uncertain and ambiguous. Based on matter-element model, extension set and correlation function theory, a multi-index extension comprehensive assessment method is established to create a multi-index matter-element model for the performance parameters comprehensive assessment. This model can concisely and clearly give out the assessment results by quantitative values [5-7]. To this end, this paper established an urban rail transit environmental impact assessment index system based on matter-element model, extension mathematical method and correlation function theory and created an extension matter-element model for the assessment of urban rail transit environmental impact.

2 Urban Rail Transit Environmental Impact Assessment Index System

Urban rail transit environmental impact assessment index system should first meet the macro requirements of environmental impact assessment and focus on macro impact analysis and assessment, thus reflecting the environmental, social, economic interaction and development results. A scientific and rational urban rail transit environmental impact assessment index system should at least meet the following requirements: reasonable structure, universality, comparability, accessibility, standardization and advancement.

Based on the above requirements and referring to relevant literatures [8-10], this paper has established an urban rail transit environmental impact assessment index system as shown in table 1.

Table 1. Urban Rail Transit Environmental Impact Assessment Index System

Goal W	Rules	Indexes
Urban rail transit environmental impact assessment	Eco-environment	Noise and vibration impacts
		Electromagnetic interference intensity
		Water environmental impact
		Change of the number of days in a year with standard air quality
	Resources Environment	Rational utilization of land
		Rational utilization of water
		Rational utilization of energy
	Economic Environment	Urban GDP increase speed
		Impact on industrial structure
		New jobs created by the project
	Social Environment	Landscape satisfaction
		Rail transit passenger volume proportion
		Public satisfaction

3 Extension Matter-Element Model for Urban Rail Transit Environmental Impact Assessment

Establish Multi-Index Comprehensive Assessment Matter Element. According to the extension matter-element theory, matter element is known as the orderly combination of the matter N , its eigenvalue C and its feature value X as $R=(N, C, X)$. To describe and assess the performance characteristics of urban rail transit environmental impact, it is necessary to define the urban rail transit environmental impact assessment matter element. According to the urban rail transit environmental impact assessment index framework created in table 1, select key urban rail transit environmental impact factors as assessment factors (i.e., characteristic factors), expressed as C_i ($i=1,2,\dots,n$). Use N to express urban rail transit environmental impact level and use X_i ($i=1,2,\dots,n$) to express the value range determined by N and C_i . According to the definition of n -dimension matter element, urban rail transit environmental impact level can be described by the following matter element,

$$R = (N, C, X) = \begin{bmatrix} N & C_1 & X_1 \\ & C_2 & X_2 \\ & \dots & \dots \\ & C_n & X_n \end{bmatrix} = \begin{bmatrix} \text{Urban rail transit} & & \\ \text{Environmen tal} & C_1 & X_1 \\ \text{impact level} & C_2 & X_2 \\ & \dots & \dots \\ & C_n & X_n \end{bmatrix} \quad (1)$$

Determine Classical Domain and Matter Element to Be Assessed. Let urban rail transit environmental impact has m assessment levels, N_j ($j=1,2,\dots,m$); define the classical domain as a range of various characteristics of C_i on various assessment levels N_j . The matter element matrix can be expressed as follows,

$$R_j = (N_j, C_i, X_{ji}) = \begin{bmatrix} N_j & C_1 & X_{j1} \\ & C_2 & X_{j2} \\ & \dots & \dots \\ & C_n & X_{jn} \end{bmatrix} = \begin{bmatrix} N_j & C_1 & \langle a_{j1}, b_{j1} \rangle \\ & C_2 & \langle a_{j2}, b_{j2} \rangle \\ & \dots & \dots \\ & C_n & \langle a_{jn}, b_{jn} \rangle \end{bmatrix} \quad (2)$$

Where, N_j ($j=1,2,\dots,m$) is the number j level of C_i and X_{ji} is the characteristics range of N_j , namely, the classical domain $\langle a_{ji}, b_{ji} \rangle$ of characteristics C_i on various levels.

Joint domain is defined as the range of all characteristics of C_i on all levels. The matter element matrix is expressed as follows,

$$R_p = (N_p, C_i, X_{pi}) = \begin{bmatrix} N_p & C_1 & X_{p1} \\ & C_2 & X_{p2} \\ & \dots & \dots \\ & C_n & X_{pn} \end{bmatrix} = \begin{bmatrix} N_p & C_1 & <a_{p1}, b_{p1}> \\ & C_2 & <a_{p2}, b_{p2}> \\ & \dots & \dots \\ & C_n & <a_{pn}, b_{pn}> \end{bmatrix} \quad (3)$$

Where N_p is the totality of matter levels, $X_{pi} = \langle a_{pj}, b_{pj} \rangle$ is the joint domain of N_p on characteristics parameter C_i and $X_{ji} \in X_{pi}$ ($i = 1, 2, \dots, n$; $j = 1, 2, \dots, m$) is tenable.

Reflect the urban rail transit environmental level factor operational factors by matter element, known as matter element to be assessed of urban rail transit environmental impact level. The matrix of matter element can be expressed as follows,

$$R_0 = (P_0, C_i, X) = \begin{bmatrix} P_0 & C_1 & X_1 \\ & C_2 & X_2 \\ & \dots & \dots \\ & C_n & X_n \end{bmatrix} \quad (4)$$

Where P_0 refers to the urban rail transit environmental impact level to be assessed, C_i is the characteristic parameter of P_0 , X_i ($i = 1, 2, \dots, n$) refers to the specific value of characteristic parameter C_i , namely, the actual expert assessment value or measured value of the eigen-element.

Construct Correlation Function and Calculate Correlation. According to the definition of correlation function of the extension, correlation function is the scope in line with requirements when the matter element value is a point on the real axis. That means it refers to the range of matter element P_0 belonging to the urban rail transit environmental impact level grade N_j when choosing the specific value of the characteristic parameter X_i . Let the module definition of the bounded interval $X_{ji} = [a_{ji}, b_{ji}]$ to be $|X_{ji}| = |b_{ji} - a_{ji}|$ and then the distance between the point X_i to the interval $X_{ji} = [a_{ji}, b_{ji}]$ is,

$$\rho(x_i, x_{ji}) = \left| x_i - \frac{a_{ji} + b_{ji}}{2} \right| - \frac{1}{2}(b_{ji} - a_{ji}) \quad (5)$$

Similarly, the distance between the point X_i to the interval $X_i = [a_{pi}, b_{pi}]$ is,

$$\rho(x_i, x_{pi}) = \left| x_i - \frac{a_{pi} + b_{pi}}{2} \right| - \frac{1}{2} (b_{pi} - a_{pi}) \quad (6)$$

Let the correlation function to be,

$$K_j(x_i) = \begin{cases} -\rho(x_i, x_{ji}) / |x_{ji}|, & x_i \in x_{ji} \\ \rho(x_i, x_{ji}) / [\rho(x_i, x_{pi}) - \rho(x_i, x_{ji})], & x_i \notin x_{ji} \end{cases} \quad (7)$$

Where $K_j(x_i)$ refers to the range of matter element P_0 to be assessed belonging to the urban rail transit environmental impact level grade N_j when choosing the specific value of the characteristic parameter X_i .

Determine the Correlation and the Assessed Grade. If the weight coefficient of the factor C_i to be assessed is ω_i and $\sum_{i=1}^n \omega_i = 1$, the correlation of the matter P_0 to be assessed on grade N_j is,

$$K_j(P_0) = \sum_{i=1}^n \omega_i K_j(X_i) \quad (8)$$

Then, $K_j = \max K_j(P_0)$, so as to determine the urban rail transit environmental impact level to be level j .

4 Example Analysis

An urban rail transit planning program has passed through the economic assessment and now, the environmental impact assessment shall be carried out. The assessment will be made based on the extension matter-element model.

(1) Take indexes listed in table 1 to build an assessment system, expressed as C_i ($i = 1, 2, \dots, n$); after investigation and interview of different urban rail transit environmental impact levels and experts, assessment indexes are divided into I-IV levels, referring to the four urban rail transit environmental impact levels as Good, Preferable, Acceptable and Poor. The classical domain $\langle a_{ji}, b_{ji} \rangle$ of the urban rail transit environmental impact assessment can be hereby built.

Since the environmental assessment is advance in the planning phase, many indexes should be determined through status investigation and multiple prediction and analysis method. Normalized urban rail transit environmental impact assessment

index data can be obtained through field survey and analysis, expressing by P_0 . The results are as shown in table 2.

(2) Use Delphi method to score the 13 indexes for urban rail transit environmental impact assessment and determine the weight of various indexes, as shown in table two.

(3) Comprehensive correlation calculation.

Table 2. Urban Rail Transit Environmental Impact Assessment Index Grading Standard

C	Index Assessment System	Fully successful $<a_{ji}, b_{ji}>$	Basically successful $<a_{ji}, b_{ji}>$	Partially successful $<a_{ji}, b_{ji}>$	Unsuccessful $<a_{ji}, b_{ji}>$	Urban rail transit environmental impact assessment value P_0
Eco-environment t (0.3)	C1(0.07)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.74
	C2(0.09)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.71
	C3(0.07)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.81
	C4(0.08)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.84
Resources environment t (0.3)	C5(0.07)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.84
	C6(0.09)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.74
	C7(0.07)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.66
Economic environment t (0.2)	C8(0.08)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.88
	C9(0.09)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.76
	C10(0.08)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.78
Social environment t (0.2)	C11(0.06)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.83
	C12(0.08)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.85
	C13(0.07)	$<0.75, 1>$	$<0.5, 0.75>$	$<0.25, 0.5>$	$<0, 0.25>$	0.78

According to weights above, calculate by Equations (5)~(8). The comprehensive correlation and environmental impact level extension comprehensive assessment level for various indexes based on the assessment standard N_j ($j=1,2,3,4$), as shown in table 3:

Table 3. Urban Rail Transit Environmental Impact Level Comprehensive Correlation and Extension Comprehensive Assessment Table

Level	Good	Preferable	Acceptable	Poor
$K_j(P_0)$	1.77	-1.67	-5.94	-7.37

It is shown by the computing results that the comprehensive correlation of urban rail transit environmental impact level is 1.77. Thus, the urban rail transit environmental impact is in “Good” level.

5 Conclusions

(1) Extension theory is a formal tool. It considers the combined effect of multiple factors and research and solve incompatible problems from qualitative and quantitative perspectives. The urban rail transit environmental impact level can be directly reflected through establishing assessment index matter-element model to describe characteristics of objective matters and expressing assessments results by specific values.

(2) It is a new method for building extension matter-element model to assess the urban rail transit environmental impact level. This method is rigorous, practical and easy for calculation. Besides, flexible adjustment of assessment indexes and standards can also be supported so as to facilitate the electronic data processing. Scientific and reasonable assessment results can be obtained through this method.

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A Class of Exact Solutions of the BBM Equations

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Abstract. Solutions of nonlinear partial differential equations are hard to be solved generally. In this paper, BBM equation is transformed into the system of algebraic equations, and their coefficients can be easily determined by the homogeneous balance method by means of one-dimensional cubic nonlinear Klein-Gordon equation. Then, the exact solutions of BBM equation is successfully obtained. The solutions contain triangular periodic solutions, Jacobi elliptic function solutions, and so on. The method in the paper can be used to solve other nonlinear evolution equations.

Keywords: BBM equation, homogeneous balance method, Klein-Gordon equation, exact solution.

1 Introduction

With the development of science and technology, nonlinear problems of the natural sciences and social sciences have become increasingly important. Physics, chemistry, biology, engineering, and even economic research and so there are lots of non-linear problems, which problem can be the nonlinear ordinary differential equations or the nonlinear partial differential equations to describe. Therefore, how to solve these nonlinear equations become the math, science and technology workers working on important subjects. Finding the solutions have very important significance.

In recent years, the nonlinear evolution equations are interested in traveling wave solutions, it is because traveling wave solutions can describe the nonlinear phenomena, such as, the wave phenomena of the fluid dynamics, the optical fiber phenomena. On the method for finding the traveling wave solutions of the soliton theory is an important research field, such as the tanh function method, the sine-cosine method, the Jacobi elliptic function expansion method and so on[1, 2]. The homogeneous balance method is one of the most direct and effective method that is developed for the nonlinear traveling wave solutions of the equation [3, 4].

In 1972, the Benjamin-Bona-Mahony equation, denoted by BBM equation[5] as exact solutions of KdV equation proposed by Benjamin T. B. Bona J. L. and Mahony J. J. [6,7]. Since then, for a variety of generalized BBM equation with periodic boundary initial value problem and initial boundary value problems are studied extensively [6-9]. In this paper, using the homogeneous balance method the exact solutions of the BBM equation obtained.

2 Solve the BBM Equation

We consider the following forms of BBM equation [5]:

$$u_t + u_x + uu_x - \beta u_{xxt} = 0. \quad (1)$$

Now we use the homogeneous balance method to solve the equation.

$$\text{Let } u = u(x, t) = u(\xi),$$

where, $\xi = ax + bt + \xi_0$, a and b is a constant, ξ_0 is an arbitrary constant..

Put $u = u(x, t) = u(\xi)$ into Eq. (1), we get:

$$(a + b)u' + auu' - \beta a^2 bu''' = 0, \quad (2)$$

$$\text{where } u' = \frac{du}{d\xi}.$$

Therefore, integrating (2), and taking integration constant to zero, we know:

$$(a + b)u + \frac{au^2}{2} - \beta a^2 bu'' = 0. \quad (3)$$

Next we balance equation (3) of the highest order nonlinear terms and the highest order derivative terms.

Let $u = a_0 + a_1\varphi + \cdots + a_n\varphi^n$, where $\varphi(\xi)$ satisfies one-dimensional cubic nonlinear Klein-Gordon equation:

$$\begin{cases} \varphi_\xi^2 = c_0 + \lambda\varphi^2 + \frac{1}{2}\mu\varphi^4, \\ \varphi_{\xi\xi} = \lambda\varphi + \mu\varphi^3 \end{cases}. \quad (4)$$

From Eq. (3) we know the nonlinear terms of $u = a_0 + a_1\varphi + \cdots + a_n\varphi^n$ is $2n$, the highest order derivative terms is $(\varphi^n)'' = n(n-1)\varphi^{n-2}(\varphi')^2 + n\varphi^{n-1}\varphi''$, From (4) we see φ'' is equivalent to φ^3 , so we get $n = 2$.

Therefore

$$u = a_0 + a_1\varphi + a_2\varphi^2, \quad (5)$$

Put (4) and (5) into (3) we have

$$\begin{aligned}
 & (a+b)a_0 + \frac{aa_0^2}{2} - 2a^2b\beta a_2c_0 + ((a+b)a_1 + aa_0a_1 - a^2b\beta a_1\lambda)\varphi \\
 & + ((a+b)a_2 + \frac{aa_1^2}{2} + aa_0a_2 - 4a^2b\phi a_2\lambda)\varphi^2 + (aa_1a_2 - a^2b\beta a_1\mu)\varphi^3 \\
 & + (\frac{a_2^2}{2} - 3a^2b\beta a_2\mu)\varphi^4 = 0,
 \end{aligned} \tag{6}$$

Then, make all coefficient of $\varphi(\xi)$ in (6) of each power term is zero, we get:

$$\begin{cases}
 (a+b)a_0 + \frac{aa_0^2}{2} - 2a^2b\beta a_2c_0 = 0, \\
 (a+b)a_1 + aa_0a_1 - a^2b\beta a_1\lambda = 0, \\
 (a+b)a_2 + \frac{aa_1^2}{2} + aa_0a_2 - 4a^2b\phi a_2\lambda = 0, \\
 aa_1a_2 - a^2b\beta a_1\mu = 0, \\
 \frac{a_2^2}{2} - 3a^2b\beta a_2\mu = 0,
 \end{cases}, \tag{7}$$

Solving the system (7) we deduce

$$a_0 = \frac{-(a+b) \pm \sqrt{(a+b)^2 + 6a^5b^2\beta^2\mu^2c_0}}{a}, a_1 = 0,$$

$a_2 = \frac{3}{2}a^2b\beta\mu$, so we can get the form of the exact solution of the BBM equation:

$$u = a_0 + \frac{3}{2}a^2b\beta\mu\varphi^2(\xi),$$

$$\text{where } a_0 = \frac{-(a+b) \pm \sqrt{(a+b)^2 + 6a^5b^2\beta^2\mu^2c_0}}{a}, a_2 = \frac{3}{2}a^2b\beta\mu,$$

$\xi = ax + bt + \xi_0$, a, b, ξ_0 are an arbitrary constants, $\varphi(\xi)$ satisfies Eq. (4).

3 Examples of BBM Exact Solutions

Using the variety of exact solutions of the one-dimensional cubic nonlinear Klein-Gordon equation in [5], we can obtain several exact solutions of the BBM equation.

(1) when $\lambda = 1, \mu = -2, c_0 = 0$, we have: $u = a_0 + a_2\varphi^2(\xi)$,

where $a_0 = 0$ or $a_0 = -\frac{a+b}{a}$, $a_1 = 0$, $a_2 = -3a^2b\beta$, $\varphi(\xi) = \operatorname{sech}(\xi)$,
 $\xi = ax + bt + \xi_0$, a, b, ξ_0, β are arbitrary constants.

(2) when $\lambda = -(1+k^2)$, $\mu = 2k^2$, $c_0 = 1$, we have $u = 3a^2b\beta k^2 \operatorname{sn}^2(\xi) + a_0$,

where $a_0 = \frac{-(a+b) \pm \sqrt{(a+b)^2 + 24a^5b^2\beta^2k^4}}{a}$, $\xi = ax + bt + \xi_0$, a, b, ξ_0, β are arbitrary constants.

(3) when $\lambda = -\frac{(1+k^2)}{4}$, $\mu = \frac{k}{2}$, $c_0 = \frac{k}{4}$, we have:

$$u = \frac{3}{4}a^2b\beta k \left(\frac{\sqrt{2k(1+ksn(\xi))(1+sn(\xi))}}{\sqrt{1+k(1+ksn(\xi))}\sqrt{1-kdn(\xi)}} \right)^2 + \frac{-(a+b) \pm \sqrt{(a+b)^2 + \frac{3}{8}a^5b^2\beta^2k^3}}{a}$$

where $\xi = ax + bt + \xi_0$, a, b, ξ_0, β are an arbitrary constants.

4 Conclusion

In this paper, the exact solutions of the BBM equations is obtained by the homogeneous balance method and by means of the exact solution of one-dimensional cubic nonlinear Klein-Gordon equation. The method is universal. It can be used to solve more nonlinear evolution equations.

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Research on Sentiment Analyzing in Multi-topics Texts

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Abstract. Many web texts coverage multiple topic. How to analyze sentiment this kind of texts is a key problem in information reveal. In this paper, we proposed a new method to analyze sentiment of multi-topics texts on the Internet. Firstly, the Latent Dirichlet Allocation model is used to reveal to the latent topical facets in texts. Then a two a two-layer conditional random fields is introduced to analyze sentiment of every topic in the texts. Empirical results show that this approach is effective for extracting subtopics and identifying sentiments of each topic. Moreover, this method is quite general and can be applied to any kinds of web texts.

Keywords: Analyzing Sentiment, Conditional Random Fields, Extracting Topic, Latent Dirichlet Allocation.

1 Introduction

With the rapid growth of semantic web page in Internet, people pay more attention on the analysis and detection of sentiment expressed in a text . Previous work is focused on polarity classification [1, 2], opinion extraction [3] and opinion source assignment [4, 5]. However, a common deficiency of all this work is that the proposed approaches extract only the overall sentiment of a text or query, but can neither distinguish different subtopics within a text, nor analyze the sentiment of a subtopic. Since a text often covers a mixture of subtopics and may hold different opinions for different subtopics, it would be more useful to analyze sentiments at the level of subtopics. In all these scenarios, a more in-depth analysis of sentiments in specific aspects of a topic would be useful.

In this paper, we propose a novel approach to extract subtopic in the web texts and analyze sentiment of texts. Moreover we model the dynamics of each topic and its associated sentiments.

2 Method of Extracting Subtopics

In this paper, we propose a probabilistic generative model approach is used to extract subtopics in multi-topic documents.

Latent Dirichlet Allocation Model

LDA model is proposed in 2003, is a kind of generative probability model, including three layers of bayesian networks.

Assuming M is the number of texts in corps, K is the number of topics. Each theme is created by polynomial distributed of words. w_{in} denotes the n -th word in the i -th text. V is Dictionary set, and $w_{in} \in V$. z_{in} denote the theme created by word w_{in} . α and β are parameters. θ_d is the distribution proportion of the d text on themes, and it obeys Dirichlet distribution. LDA model generation process is described below:

- (1) Extract polynomial distributed for each topic k ;
- (2) extract polynomial distributed for each text d ;
- (3) Extract theme from polynomial variable θ_d and extract ϕ_z from word w_{dn}

The key problem in applying LDA model is calculated the posterior distribution of hidden variables according to the given document. This distribution can only be attained by approximate algorithm. In this paper, we use Gibbs sampling to compute ϕ and θ . Gibbs sampling algorithm process as follows:

- (1) First of all, give a random theme to w_n and constitute the initial markov chain. w_n represents the word w , and it relates to the position of the word w in text position, called the sign of the word.
- (2) Given the word w_n , firstly fixed theme distribution of other words, and calculate $p(z_n = j)$ in order to obtain the next state of markov chain. Executive iterative calculation enough times, markov chain obtains stability state.
- (3) Compute θ and ϕ of words:

$$\phi_{w_n}^{(z=j)} = \frac{L_{w_i j}^{V \times K} + \beta_{w_i j}}{\sum_{v=1}^V (L_{v_i j}^{V \times K} + \beta_{v_i j})} \quad (1)$$

$$\theta_{z=j}^{(d)} = \frac{L_{d_i j}^{M \times K} + \alpha_{d, j}}{\sum_{k=1}^K (L_{d_i k}^{V \times K} + \alpha_{d, k})} \quad (2)$$

$L^{V \times K}$ and $L^{M \times K}$ are matrixes and their dimensions respectively are $V \times K$ and $M \times K$. $L_{w_i j}^{V \times K}$ denotes the frequency of the theme j Which does not include w_n ; Similarly, $L_{d_i j}^{M \times K}$ represents the number of word distribution to the theme j .

Through the above process, parameter estimation of the LDA model is completed. According to LDA model, subtopics can be extracted from documents.

3 Identifying Sentiment of Subtopic

Conditional random fields, a frame work for building probabilistic models to segment and label sequence data. We use CRF model to extract subtopics of documents.

A subtopic usually includes subjective and objective content. Sentiment only exists in subject content .Object content has a bad influence on identify sentiment and must be removed. Conditional random fields can solve the label bias problem in a principled way, is adopted to remove objective content. Then, subjective content is conserved and sentiment of subjective content is regarded as of subtopic. Sentiment of sentences in subjective content influences each other and finally determines the sentiment of the subtopic. Because sentences in the subtopic are related in context, we treat the identification of sentiment of these sentences as a tagging task, and also can use conditional random fields to address this problem. Based on this, we propose a two-layer CRF model. This model is showed in Figure 1.

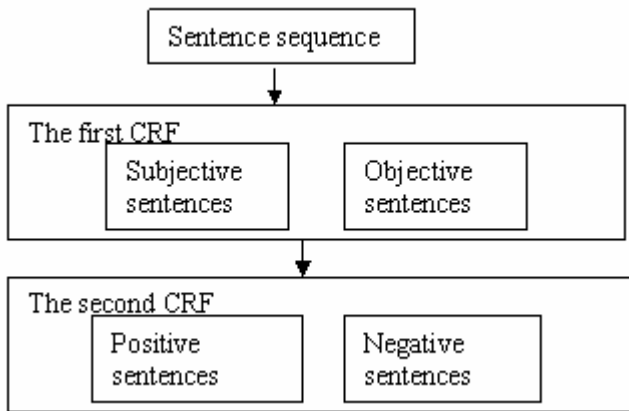


Fig. 1. A two layer model

This model specifically includes the following two steps:

- (1) The target of CRF model on the first layer is to identify subjective sentences.
- (2) Subjective sentences which are labeled in step 1 as input information is entered into CRF model on the second layer in order to label polarity of sentiment of sentences.

CRFs are parametric families of conditional distributions that correspond to undirected graphical models and have been mostly applied to sequence annotation. The standard graphical structure is a chain structure on y with noisy observations x .

$$P(Y|X) = \frac{1}{z_\lambda} \exp\left(\sum_{i=1}^k \lambda_i f_i(Y, X)\right) \quad (3)$$

As mentioned before, in the first layer of model, we define X as a sequence of sentences with X_i representing the i -th sentence in a subtopic. And the sequence y

represents the subjective sentences. In this layer, the features of the model are called subjective features that are sentiment words. If a sentence contains one or more sentiment words, it is labeled as subjective sentence; otherwise it is labeled as objective sentence. We construct a sentiment words database by analyzing HowNet resources and a polarity seed collection that we select from Chinese texts corpus. In sequence annotation a standard choice for feature is $\lambda_i f_i(Y, X)$ which is a binary function. We choose sentiment words which may be adjectives or adverbs to represent feature of observation sequence X .

In second layer model, we define X as a sequence of sentences with X_i representing the i -th sentence which is output from the first model. And the sequence y represents the polarity of sentences. the features of the model are called polarity features. The sentiment words in sentiment words database which we construct include two properties, one is polarity (turn up or turn down), and the other is the value of polarity. We label seed words with polarity values which may be -1 or 1 . The value of 1 means the positive polarity and the value of -1 means the negative polarity. So $\lambda_i f_i(Y, X)$ is selected from polarity values of sentiment words. Moreover, negation words have influence on sentiment words. If they modify sentiment words, the polarity of these words will be reversed. We build a list which includes familiar negation words. The effect of these words will not cross punctuation, such as commas, question marks, etc. Therefore they just will negate the polarity of the closest sentiment word.

Training CRFs model is typically estimated by maximum likelihood or MAP. In our work, maximum likelihood is adopted to train the model. Likelihood function is described in (4).

$$L(\lambda) = \sum_i [\lambda \times F(Y_k, K_k) - \log Z_\lambda(X_k)] . \quad (4)$$

According to CRFs model, the polarity of sentences in a subtopic is determined. We calculate the polarity of a subtopic as in (5).

$$C = \sum_{j=1}^l S_j . \quad (5)$$

Where C denotes the sentiment value of a subtopic, S_j denotes the sentiment value of the j -th sentence in the subtopic.

4 Experiments

In this section, we describe the data and evaluations used in our experiments, and present our results.

5 Data

To examine the ideas proposed in this paper, We collected a corpus, which includes 2000 on line reviews. Most of these reviews coverage multiple topics. The proportion of documents with multiple topics on the whole dataset is 79.8%, the average of the

number of topics of a document is 3.2. In particular, sentiment of every text was labeled manually and sentiment of all sentences was also annotated based on their context within every document. Sentences were annotated as neutral if they conveyed no emotion or had indeterminate sentiment from their context.

6 Results

Our first experiment is to evaluate the method of extracting subtopic. As with other information extraction task, we use precision (P), recall (R) and F to evaluate the result. $P = \frac{|n_r \cap n_e|}{|n_e|}$, $R = \frac{|n_r \cap n_e|}{|n_r|}$ and $F = \frac{2PR}{P+R}$. n_r is a set of relevant topics and n_e is a set of estimated topics. A higher F-measure indicated a better ability to discriminate topics.

We respectively use 6 data sets, which include the 15%, 30%, 50%, 70%, 80%, and 95% of 2000 on line reviews to implement our method. Fig.2 shows the value of F in these six experiments.

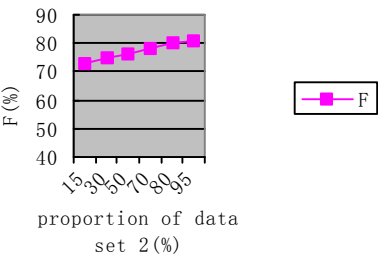


Fig. 2. F changes with the size of test data

Fig.2 shows that the average of F arrives to about 78%. And with the increase of test data, the value of F also improves. Results demonstrate that LDA model has better efficiency on extracting subtopics.

The second experiment is to evaluate the effectiveness of the method for analyzing sentiment. Firstly, we evaluate the efficiency of method in analyzing sentiment. Our method proposes a two-layer CRF model that removes objective sentences in the first CRF model and label sentiment of sentiment in the second CRF model. So we respectively use the first CRF and the two-layer model to conduct experiment and compare the experimental results in table 1. Measures of F-measure, recall and precision are used to evaluate the efficiency of the methods.

The experimental results in Table 1 indicate that the two-layer CRF model can improve the precision of sentiment analysis. We also use measures of recall, precision and F to evaluate the result.

Table 1. Identifying sentiments in data set 2

Method	P (%)	R (%)	F (%)
Single CRF	81.54	80.13	80.54
Two-layer CRF	89.36	89.75	89.56

The experimental results in table 2 illustrate that compared with the method of single CRF model; our method can improve precision, recall and F efficiently. That is because sentiment always exists in subjective sentences and our method removes objective content of subtopic and only analyze sentiment in subjective content.

7 Conclusion

In this paper, we propose a new method to extract subtopic and identify sentiment of subtopic in multi-topic web document. With this method, we could effectively extract topic and identify sentiments of every topic, especially represent the associated sentiment dynamics. We evaluate our method on different collections; the results show that the method is effective for web texts, which have multiple subtopics.

An interesting future direction is to further explore other applications of our method, such as user behavior prediction.

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The Relationship of Cell Factors and Coronary Artery Disease and Risk Factors

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Abstract. List the keywords covered in your paper. These keywords will also be used by the publisher to produce a keyword index. The paper using particle enhancement immunity turbidity to determinate the acute coronary syndrome (ACS), stable angina (SA) patients and healthy person plasma c-reactive protein (CRP), serum amyloid A (SAA) concentration, enzyme-linked immunosorbent absorption spectrometry plasma interleukin 6 (IL - 6), tumor necrosis factor (TNF- α) concentration, analyzes the cytokines with coronary heart disease (CHD) related risk factors. The results showed that the SAA, CRP, IL - 6, TNF alpha concentrations of ACS and SA patients were higher than those in control group ($P < 0.01$), The SAA, CRP and IL - 6 levels of ACS patients were higher than SA person; CHD patients with SAA CRP is highly relevant, SAA, CRP and TNF alpha and IL - 6 are low correlative. Cholesterol, smoking index, SAA, TNF- α , CRP, history of hypertension and CHD family history for CHD independent risk factors, the above factors leading to the relative risks is SAA > Cholesterol > smoking index > TNF- α > CRP > history of hypertension. Clew the rise of SAA, CRP, IL - 6, TNF- α on CHD patients can make the athermanous plaque is not stable, cause the ACS occur, SAA, CRP, TNF alpha and IL - 6 jointly participate. The paper can play an important role to estimate occurrence and development of CHD risk..

Keywords: Cytokines, Coronary heart disease, Risk factors.

1 Introduction

Research found that by cytokines mediated inflammation plays an important role in the atherosclerotic process (AS), inflammatory markers c-reactive protein (CRP), serum amyloid A (SAA), interleukin 6 (IL - 6) , tumor necrosis factor (TNF- α) , coronary heart disease (CHD) growth and prognosis were closely related. To explore relationship of the cell factors and the risk factors of CHD, We carried on the related research March 2009 ~ in November 2010.

2 Information and Method

A. Clinical Data

In this paper ,CHD group have 178 patients, male 105 cases, female 73 cases, age (64.15 ± 10.80 years old); Including acute coronary syndrome (ACS) 73 cases, including

unstable angina (USA), acute myocardial infarction (AMI), stable angina (SA) 105 cases. USA, SA accord with Chinese Medical Association diagnostic criteria [1, 2]. The control group 192 cases, male 80 cases and female of 112 patients, age (6.455 ± 7.75) years, they are CHD attacker the medical community in Wuhan. Above participant exclude cardiopulmonary function is not complete, myocarditis, infective endocarditis and rheumatic heart disease, connective tissue diseases, infection, tumors and peripheral vascular disease history.

B. Detection Methods

In the paper we research CHD risk factors to objects, including the questionnaire survey (general situation, the history of smoking, drinking histories, CHD family history, diabetes history, history of hypertension, etc.), measuring height, weight, waistline, Fast after fasting blood, 12h early detection of serum total cholesterol (TC), triglycerides (TG); Meanwhile extraction peripheral blood 5ml placement anticoagulation tube, 1 000r/min centrifugal 10min take plasma, in -70 °C preservation for later use. CHD group of patients after admission 48h inside exsanguinate on. Adopt double antibody sandwich enzyme-linked immunosorbent adsorption method (ELISA) test plasma IL - 6, TNF alpha particle concentration, enhance the immune than turbidity determination of CRP, SAA concentration.

C. Statistics Processing

Application SAS8.1 statistical software data analysis, and the correlation analysis with Pearson correlation analysis, statistical each cell factor levels found a skewness distribution data, so the obtained data with median (fourth digit span), M (Q), said the single factor analysis with unconditional Logistic regression analysis, multi-factor analysis with Logistic regression method. $P < 0.05$ is a statistical significance.

3 Result

A. CHD Group and Control Group General Data

Two groups of gender, body mass index, TC, smoking index, CHD family history, history of hypertension and diabetes history was statistically significant ($P < 0.05$), age and TG, waist circumference, sleep and drinking histories was not statistically significant ($P > 0.05$).

B. CHD Group and Control Group Cell Factors Comparison

Table 1 shows that CHD group ACS and SA patients SAA, CRP, IL - 6, TNF alpha concentrations were significantly higher than those in the control group ($P < 0.01$), the ACS patients SAA,CRP and IL-6 concentration significantly higher than SA patients ($P < 0.01$).

Table 1. Chd Group and Control Group Cell Factors

group	α	SAA(mg/L)	IL-6(pg/ml)	TNF- α (pg/ml)	CRP(mg/L)
CHDGroup	178				
ACS	73	8.39(36.53) * Δ	8.32(16.30) * Δ	10.00(25.10*)	6.20(15.87) · Δ
SA	105	2.97(5.92)	4.90(14.10) *	18.50(26.90*)	3.03(4.01) *
Control Group	192	2.97(0)	1.16(2.93)	1.10(7.40)	3.03(0)

C. Correlation analysis SAA, CRP, IL-6, TNF- α of CHD patients

SAA and CRP of CHD patients' plasma is highly relevant ($r=29$), SAA, CRP ,TNF- α and IL - 6 are low positive correlation ($r =0.1608, 0.3284, 0.2503$), SAA, CRP and TNF- α did not see a clear correlation.

D. Analysis the associated risk factors of the single factor of CHD

The results showed, body mass index, TC, smoking index, diabetes, hypertension, medical history, history of

CHD family history, gender, SAA, TNF- α , IL - 6 and CRP on CHD occur significantly influences the ($P < 0.01$),

TG, waist circumference, sleep, age, drinking histories was not statistically significant.

E. CHD associated risk factors multivariate analysis

The results showed that the TC, history of hypertension, smoking index, SAA, TNF alpha, CRP and CHD family history are CHD independent risk factors, between groups have quite significant statistically significant ($P < 0.01$). According to the standard of regression coefficients to compare the harmfulness of selected factors leading to CHD occurs. The results showed that, SAA > family history of CHD > TC>smoking index > TNF- α > CRP > history of hypertension.

4 Conclusion

SAA, CRP, IL - 6, TNF- α are sensitive inflammatory markers, and they have direct damage action of vascular endothelial cells, and with dose-response, and they are positively correlated with action time[3]. By promoting vascular smooth muscle cell proliferation, induce the generation of endothelial cell adhesion factor, accelerate AS form, By expanding lipid necrosis core, induction of inflammatory cells infiltrating, cutting thin fibrous cap thickness and the ability of repair, change atheromatous plaque structure, increase its instability, promote thrombosis, cause the progression of AS.

A. Conclusion

SAA, CRP, IL - 6, the elevation of TNF- α and the happiness of CHD are closely related. With the improvement of SAA, CRP and IL - 6, increases the risk of ACS occur. Clew SAA, CRP and IL - 6 detection can be regarded as a judge plaques instability and prognosis index, inflammation in the ACS occur process, which occupies an important position.

SAA, CRP and TNF- α and IL - 6 possible induct through mutually and interacted each other, participated occurrence and development of CHD, in which the mutual induction of SAA and is the strongest.

SAA, TNF- α , IL - 6, CRP, gender, body mass index, TC, smoking index, CHD family history, history of hypertension and diabetes history are CHD associated risk factors, among which SAA, CHD family history, history of hypertension, TC, smoking index, TNF- α , CRP is independent risk factors for CHD, and CHD are caused by various factors.

Inflammation is probably one of the pathogenesis of CHD, these inflammatory markers have irreplaceable important position in the evaluation of the risk of CHD, such as SAA, TNF- α , CRP etc. SAA influence the occurrence of CHD strongest, it predictive the occurrence of CHD higher than CHD family history, history of hypertension, TC, smoking index. So, in conclusion, detection of SAA is simple and convenient, and it can be used as clinical conventional inspecting index, evaluate the risk factors for CHD with other CHD risk or alone.

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A Relative Achievement Method for Marine Environmental Management Evaluation

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Abstract. The purpose of this paper is to set up a relative achievement method to improve existing marine environment management. The method adopted optimal frontier re-assessment method into fuzzy DEA that overcomes the limitation of re-assessment built on investment, and neglects the progress made by those with less investment but strict environment control activities. The advantage of the method is comparative characteristics, the method focuses on the environmental change due to the effort of business management behavior instead of environment assessment index by environmental institutions only. The result shows that the environment management evaluation becomes more objective and equity by adopting the method.

Keywords: marine environment, management evaluation, relative achievement method, fuzzy DEA.

1 Introduction

The total marine production value was 3843, 9 billion *Yuan* in 2010, and it is 12.8% increase than that of last year. Total marine output value is 9.7% of GDP[1]. According to marine environmental quality report, in year of 2009, there is area of 146 980 square kilometers fell to reach the standard of clean water quality and that is 7.3% increase than previous year. The healthy, semi-healthy and ill healthy alongshore ecological system indexes are 24%、52%和24% [1]. The sources of marine pollution come from shipping, oil development, ocean industry production and domestic sewage, and major pollutants are inorganic nitrogen, labile phosphate and oil. More over, the emergence of large scale enclosing and filling up sea project are very serious, which simply focuses present development and ignore long-term grow [2]. Marine environmental management plays an important role on economy and environment sustainable development protection. Traditionally, marine environmental inspection and management are the task of environmental institution and governmental administration department by applying administrative, legal, economic and standard to keep marine environmental in good condition. Marine environmental management mainly includes marine environmental planning, marine environmental quality management and marine environmental technology management. We argue that marine business companies such as fishing, transporting and oil corporations are key units in protecting environment. And they should take active role on marine

environmental quality management instead of being inspected passively. And setting up management evaluation system, and establish integrated environmental management evaluation assessment system by government, business companies and the third inspection party. The aim of the management evaluation is to strengthen and assess behaviors of business operations situation. To date, little research has been carried out to develop the method for marine environmental evaluation management, and this study will provide valuable insight to academicians and ocean business managers.

2 Discussion for Related Evaluation Theory

So far, most of the studies are focusing on the technology of environmental quality while pay little attention on the user of technology, that is business manager, and how well these technology are effected. Li Yanan, Sui Jixue, Zhan and Zhang studied the importance of marine environmental quality evaluation method in a macro level[3], Fu Hui, Sun Yinglan, Sun Lei and Wang Cui made research on the application of grey relational analysis in assessment of marine environmental quality[4]. While, Li Pengshan, Xie Genzong, Chen Xiaohong and Jiang Mingxin put forward the Application of numerical simulation in marine environmental impact assessment [5]. Liang Juanzhu studied the marine environmental quality evaluation and its visualize based on GIS(Geographic Information System)[6]. We believe, it is the business managers and their actions and their daily decisions influence marine environment most. Thus we put forward the re-assessment model based on production frontier of fuzzy DEA method on managerial aspect. Through the establishment of production frontier, business company may realize the situation face and progress made on pollution protection compare to rest of companies, and takes actions to reduce pollutions actively by improve management styles. The most obvious advantage of the method for this relative achievement method is to change the situation of cat-and-mouse game, and let business companies take the initiative in environment protection. Meanwhile, shift the administration role into both government and business companies.

There are different methods for assessing environmental protection performances of companies, and fuzzy DEA assessment is one of them. Generally, performance evaluation methods can be divided into two types: fuzzy DEA effective (including pessimistic fuzzy DEA effective and optimistic fuzzy DEA effective) and non-fuzzy DEA effective (including non-pessimistic fuzzy DEA effective and non-optimistic fuzzy DEA effective). For non-fuzzy DEA effective units, abundant management decision information can be obtained. But for fuzzy DEA effective units, especially pessimistic fuzzy DEA effective units, it can only be estimated as effective or weak effective and it can not be differentiated further. The information shortage of these fuzzy DEA effective units is obviously unsatisfied for valuator, especially even when many or all of the decision units being assessed as fuzzy DEA effective, DEA assessment information gained is very limited. Some studies adopt other non-DEA methods to re-assess DEA effective units.

Most performance re-assessment often adopts the assessment models either based on weight or estimated principle, and each decision unit has the same title in making

index weight. There is large difference for each company on environmental protection investment, political background and the location of operating coastal area. The “voice power” they hold is naturally different in deciding index weight. This may make part of DEA effective units become ineffective units and the number of DEA effective units decreases. The new method overcomes the shortage.

3 Assessment Method Based on Optimal Frontier

Decision unit DEA effective means assessed unit lies on effective production frontier constituted by present product possibility set. For the dots on the same effective production frontier, DEA can not differentiate them further. If a new production frontier is established and it may make assessed DEA effective units do not located on the frontier, then DEA effective unit can be distinguished. Following this idea, we put forward DEA effective unit re-assessment method based on optimal frontier and based on critical frontier.

For DEA effective unit, if a new production frontier is established and make it lie over the new production frontier. When DEA effective unit turns to non-DEA effective unit, it means the decision unit lie over the new frontier is more effective than original decision unit [7]. In order to establish more effective new decision unit, we borrowed thought of establishment for ideal solution from the multi-goal decision method -- TOPSIS, and established following virtual ideal decision unit:

Suppose there are n production decision units, each decision unit DMU_j has m input index and s output index:

$X_j = (x_{1j}, \dots, x_{mj})^T > 0, Y_j = (y_{1j}, \dots, y_{sj}) > 0, j = 1, \dots, n$. In order to make effective rank order for all units, establishes a new decision unit DMU_{n+1} , let decision unit's input be minimum value from all of the decision units, and the output is the maximum value of all of the decision units, that is

$$x_{i,n+1} = \min(x_{i1}, \dots, x_{in}), i = 1, \dots, m;$$

$$y_{r,n+1} = \max(y_{r1}, \dots, y_{rn}), r = 1, \dots, s$$

Define two production probable sets Z_m and Z_n constituted from m and n decision units, if $Z_m \subset Z_n$, and there is maximum one DEA effective unit $DMU_j \in Z_m$, in Z_n . Then, Z_n is optimal production probable set of Z_m

Define the effective frontier Z_m constructed by production probable sets of Z_n is named as optimal frontier of Z_n .

Obviously, new established decision unit is not worse than any decision unit of the original production possibility set, and it constitutes the new production probable sets with original decision unit becomes optimal production probable sets of original production possibility set. Take optimal production probable sets frontier -- optimal

frontier as standard to measure original decision DEA effectiveness. DEA effective unit re-assessment model based on optimal production frontier is:

$$\begin{aligned}
 & \min \theta \\
 & s.t. \sum_{j=1}^{n+1} \lambda_j X_j + S^- = \theta X_0 \quad \sum_{j=1}^{n+1} \lambda_j Y_j - S^+ = Y_0 \\
 & \lambda_j \geq 0, j = 1, \dots, n+1 \\
 & S^- \geq 0, S^+ \geq 0
 \end{aligned}$$

There are several ways to establish virtual decision unit. The operation situation of these virtual units is recognized relatively ideal.

4 Procedures for the Application of the Method

DEA effective unit re-assessment is proved effective and feasible for empirical analysis. The reason that most, even all of the decision units may assessed DEA effective in DEA assessment is apart from each decision unit confirm index weight from the benefit from itself, more over, DEA assessment is only a relevant assessment and not “absolute assessment”. That means the effectiveness for excellence or inferior from the assessed unit is relevant only with units in the reference set, and irrelevant with others. The characteristic of DEA can only use on relevant effective assessment may generate a question on the emergence of many effective units[8].

To solve the problem that DEA is only applicable for relevant effective assessment and hard to conduct “absolute assessment” for single company, and can not conduct “effective identification”, this study put forward the method of “reference set selection”. That is, administration institution conducts large scale of assessment and selects several companies as representatives for reference set for assessment later on. According to the method we provided the evaluation process is as following:

(1) Local environmental institutions organize marine companies to take part in the environmental management assessment. Set up assessment factors and give weight for each factor. According to the assessment system, ask specialist to score the companies behavior.

(2) According to the result of assessment, classifying companies into several layers as excellent, medium and relative inferior in terms of protection behaviors.

(3) Select several representative companies from each layer and make up reference set.

(4) Promulgating reference set without specific information of certain company, and use it as reference set for self assessment of any company, or take it as performance assessment for each other among companies.

(5) There is certain requirement for companies in different period, so the selection of reference set is a dynamic process needs to be repeat from (1) to (4) periodically or non-periodically, or take real assessment company as select unit and renew reference units continually[8].

5 Summary

Traditional evaluation of Absolute Progress Effectiveness (APE) on performance of management has been adopted ratio of total comparative index. This paper really reflects the effective progress based on the same reference in marine business companies environmental management, evaluates Relative Progress Effectiveness (RPE) depend individual relative progress index and individual valid exerting degree by DEA method, which is useful for marine business companies to improve the environmental effectiveness and take active role in environmental protection by management decisions. The model provided by this paper considers the final result of management efficiency, meanwhile, pays attention to the effective management effort for managers. The results show that the new model takes the referring period data as assessment base, receive individual progress indicators through the data comparison between base period and current period. To measure the relative progress level from overall point of view has provided the effective progress measurement under the similar references for companies. It is a useful instrument for stimulating companies to protect environment actively and improve the ability for sustainable development.

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Impact of Different Spatial Resolution Image on Landuse/Cover

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Abstract. In this paper, taken Landsat5/TM and SPOT5 images which were imaging in the close time as data source, the land-use map interpreted by Landsat5/TM and SPOT5 were obtained, respectively. To do some researches about LUCC and ecological effect, ecosystem services value was selected as ecological index. By analysis and contrast, it concluded that for the land use interpretation, different resolution images have little impact on the centralized distribution land use types, but it has great impact on scattered distribution land use types and washy land use types. Ecosystem services value evaluated by Landsat5/TM and SPOT5 showed that ecosystem services value obtained by SPOT5 image is lower than Landsat5/TM about 4.43×10^8 yuan. The difference was mainly caused by wetlands and grass. It hopes that the research can provide instructive suggestion for the future work.

Keywords: TM, SPOT5, Land use/cover change, ecosystem services value.

Introduction

Since 1990, in China, it put up a lot of researches on LUCC, such as multi-scale LUCC dynamics, LUCC effect factors, driving force and mechanism, ecological effect and model[1,2,3]. The above researches prompt the development of LUCC and make contribution to the related research.

On the basis of the status of LUCC research, chosen the different image data source, SPOT5 (2.5m) and TM (30m) as data source which have similar time and different spatial resolution, it got the land use map. From the view of ecological effect, chosen ecosystem service value as study index, it analyzed the difference of ecological effect evaluation caused by the land use from the different spatial resolution. By this research, it try to provide suggestion for the application of land use in the ecological effect evaluation.

1 Study Area

Kedong county is located in the middle of HeiLongJiang in China, between longitude $126^{\circ}01'$ to $126^{\circ}41'$ east and latitude $47^{\circ}43'$ to $48^{\circ}18'$ north, and its area is 2079.41 km^2 .

Kedong county falls into a temperate continental monsoon climate. Its mean annual temperature is 1.2°C, and annual precipitation is 525.1mm. Its accumulation temperature which is higher than 10°C for the whole year is 2300 ~ 2400°C. The period without frost is between 115~ 125day. Kedong county is in the edge belt of North Songnen Plain, North high and South low, and in geomorphology, it is in the transition zone of lesser Hinggan Mountains and Songnen plain and the geomorphology characteristic is Rolling Hilly. This county is in the center belt of Black Soil Area of Northeast China.

2 Materials and Methods

2.1 Land Use/Cover Data Acquire

The data in this study mainly include Landsat/TM image with resolution 30m in Jun. 20, 2005 and SPOT5 image with resolution 2.5m in Jun. 23, 2005. First with the ERDAS IMAGE 8.7 software, the imagery geometric correction was implemented. Then according to the image characteristic, such as tone, texture, shape, and integrating expert knowledge, field data and other related geographic maps, it set up the interpretation signs. With the help of above information, on the platform ArcView 3.3, the imagery were interpreted and get the landscape map for Landsat/TM and SPOT5 image. Reference to global changes study of land use classification system at home and abroad (including LUCC), with the study purpose, data sources and the characteristics of the study area, it divided the land use into 6 types. They are cropland, woodland, grassland, water, construction land and untilled land and 9 types of sub-land use types[4].

2.2 Evaluation on Similarity of Land Use/Cover

In order to evaluate the difference of land use/cover from TM and SPOT image, it used the index difference percent to do some evaluation. Its formula is:

$$a=(\sum A_i - \sum B_i) / \sum B_i. \quad (1)$$

Where a is difference percent; A_i is the area of land use i from SPOT image. B_i is the area of land use i from TM image.

In order to evaluate the similarity of land use/cover from TM and SPOT image, it used the index similarity to do some evaluation. Its formula is:

$$s = \sum A_i / \sum B_i. \quad (2)$$

Where s is similarity; A_i is the overlap area of land use i from SPOT image. B_i is the area of land use i from TM image.

2.3 Evaluation Method of Ecosystem Service Value

Ecosystem provides the resource and condition for human survival. Besides the substantial ecological products, it also provides more unsustantial ecological service. In 1997, Costanza first made the evaluation method of ecosystem service value in the world, and this made sure of the principles and evaluation methods of ecosystem service value from the scientific view. However, the conclusion of Costanza has some dispute. So in 2003, according to the Chinese fact, reference to the research result of Costanza[5], Xiegaodi made the ecosystem services value of unit area table for the China terrestrial ecosystem. In this paper, reference to the formula of Costanza and the theory of Xiegaodi, it evaluated the Ecosystem services value in Huinan county. The formula is as follows:

$$ESV = \sum_{i=1}^n P_i \times A_i. \quad (3)$$

Where ESV is ecosystem serv ice value of study area(yuan); P_i is ecosystem services value of unit area of land use type i (yuan/ha); A_i is the area of land use type i (ha); n is the amount of land use; A_i refered to the ecosystem services value of unit area table for the China terrestrial ecosystem made by Xiegaodi[6].

3 Result and Analysis

3.1 Characteristic of Land Use/ Cover Change

The difference of resolution in TM and SPOT image made the land use/cover different in study area. It reason is that the different resolution makes the image characteristic, such as tone, texture, shape et al. different, and the high resolution recognizes the interpretation signs much more easy ,so its precision is much more good. From the Fig. 1 due to the high resolution, SPOT5 can interpret the sporadic objects, so it can recognize the bare land and its area is 687.72ha, but TM can not recognize the bare land. Beside these, it can conclude that cropland is the main land use/cover, and area percent in both images is more than 70%. The forest is another main land use. According to the land use area and the and the difference percent, it concluded that the difference percents of paddy, forest, grass and wetland were much more higher, and it reached 92.56%, 33.95%, 45.74%,43.64%, respectively.

In order to further analyze the difference, it do the transition characteristic analysis of land use and get the similarity (Table 1).The total similarity in both images is 79.17%.the cropland and forest have the most high similarity, and its is 91.92%, 80.61% respectively. The imilarity of construction and water is secondly, its is 68.18%, 58.89% respectively. Paddy has the lowest similarity, only 3.17%. Wetland and grass are 19.14%, 20.63% respectively.

Table 1. Land use and cover transition matrix of SPOT5 and TM[m²]

TM SPOT5	paddy	dryland	Forest	Grass	Water	Construction	Wetland	Unusd land	similarity [%]
paddy	185.13	5022.81	46.53	67.05	292.41	28.08	191.79	1.17	3.17
dryland	33.39	136343.07	5843.25	2575.17	997.47	1631.43	674.01	234.99	91.92
Forest	0.00	2529.72	13387.95	482.13	15.39	6.66	160.56	26.19	80.61
Grass	28.17	5722.83	2057.94	2626.11	1040.40	79.74	1118.52	58.32	20.63
Water	152.73	2342.07	107.91	188.37	5141.07	17.64	690.39	89.19	58.89
Construction	0.00	1927.98	187.11	89.28	56.97	5410.80	13.77	250.29	68.18
Wetland	34.02	3499.92	629.01	881.91	1128.42	20.34	1504.62	28.62	19.47

According to data of Table 1, Fig. 1 and the discovery in the research, the difference resulted from below reasons. Crop land as the most largest land use type, its characteristic-centralized distribution, lager area is relative similar in both images, so it had little difference. In TM image, the paddy and wetland distributed in the region with abundant water source, and they had similar color characteristic, but color differed from the crop land. So it could divide the paddy, wetland and crop land into different type. In fact, in the SPOT image, it could find that most of paddy and wetland in TM image were crop land, the commission resulted from the water content in land use type. It lead to the difference of paddy and wetland in both images. Reference to the transition matrix of SPOT5 and TM, about 5022.81ha paddy and 3499.92 ha wetland whose percent is 86.08% and 44.1% in TM were cropland in SPOT. For the forest, it had much larger similarity, because it distributed in convergence, and in two kinds of image it can be easy to get the centralize forest. The reason of difference was that the sporadic forest, such as shelter belt, small distributed forest in cropland et al. can be recognized.The reason of difference in grass was the commission in grass and cropland. The water and construction was the steady region.

In a word, the land use/cover area and pattern getting from TM and SPOT5 did not show very obvious difference. The different resolution caused little effect on the extensive and centralized distributed land use type, and its main effect was on the land use type locating by the water and sporadic land use/cover.

3.2 Compare of Ecosystem Service Value

Fig. 2 showed the ecosystem service value which get from the SPOT and TM image according to formula. Ecosystem service value acquired from the SPOT and TM image was 27.07×10^8 yuan and 31.50×10^8 yuan, respectively. The Ecosystem service value acquired from the SPOT was low about 4.43×10^8 yuan in TM image. The difference was mainly caused by wetland and its change amount was 4.86×10^8 yuan. Besides, the grass change amount was 3.73×10^8 yuan. Wetland and grass were very

important in the ecosystem service evaluation. However, the low resolution made miscarriage of justice to the wetland near the water and increased the area. In addition, the grass of the valley in the TM was also existence of above phenomenon. All in all, low resolution TM image will bring effect on the ecosystem service value evaluation.

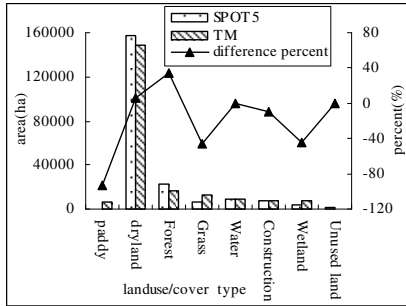


Fig. 1. Area of land use and cover

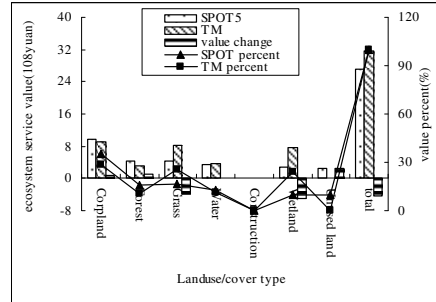


Fig. 2. Value and value change of ecosystem service

4 Conclusion

For the land use/cover acquired from TM and SPOT, by the analysis of difference and similarity, the different resolution caused little effect on the extensive and centralized distributed land use type, such as cropland and its main effect was on the land use type locating by the water which lead to the spectrum characteristic change such as paddy, wetland, grass, and sporadic land use/cover.

The Ecosystem service value acquired from the SPOT was low about 4.43×10^8 yuan than in TM image. The difference was mainly caused by wetland and grass change. All in all, low resolution TM image will bring effect on the ecosystem service value evaluation.

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The Testing Technology Research of Automotive Fastener Comprehensive Performance

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Abstract. Based on the detection requirements of automotive fastener, using the control method of the machine-electron-liquid, the closedown force of automotive fastener was researched, and realization method. The detection of closedown force need a simulated environment, the paper adopt hydraulic servo load simulation environment, using the proportion servo valve control hydraulic damper throttling to adjust the size of the damping force, and constitute closed servo control system, and realize simulating load control. The technology was used in actual testing, testing precision meets the requirement.

Keywords: Automobile, Automotive Fastener, Detection, Control.

1 Introduction

The automotive fastener is the perform institution about the door of car automatically open and close, and is an important the components of the electric lock of car, and is the core of fastener system. The early, the automotive fastener was used in the import of luxury cars. Along with the development of the automotive industry, now the switch of automotive door was adopted the automatic control electric switch at mostly car. Due to the above factors, the reliability of automotive fastener determines the safety of automobile driving, and determines the prevent-stealing performance at the time of parking. So the comprehensive performance test is very important at the production process of automotive fastener.

The basic functions of automotive fastener have, to open and close the door of car, and to prompt the open and close state of door. On some upscale passenger car, the functions was expanded, for the automotive close the door of car in driving, and the prevent-stealing and the prevent-rob performance, etc. Because the type of automotive fastener is quite many, and each kind of automotive fastener of car is different, although like this, they have some together character, these character are the micro-motor actuation, the conversion of manual and automatic using the inertia coupling to carry, all the interior has the closed arriving switch of car door and so on. The paper research the detection technology of automotive fastener comprehensive Performance, the important research the closedown force of automotive fastener and realization method, to satisfy the detection technology request of experiment and detection in the automotive fastener design and the production process.

2 The Request of Detection Technology on Automotive Fastener

The plane structure of automotive fastener was showed at Fig1, in the Fig1, the 1 is locking bar, the 2 is the mounting screw, the 3 is locking body, the 4 is motor, and the 5 is power-supply wiring mouth. General, The detection content of automotive fastener have the closedown force, the traveling displacement of locking bar, the resistance of switch, the voltage and electric current of micro-motor, and the position of mounting screw, etc.

The measurement range of experimental strength is 1N to 50N, the precision is $\pm 1\%$.

The measurement range of displacement is 0.1mm to 15mm, the precision is $\pm 1\%$.

The measurement range of electric current is 0.1A to 10A, the precision is $\pm 2\%$.

The measurement range of simulation load is 5N to 50N, the precision is $\pm 2\%$.

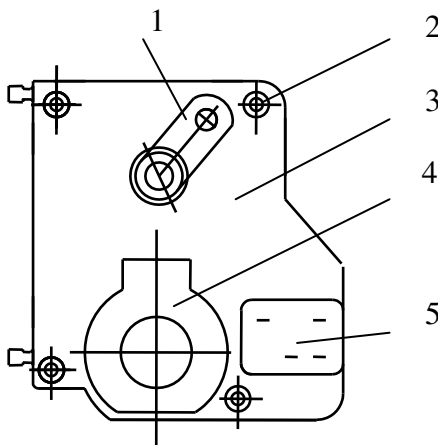


Fig. 1. The plane structure of automotive fastener

3 The Key Mechanical Structure of Testing Instrument on the Automotive Fastener

In the detection process for the automotive fastener, the detection of closedown force is very important the target of detection. The same time the detection of the wallop and pull-slip strength are very important detection project in the detection process for closedown force, but the detection of the wallop and pull-slip strength need a load simulation environment, this is the key technology, this technology require that the installment can provide a bidirectional passive load to automotive fastener at the time to pull and to press, to simulate the actual stress situation of automotive fastener. According to this request, the paper has designed a load simulator (Fig2), in the fig2, the 1 is the simulation pulling-staff, the 2 is the hydraulic system, and the 3 is the servo valve.

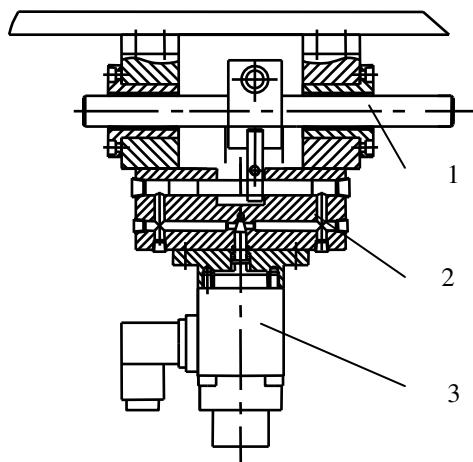


Fig. 2. The structure of load simulator

The innovation of load simulator is the hydraulic pressure servo damping mode, the adjustment of damping force size is using proportion servo valve to control hydraulic pressure attenuator, the closed servo control system was constituted by the adjuster with burthen the sensor, because the proportion servo system have the characteristic of high-speed response and the precise control, so the load simulator have the characteristic of control precision higher, the load characteristics better, speed of response quick, etc.

4 The Control Method of Automotive Fastener Detection Instrument

The automotive fastener detection instrument is the integrated control system which mechanical and electrical unifies, the complete transmission was completed using pneumatic control system, t, the load simulation was realized by the proportion servo valve when the open and close process of automotive fastener. The survey parameter of instrumentation is many, the function of showing and printing is complete, In order to satisfy the detection request, this system uses the industrial control computer to do for the hardware platform, and uses WINXP operating system as software platform, to realize the control. The software of control was wrote by the VB and VC, the Fig3 show the system structure diagram of control.

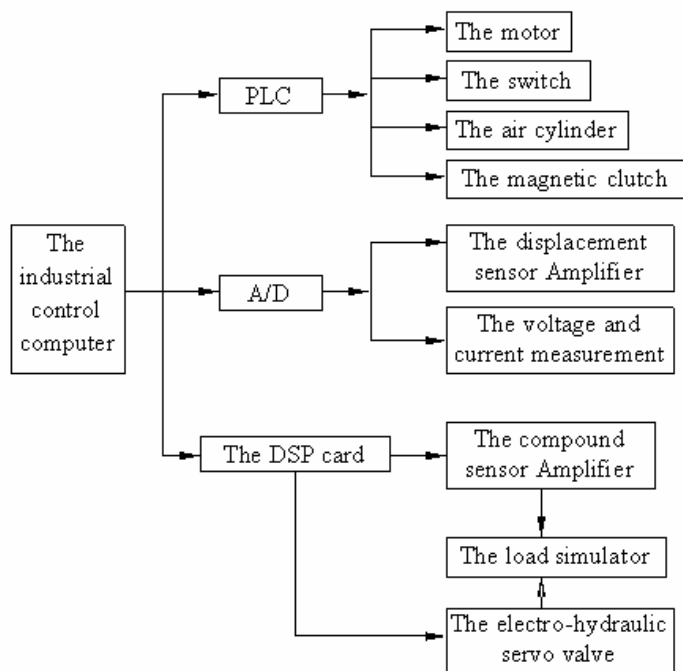


Fig. 3. The system structure diagram of control

The software of first floor data acquisition and real-time control were wrote by VC++ 6.0, and by VB procedure transfer as dynamic link storehouse form.

The software is as follows.

```

Fcs = ff + " * "
s0 = "@00RR00000001"
s00 = s0 + Fcs( s0)
MSComm1. Output = s00 + Chr( 13)
Dim t As Single
t = GetTickCount
Do
    DoEvents
    If ( GetTickCount - t) >= 5000 Then
        GoTo exit0
    End If
Loop Until MSComm1. InBufferCount >= 15
instring = MSComm1. Input
str1 = Mid( instring, 8, 4)
Text1. Text = str1
MSComm1. InBufferCount = 0
  
```

In the software, the Fcs is the character check code, the S0 is the Control word of Reads the mouth, the S00 is the command character of verification about the odd

number and even number, the read-out character was placed in character variable str1, and the state of in-out was read through the following character handling procedure, and the order should transmit the PLC through the mouth, to realize the entire detection automatic control.

5 Conclusion

The detection instrument of the paper research has the characteristic of control precision higher, the load characteristics better, speed of response quick, etc. the detection instrument was applied at the actual detection, the detection result show the obtaining data in stipulation scope, simultaneous, the detection content was comprehensive accurate and time quickly, the detection method advanced reliable.

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Design of Adaptive Controller for Micro Reactor Temperature Control

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Abstract. As the micro reactor has the characteristics of time varying and time delay, minimum variance adaptive temperature control method should be used on micro reactor. By estimating the parameters online by recursive least squares, we use this result in the calculation of generalized minimum variance controller in the current period. Act the control variable on the time varying system and use the system output temperature, then an adaptive control cycle is generated. The experimental results show that the proposed (minimum variance adaptive) controller has the characteristic of good adaptability and robust capability, no static error, linear heating up, anti-interference and no overshoot, and it can meet the expected requirement.

Keywords: micro reactor, adaptive, generalized minimum variance, temperature control.

Introduction

Micro reactor is the chemical production equipment, which can be used in fuel cells, catalytic reaction and other chemical fields. Because those fields have strict requirements on temperature, the key issue is to control reaction temperature[1]. As the micro reactor has the characteristics of time delay and system model changing with temperature, conventional control methods can not achieve good control effect in dynamic performance. We know self-tuning controller can be controlled by online setting parameter without establishing the precise model[2]. As a method in adaptive control field, generalized minimum variance controller can be used in various control fields. And for the unstable controlled object, non-minimum phase system[3] and systems with time delay[4], generalized minimum variance controller can provide good control effect and stability[5]. According to the control characteristics of micro reactor, adopt generalized minimum variance adaptive control, which do not need establishing accurate mathematical model and can overcome the system lag.

1 System Modeling

For the micro reactor has the characteristics of time delay , we select 2 seconds as the sample period, start heating at a stable room temperature with full power 1000 watts,

and keep heating until the temperature stabilizes again. The temperature response curve is shown in Figure 1.

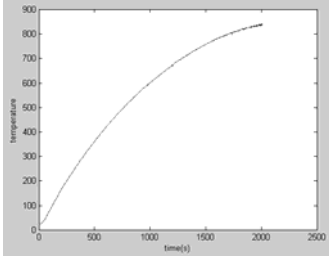


Fig. 1. Full Power Heating

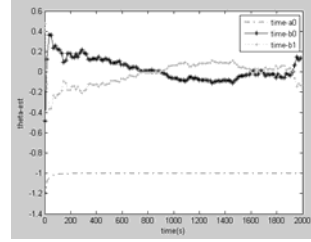


Fig. 2. Model parameter estimate experiment

According to CARMA, the system model can be described as follows:

$$A(z^{-1})y(t) = B(z^{-1})u(t) + C(z^{-1})w(t) \quad (1.1)$$

Combined with temperature curve (Fig. 1), we know it is a first-order inertial delay system, with 8 seconds lag time. And as the sampling period is 2 seconds, it can be determined the system is 4-order delay. The resulting temperature control model of micro reactor is as follows:

$$y(t) + a_1 y(t-1) = z^{-4} (b_0 u(t) + b_1 u(t-1)) + w_N \quad (1.2)$$

In identification, the initial data length is set as $N=10$, and system is 4-order delay ($d=4$), from which will the initial matrix for identification be set as follows

$$\varphi = \begin{bmatrix} y_5 & u_2 & u_1 \\ \dots & \dots & \dots \\ y_{14} & u_{11} & u_{10} \end{bmatrix}, y_N = \begin{bmatrix} y_6 \\ \dots \\ y_{15} \end{bmatrix} \quad (1.3)$$

The obtained curve(Fig. 2) of each parameter in full power heating shows the model parameters have time-varying characteristics.

2 Self-adaptive Temperature Controller

Using generalized minimum variance self-tuning controller with auxiliary model, can not only overcome the difficulty that non-minimum phase systems enable self-tuning regulator instability or produce large control signals, but also eliminate the steady-state error produced by control system, meanwhile, maintain the fluctuations of output value with a given value as small as possible.

2.1 Calculation of Generalized Minimum Controlled Variable for Micro Reactor

The introduced auxiliary variable $x(t)$ is expressed as the following equation:

$$x(t) = \Gamma y(t) - \Psi y_r(t-d) + \Lambda u(t-d) \quad (2.1)$$

Where, Γ , Ψ and Λ is the weight coefficient, $u(t-d)$ is the temperature control variable, $y_r(t-d)$ is the setting temperature. Controlled object model for micro reactor is expressed as follows:

$$y(t+d) = \frac{B(z^{-1})}{A(z^{-1})} u(t) + \frac{C(z^{-1})}{A(z^{-1})} w(t+d) \quad (2.2)$$

By the Diophantine equation [4], we have the following expression:

$$\frac{C(q^{-1})}{A(q^{-1})} = F(q^{-1}) + \frac{q^{-d}G(q^{-1})}{A(q^{-1})} \quad (2.3)$$

Put Eq. 2.2 and Eq. 2.3 into Eq. 2.1, and calculate the partial derivative about $u(t)$ of the variance of $x(t)$, then order it to zero to get the control variable. The expression of $u(t)$ is:

$$u(t) = -\frac{\Gamma G(z^{-1})y(t) - \Psi C(z^{-1})y_r(t)}{\Gamma B(z^{-1})F(z^{-1}) + \Lambda C(z^{-1})} \quad (2.4)$$

Where, $B(q^{-1})$ and $C(q^{-1})$ is the parameter for controlled system, $G(q^{-1})$ and $F(q^{-1})$ is required to calculate. From the above analysis, we know, the controlled object is the first-order inertial delay system with a four sampling period delay. That is $d=4$, $n_a=1$, $n_b=1$, and $n_f=d-1=3$, $n_G=n_a-1=0$. $F(q^{-1})$ and $G(q^{-1})$ is expressed as:

$$F(q^{-1}) = 1 + f_1q^{-1} + f_2q^{-2} + f_3q^{-3}, \quad G(z^{-1}) = g_0 \quad (2.5)$$

The following equation can be obtained by putting Eq. 2.5 into the Diophantine Eq. 2.3:

$$1 = (1 + a_1q^{-1})(1 + f_1q^{-1} + f_2q^{-2} + f_3q^{-3}) + q^{-4}g_0 \quad (2.6)$$

Transform Eq. 2.6 to find the relationship between the parameters f_1, f_2, f_3, g_0 and a_1 , that is:

$$f_1 = -a_1 \quad f_2 = a_1^2 \quad f_3 = -a_1^3 \quad g_0 = a_1^4 \quad (2.7)$$

The ultimate expression of $u(t)$ is obtained by putting Eq. 2.7 into Eq. 2.4:

$$u(t) = [\Psi y_r(t) - \Gamma a_1^4 y(t) + (a_1 b_0 - a_2)u(t-1) + (a_1 b_1 - b_0 a_1^2)u(t-2) + (b_0 a_1^3 - a_1^2 b_1)u(t-3) + a_1^3 b_2 u(t-4)] / (\Lambda + b_0) \quad (2.8)$$

According to Eq. 2.8, after determining the weight coefficients Γ, Ψ, Λ and the setting value $y_r(t)$, and identifying the system parameters a_1, b_0, b_1 , we can get the current controlled variable $u(t)$, so as to role it in the current identification system.

2.2 Weighting Coefficients of Auxiliary Variable

After determine the specific expression of the generalized minimum variance, we obtain the closed-loop system. The characteristic equation is as follows:

$$C(A\Lambda + \Gamma B) = 0 \quad (2.9)$$

To make the system stable, you must select a reasonable value of Λ and Γ to ensure closed-loop roots of the equation within the unit circle. Following the Eq. 2.9 and requirement of tracking set value in programmed temperature control, select $\Gamma=1$ and $\Psi=1$. Solve the closed-loop characteristic equation by keeping the solutions in the range $(-1, 1)$ to obtain the range of Λ .

System closed loop characteristic equation is as follows:

$$(1 - 0.9984q^{-1})\Lambda + (0.0062 - 0.0045q^{-1}) = 0 \quad (2.10)$$

In which solve the range of the third weighting coefficient Λ satisfy the inequality:

$$\Lambda < -1.1671 \text{ or } \Lambda > 0 \quad (2.11)$$

3 Simulation Experiments

In practice, micro reactor do temperature control following the pre-set different slope. In order to investigate the control effect of the adaptive controller, the process that keep temperature rising along different pre-set slope to holding temperature, is need to be simulated and verified.

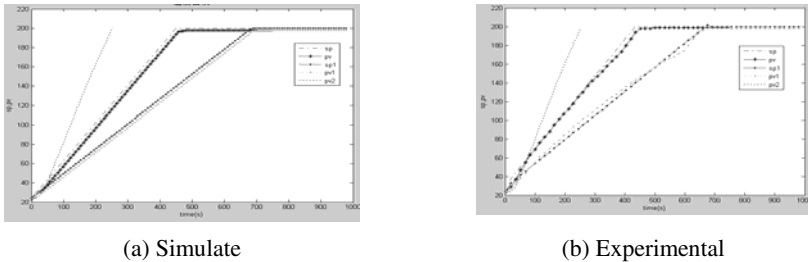


Fig. 3. 200°C Control results

We do simulation and the actual verification in two groups respectively. The simulation results display in a coordinates for comparison, shown in Figure 3(a). sp is the set temperature and pv is the output temperature in group one, sp1 is the set temperature and pv1 is the output temperature in group two, pv2 is the full heating output temperature. As showed in Figure 3 (b), generalized minimum variance temperature controller can be applied to heating control at any setting slope, with the characteristics of linear heating up, no static error, no overshoot.

Do interference tests by implementing two kinds of outside interference. It can be seen from the results that the actual system can re-tracked to the set value under the two types of disturbance and generalized minimum variance adaptive controller has strong anti-interference ability.

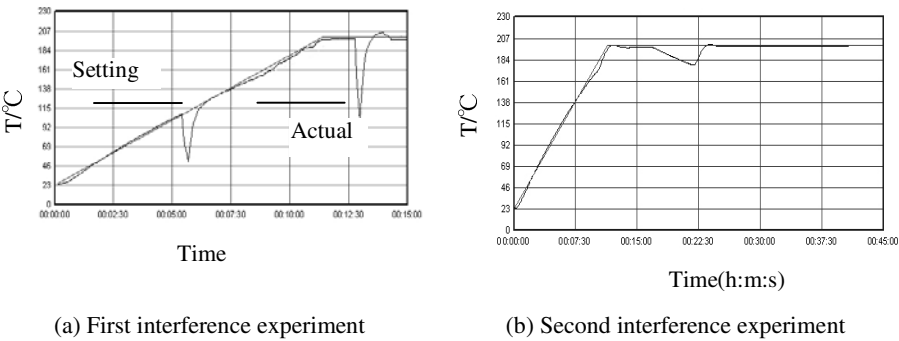


Fig. 4. Two kinds of interference experiment

The experimental test of micro reactor temperature programmed process is divided into 4 stage, the corresponding temperature and time settings as shown in Table 1.

Table 1. Program heating control parameters

stage	C1(°C)	C2(°C)	ts(s)	k
1	24	200	685	0.257
2	200	200	900	0
3	200	300	300	0.333
4	300	300	600	0

From the results shown in Figure 5, we know that it can be satisfied to apply micro reactor generalized minimum variance controller to multi-segment temperature program.

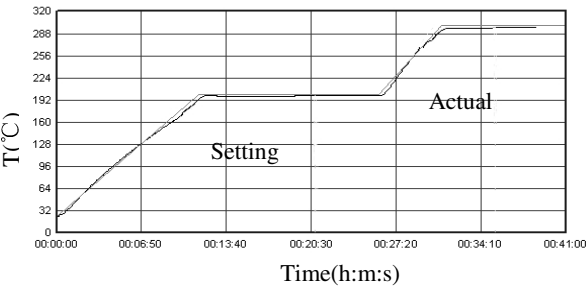


Fig. 5. Stage program heating curve

4 Summary

Based on the micro reactor temperature control requirements, a generalized minimum variance adaptive temperature control methods should be introduced. The key issue in the application is identified the coefficients of system model, to apply it to calculate the controlled variable of temperature controller. Experiments show that, the control method has the characteristics of first order inertia with time delay, meets the temperature control requirements of no overshoot, zero static error, linearity, and good tracking performance, multi-segment temperature program. In the experiments brought in typical interference, our system track to the set value fast, at most 120 seconds.

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The Design for the Developing Environment of Configuration Software

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Abstract. The developing environment of configuration software is the important tool for user to configure the monitoring screen. This paper mainly presents a detailed design for the configuration screen subsystem, and builds the system structure of developing environment. Users can build the configuration screen using the configuration tool of the developing environment. Under the running environment of the system, the project file loaded into memory is put into the screen for real time operation, which can reflect the image of the parameters and the coalmine field to meet the needs for the safety monitoring.

Keywords: configuration software, developing environment, screen configuration.

1 Introduction

In general, the configuration software acquires the real-time data from the interface of the on-site I / O devices and processes it as required. On the one hand, the acquired data can be displayed on computer screen by means of intuitive graphical; on the other hand, the controlling data can be sent to I/O device in accordance with the requirements of the operator to adjust its controlling parameters or execute real-time controlling. The real-time database is the kernel of the configuration software. Operation of data processing, I / O data connection, controlling database redundancy are done by the real-time database system. The monitoring real-time database and I / O drivers are the kernels of Graphical interface system. They communicate and share data each other through efficient internal protocols. The configuration software is composed of the developing environment and the running environment. This article focuses on the developing environment design for the configuration software of coalmine security monitoring (CSCM). It has important significance for the research and development of general configuration software.

2 Technical Scheme

For the specific project requirements of CSCM, the developing environment system is divided into seven parts. The relationships between the various parts are shown in Fig. 1.

Screen Configuration: is responsible for drawing monitoring screen and displaying monitor dynamic screen, is also the interface for operator.

Variable Manager: is the “point” for deploying project management; it is divided into analog and digital variable points; the variables are associated with the data area in device and the screen is associated with the variables.

Device Manager: is used for deploying the communication channel and the device of the project. management.

Device driver: is used to deploying the different device communication protocol. It executes the reading and writing between the monitoring system and the communication devices through a variety of device drivers. The device driver is loaded by Dll mode. Dll interface is provided by the system. Users can also develop their own device drivers for new equipment.

Database Access: accesses historical data interface.

Script Manager: controls the VB script execution in the configuration project, including a script editor.

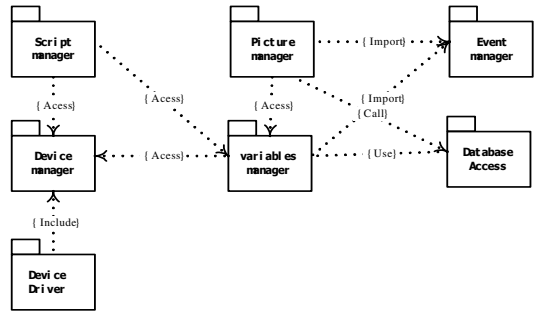


Fig. 1. The system structure of the developing environment

3 The Design of Graphic System

The current methods of graphical interface design can be roughly divided into two categories: the pixel-based methods and the vector method.

In the vector method, the points coordinates of vector graphic is stored so the vector data is small, very convenient either to enlarge or minify the graphics. Further more, there are not distortion and deformation for the changed graphics. It has the advantage of sharing relatively small storage, which is very suitable for real-time monitoring system.

The monitoring Configuration software uses the vector method to complete screen configuration. An object of CGraph class represents a system screen, which provides management and operation for the interface screen. An CGraph object contains several objects, and each CDrawObj object represents a graphic primitive. DrawObj class is designed with the pattern of combination, that is, a CDrawObj class can contain a CDrawObj objects array. In this design, users can achieve the function of primitive combination. In the configuration software, every primitive is a subclass derived from CDrawObj class. Thus, in view of the class application, as long as the

object contains one CGraph object, it can do all sorts of graphics screen operation. Cgraph class is shown as Fig. 2.

Animation effect is achieved mainly through the dynamic changes of bitmaps' location, size, color, etc. Dynamic Change or not is mainly according to whether the conditions set by the user are met. These conditions are generally associated with the system variables, including the composition of the system variable formula, or a script containing the system variables.

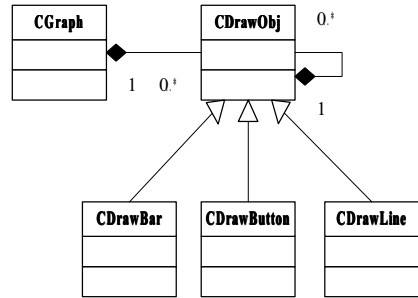


Fig. 2. CGraph class

3.1 The Primitive Interface and the Design of Primitive

If it needs to design a new primitive, users can build a new CDrawObj class and build its interfaces to make it. The new variables can be added to it, too. CdrawObj class provides the following interfaces:

```

CDrawObj& operator=(CDrawObj& drawObj);
virtual CDrawObj* Clone(void);
virtual void Serialize(CArchive& ar);
virtual BOOL OnAttrib(void);
virtual BOOL OnAttrib(CPropertySheet& sheet);
virtual void Draw(CDC* pDC);

```

If there are new member variables added to the class a, the following interfaces need to be rewritten.

```

CDrawObj& operator=(CDrawObj& drawObj);
virtual CDrawObj* Clone(void);
virtual void Serialize(CArchive& ar);
virtual BOOL OnAttrib(void);
virtual BOOL OnAttrib(CPropertySheet& sheet);

```

If there is no new member object, the primitive interface can be written as following:

```

virtual void Draw(CDC* pDC);

```

After the completion of the class code, it is needed to register the new primitive in CMainFrame:: OnCreate function. The registration method is to add the following code:

```

CDrawObj::RegisterClass("Name of Primitive", RUNTIME_ CLASS (CDrawXXX));

```

3.2 The Selection of Graphic Objects

Editing graphic objects must first select the object that users want to edit. Each graphic object has a certain range as its selected region. For example, the rectangle size of the object is the selected range. The key of graphic object selection is to determine the boundaries of the object rectangle and to determine whether the mouse

point is within the range of the graphic object. The object rectangle refers to the smallest external rectangle of the graphic object. The boundaries of any graphic object can be calculated from its rectangular feature points. Specifically, it is to determine whether the distance between mouse position and the boundaries of graphic objects belong to the scope of a given recognition accuracy. In this software, the recognition accuracy can be changed. There are several methods to select graphic objects, here are two ways: the point selection method and the range selection method.

(1) The point selection method

In the software, the basic idea of mouse point selection is that: first, set a flag for the selected symbol; then, determine whether the mouse clicks are in the scope of the object rectangle. If it is, the pointer of the graphic object will be storied into the list of the selected graphic object. The process is shown as Fig. 3.

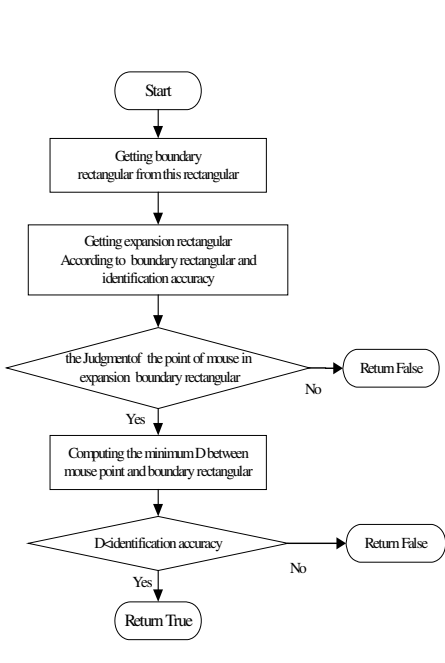


Fig. 3. The process of the graphic object pointer being storied into the list of the selected graphic object

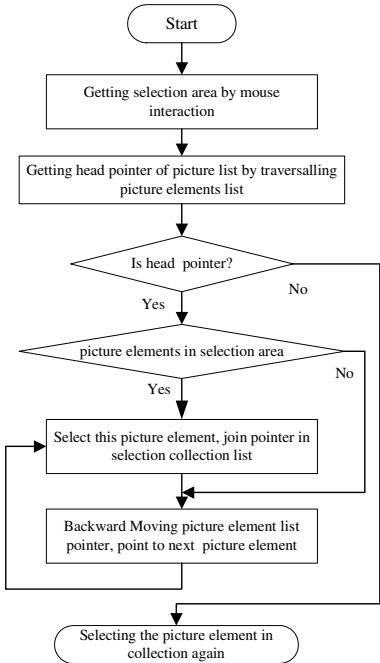


Fig. 4. The program flow chart of selecting graphic objects by area selection method

(2) The area selection method

The area selection method refers to the user pressing the mouse left button and moving in the view to select the graphic objects in the area. The left button has been in the state of pressing during moving. Once the left button is pressed, that means a rectangular area selected is starting. When the left mouse button is released, a closed rectangular is determined by the starting point and the end point. If the smallest external rectangle of a graphic object and the selected rectangular area has any

intersection, the object is selected, and the pointer of the graphic object will be storied into the list of the selected graphic object. The program flow chart of selecting graphic objects by area selection method is shown in Fig. 4.

3.3 The Scaling of Graphic Objects

Any a primitive has some handles. The handle in the program is defined as the small rectangle. The scaling of graphic objects is achieved by dragging these handles. If the primitive is selected, these handles will be apparent. For irregular polygons, the handles are the polygon vertexes. While others primitives have the fixed eight handles, respectively, corresponding to the four mid-points of the sides and the four vertices of the rectangle bounding.

When the handle of a side is dragged, it will change the side position and the lengths of the two vertical edges. It will change the two sides' location and length intersecting with the vertex point at the same time. In the software, the different location of a handle is marked by defining an integer variable, nHandle.

The mouse events involved in the process of scaling primitive is WMMOUSEMOVE. When the mouse moves on a selected element, the selecting tool will determine whether the coordinates of the mouse are within the small rectangular area of the handle. If true, the cursor will be adjusted to the appropriate shape, and the software enters the scaling state.

3.4 Graphic Composition and Decomposition

In the process of editing primitive, it is needed to move or delete several primitives sometime, which can be done by the graphic composition and decomposition. These operations can be achieved by CCombineObj class, which is derived from CDrawMeta class. After a few primitives being selected, select the "Combination" command to assemble the primitives. Then, these primitive will be used as an object for users. When selecting graphic combined, selecting the "BreakDown" command, you can decompose the graphic into a number of original primitives. Combination functions can be used multiple times. The combination of graphics can be further combined with other primitive to produce a larger combined graphic.

3.5 To Build and Delete the Primitive

Users can change the graphics screen list, m_objects. The process to add graphic objects is that: after selecting the graphic tools, if the mouse is clicked, the graph corresponding to the tool is built. Then, the graphic object is added to the end of m_objects.

m_obj.AddTail(pObj); //pObj is a CDrawObj class, the graphic object pointer.

The process to delete the graphic object is that: after finding the selected object in m_objects, then delete it. The program code is:

```
POSITION pos=m_obj.Find(pObj) ;  
if(pos!=NULL)  
m_obj.RemoveAt(Pos);
```

3.6 To Copy, Cut and Paste the Graphic Objects

In the developing environment of the system, an intermediate variable list is generated to save, copy or cut the graphic objects. It is needed to empty the list before copying and cutting the objects. Then, copy the objects to the list. For the cutting function, it is also needed to remove the selected graphic object from the graphic list, to free its memory space at the same time. During the pasting time, the object is achieved from the intermediate variable, and then is added to the graphic list. Of course, it is not needed to delete the intermediate variables, because the same pasting is maybe done more than once.

3.7 The Graphic Library Management

The graphic library is often used to manage and save the primitives of repeated use, and can provide the function of adding the primitive to the current screen.

There is a list of the primitives in the graphic library. When users add a primitive to the library, the developing environment saves the address of the primitive into the object point exposed to the library, then sends window message to inform that there are primitives waiting for entering the library. When mouse clicks on the library, the library will make a copy of the primitive and add it to the list of the library. At the same time, the showing position of the primitive is set in accordance with the mouse current location.

The process adding the primitive to the edit screen from the library is in contrast to the process of saving the primitive into the library. When mouse clicks on a primitive in the library, the library saves the address of the primitive into the object point exposed to the edit screen, then sends window message to edit screen to inform that there are primitives waiting for entering. When mouse clicks on the edit screen, the screen will make a copy of the primitive and add it to the list of the screen. At the same time, the showing position of the primitive is set in accordance with the mouse current location in the screen.

4 Conclusions

This paper builds the development environment structure of CSCM, and presents a detailed analysis of the screen configuration subsystem. In the graphic interface design based on primitives, it uses the vector graphics technology for the screen configuration. Animation is achieved by changing the graphic's location, size and color to simulate the devices on-site. This paper also talked about the graphic primitives' selection, scaling, adding, deleting, decomposition, composition and the graphic management, etc. It makes some technical basis for the general configuration software.

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Artificial Neural Network Based Modeling of Glucose Metabolism

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Abstract. Neural network the number of hidden neurons for the network performance has a significant impact, usually for a specific problem, there is no way to determine a certain level in the end should be hidden together the number of neurons, the general test Way through many experiments to achieve the desired effect. The improved BP algorithm, the establishment of the BP neural network diagnostic model, tested its correct diagnosis was 100%, BP model diagnostic accuracy was 95.39%. The results show that the BP neural network suitable for solving the complex problem of disease diagnosis.

Keywords: Neural network, BP algorithm, glucose metabolism, PET.

1 Introduction

Since the world's first since the birth of a fuzzy controller, fuzzy control has made a large number of applications, especially for those who delay, nonlinear strong, rough or difficult to obtain models of complex mathematical models of industrial objects, the application of fuzzy control is very successful. The 80 years since the 20th century, artificial neural network research set off a new upsurge, and made considerable progress, causing widespread concern in academic circles. In 1987, B. Kosko first to fuzzy theory and neural network theory organically and conducted a systematic study, since then, fuzzy neural network theory and its application has been rapid development, many experts and scholars has become a hot research topic.

At present, the practical application of artificial neural networks, most of the neural network using BP neural network models and their variations. It is also the core of the network before, reflecting the essence of artificial neural networks. Have shown: from a single hidden layer and the non-linear function consisting of excitatory MLP network is the general classifier, that is, such a network can approximate any complex decision boundaries. But has not been a good way to determine the BP network

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hidden layer neuron number, neuron does not result in correct classification of too little, too much will lead to overfitting, so that the generalization ability of the network down. Over the years, many people are relying on experience or trial to determine, this traditional machine learning methods - decision tree algorithm combined with the BP network, classification tree by mapping to the hidden layer neural network structure, and thus determine the hidden layer The number of neurons.

Traditional methods of statistical analysis the existence of multiple testing, dimensional problems, depend on many issues such models, in which each additional dimension of distress is a gene locus, the required sample size fold increase exponentially, even if a larger sample size, it is may be too few observations in some combination of genotypes or absent, and this will lead to interaction effects of parameter estimation is not accurate. This relatively sophisticated neural network learning algorithm to solve the above problem provides a new way. Neural network models of brain systems by mimicking biological processing can be achieved between the input and output to any high-dimensional mapping of nonlinear optimization, in the face of complex data relationships, the traditional statistical methods ineffective or can not achieve the purpose, the use of neural networks models are often able to receive good results. Therefore, the neural network is introduced to the etiology of complex disease has a broad prospect.

2 BP Network Structure

BP network typically consists of input layer, output layer and several hidden layers, the structure shown in Figure 1, BP network nodes each composed by a number, each node represents a neuron, the upper and the lower node weight between nodes connected by the same level no connection between nodes, weight representative of the size of a node on the node to the next level, the degree of influence, hidden layer and output layer weights between nodes assigned reflect the mapping between input and output relationship.

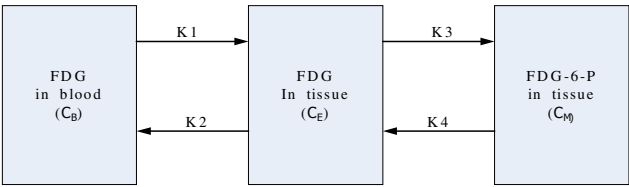


Fig. 1. FDG metabolism in the three compartment model with four parameters

For the input signal to go through the input layer, pass forward to the first hidden layer nodes, through the role of function (or activation function), then the output of the first hidden layer to the next hidden layer node point, after all the hidden layer after layer, the signal to the output layer nodes.

BP network model is the height from input to output nonlinear mapping, for sample collection, input and output between the theoretical existence of a mapping

function, BP network learning goal is to use the network model to achieve the estimated mapping function.

Neural network algorithm basic idea is based on gradient descent, based on the training process by the forward propagation and back propagation component, the purpose is to adjust the weight between nodes coefficient of the network's output vector and the known training samples vector error between the desired requirements. In the forward propagation process, the input information from the input layer through hidden layer gradually processed and transmitted to the output layer. If the output layer has not been the expected output, that is the actual output value and large error between the desired output value, then transferred back propagation, the error signal back along the original connection path, and according to the size of the error to adjust the layers of Results point of asking the right values, so that the network error becomes smaller toward the correct direction of change, according to this rule cycle, until the entire network error converges to within the specified date value.

PET can be any part of the body non-invasive monitoring of physiological and biochemical processes, so in many areas of life sciences has been widely used. The principle is that intravenous injection of radionuclides (such as ^{11}C , ^{13}N , ^{15}O , and ^{18}F) of the tracer, positron radionuclide release and a negative electron binding the body, resulting from Ya-ray annihilation. PET scans obtained in vitro by positron emission sources on the location and density of the three-dimensional images, which calculate the various parts of the body of local blood flow, material transport rate, metabolic rate and the rate of receptor binding parameters, in order to reflect organizational functions activity changes.

Under normal circumstances, occurred in the mitochondrial oxidative phosphorylation in response to glucose into energy is the rate-limiting step, and cerebral hypoperfusion, the aerobic oxidation of reduced, anaerobic glycolysis increased. Anaerobic glycolysis capacity is low, have to consume large amounts of glucose to maintain brain energy metabolism homeostasis, when glucose uptake in human brain tissue by the blood of a rate-limiting step. Therefore, the brain cells of glucose uptake in the hypoxic brain injury and plays a key role in the anti-injury. Changes in glucose uptake is to evaluate the effects of various treatments key; for exploring the regulation of glucose uptake capacity factors are also important.

Chemical method is to measure the enzyme content of the classical method of glucose. Animal brains were removed, weighed by tissue homogenates, protein, centrifuged, the supernatant obtained. Determination of application hexokinase glucose content in the supernatant. The Principle of glucose in the hexokinase reaction is a phosphate to glucose, which is a glucose-phosphate dehydrogenase under the action of stone formation 6 - phosphoric acid, while the NADP reduced to NADPH. NADPH at 340nm are characteristic absorption peak, so that by drawing the standard concentration of glucose on NADPH absorbance calibration curve can be derived glucose concentration in the supernatant. Organized according to the quality used to calculate tissue glucose. Changes in tissue glucose content of glucose uptake and metabolism by the impact of such links, combined with glucose uptake of glucose metabolism can be analyzed adjustments.

3 Model Design

Application of BP neural network model of multi-gene interaction between the modeling process is as follows: First, sample collection and disease genotype or phenotype and other information; and then input to the designed neural network model for repeated training until the network convergence (that the expected training error), in the training process may be appropriate to use certain techniques to make the training of the fastest network, error, and model the best.

1) Training samples to determine

Training samples should be derived from research in general a random unbiased sample. Sample size should be suitable for training, speed training content over the General Assembly created Pianman, training results over the training set approximation ("over learning"), makes the promotion of the reduced network model, and a large sample collection greatly increased the workload; content is too small representation is not enough cause to make the training results were not reliable. In general, the more complex the structure of the network required more samples, the simpler the structure, the required samples can be reduced accordingly.

The initial weights of the network selection is another important issue. If the inappropriate choice of initial weights, training time is too long may cause the error plane into a local minimum, or even training does not converge. Typically, according to the role of function Sigmoid-type features in the initial weights should be selected so that each node as the absolute value of the weighted input is less than 1, but not too small, where K_i is connected to the neural element node all the previous layer i the number of nodes, thus to some extent to prevent the start of network training role in neuronal function, the saturation zone.

2) Variable value of the normalized

Need for the role of the characteristics of function samples normalized. For example, taking into account the role of function Sigmoid type 0 and 1 in the vicinity of the change is very flat, the network training speed is relatively slow, typically the raw data normalized to $[0,1]$ or $[0.2,0.8]$ interval, which can speed up the the network training speed.

Determine the network layers of hidden layers and hidden layer nodes for neural network modeling is the most important issue. In general, three BP networks can be resolved between the input and output of any nonlinear mapping. The provisions of hidden layer nodes, the network's input layer with n neurons, the hidden layer nodes is generally not more than $2n + 1$. Otherwise, you will most likely lead to the promotion of neural network model becomes worse.

Hidden layer nodes in the network selection, the classic approach is determined by numerical experiment: for a given number of hidden layer nodes different neural networks, respectively, the network training and generalization testing, to continue to improve the accuracy when the training stop when the test error begins to increase training for small and promote optimal performance accuracy of the network corresponding to the hidden layer nodes for the optimal hidden layer nodes.

4 Conclusions

Compared with traditional statistical methods, neural network model of the interactions between multiple genes, have unparalleled advantages. Most of the traditional analysis methods are based on the interaction of some models, such as multivariate regression analysis based on the majority of the multiplicative model, so the analysis on the premise that the information must comply with the multiplication model for interaction. Verified with the traditional method of hypothesis in different ways, neural network model is obtained by studying samples of the internal variables of the question, the law, can the relationship between variables in the absence of any prior knowledge of the premise, not all kinds of interference and the mixed influence to obtain a more realistic and rich relationship between input and output, to analyze complex interactions factor Q. Therefore, the study of complex diseases, neural network analysis of etiology, especially in-depth study of a gene interaction in genetic ways and means of application of great significance and broad prospects.

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The Monetary Multiplier Effect of Electronic Money—Co-integration Test Based on Quarterly Data of China

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Abstract. This paper using co-integration theory to analyze the monetary multiplier effect of electronic money in China based on the quarterly data of 1994-2010. The results show that there is a stable relationship between the development of electronic money and monetary multiplier in the long term. And electronic money has an amplification effect on monetary multiplier. Then we propose several policy recommendations to promote the development of electronic money.

Keywords: Electronic money, Monetary multiplier, Co-integration test.

1 Introduction

As a new form of money, electronic money develops rapidly since it was born. It has had great effects on both of traditional money theory and the real economy, and the effect on money supply is particularly significant. Between the two factors that determine the money supply, monetary multiplier is more important than base money. Monetary multiplier reflects the quantity depending relationship between base money and the gross of money supply. In the traditional money theory, we can see that the central bank can control base money directly or indirectly. So base money is an exogenous variable for the central bank. While monetary multiplier is an endogenous variable, central bank can't control it easily. Electronic money enhances the endogeneity of monetary multiplier, which makes monetary multiplier more complicated and increases the difficulty of money supply controlling. Therefore, both of understanding the monetary multiplier effect of electronic money correctly and mastering the law of monetary multiplier varying accurately are very important for the central bank to use the monetary policy flexibly and improve the effectiveness of monetary policy.

2 Narrow Monetary Multiplier and Broad Monetary Multiplier

According to the traditional money theory, money supply is determined by base money and monetary multiplier, which can be written:

money supply = base money $\times$ monetary multiplier. Base money is the basis on which the entire commercial banking system creates deposit money. Monetary multiplier reflects the expansive relationship of base money and money supply quantitatively. It shows that different levels of money supply follow different monetary multiplier, so the impacts on money supply are also different.

On the basis of the current division of currency in our country, money supply is divided into three levels: M_0, M_1, M_2 . Among them M_0 = Circulating cash (C), $M_1 = M_0$ + Current deposit (D), $M_2 = M_1$ + Total fixed deposit (TD). And M_1 is called money supply in narrow sense, M_2 is called money supply in broad sense. Suppose B as base money, then we can get narrow and broad monetary multiplier: m_1, m_2 , which are determined by the formulas respectively: $m_1 = \frac{M_1}{B}$, $m_2 = \frac{M_2}{B}$.

3 Empirical Analysis of Electronic Money's Impact on Monetary Multiplier

A. Variables and Data Selection

Electronic money affects the velocity of money by the substitution effect of cash, deposit and other money. Early in the development of electronic money, it substitutes the cash more than other forms of money. But with the constant development of electronic money, when it develops to a certain extent, electronic money will reflect more on the substitution effect of deposit, then will gradually on liquidity weaker currency instead. According to the development characteristics of electronic money, we designed empirical indicators to measure the electronic money's substitution levels for cash, deposit and high-level degree money to study the electronic money's affections on two levels of money multiplier. The dependent variables of empirical analysis are m_1 and m_2 , and the explanatory variables are Cash leakage ratio (K_t), Money supply liquidity index (ML_t) and Financial interrelations ratio (FIR_t).

The following will describe the meaning and nature for the selection of these three indicators.

1) K_t is the ratio of cash to current deposit, that is, $K_t = \frac{C}{D}$. Cash leakage ratio is

a very important factor that affects monetary multiplier, meanwhile, and the indicator also reflects the substitution effect of electronic money to cash in the early development period. K_t will drop due to the emergence of electronic money. 2) Money

supply liquidity index $ML_t = \frac{M_1}{M_2}$, it mainly measures the proportion of narrow

money supply to broad money supply. To some extent, it reflects the substitution effect of electronic money to higher liquid asserts in the early stages of development.

ML_t will also drop due to the emergence of electronic money. 3) Financial interrelations ratio FIR_t refers to the ratio of the value of a country's total financial assets (TFV) to the economic aggregate. Also, we use the sum of Broad money (M_2), Securities (L) and Financial institutions' loans (F) and the gross national product (GDP) to represent TFV and economic aggregates respectively. That is
$$FIR_t = \frac{TFV}{GDP} = \frac{M_2 + L + F}{GDP}$$
. When the development of electronic money to a

certain size, the electronic money not only substitutes cash, current deposit and other highly liquid money, but also promotes the higher liquid assets transform into less liquid assets. We can judge the substitution effect of electronic money to analyze the possible impact on the monetary multiplier when electronic money is fully developed. By analyzing the relationship of these indicators, m_1 and m_2 , we can measure electronic money's influence on monetary multiplier in different stages of development.

This article's sample space is from Q1 1994 to Q4 2010, a total of 68 samples. Meanwhile in order to weaken the degree of co-linearity and heteroscedasticity between these indicators in the empirical process and smooth the data, the paper took the logarithm of these five indicators. Time series of quarterly data are required seasonal adjustment before empirical process to reflect the objective laws of economic events' motion. So, in this paper, we use Eviews5.0 software and Census X12 seasonal adjustment method to adjust the quarterly data.

B. The Establish of Co-integration Model

Before the co-integration test, we should test the stability of these indicator variables to avoid the appearance of "Spurious Regression". Unit root test is the common method that used to test the stability of variables, which test the existence of the unit root of the original sequence. If there exist a unit root, the original sequence is not stationary. In this paper, we use the ADF unit root test method, unit root test results of the original sequence and the first difference sequence are as follows:

Table 1. ADF unit root test results of variables

[Variable]	[Method (C,T,K)]	[ADF Statistic]	[1% Critical value]	[Conclusion]
[m_1]	[c, t, 0]	[-2.679253]	[-4.100935]	[nonstationary]
[m_2]	[c, t, 0]	[-2.514127]	[-4.100935]	[nonstationary]
[K]	[c, t, 0]	[-0.993404]	[-4.100935]	[nonstationary]
[ML]	[c, t, 5]	[-4.063706]	[-4.113017]	[nonstationary]
[FIR]	[c, t, 1]	[-3.692384]	[-4.103198]	[nonstationary]
[Δm_1]	[c, 0, 0]	[-8.734688]	[-3.533204]	[stationary]
[Δm_2]	[c, 0, 0]	[-8.466379]	[-3.533204]	[stationary]
[ΔK]	[c, 0, 0]	[-8.152358]	[-3.533204]	[stationary]
[ΔML]	[c, 0, 3]	[-4.657037]	[-3.538362]	[stationary]
[ΔFIR]	[c, 0, 1]	[-9.336260]	[-3.534868]	[stationary]

Note: Test method indicates if there was constant C, time trend term T and lag order K in the ADF test; Δ means first difference; Lag order selection following the AIC criteria.

The unit root test results can be seen from the table. Under the 1% significance level, the absolute values of ADF test of the original sequence are less than the absolute critical value. And this indicates that the original sequences of all variables exist unit root, they are nonstationary. But the absolute ADF test values of their first difference sequences are all greater than the absolute critical value of 1%. And this indicates that the first difference sequences of all variables doesn't exist unit root, they are stationary. So we can judge that the indicators all meet the premise for co-integration test.

First, we establish the co-integration test of the narrow monetary multiplier m_1 and the three indicators. The first step, establish a regression equation:

$$m_1 = \beta_0 + \beta_1 K + \beta_2 ML + \beta_3 FIR + \mu_t \quad (1)$$

The estimated regression equation is:

$$m_1 = 0.282453 - 0.538067K - 0.272914ML + 0.105264FIR \quad (2)$$

$$t = (2.667946) \quad (-20.56965) \quad (-2.411839) \quad (2.829721) \\ \bar{R}^2 = 0.961845 \quad F = 563.9972 \quad DW = 0.572012$$

If given a significant level of 2%, the t values of each coefficient are all more than the critical value $t_{0.01}(64) = 2.3879$. Therefore, the null hypothesis of each coefficient can all be rejected, which means that the estimated coefficients are significantly. The values of F and $\bar{R}^2$ show that the model fits very well.

Then, we do unit root test for the residuals ($\hat{\mu}_t$) of the equation (2). The estimated residuals can be obtained by the regression equation:

$$\hat{\mu}_t = m_1 - 6.334623 + 1.830045K + 1.947523ML - 0.340825FIR \quad (3)$$

The ADF test value of $\hat{\mu}_t$ is -3.037640, so we can reject the null hypothesis at the 1% significance level and ensure that $\hat{\mu}_t$ is a stationary series. And this can verify that the co-integration relationship is correct and reflect that there exist a long-term equilibrium relationship between the narrow monetary multiplier and the measurement indicators.

Secondly, we establish the co-integration test of the broad monetary multiplier m_2 and the three indicators.

Similarly, we can obtain the estimated regression equation:

$$m_2 = 0.280612 - 0.538145K - 1.274878ML + 0.105148FIR \quad (4)$$

$$\begin{aligned} t &= (2.647940) \quad (-20.55227) \quad (-11.25541) \quad (2.823807) \\ \overline{R^2} &= 0.973628 \quad F = 825.5246 \quad DW = 0.594636 \end{aligned}$$

If given a significant level of 2%, the t values of each coefficient are all more than the critical value $t_{0.01}(64) = 2.3879$. Therefore, the null hypothesis of each coefficient can all be rejected, which means that the estimated coefficients are significantly. The values of F and $\overline{R^2}$ show that the model fits very well.

And then, do unit root test for the residuals ($\hat{\mu}_t$) of the equation (4), the estimated residuals can be obtained by the regression equation:

$$\hat{\mu}_t = m_2 - 6.334466 + 1.83012K + 2.947781ML - 0.340743FIR \quad (5)$$

The ADF test value of $\hat{\mu}_t$ is -3.134787, so we can reject the null hypothesis at the 1% significance level and ensure that $\hat{\mu}_t$ is a stationary series. And this can verify that the co-integration relationship is correct and reflect that there exist a long-term equilibrium relationship between the narrow monetary multiplier and the measurement indicators.

4 Conclusions and Policies Proposals

Equation (2) and (4) is the co-integration equations of the two monetary multiplier models, which reflects the long-term equilibrium relationship between variables. In the long term, the relationship between m_1 and three explanatory variables is consistent with the relationship between m_2 and three explanatory variables. That is, they are negatively correlated with K and ML , m_1 and m_2 decreases with K or ML increasing. They are positively correlated with FIR , m_1 and m_2 increase with FIR increasing. K and ML reflect the substitution effect of electronic money to cash and current deposit in the early development period, FIR reflects the substitution effect of electronic money to illiquid financial assets in the later development period. It can be seen that, in the early development period, electronic money mainly substitutes the cash which will lead to the decreasing of K , and the proportion of cash, current deposit and other highly liquid money in the broad money decreases which will lead to the decreasing of ML , so electronic money will increase the monetary multiplier. In the later development period, when electronic money is fully developed and substitutes higher level of money can still play a role in increasing the money multiplier.

The amplification effect of electronic money to monetary multiplier enhances the endogenous of monetary multiplier. So we should give proper attention, necessary guidance and supervision to the development of electronic money.

For this, we propose the following supervise proposals:

1) Appropriate supervision should be implemented on electronic money to promote the development of electronic money.

In practice, appropriate supervision can improve the efficiency of the financial system and also contribute to the development of financial innovation. In the early stage of the development of electronic money, we must reserve a certain space to make a relatively flexible supervision when regulating and controlling the risk of electronic money system. Only in this way can we adapt to the changes in technology and environment, and then promote better development.

2) Enhance the management on the liquidity risk of electronic money.

In the formulation of monetary policy, the central bank should note that policy operation must be different when the regulation target at different levels of money supply. In order to prevent the liquidity risk of electronic money arising, we should put forward more requirements on reserve fund and capital adequacy ratio for the issuer of electronic money.

3) Make great efforts to mitigate the negative impact of electronic money to monetary policy.

The reason why electronic money has a negative impact on monetary is that the development of electronic money blur the money supply, which is one of the monetary policy intermediate targets. In order to increase the testability and controllability of money supply, we can consider re-dividing the currency levels, then according the idea of basic Poole analysis; determine the level of money supply that can make the minimum output variance. And let the level of money supply as the intermediate target of monetary policy, others as the appropriate monitoring indicators.

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Soil Moisture Retrieval from Remote Sensing Data in Arid Areas Using a Multiple Models Strategy

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Abstract. Due to the heterogeneity of land surface features in a large-scale region, this study examines the effectiveness of a multiple models strategy in soil moisture retrieval from MODIS in Xinjiang, and established a robust model for soil moisture retrieval from remote sensing data in arid and semi-arid areas where diverse land surface covers such as bare soil, sparsely vegetated and densely-vegetated lands exist. Specifically, the composed inversion models: ATI-based, TVDI-based and an averaged model were developed and used to estimate land surface soil water content in bare-soil, densely-vegetated and sparsely-vegetated areas, respectively. The models were verified and validated using the in-situ measured data, and the result indicates that, the proposed composite model performed better and achieved more accurate estimate of Xinjiang surface soil moisture than either ATI-based model or TVDI model.

Keywords: MODIS, composite model, soil moisture, TVDI, thermal inertia.

1 Prologue

The monitoring of soil moisture is of great importance to protecting desert vegetation, and to water regulation and water-saving irrigation in precision agriculture over large areas. In recent years, remote sensing based monitoring measures are increasingly more mature in terms of the basic theory and the application models, and have come to the quantitative research stage, thus soil moisture monitoring over large areas has become possible [1, 2]. The quantitatively soil moisture retrieval from remotely sensed data is considered one of the most effective means for studying the soil water content on a spatio-temporal scale. Currently, remotely sensed optical, thermal infrared or microwave wavelengths data were mainly used in soil moisture retrieval [3-7].

The thermal inertial based inversion model is the earliest and most popularly used in the soil moisture retrieval from remotely sensed data, which is based on the thermal property of soil with different water content levels [8]. In the areas covered with vegetation, Moran et al and Carlson et al used different data sources to structure the Ts/VI feature space and extracted from the triangular/trapezoid boundaries the information related to surface energy flux and soil moisture [1, 9]. Sandholt et al found that there were many isolines in the Ts/NDVI feature space, so they put forward an index to reflect the soil dryness in the area on this Ts/NDVI feature space – the Temperature Vegetation Dryness Index (TVDI) [3]. Stisen et al found that these

isolines carried significant errors if they were close to the dry edge, so they revised the original concept for TVDI based surface parameters retrieval and put forward the empirical real dry edge correction method[10]. In recent years, the TVDI retrieval of surface parameters is widely applied[11]. Further research is conducted on this basis by some scholars to improve the TVDI model[10, 12, 13].

But each of the above models has its own merits: the thermal inertia model is generally suitable for bare or sparsely vegetated soil since thermal inertia is not only related to the water content in the surface soil, but is also related to the surface cover types as well. And the TVDI based retrieval of surface soil moisture is generally suitable for vegetated areas. However, in arid and semi-arid areas, the surface covers will vary greatly from desert and sparse grassland to farmland, Alpine meadow and forests with striking spatial heterogeneity in the underlying surface, and a single model is often inadequate in retrieval of soil moisture over a large area. Therefore, how to take the respective advantages of the two models, while considering the biological and climatic conditions of the arid and semi-arid regions, is very meaningful.

2 Soil Moisture in Different Cover Types

2.1 Correlation between ATI and Soil Moisture under Different Vegetation Covers

In arid areas, the cover types vary greatly from desert, to Gobi to farmland and highly vegetated grassland and forests, the variation in vegetation covers and types is the underlying cause. For different normalized difference vegetation index (NDVI), the actually measured soil moisture data and the retrieved ATI are put to regression analysis respectively under different vegetation covers, and the regression analysis result will be used to determine the correlation between the apparent thermal inertia (ATI) and soil moisture. That is, the ATI will be less correlated to the soil moisture when there is higher vegetation coverage. This indicates that the thermal inertia approach is mainly applicable to the bare land or the early days of vegetation growth, where the perfect linear correlation between soil water content and its thermal inertia can be used for direct retrieval of soil moisture. Soil moisture retrieval by the thermal inertia approach is less effective for highly vegetated areas (Table 1).

Table 1. Relation between ATI and Soil Moisture under Different NDVIs

NDVI	<0.12	<0.13	<0.14	<0.15	<0.16	<0.18
R ²	0.7625	0.7322	0.7638	0.6456	0.631	0.3683

2.2 Correlation between TVDI and Soil Moisture under Different NDVIs

In the Xinjiang Region, the regression coefficients between TVDI and in-situ measured soil moisture data sets are shown in Table 2. The correlation coefficient drops with the NDVI value. This shows the smaller the NDVI value, the lower the correlation coefficient between TVDI and the in-situ measured soil moisture. This is

mainly attributable to the fact that where NDVI is smaller than 0.1, it is basically bare soil, and the error between the fitted and the actual values of the dry edge tends to be bigger. When using the Ts-NDVI feature space model there will be considerable error in the surface soil moisture, and this is consistent with the research conducted by Sandholt[3].

Table 2. Correlation between TVDI and Soil Moisture under Different NDVI values

NDVI	>0.3	>0.18	>0
R ²	0.7679	0.7282	0.5376

The above analysis indicates that vegetation coverage is the most important factor determining the accuracy of remote-sensing based estimation of soil moisture, especially when the local surface coverage varies greatly from type to type. No single model alone, whether thermal inertia or temperature – vegetation coverage index based, will satisfy the monitoring of soil moisture in an area as large as Xinjiang.

3 Retrieval Strategy and Composite Model

The thermal inertia approach is based on the thermal exchange between the ground surface and the atmosphere. It is a theoretical model developed by inferring the radiation transmission process and will give rise to considerable error due to the interference from the vegetation information where the vegetation coverage is high. The methods based on the energy balance equations that combine ground surface temperature and vegetation index will also give wrong estimation on the in-situ soil water content, due to the substantially increased impact from the soil background on the vegetation information where the vegetation coverage is small and close to bare land.

In order to solve this problem this paper divides the ground surface into three types, namely bare, sparsely vegetated and densely vegetated soil. The image pixel will be used as the basic unit, and the vegetation index threshold values will be used for identifying the above-mentioned three vegetation categories, thus simplifying the complex surface cover (regardless of the crop seasons). A suitable optimized retrieval model will be used for better accuracy of surface soil moisture in the entire area.

3.1 For Bare Soil: Thermal Inertia Model

The earliest research on soil thermal inertia focused on calculating the analytic expression, and the influence of the environmental factors[8]. In recent years, the conventional thermal inertia model has become more mature after further optimization efforts made by many scholars [5, 14, 15]. Thermal infrared remote sensing is used in detecting the changes in soil temperature and obtaining the soil thermal inertia for estimation of soil water content. The thermal infrared sensor retrieves the daytime ground surface temperature, and synthesizes it by way of maximum composite method. For retrieval of soil moisture over large areas, the

product synthesized on a 16-day basis can eliminate the influence from the clouds to the maximum degree, while ensuring the continuity of the data space as shown in formula (1):

$$LST_{MAX}=MAX(LST_{DAY1}, LST_{DAY2}, LST_{DAY3}, \dots, LST_{DAY16}) \quad (1)$$

Where MAX() is the max value function used for the band, LST_{MAX} is the image synthesized on the basis of the max value as returned by the function, and LST_{DAY1} , LST_{DAY2} , LST_{DAY3} , ... LST_{DAY16} are the daytime ground surface temperatures for each of the 16 days. Formula (2) is used to get the full band albedo α .

$$\alpha=0.160\rho_1+0.291\rho_2+0.243\rho_3+0.116\rho_4+0.112\rho_5+0.081\rho_7-0.0015 \quad (2)$$

Then the apparent thermal inertia (ATI) is calculated using formula (3). Fig. 3 is a chart showing the correlation between the ATI based on the data collected from Day 129 to Day 144 (May) of 2009 and the in-situ measured soil water content.

$$ATI = (1 - \alpha) / \Delta T \quad (3)$$

In specific application, ATI is often used to substitute for the real thermal inertia. A relation model between thermal inertia and soil moisture is required if a remote-sensing based statistics approach between ATI and soil moisture is to be directly established for monitoring soil water content. Whether this relation model is properly established will directly affect the accuracy of remote-sensing based soil moisture retrieval. This paper adopts the most concise and widely applied linear empirical model as the follows:

$$W = a + b * ATI \quad (4)$$

In formula (4), W is soil water content; a, b are the regression coefficients, and ATI is the thermal inertia. The ground surface thermal inertia is calculated by retrieving the albedo from the multi-spectral remote sensing reflectance and by retrieving the day/night temperature difference from the multi-temporal emissivity of the thermal infrared band. Based on the relation between ATI and soil moisture, plus other supporting information, formula (4) is used for estimation of soil moisture over a large area.

3.2 Densely Vegetated Condition: TVDI Model

The temperature – vegetation dryness index (TVDI) was proposed by Sandholt et al. Before that, Jiang et al introduced the Priestley Taylor parameter in the Ts/VI feature space for retrieval of LE[16]. Using the Ts-NDVI feature space, Sandholt proposed an indicator for water stress – TVDI. In the simplified feature space, the moist side (Ts_{min}) is treated as a straight line parallel to the NDVI axis, the dry edge (Ts_{max}) is in a linear relation to NDVI, and $TVDI = 1$ on the dry edge, and $TVDI=0$ on the moist side. The greater the TVDI value, the lower the soil moisture, and vise versa. To estimate these parameters the area in question should includes surface coverage changing from bare soil to fairly dense vegetation, and the surface soil water content changing from wilting water content to field water capacity. The ground surface

vegetation is represented by NDVI, and in the two-dimensional space of surface temperature T_s and NDVI, TVDI is expressed in formula (5):

$$TVDI = \frac{T_s - T_{s_{\min}}}{T_{s_{\max}} - T_{s_{\min}}} = \frac{T_s - (a_2 + b_2 NDVI)}{a_1 + b_1 NDVI - (a_2 + b_2 NDVI)} \quad (5)$$

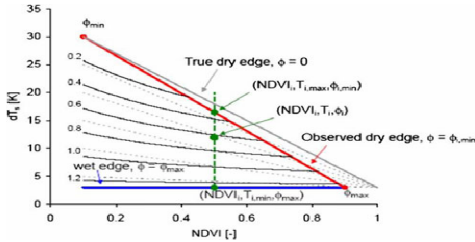


Fig. 1. Correction of the TVDI Real Dry Edge (Source: Stisen et al., 2008)

same NDVI value of given pixels; and $T_{s_{\min}} = a_1 + b_1 \cdot NDVI$, where $T_{s_{\max}}$ is equivalent to the lowest temperature under the same NDVI value of the given pixels. The TVDI is valued between 0 and 1; the TVDI of dry edge being the greatest value of 1, and the soil moisture is close to the wilting coefficient.

However, in the T_s -NDVI feature space, when the surface temperature is up to a certain level, i.e. arriving at the simulated dry edge temperature, the vegetation will close up all the stomata and stop evapotranspiration to prevent outflow of water under the high temperature [17]. This means that the soil moisture will stay unchanged rather than continuously decline due to the high temperature, that is, the soil water content in the pixels on the fitted dry edge will change with NDVI. For instance in the desert area (low NDVI), the soil moisture on the dry edge may be close to 0, while in the vegetated area (high NDVI), it cannot be 0 even if the pixel is on the dry edge. Therefore, especially for the areas with higher vegetation, the temperature of the dry edge obtained from remote-sensing data will be lower than that of the real dry edge, in other words, the soil water content will be the same for the pixels everywhere only if they are on the real dry edge. As is shown in Fig. 1, the higher the vegetation index, the greater the difference between the simulated dry edge and the real one; and the barer the ground surface, the lower the NDVI value. The simulated and real dry edges will almost overlap.

In order to correct this error, it is necessary to “restore” the simulated dry edge to the true dry edge, as shown in Fig. 1. Stisen et al thought the soil moisture isoline intersects non-linearly with the simulated dry edge [10]. The evaporation correction in high NDVI area increases rapidly as the NDVI grows bigger, while low NDVI causes slow increase, therefore this part of correction is non-linearly related to NDVI. According to the method proposed by them, we corrected the observed dry edge in the TVDI model as shown in formula (6):

$$TVDI(C)_i = TVDI_i - C((NDVI_i - 0.1) / 0.8)^2 \quad (6)$$

Where C is the correction coefficient, and is related to the rainfall conditions in the research area; $TDVI_i$, $NDVI_i$ and $TDVI(C)_i$ are the TVDI and NDVI before and after the correction, respectively.

The typical Sandholt's TVDI model for soil moisture retrieval is improved so that it can cover larger areas. The steps taken are as follows: firstly, the influence of clouds on TVDI retrieval of soil moisture is reduced by cloud masking and synthesized max temperature as shown in formula (1). Then the calculation of the dry edge is then improved. Finally the in-situ measured data from the Xinjiang test area are fitted with the modified parameters of the model to establish a retrieval model suitable for Xinjiang.

3.3 Establishing the Composite Model and Composite Retrieval Approach

In the arid areas in Northwest China, the monotonous landscape is in fact highly heterogeneous. In the mountainous area, there are mainly three types of land covers: medium-high mountainous grassland, medium mountainous forest belt and low-hilly desert grassland. The plain terrain is mainly covered by: farmlands (in the oases), natural shrubs (in the oasis-desert transitional areas and deserts), as well as desert. The plain desert area is mainly covered by desert grassland, the Gobi, and sandy land. Therefore, for the three topographical features of mountainous area, desert plain and oasis, the research on remote-sensing based retrieval of soil moisture designed by this paper will focus on three soil cover types: bare, sparsely vegetated and densely vegetated soils respectively. A composite model suitable for different cover conditions is finally established by way of optimizing and segmented selecting of the existing models. In running the composite model, the selection of the sub-model is determined as follows: Where $NDVI \leq 0.1$, the thermal inertia model is used for retrieving the soil moisture in these areas; Where $0.1 < NDVI < 0.18$, the average value of TVDI-based and thermal inertia retrievals shall apply; Where $NDVI \geq 0.18$, the TVDI method is applied. In this way, all that is required is to analyze the research area and find out the critical NDVI value as selected by the correct model corresponding to segmented area, without human interference in the running of the composite model.

4 Results and Accuracy

4.1 Data Acquisition

There are four types of satellite data used in the test: the MODIS retrieved NDVI product MOD13A2 synthesized on 16-day basis from Day 129 to Day 144 (May) of 2009, the MODIS retrieved daily land surface temperature product MYD11A1, and the MODIS retrieved 16-day ground surface reflectance product MCD43B4. The MODIS processing tool MRT provided by USGS was used for processing the MODIS data, then IDL was used to implement the models and the modules were used for retrieving the soil moisture. Three steps are involved: first, the pre-processed data were used to create the cloud mask expansion, then formula (1) was used for synthesizing the 16-day max value of temperature. On the basis of the corrected surface temperature and vegetation index an NDVI-Ts feature space was established

at an NDVI step of 0.01. The maximum and minimum values out of all surface temperatures corresponding to a given NDVI were extracted and linearly fitted to derive a fitted equation.

4.2 Implementation of Composite Model

After corrections to the MODIS image in cloud mask expansion and TVDI true dry edge, the temperature-vegetation dryness index (TVDI) and thermal inertia (ATI) were calculated, on this basis a composite model is structured in combination with formula (7), which is shown as follows:

When $NDVI < 0.1$, $SM_1 = a_3 + b_3 * ATI$;

When $0.1 < NDVI < 0.18$, $SM = (SM_1 + SM_2) / 2$;

When $NDVI > 0.18$, $SM_2 = a_4 + b_4 * TVDI$

Where SM is the retrieved surface soil moisture, a and b are the regression coefficients respectively. The in-situ measured data are fitted with ATI and TVDI in formula (7) to achieve the largest correlation coefficient between the retrieved SM as in formula (7) and the in-situ measured soil moisture. An error analysis is conducted as shown in Table 3. The average error of the results derived from the composite model has a higher accuracy than that from the individual model, and the data retrieved by the composite model are strongly correlated with the observed data, with the correlation coefficient R^2 being 0.77. The proposed composite model is therefore more suitable and practical in estimating the soil water content in the arid areas.

Table 3. Statistical Analysis of Soil Moisture Retrieved by the Models

Accuracy Statistics	ATI Model	TVDI Model	Composite Model
R^2	0.7	0.55	0.77
RMSE	5.29	6.53	4.81

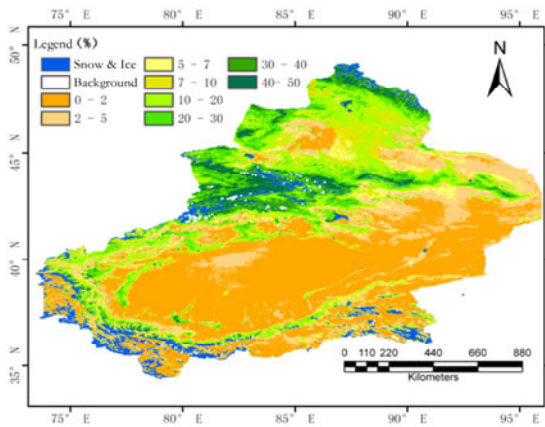


Fig. 2. Composite Model Retrieved Soil Moisture Distribution in Xinjiang, Mid-May 2009

Compared with the TVDI and thermal inertia models as shown in Table 3, the composite soil moisture retrieval model as proposed in this paper is quite effective for application in arid areas. The Xinjing’s soil moisture map using the composite model for mid-May 2009 (the 129th to the 144th day) is shown in Fig. 2. It indicates that in general, the volumetric soil moisture in the Taklimakan desert is

below 2%, while there are patches of high soil moisture areas on both sides of the Tianshan and Kunlun Mountains (at least 10% to 20%). The distribution pattern of Xinjiang's soil moisture is clearly that the North Xinjiang and South Xinjiang deserts are highly arid, and the Turpan Basin is also very arid due to its low altitude and high temperature. In May, the soil moisture in North Xinjiang will be relatively higher, which is consistent with the soil moisture data collected in field. In general, the composite model retrieved soil moisture map is capable of reflecting the actual soil moisture distribution condition in Xinjiang.

5 Conclusion

In remote-sensing based soil moisture monitoring over a large area, there is often the problem of low retrieval accuracy due to high degree of heterogeneity in ground surface covers, particularly so in the arid areas in Xinjiang: from the deserts entirely void of any vegetation, to sparse grasslands, to oasis farmlands with higher vegetation and mountainous forests and alpine meadows. The TVDI model has the following problems when retrieving soil moisture over a large area: inadequate accuracy of the cloud mask products, uneven exposure of pixels due to the topographical undulation and differences in latitudes and ground cover types, as well as errors in the dry edge simulation by the TVDI model. It is against these problems in TVDI model that this paper proposed the improvements, so that surface soil moisture information is better retrieved for the vegetated areas. Combined with the inertia model, a composite model for remote-sensing based soil moisture retrieval of arid areas with complicated coverage is established utilizing the advantages of both models. The results show that the estimation accuracy given by the composite model proposed in this paper is obviously higher than either of models on its own, and can basically satisfy the needs for soil moisture monitoring over large areas.

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On Regulation of Urban Runoff Pollution Abatement

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Abstract. A new regulation and storage mode, which the higher concentration initial rainwater is intercepted to the reservoir and sewage treatment plant, and the river self-purification capacity to treat the lower concentration initial rainwater is applied as a supplement way. The range of interceptive time and storage principle in the different rainfall patterns and different return periods is studied by considering the effect of the initial rainwater on river water quality. It is shown that the new regulation and storage system improve the interceptive effect. The effectiveness of urban runoff pollution control system is proved.

Keywords: initial rainwater, regulation and storage, interceptive time, river dispersion.

1 Introduction

Initial rainwater is generated during the initial runoff phase. The pollutant concentration of urban initial rainwater runoff is high and it is a major non-point source pollution for urban surface water [1] Runoff interception is the main approach for controlling the pollutant of initial rainwater. Xue et al established a method to determine the reservoir volume of initial rainwater based on the interceptive effect of pollutant [2]. Chang et al. applied SWMM model to correlate the relationship between pollutant mass and runoff volume in two industrial areas [3]. The governance of initial rainwater started late in China. Shanghai and other Chinese cities began to study the pollution of initial rainwater in the middle of 80s [4,5]. The overflow reduction strategies and the control regulation of urban initial period rainwater pollution was studied in recent years in Tianjin [6,7].

The rainwater runoff is discharged into river directly in Tianjin, while the initial rainwater brings a large number of pollutants causing serious pollution to receiving water. Unlike the previous research on the regulation and storage of initial rainwater, which the initial rainwater at the beginning of rainfall is intercepted, a comprehensive operation mode is proposed in this paper from the management and control aspects. It is the comprehensive utilization of reservoir, surplus capacity of sewage treatment plant and river self-purification ability. The interceptive time is discussed for different rainfall patterns and return periods in Tianjin and the range of interceptive time for higher concentration is proposed. The migration and diffusion of pollutants discharged into river is simulated. The new operation mode provides a theoretical and technical support for the control of initial rainwater pollution.

Rainfall Design. The rainfall is designed by Tianjin storm intensity formula [8]. The time of peak rainfall and rainfall pattern is determined by rainfall peak coefficient(r). According to lots of domestic and abroad data, it indicates that rainfall peak coefficient is 0.3~0.5 [9]. Two typical kinds of rainfall are studied here. For different rainfall return periods, r is chosen as 0.4. For the same rainfall return period, r is chosen as 0.1 (peak in front), 0.4 (peak in middle) and 0.6 (peak at back), respectively.

Case Overview. The Red Dragon river pumping station service area is taken as an example. The region covers an area of 114.3 hectares. The ground level is about 3m. The study area is in the central of city and the rate of impervious catchment area is 70%-90%. The drainage system is transformed from the combined system into a triage system which has a total of 21 rainwater pipes and 4800 meters in length. The generalization graph and pipe network are shown in Fig.1. The regional outfall discharged into river is at O point. The four concerned water quality parameters TSS, COD, TN, TP are chosen as the main pollution factors of scouring surface runoff. SWMM model is chosen to simulate the quality of rainwater flow in pipe net. The pollutant accumulation and wash off parameters are chosen from the results of surface accumulation load test in the functional areas of Chicago and Changsha [10,11].

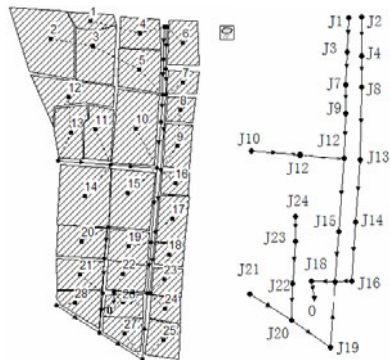


Fig. 1. The generalization graph and regional pipe network

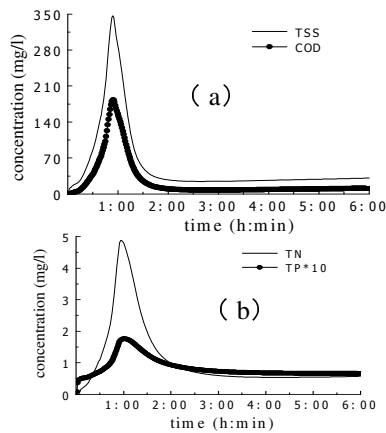


Fig. 2. Initial concentration at outfall O with respect to time (a) TSS, COD; (b)TN, TP

2 Results and Discussion

In case of five year return period, the initial state concentration of outfall with respect to time is shown in Fig.2. It is shown that the rainwater runoff with high concentration is located in a short time with respect to the rain. If the rainwater runoff with high concentration were intercepted, the pollution of receiving water should be reduced greatly. Fig.2 shows the concentration of TN and TP discharged into river is lower than the requirement of river discharge standard of V category of China. Therefore,

only the concentration of COD is higher than background value (50mg/l) . The concentration of COD discharged into the river is considered.

A reservoir is assumed to be built at the end of main pipeline. If the interception rule of rainwater is to intercept the rainwater with the COD concentration exceeding 50mg/l to reservoir, the reservoir volume is 12613m³. The land and money to build the reservoir is costly. A new regulation and storage mode of initial rainwater is needed.

3 Interception of Reservoir and Sewage Treatment Plant

To avoid building large reservoirs, the surplus capacity of sewage treatment plant and river self-purification capacity can be used to the effects of rainwater pollution, namely the comprehensive utilization of reservoirs, sewage treatment plant and self-purification capacity of rivers. In case of five year return period ($r=0.4$), if 4mm runoff is intercepted into reservoir, the volume is 4572m³. For convenience, the construction volume of reservoir is chosen as 4800 m³.

The Red Dragon river pump station service area belongs to Jizhuangzi drainage network. At present, its surplus capacity is 22×10^4 t/d. According to the proportion of service area and two hours rainfall duration, the surplus capacity to intercept rainwater is 0.056×10^4 t.

As shown in Fig.2, the low concentration of initial rainwater is not required to be intercepted at the beginning of rainfall. Therefore, a new interception rule to load high concentration rainwater is proposed. Fig.3 shows COD concentration with respect to time after intercepting high concentration rainwater at outlet. Fig.4 shows the amount of rainwater discharges to the reservoir and sewage treatment plant. Table 1 shows the amount of intercepted pollution takes past and current measures for different return periods. It indicates that our proposed measure is more efficient than that of past one for pollutant interception and the rate of COD interception is large for big return period.

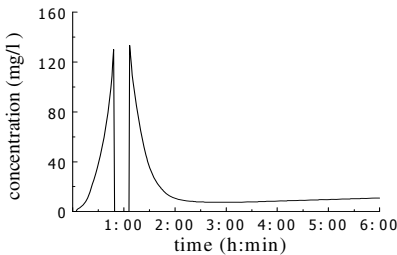


Fig. 3. COD concentration with respect to time after intercepting high concentration rainwater at outlet

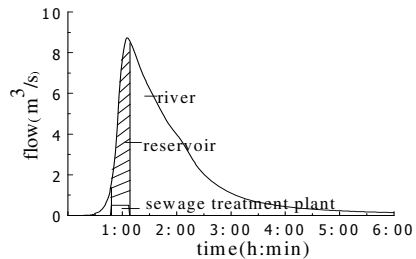


Fig. 4. assignment of rainwater

Table 1. The amount of intercepted pollutant for different return periods ($r=0.4$)

COD amount return period	Initial state (kg)	by past measures (kg)	By current measures (kg)	The rate of COD interception
P=1	1880.40	1550.582	1210.48	35.63%
P=5	1942.00	1221.645	1129.13	41.86%

4 Influenced River Area

Now the impact of rainwater draining to river on the river water quality is considered. For estimating the influenced area of river, the pollutant discharge at outfall is assumed to be constant and continuous. The flow velocity of river is a constant. For the release of steady continuous point source, C_0 is the concentration, the concentration distribution of the river is:

$$C(x, y, t) = \frac{C_0 Q}{4\pi h \sqrt{D_x D_y}} \int_0^t \frac{1}{t} \exp \left[-\frac{(x - ut)^2}{4D_x t} - \frac{y^2}{4D_y t} \right] \exp(-Kt) d\tau \quad (1)$$

here, $h=2\text{m}$; $u=0.2\text{m/s}$; $K=0.25\text{d}^{-1}$. The dispersion coefficients are determined by Taylor method as $D_x=0.022\text{ m}^2/\text{s}$, $D_y=0.1242\text{ m}^2/\text{s}$.

For $P=5a$, $r=0.4$, the contour of COD concentration is shown in Fig.5 after discharging rainwater for 15min. The concentration of COD is decreased to 50mg/l in about 125m downstream. It means that the rainwater discharge to river does not cause serious impact on the water quality of river if the peak concentration rainwater is intercepted into reservoir and sewage treatment plant.

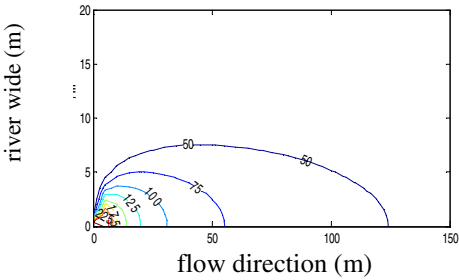


Fig. 5. contour of COD concentration in river

5 Discussion of Interception Time

There is no common idea of initial rainwater in China. Some suggest that 6~8mm rainwater in the beginning of rainfall is initial rainwater and the other consider 3min or 5min initial rainfall [2]. For different rainfall patterns, there is some time from the beginning to the peak pollutant concentration at outlet. The COD concentration initial state at outfall is shown in Fig.6, and the time of peak concentration is suggested for different rainfall patterns. For the same rainfall and position of rainfall peak, the COD amounts of runoff erosion into river are 2024.70kg, 1941.68kg, 1939.88kg, respectively for three rainfall patterns. Although the amount of pollutant is close, the process of pollution production is different.

The time of concentration peak is depended on the position of rainfall peak. The interception time for different rainfall patterns and return periods is shown in Table 2. In this case, the reservoir volume is 4800m³ and the surplus capacity of sewage treatment plant is 0.056×10⁴ t.

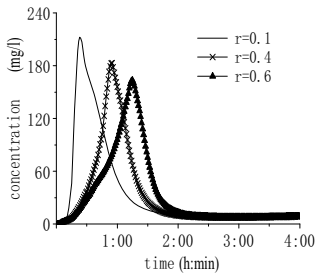


Fig. 6. COD concentration with respect to time

Table 2. Interception time for different return periods and patterns (min)

Rainfall pattern Return period	Peak in front (r=0.1)	Peak in middle (r=0.4)	Peak at back (r=0.6)
P=1	23-59	54-79	75-95
P=2	20-49	51-72	72-93
P=5	19-43	49-67	67-84
suggestion	19-59	49-79	67-95

6 Conclusion

(1) The new regulation and storage mode is proposed. The new regulation is the comprehensive utilization of reservoir, surplus capacity of sewage treatment plant and river self-purification ability.

(2) In order to improve efficiency, the conception of interception higher concentration initial rainwater is proposed. The river self-purification capacity is used to treat the lower concentration initial rainwater. The rates of COD interception are 35.63%、41.86% respectively, in the case of one and five year return periods. The suggested ranges of interceptive time in different rainfall patterns are 19min-59min, 49min-79min, 67min-95min in Tianjin. It provides technical support to control the pollution of initial rainwater runoff.

(3) After the application of new regulation and storage mode, the pollutant concentration of rainwater discharged into river. It is found that concentration of river decreases to its background value in a short distance (125m in the case of 5a return period) and time. The river can be recovered by its self-purification capacity.

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Optimization of Urban Rainwater Drainage System with Help of Remote Sensing Technology

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Abstract. With the help of Geographic Information System (ArcGIS), the operation situation of the rainwater drainage system of a selected area is simulated by the integration RS technology into InfoWorks CS. The “bottleneck” of the pipe network is found out. Enlarging some pipes diameter and adding intercepting pipe have been proposed to improve the discharge ability of the rainwater drainage system according to the characteristics of regional flat. The result shows that the overflow of the whole drainage system is reduced obviously and it is reduced up to 83.49% for a half-year return period of rainfall. Our result indicates the importance of optimization and reconstruction of urban drainage network.

Keywords: remote sensing, InfoWorks CS, rainwater drainage system, reconstruction, overflow reduction.

1 Introduction

Urban rainwater drainage network is a gigantic scale, structure complicated network system. The rainwater network modeling includes surface runoff process simulation, runoff pollution process simulation and network transmission simulation. The setting of catchment region, including the subset area, distribution and the proportion of each function region, is significant in modeling process. In the past research, most scholars divided the whole catchment region into several classes, and the proportion of each kind of function region is set with a fixed value [1,2]. Some also estimated the value of function region visually from the satellite images [3]. Actually, the above methods caused the large difference between the real situation and simulation input, and further might lead to inaccurate results. For solving the problem, the remote sensing technology is applied here to determine the areas of function regions and the coordinates of all subset catchment regions. This way greatly improves the input accuracy of catchment regions. After the function region is determined, rainwater drainage system is simulated by InfoWorks CS and several feasible optimization methods are proposed. The capability of drainage pipeline is greatly improved to reduce the surface overflow.

2 RS Technology and Modeling

RS Technology and ERDAS Software. With the acceleration of urbanization, remote sensing research on urban area has attracted more attention and made a lot of achievements [4-6]. Chatterjee [7] evaluated the flood area through combining with the GFM (groundwater flow model). The combined application of remote sensing technology and GIS was realized. Martin [8] studied the spectral reflectance characteristics of different types of functional surface in city. Accurate feature extraction by remote sensing technology was provided. ERDAS IMAGINE is a remote sensing image processing system. The system covers many functions, such as image data input/output, calibration, image enhancement, information extraction, image classification, and combination with GIS.

InfoWorks CS Software. It's a simulation software developed by the British Wallingford software company for modeling the whole water cycle in city and suitable for rainwater, sewage and the combined sewage system modeling ,designing and optimizing [9].

Modeling. Each subset catchment region is mapped out by ALOS satellite images with the help of ERDAS. The data of catchment region and network are combined by the platform of ArcGIS and imported into InfoWorks CS. By applying remote sensing technology and GIS, the InfoWorks CS modeling process is simplified and the modeling efficiency and accuracy are enhanced.

Pipe Network. The network information of the selected area include: position of networks, node elevation, conduit diameter and flow direction, length, slope, etc. The coordinate system of nodes and conduits in drainage network is defined according to the satellite images (UTM- WGS84 coordinate system), refers to Fig. 1. It makes the network have the same coordinate system as the catchment region for easily data importing into InfoWorks CS.

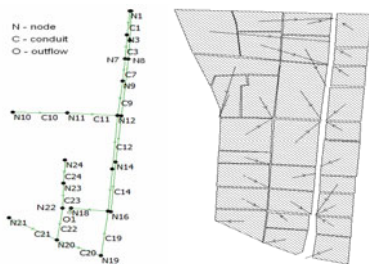


Fig. 1. The generalization graph of node and conduit (left) and catchment region(right)

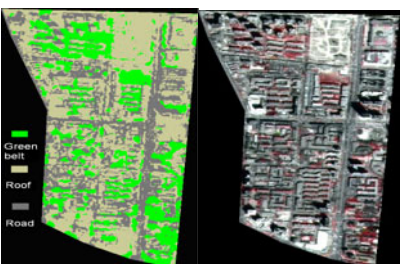


Fig. 2. The function region classification image (left) and false color image RGB:432(right)

Catchment Region. The satellite image of the study area is input in ERDAS for supervised classification, classification extraction, then fixing the area of different function region, refer to Fig. 2. Each subset catchment region is draw with vector tools and exported by the *shp* format. Vector diagram is converted to *AOI* (Area of Interest) format and the catchment region is cut from the original remote sensing image. The proportion of function region is obtained by classified statistics.

3 Case Study

Region Overview. This region covers an area of 111.6 hectares with a small average slope, and the ground elevation is about 3 meters. Ground is asphalt, buildings are residential mostly, and the rate of impervious catchment area is 70%~80%. The drainage system is transformed from the combined drainage system into a triage system with a total of 21 rainwater pipes and 4800 meters in length. The regional outfall discharged into river is at O1 point (see Fig. 1).

Model Parameters. Some parameters are fixed automatically in ERDAS and ArcGIS, and other parameters are setting according to regional characteristic by referring to references at home and abroad [10]. Horton Model is adopted in infiltration with an initial permeability of 200mm/h, a steady permeability of 12.7mm/h and an infiltration decline rate of $2h^{-1}$. The roughness coefficients of pervious and impervious areas are 0.4 and 0.02, respectively. Manning roughness of concrete pipe is 0.013. Simulation time is 6 hours with a time step of 30 seconds. Rainfall duration is 2-hours.

4 Results Analysis

Simulation results show that part of nodes is overflowed seriously during different return periods of 0.5a, 2a, 5a. For instance, in case of 0.5a return period, the nodes of N1, N10, N11, N24 are flooded most seriously as shown in Table 1.

Table 1. Overflow of serious flooding node

Nodes State	N1		N10		N11		N24	
	Flood Time /min	Flood Volume /m ³	Flood Time /min	Flood Volume /m ³	Flood Time /min	Flood Volume /m ³	Flood Time /min	Flood Volume /m ³
Initial State	74.5	550.6	102.3	1149.4	82.6	645.7	86.2	335.9
Optimized State	0	0	24.4	100.8	22.9	80.5	48.2	136.7
Efficiency	100%	100%	76.1%	91.23%	72.28%	87.53%	44.08%	59.30%
0.1m Siltation	90.3	740.8	115.7	1313.4	92.0	757.1	106.9	432.5

Solid particles cause the pipeline siltation and make the efficient diameter decrease and roughness coefficient increase. In case of 0.5a return period, operation situation is simulated with assuming that all pipeline siltation are 0.1m thickness. The results show that the flood of the whole rainwater drainage system increases. After 6-hours simulation process (2-hours rainfall duration), the total flood volume of drainage system increases by 1334.9m³ - 48.42%, shown in Table 1. The pipeline siltation slows down the flow in conduit and leads to the risk of upstream pipeline siltation. It's necessary to clean the conduit regularly.

5 Optimizing of Pipe Network

Network reconstruction measures include basically the following kinds: structural modification, facility reconstruction, layout transformation and Best Management Practices (BMPs) measures, etc. Network optimization should start before examining the distribution reasonability of catchment region which the upstream conduits belong to or whether there are depression storages, then inspecting the pipe diameter, the slope, or pipe siltation. After the flooding reason is found out, reconstruction scheme is determined according to the construction difficulty, the construction cost, operation cost and other comprehensive factors in order to realize the optimal operation. The three main "bottleneck" regions of selected area is N10 ~ N12, N1 ~ N9 and N24 ~ N21. Considering the high cost of reservoir, the following two methods are adopted.

Increasing Diameter. This scheme is used in No.1 and 3 "bottleneck" area. The results show that the overflow is alleviated after increasing the pipe diameter. For example, in case of 0.5a return period, the total flood volume of N24 falls to 136.7 m³ from the initial value of 335.9 m³. The flood volume of N10 and N11 decrease 91.23% and 87.53%, respectively, when increases the diameter of C10, C11 and C22 from 800mm, 800mm and 600mm to 1200mm, 1200mm and 1000mm. The data of node flood are seen in Table 1.

Interception Pipe. To improve the situation of No.2 "bottleneck" area, it is a choose to increase the diameter of C1、C3、C7 and C9. Due to the high cost of constructing long conduits, it's not economical. By analyzing the drainage condition of pipeline laid side by side, another feasible scheme is that a 14.6m length intercepting pipeline could be used to connect the nodes N7 and N8. The results show that the flood volume of N1 decreases from 550.6m³ to 0m³. In 6-hours of simulation process (2-hours rainfall duration), the total flood of this area is reduced to 793.3 m³, see Table 2.

Table 2. Flood of nodes in No.2 "bottleneck" area

State \ Nodes	N1	N3	N7	N8	N9	Total Area	Reduction Percentage
Initial Flood/m ³	550.6	286.8	0	0	0.2	837.6	—
Reduction Volume/m ³	550.6	247.8	0	0	-5.1	793.3	94.7%

Comprehensive Optimizing Scheme. By combining the two optimization scheme above, the drainage capacity of system is improved greatly and the flood of whole drainage system decreases from 3302.6m³ to 545.4m³ in the case of $P=0.5$. For different rainfall return periods, the flooding reduction is limited for the return period more than 2a, as shown in Table 3. It indicates that the economic optimization scheme cannot improve the performance of drainage system too much.

Table 3. Reduced flood and efficiency of optimized drainage system for different return period

	P=0.5a	P=2a	P=5a
Reduced Flood Volume/m ³ (Efficiency)	2757 (83.5%)	3803 (12.8%)	4320 (8.2)%

For $P=0.5a$, 0.1m pipeline siltation has influence on the comprehensive optimization scheme. Compared with no siltation, it increases the flood volume of N1, N3 from 0m³, 80.5m³ to 20m³, 131.6m³, respectively.

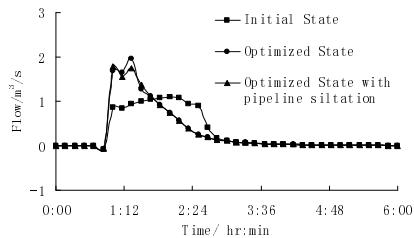


Fig. 3. Flow rate of N12

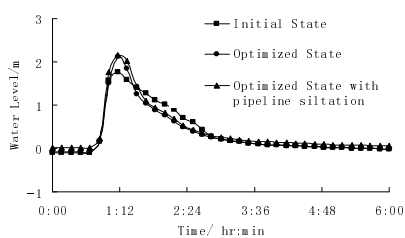


Fig. 4. Water level of N12

The overflow is alleviated while the optimization scheme increases the load of downstream nodes such as N12. Compared with the original state, the maximum flow increases 0.85m³/s, and the highest water level increases 0.34m, see Figs.3 and 4. The other downstream node follows the same rule also. Therefore, optimization should take into account the load capacity of downstream nodes to avoid new overflow. Results also indicate the effect of 0.1m pipe siltation is limited for diameter increase or interception pipe. The requirement of downstream pipes clean is loosened.

6 Conclusion

Remote sensing technology is adopted to determine the area, coordinate and functional region percentage for each subset of catchment region. The accuracy of settings in catchment region is much improved. Rainfall drainage system is simulated by InfoWorks CS and several economic optimizing schemes are proposed to reduce the overflow. Main conclusions are listed as following.

(1) By the measure of diameter increase and interception pipe, the flood of whole drainage system decreases from 3302.6m^3 to 545.4m^3 in the case of $P=0.5$;

(2) With the increasing of rainfall return period, the reduction effect of flood is more limited, especially for the return period more than $2a$. The design of rainfall drainage system with high return period is substantial to city flood reduce;

(3) Optimization scheme not only alleviates the overflow of nodes, but also increases the risk of overflow of downstream nodes. Therefore, the drainage capacity of optimized network need to reassess to assure the performance of the whole system improved.

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The Segmentation Algorithm of Region Feature Based on MAPX

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Abstract. The algorithm about region feature divided by straight-line was described by this paper, and it was based on the programming environment of VB6.0 + MAPX5.0. There are three cases were taken into account in this algorithm: the first, the points of intersection do not overlap with the vertices of region feature; the second, the points of intersection just overlap with the last vertex of region feature; and finally, the points of intersection overlap with other vertices except the last vertex of region feature. The results show that, this algorithm is stable and effective.

Keywords: MAPX, Forest Resources, Region Feature, Segmentation Algorithm.

Introduction

Geographic information system has been more widely used in forest resources management with the continuous development of "3S" (RS, GIS, GPS) and other related hardware and software technologies[1,2,3]. To some extent, as MapInfo, accepted by many users because of its simplicity and ease of use with more comprehensive functionality[4,5]. Of course, no matter what type of GIS software, considering the functional versatility for general users, its operation is still complex, which provides a market space for developing dedicated geographic information system which was usually gotten by programming with object-oriented programming language and GIS middleware. MAPX is a kind of middleware technology that can provide most of the function of MapInfo for programming.

Subcompartment is the basic unit for forest resource management, and its area should be adjusted according to different management objective. Usually, in geographic information system of forest resources, a subcompartment should be represented as a region feature, so its size can be adjusted by splitting and merging for features. The algorithm about region feature divided by straight-line was designed and implemented by this paper, and it was based on the programming environment of VB6.0 + MAPX5.0.

1 The Segmentation Process for Region Feature

The segmentation process for region feature is shown in figure 1.

2 The Specific Steps for Segmenting

2.1 The Segmenting Schematic Diagram for Region Feature

The schematic diagram of segmentation for region feature as shown in figure 2.

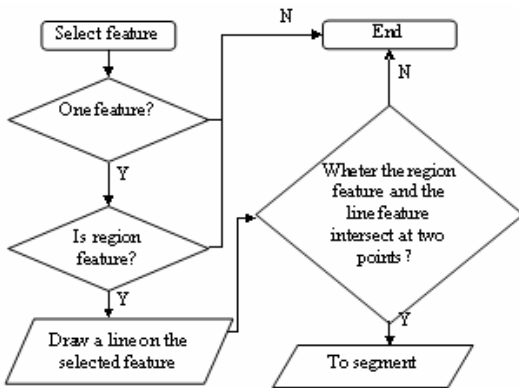


Fig. 1. The segmentation process for region feature

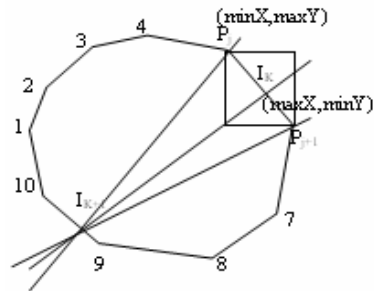


Fig. 2. The schematic diagram of segmentation for region feature

2.2 The Steps for Segmenting

Now supposing there are n vertices, and $n-1$ edges in divided region feature, and $E_j (1 \leq j \leq n-1)$ is a edge which has 2 endpoint of P_j and P_{j+1} ; l is dividing line, there are 2 points of I_K and I_{K+1} that l intersect with the region feature, and the coordinates of I_K is X_{I_k} and Y_{I_k} ; $Pts1$ and $Pts2$ is the 2 point set after one region feature divide into two region feature; $ptsChange$ is a boolean variable, and its value will decide the points of divided feature should be added to $Pts1$ or $Pts2$.

(1) Set $ptsChange$ as false

(2) Loop for each edge E_j on the region feature, the variable j is from 1 to $n-1$. Then the rectangular should be created with E_j as main diagonal or sub-diagonal, $(\min X, \max Y)$ as left-top corner coordinates, $(\max X, \min Y)$ as right-bottom corner coordinates also. So the necessary and sufficient condition about intersection of l and E_j is: $\min X \leq X_{I_k} \leq \max X$ and $\min Y \leq Y_{I_k} \leq \max Y$.

(3) When the value of $ptsChange$ is false, P_j should be added to $Pts1$, otherwise to $Pts2$.

(4) When IK (or IK+1) overlap with the P_j, if ptsChange is equal to false, then set ptsChange as true and add IK (or IK+1) to Pts2, if not, we should set ptsChange as false and add IK (or IK+1) to Pts1. Otherwise, if IK (or IK+1) does not overlap with P_j and P_j+1, then set ptsChange as not ptsChange and add IK (or IK+1) to Pts1 and Pts2 at the same time.

(5) If $j \leq n-1$ then go to (2) step, or next step.

(6) When ptsChange is equal to false, the point of P_n should be added to Pts1, and if P_n overlap with IK (or IK+1) at the same time, we should add the P_n to Pts2 also. Otherwise, the point of P_n should be added to Pts2, and if P_n overlap with IK (or IK+1) at the same time, we should add the P_n to Pts1 also.

(7) Converted the point sets of Pts1 and Pts2 into independent region features which should be added immediately into current layer .

(8) Delete the straight-line feature of l and the old region feature.

3 Algorithm Implementation

The following algorithm about region feature divided by straight-line was based on the programming environment of VB6.0 + MAPX5.0

```

'Variable definitions are omitted
Set lyr = Map1.Layers(1) ' lyr point to the top layer
Set lineFtr = lyr.AllFeatures(lyr.AllFeatures.Count) 'return the last feature of lyr
Set regoinFtr = lyr.Selection(1) 'regoinFtr point to the current selected regoin
regoin
Set FtrFac = Map1.FeatureFactory
Set itstPts = FtrFac.IntersectionPoints(regoinFtr, lineFtr)
For j = 1 To regoinFtr.Parts(1).Count - 1
    If regoinFtr.Parts(1)(j).X <= regoinFtr.Parts(1)(j + 1).X Then
        minX = regoinFtr.Parts(1)(j).X
        maxX = regoinFtr.Parts(1)(j + 1).X
    Else
        maxX = regoinFtr.Parts(1)(j).X
        minX = regoinFtr.Parts(1)(j + 1).X
    End If
    If regoinFtr.Parts(1)(j).Y <= regoinFtr.Parts(1)(j + 1).Y Then
        minY = regoinFtr.Parts(1)(j).Y
        maxY = regoinFtr.Parts(1)(j + 1).Y
    Else
        maxY = regoinFtr.Parts(1)(j).Y
        minY = regoinFtr.Parts(1)(j + 1).Y
    End If
    If itstPts(1).X >= minX And itstPts(1).Y >= minY And itstPts(1).X <= maxX
And itstPts(1).Y <= maxY Then
        ptsChange = Not ptsChange
        Pts1.Add itstPts(1)

```

```

    If Not ((itstPts(1).X = regoinFtr.Parts(1)(j).X And itstPts(1).Y =
regoinFtr.Parts(1)(j).Y) Or (itstPts(1).X = regoinFtr.Parts(1)(j + 1).X And itstPts(1).Y
= regoinFtr.Parts(1)(j + 1).Y)) Then
    ' when the intersection point 1 didn't overlap with the points of region feature
        Pts2.Add itstPts(1)
    End If
End If
If itstPts(2).X >= minX And itstPts(2).Y >= minY And itstPts(2).X <= maxX
And itstPts(2).Y <= maxY Then
    ptsChange = Not ptsChange
    Pts2.Add itstPts(2)
    If Not ((itstPts(2).X = regoinFtr.Parts(1)(j).X And itstPts(2).Y =
regoinFtr.Parts(1)(j).Y) Or (itstPts(2).X = regoinFtr.Parts(1)(j + 1).X And itstPts(2).Y
= regoinFtr.Parts(1)(j + 1).Y)) Then
    ' when the intersection point 2 didn't overlap with the points of region feature
        Pts1.Add itstPts(2)
    End If
End If
If Not ptsChange Then
    Pts1.Add regoinFtr.Parts(1)(j)
Else
    Pts2.Add regoinFtr.Parts(1)(j)
End If
Next
' Process the last point of the original region feature
If Not ptsChange Then
    Pts1.Add regoinFtr.Parts(1)(j)
    If (itstPts(1).X = regoinFtr.Parts(1)(j).X And itstPts(1).Y =
regoinFtr.Parts(1)(j).Y) Or (itstPts(2).X = regoinFtr.Parts(1)(j).X And itstPts(2).Y =
regoinFtr.Parts(1)(j).Y) Then
        Pts2.Add regoinFtr.Parts(1)(j)
    End If
Else
    Pts2.Add regoinFtr.Parts(1)(j)
    If (itstPts(1).X = regoinFtr.Parts(1)(j).X And itstPts(1).Y =
regoinFtr.Parts(1)(j).Y) Or (itstPts(2).X = regoinFtr.Parts(1)(j).X And itstPts(2).Y =
regoinFtr.Parts(1)(j).Y) Then
        Pts1.Add regoinFtr.Parts(1)(j)
    End If
End If
Set regoinFtr1 = FtrFac.CreateRegion(Pts1, regoinFtr.Style.Clone)
Set regoinFtr2 = FtrFac.CreateRegion(Pts2, regoinFtr.Style.Clone)
lyr.AddFeature regoinFtr1 'Add the regoinFtr1 into lyr
lyr.AddFeature regoinFtr2 ' Add the regoinFtr2 into lyr
lyr.DeleteFeature regoinFtr 'delte the old region feature
lyr.DeleteFeature lineFtr 'delete the line feature

```

4 The Result of Segmentation

The experimental results shown in fig.3. The algorithm achieve to the segmentation operation that region feature divided by straight-line feature, which runs stable and segmentation is effective also.

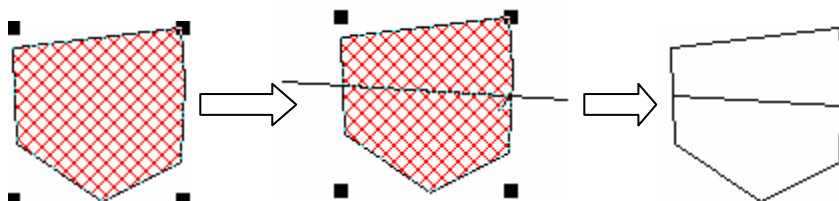


Fig. 3. The result of segmentation

5 Discussion

The algorithm deals only with the division operation that intersect at two points between straight-line feature and the region feature, but in practice, the intersection may be more complex, for example, if more than two intersection points, or the line type is polyline and so on. How to achieve split operations in these complex cases will need to be further research.

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Evaluation on Water Quality Risk Based on Unascertained Mathematics Theory of Wohushan Reservoir

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Abstract. Based on unascertained mathematics theory, with unascertained rational number used for single factor quality risk assessment and AHP applied to weight the detection indexes to evaluate the comprehensive risk of water quality on Wohushan reservoir, the calculated results indicated the maximum risk possibility of water quality due to six Pollutants is 0.7368, meanwhile the over standard discharge degree of risk possibility is 73.68%. With the uncertainty characteristics of risk assessment on water quality, the unascertained mathematics theory has better system performance over uncertainty of the parametric information.

Keywords: water quality risk assessment, unascertained rational number, Wohushan reservoir.

1 Introduction

It's a dynamic and unascertained process for transportation and diffusion of pollutants in the aquatic environments, even effluent compliance 100%, it still has possible destructive risk in water quality in some degree. This risk, different from risk of sudden accident, is called "non-sudden risk" [1]. The non-sudden risk, mainly caused by uncertainty in water environment, has potential complex and long-term characteristics, ignoring the uncertainty is to cover up the potential risk of over standard. Now, study on uncertainty changes has gotten more and more attention, among which, unascertained rational number is an effective mathematical model to deal with uncertain problem [2]. This paper is based on unascertained mathematics theory to establish an unascertained model for evaluation the risk of Wohushan reservoir water quality.

2 The Basic Situation of Study Area

Wohushan reservoir, possessing abundant water resources, within the territory of Zhonggong town, which is located in south of Licheng urban of Jinan city, lying in upper reaches estuary of Jinxiu river, Jinyang river and Jinyu river, is a comprehensive large reservoir with function of flood control, urban water supply and

farmland irrigation. The water quality of Wohushan reservoir has directly influence for other ecological status and city drinking water safety. Recent years, the water environmental quality reaches a stable level of II-III, but water resources quantity and water environmental capacity have been decreased, origin area is often over standard on COD, which of these pose a threat to water safety.

Sampling examination methods were used to carry out observation on monitoring sections from August 2008 to December 2009. Based on the pollution situation and reservoir function, we chose monitoring indexes as follows: DO, Permanganate Index, Amino-Nitrogen, Total Phosphorus, Total Nitrogen and Hexavalent Chromium. Sample, sample storage and sample transportation were executed on the standard.

3 Single Factor Risk Assessment of Water Quality on Wohushan Reservoir

As a big open system, water quantity, pollutant concentration, diffusion coefficient and attenuation coefficient have great uncertainty in Water Environmental System of Wohushan reservoir. Those uncertainties, caused by neither objective reality, incomplete information nor imperfect knowledge of mechanism and change law, makes it success to use unascertained rational number to assess the water quality risk.

Calculation model, based on unascertained information of over standard discharge possibility on pollution source, is as follows:

The definition of unascertained event is:

Suppose unascertained number $A = \{[x_1, x_n], f(x)\}$, $B = \{[y_1, y_m], g(y)\}$, among which

$$f(x) = \begin{cases} \alpha_i, x = x_i, i = 1, 2, \dots, n \\ 0, \text{others, and } 0 < \sum_{i=1}^n x_i = \alpha \leq 1, 0 < \alpha_i \leq 1, i = 1, 2, \dots, n \end{cases} \quad (1)$$

$$g(y) = \begin{cases} \beta_j, y = y_j, j = 1, 2, \dots, m \\ 0, \text{others, and } 0 < \sum_{j=1}^m \beta_j = \beta \leq 1, 0 < \beta_j \leq 1, j = 1, 2, \dots, m \end{cases} \quad (2)$$

We call the inequalities $A \geq B$, $A \succ B$ (or $A \leq B$, $A \prec B$) as unascertained

event. And then suppose $A \geq B$ as unascertained event, we call $\sum \alpha_i \beta_j$ as reliability of $A \geq B$, denoted by $Cr\{A \geq B\}^x \geq y_j$, that is

$$Cr\{A \geq B\} = \sum_{x_i \geq y_j} \alpha_i \beta_j \quad (\text{obviously, } 0 \leq Cr\{A \geq B\} \leq \alpha \beta).$$

If $Cr\{A \geq B\} = \alpha\beta$, it is $A \geq B$.

If $Cr\{A \geq B\} = 0$, it is $A < B$.

If $0 \leq Cr\{A \geq B\} \leq \alpha\beta$, it is uncertainty relation of $A - B$.

Here, We define B as integrated wastewater discharge standard, for consistency of habit, expressing B as real number form (reliability $\beta=1$); define A as pollution source discharge concentration, expressed as unascertained number form. Therefore, the unascertained event $A \geq B$ is the risk of over standard discharge. The risk based on unascertained theory is called unascertained risk and the occurring probability can be measured by formula below:

$$Cr\{A \geq B\} = \sum_{X_i \geq B} \alpha_i = \alpha \quad \sum_{X_i < B} \alpha_i = \alpha \quad F(x_i)$$

Among them, $X_1 = \max\{X_i \mid X_i < B\}$; $F(x_1)$, distribution function of A , is unascertained number.

Applying method above to calculate the water quality risk of Wohushan reservoir and using the six indexes from August 2008 to December 2009 to assess degree of over standard discharge risk according to the first class water quality standard for surface water.

(1) The calculation process of over standard discharge risk on DO is as follows:

$$C_{Do} = \{[5.93, 13.18], F(c)\}$$

$$F(c) = \begin{cases} 0.2273, & C = [5.93, 7.06] \\ 0.0909, & C = [7.53, 7.64] \\ 0.2273, & C = [8.53, 9.64] \\ 0.1818, & C = [10.19, 10.74] \\ 0.2727, & C = [11.32, 13.18] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on DO is $P_{Do} = \{A \leq B\} = \sum_{X_i \leq B} \alpha_i = 0.2273$, among these, A is monitoring index of DO,

and B , the first class water quality standard for surface water on DO, is 7.5.

(2) The calculation process of over standard discharge risk on potassium permanganate is as follows:

$$C_{Mn} = \{[0.14, 3.74], F(c)\}$$

$$F(c) = \begin{cases} 0.1364, & C = [0.14, 2.0] \\ 0.5, & C = [2.1, 2.98] \\ 0.3636, & C = [3.0, 3.74] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on Permanganate is:

$$P_{Mn} = \{A \geq B\} = \sum_{X_i \geq B} \alpha_i = 1 - \sum_{X_i < B} \alpha_i = 1 - 0.1364 = 0.8636$$

Among these, A is monitoring index on permanganate, and B , the first class water quality standard for surface water on permanganate, is 2.

(3) The calculation process of over standard discharge risk on Ammonia is as follows:

$$C_{NH_3-N} = \{[0.01, 0.495], F(c)\}$$

$$F(c) = \begin{cases} 0.2273, & C = [0.01, 0.015] \\ 0.1818, & C = [0.029, 0.05] \\ 0.3636, & C = [0.08, 0.14] \\ 0.2273, & C = [0.16, 0.56] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on Ammonia is:

$$P_{NH_3-N} = \{A \geq B\} = \sum_{X_i \geq B} \alpha_i = 1 - \sum_{X_i < B} \alpha_i = 1 - 0.2773 - 0.1818 - 0.3636 = 0.2273$$

Among these, A is monitoring index on Ammonia, and B , the first class water quality standard for surface water, is 0.15.

(4) The calculation process of over standard discharge risk on total Phosphorus is as follows:

$$C_p = \{[0.007, 0.29], F(c)\}$$

$$F(c) = \begin{cases} 0.1818, & C = [0.007, 0.01] \\ 0.5, & C = [0.012, 0.016] \\ 0.3182, & C = [0.02, 0.29] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on total Phosphorus is:

$$P_p = \{A \geq B\} = \sum_{X_i \geq B} \alpha_i = 1 - \sum_{X_i < B} \alpha_i = 1 - 0.1818 = 0.8182$$

Among these, A is monitoring index on total Phosphorus, and B , the first class water quality standard for total Phosphorus, is 0.01.

(5) The calculation process of over standard discharge risk on total Nitrogen is as follows:

$$C_N = \{[2.3, 6.0], F(c)\}$$

$$F(c) = \begin{cases} 0.6364, & C = [2.3, 3.96] \\ 0.3636, & C = [4.0, 6.0] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on total Nitrogen is:

$$P_N = \{A \geq B\} = \sum_{X_i \geq B} \alpha_i = 1 - \sum_{X_i < B} \alpha_i = 1 - 0 = 1$$

Among these, A is monitoring index on total Nitrogen, and B , the first class water quality standard, is 0.2.

(6) The calculation process of over standard discharge risk on hexavalent chromium is as follows:

$$C_{cr}^{6+} = \{[0.007, 0.075], F(c)\}$$

$$F(c) = \begin{cases} 0.3182, & C = [0.007, 0.01] \\ 0.5454, & C = [0.012, 0.019] \\ 0.1364, & C = [0.021, 0.075] \\ 0, & \text{others} \end{cases}$$

The degree of over standard discharge risk on hexavalent chromium is:

$$P_{Cr}^{6+} = \{A \geq B\} = \sum_{X_i \geq B} \alpha_i = 1 - \sum_{X_i < B} \alpha_i = 1 - 0.3182 = 0.6818$$

Among these, A is monitoring index on hexavalent chromium, and B , the first class water quality standard, is 0.01.

Comprehensive Risk Evaluation of Water Quality on Wohushan Reservoir

Index Weight Determination. Adopting AHP to determine the index weight of water quality. Suppose comprehensive evaluation objective of water environmental quality as target layer(A), evaluation criterion (Harmfulness, Recoverability, Vulnerability) as criterion layer(B) and the six detection indexes as schematic layer(C). Multiple comparisons is used in important degree evaluation according to the evaluation criterion, to construct a judgment matrix, and then using root method to calculate the largest eigenvalue and eigenvector, then to check the consistency. The result on hierarchical ranking of detection indexes is seen table 1.

Table 1. The Result on Hierarchical Ranking of Detection Indexes

Pollutants	Levels	B1	B2	B3	hierarchical ranking	
		0.3090	0.5816	0.1095	Weight	Ranking
DO	C1	0.0303	0.0333	0.4231	0.0750	6
Permanganate	C2	0.2383	0.2458	0.0427	0.2213	2
Ammonia	C3	0.0981	0.0481	0.1784	0.0778	5
total Phosphorus	C4	0.1487	0.1306	0.0973	0.1325	4
total Nitrogen	C5	0.4491	0.0762	0.2305	0.2083	3
Hexavalent chromiumis	C6	0.0355	0.4661	0.0280	0.2851	1

The result of consistency test is $CR = 0.0502 < 0.10$, which is in a good statement.

Comprehensive Risk Evaluation of water quality on Wohushan Reservoir. The calculation on comprehensive risk is to choose the degree of risk multiplied by weight coefficient, and then get summation. The result (seen below) could express the risk of water quality on Wohushan reservoir objectively.

$$P = P_{DO} * W_{DO} + P_{MN} * W_{MN} + P_{NH3-N} * W_{NH3-N} + P_P * W_P + P_N * W_N + P_{Cr^{6+}} * W_{Cr^{6+}} = 0.7369$$

The risk on over standard discharge of pollutants is 0.7369, which means frequency on over standard discharge of Pollutants is 73.69%.

Summary

The development of unascertained mathematics theory provides a new idea and a new method for uncertainty on subjective flied. This paper applied unascertained mathematics theory on the evaluation of water quality risk, with feasible theory and reliable results, to widen the application fields of unascertained mathematics theory and evaluation on water quality risk.

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The Principle and Applications of Bridge Type Loops-Water Source Heat Pump with 4 Functions

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Abstract. Bridge type loops–water source heat pump with 4 functions that has bridge type connecting multi–loops, is made up of condenser, evaporator, fan coil unit, hot water tank, indirect heat exchanger and so on 5 hot equipments, by using the connection way of the bridge circuit and 5 pairs of control nodes and 4 T–valves to connect user terminals and water source; in order to control the change of water circulation in multi–loops, and to realize heating, air conditioning, hot water, air conditioning + hot water 4 functions.

Keywords: Bridge type loops, Water source, Heat pump, 4 functions.

1 The Questions of Traditional Water Source Heat Pump

Traditional water source heat pump:

(1) To avoid the corrossions toward 2 heat exchangers of heat pump by seawater, river water, lake water, well water and so on, in order to enhance reliability and life of it, 2 indirect heat exchangers must be used to realize heat transfer between heat pump and water source. In winter the indirect heat exchanger on the side of evaporator is sheared to connect water source, in order to constitute a heat collecting circulation loop of heat pump; in summer the indirect heat exchanger on the side of condenser is sheared to connect water source, in order to constitute a cooling circulation loop of heat pump.

(2) The evaporator and condenser of heat pump must be sheared to connect user terminals and water source repeatedly according to seasons in turn, in order to realize heating and air conditioning functions, thus 13 changing valves are needed to constitute multi–loops of independent circulation.

(3) 3 fixing pressure pipelines are needed to stabilize pressure of multi–loops of independent circulation separately.

(4) 4 circulation pumps are needed to drive independent circulation of multi–loops of separately.

(5) The complexity of multi–loops of independent circulation also leads control output spots to increase, and the complex of control logic.

In order to improve traditional water source heat pump, and to increase its functions, to enhance its efficiency, to reduce its cost, to simplify its control, to enhance its

reliability, the connection way of bridge circuit is introduced into water source heat pump in this article, thereby bridge type loops–water source heat pump with 4 functions is invented[1,2,3].

2 The Constitution of Bridge Type Loops

The constitution of bridge type loops is shown as Fig. 1: Bridge type connecting multi-loops on the side of cooling carrier that is called bridge type loops for short, is made up of pipelines to supply water and to return water according to the connection way of bridge circuit, it is constituted by totally 5 pairs of control nodes numbered by 1, 2, 3, 4, 5; as well as condenser, evaporator, fan coil unit, hot water tank, indirect heat exchanger and so on 5 heat equipments. Every pair of control nodes is made up of a pair of T-pipe or T-valve to supply water and to return water, and is connected with other control nodes, or inputs and outputs of heat equipments. The different circulation loops of cooling carrier is formed by varying the combination of 4 T-valves connection way, in order to realize 4 control functions of heating, air conditioning, hot water, air conditioning + hot water. The colors of pipelines in Fig. 1, red represents heating, blue represents air conditioning, green represents hot water, yellow represents water source respectively. And in control nodes:

Number 1 nodes: connect and control condenser, hot water tank, number 4 nodes;

Number 2 nodes: connect evaporator, number 3 nodes, number 5 nodes;

Number 3 nodes: connect and control fan coil unit, number 2 nodes, number 4 nodes;

Number 4 nodes: connect number 1 nodes, number 3 nodes, number 5 nodes;

Number 5 nodes: connect and control indirect heat exchanger, number 2 nodes, number 4 nodes.

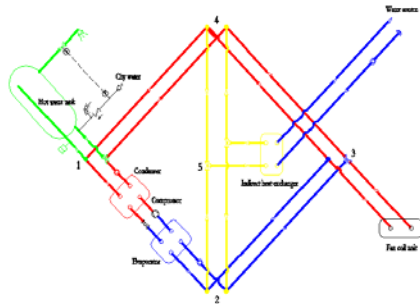


Fig. 1. Bridge type loops – water source heat pump

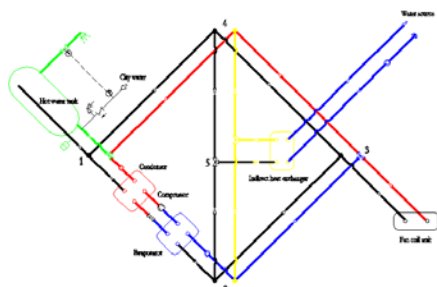


Fig. 2. Static pressure transfer of bridge type loops

3 The Structure Characteristic of Bridge Type Loops

Compared with multi-loops of independent circulation of traditional water source heat pump, the structure characteristic of bridge type loops are: simplifying of

circulation loops, adding water and fixing pressure of connecting loops, single connecting loops to avoid inner leakage and so on. The concrete elaboration is as follows:

(1) Simplifying of circulation loops: As shown in Fig. 2, in the 5 nodes to return of bridge type loops with color expression, number 1, number 3 to connect hot water tank and fan coil unit and so on user terminals, and number 5 to connect indirect heat exchanger water source, are all control nodes, changing of cooling carrier circulation loops is controlled by T-valve; the others are connective nodes, in order to form different cooling carrier circulation loops by coordination of T-pipes. Thus compared with 13 changing valves of multi-loops of independent circulation of traditional water source heat pump, only 4 T-valves can control user terminals and water source, so the circulation loops of cooling carrier are simplified greatly.

(2) Adding water and fixing pressure of connecting loops: As shown in Fig. 2, 5 nodes to supply water with black expression in bridge type loops are all T-pipes, besides number 5 node T-valve to supply water. So the black pipelines to supply water form connecting loops to realize unified static pressure transfer in the loops. Thereby only one pipeline to supply city water can realize adding water and fixing pressure in bridge type loops.

(3) Single connecting loops to avoid inner leakage: As shown in Fig. 2, number 5 node T-valve to supply water enables the black pipelines to supply water of bridge type loops to form single connecting loops, no matter what pipeline is connected. Thereby as shown in Fig. 1, Fig. 1, Fig. 1, Fig. 1 separately, the high temperature loop circulation and low temperature loop circulation of bridge type loops is connected by single pipeline, when heating, air conditioning, hot water, air conditioning + hot water 4 control functions, in order to form single connecting loops to avoid inner leakage or mixing of cool cooling carrier and hot cooling carrier between high temperature loop circulation and low temperature loop circulation, and to ensure the efficiency of heat pump[4,5,6].

4 Functions of Water Source Heat Pump

The combination of 4 T-valves connection way is changed in bridge type loops-water source heat pump with 4 functions to form the different circulation loops of cooling carrier, in order to realize heating, air conditioning, hot water, air conditioning + hot water 4 functions[7,8].

(1) Heating: As shown in Fig. 1, the compressor of a water source heat pump with 4 functions moves to drive refrigerant flowing through refrigerant side of condenser, expansion valve, refrigerant side of evaporator, compressor and so on, in order to constitute a heat pump cycle, thereby the heat energy of water source collected through heat collecting loop circulation in evaporator, is pumped into condenser, then is released to fan coil unit through heating loop circulation.

The circulation pump at input of heat pump condenser drives cooling carrier to flow through check valve, cooling carrier side of condenser, T-pipes to supply water of number 1-4-3 nodes of bridge type loops, fan coil unit, T-valve of fan coil unit, number 4 node T-pipe to return water, T-valve of hot water, filter, circulation pump,

to constitute a heating loop circulation, carrying condensation heat of the condenser to fan coil unit.

The circulation pump at input of heat pump evaporator drives cooling carrier to flow through check valve, cooling carrier side of evaporator, T-pipe to supply water of number 2 node of bridge type loops, T-valve to supply water of number 5 node, cooling carrier side of indirect heat exchanger, T-valve of indirect heat exchanger, T-pipe to return water of number 2 node, filter, circulation pump, to constitute a heat collecting loop circulation, carrying heat energy of water source collected on the cooling carrier side of indirect heat exchanger to cooling carrier side of evaporator.

This time, the circulation pump of water source drives water to flow through the water source side of indirect heat exchanger, the water is drained off to water source after its heat energy has been absorbed by heat collecting loop circulation and it has been cooled down.

(2) Air Conditioning: As shown in Fig. 1, the compressor of a water source heat pump with 4 functions moves to drive refrigerant flowing through refrigerant side of condenser, expansion valve, refrigerant side of evaporator, compressor and so on, in order to constitute a refrigeration cycle, thereby the heat released by fan coil unit and collected through air conditioning loop circulation in evaporator, is pumped into condenser, then is released to water source side of indirect heat exchanger through cooling loop circulation.

The circulation pump at input of heat pump evaporator drives cooling carrier to flow through check valve, cooling carrier side of evaporator, T-pipes to supply water of number 2–3 nodes of bridge type loops, fan coil unit, T-valve of fan coil unit, T-pipe to return water of number 2 node, filter, circulation pump, to constitute a air conditioning loop circulation, carrying evaporation heat of the evaporator to fan coil unit.

The circulation pump at input of heat pump condenser drives cooling carrier to flow through check valve, cooling carrier side of condenser, T-pipes to supply water of number 1–4 nodes of bridge type loops, T-valve to supply water of number 5 node, cooling carrier side of indirect heat exchanger, T-valve of indirect heat exchanger, T-pipe to return water of number 4 node, T-valve of hot water, filter, circulation pump, to constitute a cooling loop circulation, carrying condensation heat of the condenser to water source side of indirect heat exchanger.

This time, the circulation pump of water source drives water to flow through the water source side of indirect heat exchanger, the water is drained off to water source after the water has absorbed the heat released by cooling loop circulation and has been heated up.

(3) Hot Water: As shown in Fig. 1, the compressor of a water source heat pump with 4 functions moves to drive refrigerant flowing through refrigerant side of condenser, expansion valve, refrigerant side of evaporator, compressor and so on, in order to constitute a heat pump cycle, thereby the heat energy of water source collected through heat collecting loop circulation in evaporator, is pumped into condenser, then is released to hot water tank through hot water loop circulation and is kept in reserve.

The circulation pump at input of heat pump condenser drives cooling carrier to flow through check valve, cooling carrier side of condenser, T-pipe to supply water of number 1 node of bridge type loops, hot water tank, T-valve of hot water, filter,

circulation pump, to constitute a hot water loop circulation, carrying condensation heat of the condenser to hot water tank. The pipeline for hot water to return joints the bottom of hot water tank, but the pipeline for hot water to supply joints the top of hot water tank, thereby the hot water can be heated up through circulation and can be kept in reserve.

The circulation pump at input of heat pump evaporator drives cooling carrier to flow through check valve, cooling carrier side of evaporator, T-pipe to supply water of number 2 node of bridge type loops, T-valve to supply water of number 5 node, cooling carrier side of indirect heat exchanger, T-valve of indirect heat exchanger, T-pipe to return water of number 2 node, filter, circulation pump, to constitute a heat collecting loop circulation, carrying heat energy of water source collected on the cooling carrier side of indirect heat exchanger to cooling carrier side of evaporator.

This time, the circulation pump of water source drives water to flow through the water source side of indirect heat exchanger, the water is drained off to water source after its heat energy has been absorbed by heat collecting loop circulation and it has been cooled down.

(4) Air Conditioning + Hot Water: As shown in Fig. 1, the compressor of a water source heat pump with 4 functions moves to drive refrigerant flowing through refrigerant side of condenser, expansion valve, refrigerant side of evaporator, compressor and so on, in order to constitute a heat pump cycle, thereby the heat released by fan coil unit and collected through air conditioning loop circulation in evaporator, is pumped into condenser, then is released to hot water tank through hot water loop circulation and is kept in reserve.

The circulation pump at input of heat pump evaporator drives cooling carrier to flow through check valve, cooling carrier side of evaporator, T-pipes to supply water of number 2-3 nodes of bridge type loops, fan coil unit, T-valve of fan coil unit, T-pipe to return water of number 2 node, filter, circulation pump, to constitute a air conditioning loop circulation, carrying evaporation heat of the evaporator to fan coil unit.

The circulation pump at input of heat pump condenser drives cooling carrier to flow through check valve, cooling carrier side of condenser, T-pipe to supply water of number 1 node of bridge type loops, hot water tank, T-valve of hot water, filter, circulation pump, to constitute a hot water loop circulation, carrying condensation heat of the condenser to hot water tank. The pipeline for hot water to return joints the bottom of hot water tank, but the pipeline for hot water to supply joints the top of hot water tank, thereby the hot water can be heated up through circulation and can be kept in reserve.

This time, the circulation pump of water source is closed up, as bridge type loops-water source heat pump with 4 functions is call backing all of heat[9,10,11].

5 Conclusions

In summary, bridge type loops-water source heat pump with 4 functions:

(1) Compared with traditional water source heat pump its functions have doubled and its investment payoff period is reduced by half on the premise of both loops and movement electricity being reduced by half, thus it leads water source heat pump to

develop rapidly toward direction of more functions, higher efficiency, lower cost, and it enables water source heat pump to go upgrade overall.

(2) The hot water use of guesthouse, bathroom, apartment, naval ship and so on, has condition to adopt the way of central direct-current hot water, not only conserving energy and reducing cost, but also removing small water heater and large hot water boiler from application, to decrease the greenhouse effect. Thus it has huge value of energy conservation, environmental protection and economy, and is accord with the strategy of sustainable development, and will change profoundly the way of using energy!

(3) Strategically multi-functions and tactical high performance will enable it to replace overall traditional water source heat pump, to establish the new range pole of heating, air conditioning, hot water system in the whole world. Thereby after the product comes out, it will be certainly to reorganize the market of central heating, air conditioning, hot water; to unify building energy source frame; to promote the level of dwelling energy conservation overall; to carry city civilization forward; to build new and developing industry; to lead further building energy revolution!

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FPD Grayscale Modulation Based on Human Visual System

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Abstract. In order to meet the requirements of FPD's development which FPD must process more and more information, a new modulation method is proposed. Firstly, some available modulation technologies are introduced; secondly, the principle of the human visual system is provided so as to describe the grayscale modulation principle of FPD; thirdly, one human visual model is constructed to provide a basis for the grayscale modulation; finally, the grayscale modulation based on human visual system is used in FPD control system, and the experimental results show that this method is able to break the bottleneck of the FPD grayscale modulation.

Keywords: FPD, grayscale modulation, human visual system.

1 Introduction

FPD (Flat Panel Display, FPD) has been widely used in various occasions. It includes LCD (Liquid Crystal Display, LCD), PDP (Plasma Display Panel, PDP), LED (Light Emitting Diode, LED) and so on. At present, there are many challenges for the development of FPD. One the one hand, the size of FPD becomes more and more large; one the other hand, there are more and more information which FPD have to display with the development of video process technology and digital transmission technology, The control system of FPD must process more and more information, so as to meet the requirments of the display quality [1-4].

The process of grayscale modulation is one of important process for the control system of FPD. The control system is able to process more information and save amount of source if the method of grayscale modulation is good. There are some grayscale modulation technologies which are the time-division method, the frame-division method, pulse width modulation and so on. These available modulation technologies can not meet the requirements of FPD's development. Therefore, a new modulation method must be proposed to break this bottleneck [5-8].

2 Background

Human visual is a complex and sophisticated optical information processing system whose horizontal cross-section is shown as Fig.1. The human visual is combined mainly with the cornea, sclera, iris, pupil, lens, retina and so on [9-11].

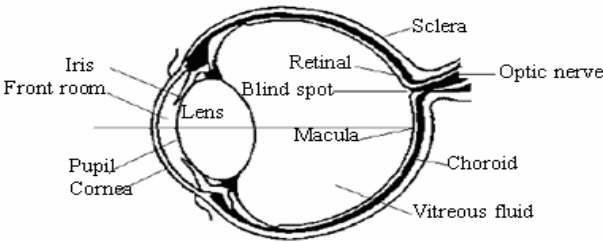


Fig. 1. Construction of the human visual

Most of the human visual characteristics result from subjective factors, and these characteristics has more or less links.

Sensitive role of the human visual is able to automatically adjust with the intensity of light of the outside world. This ability to regulate is called the brightness adaptation. It includes the regulating role of pupil and the adjust function of visual cells. The brightness of uisual system feeling is known as the subjective brightness. Many experimental data show that the subjective brightness is a logrithmix function of the light intensity into the human visual. The brightness adaption has two parts which are dark adaptation and light adaptation. It is called dark adaptation that the light intensity into the human visual change from strong to weak; and it is called light adaptation that the light intensity into the human visual change from weak to strong.

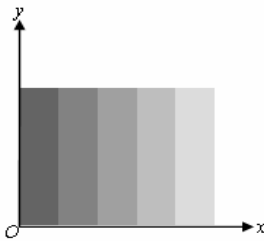


Fig. 2. Vertical distribution of the gray band image

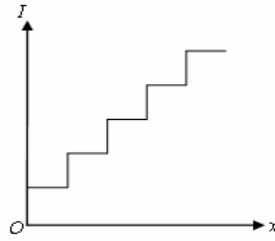


Fig. 3. Intensity distribution of each gray band

There is a vertical distribution of the gray band image as shown in Fig.2. Grayscale intensity of each band is evenly distributed, and the brightness difference between adjacent bands is constant as shown in Fig.3. The human visual feels that the left bertical brightness in band darker than the right while viewing. This phenomenon is called Mach Effect. This is a result of the spatial frequency response of the human visual. The human visual feels the light side lighter and the dark side darker because

the human visual's responding to intermediate frequency signal is higher than the responding to high frequency signal or low frequency signal.

3 Human Visual Principle

The human visual will produce a sense of flickering flashes if the frequency of the light stimulus is not too high. However, the human visual will not feel flickering if the frequency is greater than a particular value. The minimum frequency that does not cause feeling of flicker is called critical flicker frequency and CFF is its short title. The human visual feels the light stimulus like a constant light if the frequency of the light stimulus is higher than CFF. At this time, the intensity of the constant light is caculated by Eq. 1.

$$I = \frac{1}{T} \int_0^T L(t) dt \quad (1)$$

In Eq. 1, $L(t)$ is the real brightness of the light stimulus, T is the period of the light stimulus. The brightness of the human visual feeling is the average brightness of the light stimulus in one period. The brightness of the light stimulus can influence CFF, and the relationship between CFF and I is shown in Eq. 2.

$$n = a \cdot \lg I + b \quad (2)$$

In Eq. 2, n is the critical flicker frequency, a and b are two parameters. CFF increased with light intensity enhancing.

Visual inertia is the feeling of the human visual's brightness will not immediately appear oder disappear but have a dealy time. The human visual response characteristics is shown as in Fig.3. In Fig.3 the solid line denotes the light stimulus, and the dotted line denotes the corresponding human visual response. The retina can not form a stable subjective feeling but takes some time from A to B , when a certain intensity of light stimulus go into the human visual suddenly.

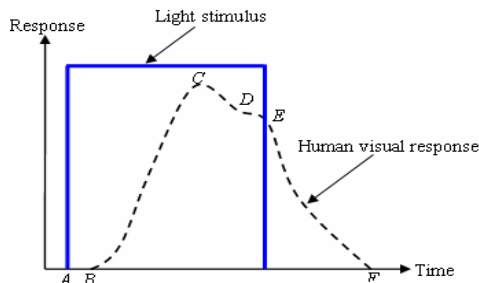


Fig. 4. Human visual response characteristics

4 Human Visual Model

The human visual system is similar to a sophisticated optical imaging system. This system is a two-dimensional linear optical system as shown in Fig.5. In Fig.5, $f(x, y)$

and $g(x, y)$ represents the input and output image of this system respectively. $H(u, v)$ is the transfer function.

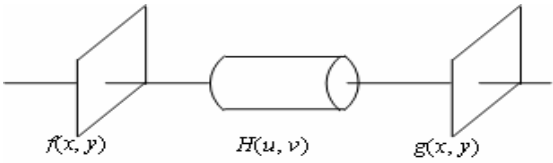


Fig. 5. Optical imaging system

The characteristic of this system can be expressed by the two-dimensional optical transfer function. $F(x, y)$ and $G(x, y)$ is setted to represent the input and output image of the system respectively, and the relationship between the input and output image is shown in Eq. 3.

$$G(u, v) = H(u, v)F(u, v) \tag{3}$$

In Eq. 3, u and v represents the spatial frequency componets in x -axis and y -axis. The transfer function $H(u, v)$ can be expressed by Eq. 4 if $F(x, y)$ and $G(x, y)$ are known.

$$H(u, v) = \frac{G(u, v)}{F(u, v)} \tag{4}$$

In the actual process of applying, the absolute ratio of the frequency of the input and output image is payed more attention, that is

$$|H(u, v)| = \frac{|G(u, v)|}{|F(u, v)|}. \tag{5}$$

$|H(u, v)|$ is called the modulation transfer function for this two-dimensional linear optical system. A possible mathematical expression for the modulation transfer function is shown as Eq. 6.

$$\begin{cases} |H(u, v)|^2 = (1 + 0.05D^2) \exp\{-(D/50)^2\} \\ D^2 = u^2 + v^2 \end{cases} \tag{6}$$

Summary, the human visual model is shown as Fig.6.



Fig. 6. Human visual model

5 Experimental Results

The grayscale modulation based on human visual system is applied to a experimental platform which is combined with four parts as shown in Fig.7.

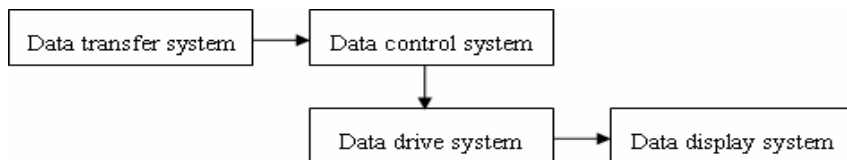


Fig. 7. Experimental platform

These four parts are FPD data transfer system, FPD data control system, FPD data drive system and FPD data display system. The experimental results show that this method is able to break the bottleneck that the available modulation technologies can not meet the requiremen of the FPD's rapid development.

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Research on Simulation of Logistic Impact on the Environment Based on System Dynamics

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Abstract. The rapid development of the logistics industry is going to have some negative impact on environment. How the development of logistics industry influences the environment with the concept of environmental costs is discussed. Also, a simulating model combined with economic, logistics and environmental system is set up. VENSIM is used to simulate and to predict the amount of investment need to be made on environmental pollution treatment. The result can be used for policy making.

Keywords: Logistics, Environment Pollution, System Dynamics, Simulation.

1 Introduction

With the rapid constantly economic growth, the rapid development of Logistics Industry is an inevitable trend, which brings a series of negative consequences, such as air pollution caused by transportation, waste material of the horn side that consumption goods produced in processing production and packaging wastes in logistics process etc.[1]. System dynamics (SD) is a kind of method of dynamic analysis system dynamics, with the traditional management program as background, citing information feedback theory and system theory, through computer simulation calculation, obtain the tracking of the true system [2]. This is in line with the feature requirement of economic system, logistics system and environment system. Using this method can realize the following functions: Establish the model of the system among economic, logistics and environment, with environmental cost as a lever to discuss the impact of logistics on the environment. According to the simulation results, this paper will provide the decision support for formulating policies.

2 Model Establish

The model is divided into three subsystems: economic subsystem, logistics subsystem, and environment subsystem.

2.1 Economic Subsystem

Considering the purpose of the model and analyzing the collected information, from various elements can be found, the typical variables which describe the abstraction of the subsystem, economic subsystem variables sets are as follows:

Box Variable-Level variables: Gross Domestic Product (GDP); Variable-Auxiliary/constant: First Industrial Added Value(FIAV), Second Industrial Added Value(SIAV), Third Industrial Added Value(TIAV), Freight Volume(FV), The First Industry Generated Coefficient(FIGC), The Second Industry Generated Coefficient(SIGC), The Third Industry Generated Coefficient(TIGC)[3]; Rate variables: economic growth (EG), economic hinder (EH). Under the circumstance of unchanging of three industries investment's ratio, the growth of GDP will increase the investment of three industries, investment returns will improve correspondingly. Output value of three industries gets higher, GDP gets higher, and three industries will generate different freight volume. System causality diagram is shown by Figure1. DYNAMO language is a simulation language which faces to the different equations, in effect to show some moment value for variable in the process of simulation, add“.” and time symbols behind the variables, namely, the time symbols plus time subscript J, K, L, JK, KL. J means “before a DT moments”; K means “now moments”; L means “a DT after future moments”; JK means “from J to K”; KL means “from K to L” [4]. The causal feedback figure of the economic subsystem is changed into flowcharts, the economic subsystem equations are as follows:

$$\text{GDP.K} = \text{GDP.J} + \text{DT} * (\text{EG.JK} - \text{EH.JK}); \text{FV.K} = \text{FIAV.JK} * \text{FIGC} + \text{SIGC.JK} * \text{SIGC} + \text{TIAV.JK} * \text{TIGC};$$

2.2 Logistics Subsystem

Logistics subsystem is mainly composed of transportation, warehousing and lauds composition. Logistics subsystem variables sets include:

Box Variable-Level variables: Logistics Industry Capital (LIC); Auxiliary/Variable: Transportation Added Value (TAV), Ware-housing Added Value(WHAV), Postal Service Added Value (PSAV), Freight Volume (FV), Transportation Table(TRTABLE), Ware-housing Table (WHTABLE), Postal Service Table(PSTABLE), Logistics Assets Depreciation Rates (LADR); Rate variables: Logistics Industry Capital Value (LICV) and Logistics Depreciation of Fixed Assets (LDFA)[5]. Logistics mainly consists of traffic transportation industry capital added value, ware-housing industry capital added value, and post service industry capital added value. They are determined by freight volume. Logistics subsystem causality diagram is shown by Figure2.

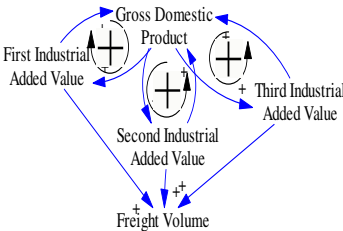


Fig. 1. Economic subsystem causality

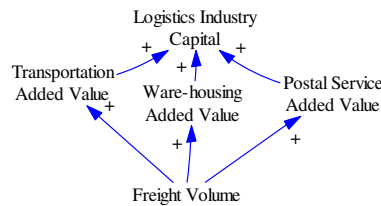


Fig. 2. Logistics subsystem causality

The causal feedback figure of logistics subsystem is changed into the flowchart, so logistics subsystem equations are as follows:

$LIC.K = LIC.J + DT * (LICV.JK - LDFA.JK)$; $LICV = TAV + WHAV + PSAV$; $TAV.KL = TABLE(TAV, FV.K, 0, 227.58, 135.87)$; $WHAV.KL = TABLE(WHAV, FV.K, 0, 227.58, 135.87)$; $PSAV.KL = TABLE(PSAV, FV.K, 0, 227.58, 135.87)$; $LDFA.K = LIC.KL * LADR$;

2.3 Environment Subsystem

The environment subsystem variables sets include:

Box Variable-Level Variables: Environment Cost(EC); Variable-Auxiliary/Constant: Exhaust Emission (EE), Solid Waste Emission (SWE), Pollution Accidents (PA), Exhaust Pollution Incidence (EPI), Solid Waste Pollution Incidence (SWPI), Pollution Disposal Investment Share of GDP (PDISOG), Pollution Direct Economic Loss Table (PDELTABLE), Pollution Disposal Investment Share of GDP Table (PDISOGTABLE); Rate variables: Pollution Treatment Investment (PTI) and Pollution Direct Economic Loss (PDEL). To prevent pollution enlargement, the government will control the development's speed of transportation, warehousing and post service. If three industries develop rapidly, this will bring exhaust emission and solid waste emission. Then it increases pollution treatment investment and pollution direct economic loss. Finally, it will cause the increase of environment cost. System causality feedback diagram is shown by Figure. 3.

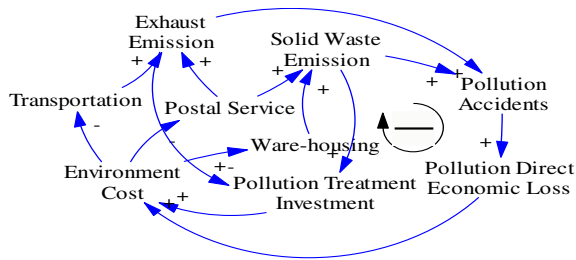


Fig. 3. Environment subsystem causal feedback

The causal feedback figure of environment subsystem is changed into the flowchart, so environment subsystem equations are as follows:

$EC.K = EC.J + DT * (PTI.JK + PDEL.JK)$; $PA.K = EE.JK * EPI + SWE.JK * SWPI$; $PDEL.KL = TABLE(PDEL, PA.K, 0, 2411, 462)$; $PDISOG.KL = TABLE(PDISOG, PA.K, 0, 2411, 462)$; $PTI.L = PDISOG.K * GDP.JK$;

Three subsystems occur by the interaction or interdependent between the input and output variables. The operating of each subsystem doesn't only depend on their internal structure, but also constrain by the change of their external conditions. The flowchart diagram of economy, logistics and environmental system is shown by Figure 4.

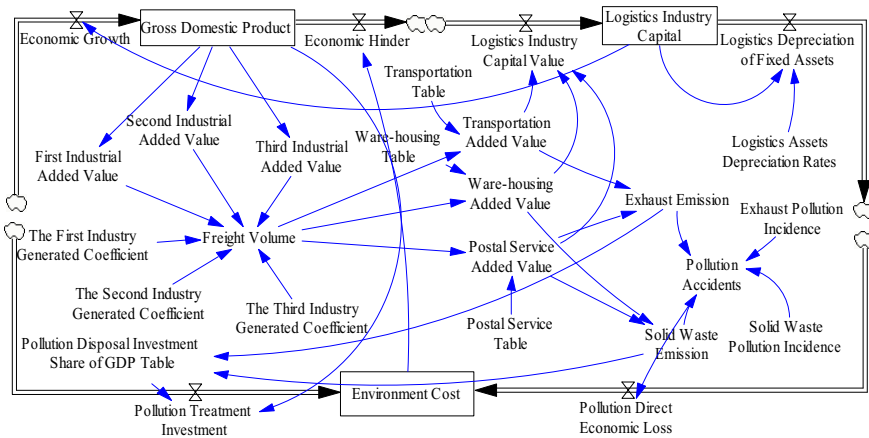


Fig. 4. System flowchart of economy, logistics and environment

3 Model Validations

Realistic logistics system, economic system and environment system are very complex. The model only is the abstraction and approximation of the reality system. Therefore, the model validation must be taken before the simulation experiment. This paper mainly uses GDP and Pollution Treatment Investment to verify the model's effectiveness. Using VENSIM software, select the data from 2006-2009 years to verify the model's effectiveness. The inspection results are shown by Table 1.

Table 1. GDP and pollution treatment investment inspection results

GDP	Year	Historical value[bn]	Simulation value [bn]	Relative error[%]	Pollution treatment investment	Year	Historical value[bn]	Simulation value[bn]	Relative error[%]
	2006	21631.4	21565.3	-0.31		2006	256.6	263.5	2.7
	2007	26581.0	25964.8	-2.30		2007	338.7	351.6	3.63
	2008	31404.5	31530.6	0.40		2008	449.0	420.2	-6.5
	2009	34050.7	34620.8	1.67		2009	452.5	462.8	2.27

According to the results of the tests, the average relative error of GDP is 1.144%, the average relative error of pollution treatment investment is 3.362%.So this model has a certain reference value, and carries out the following simulation.

4 Simulation Test

In the simulations, the starting point is 2000, the end is 2020, simulation time interval $DT = 1$ year. Through the model above, using VENSIM software to take a simulation, the impact of logistics industry on environment is shown by Figure 5; the environmental pollution treatment investment is shown by Figure 6.

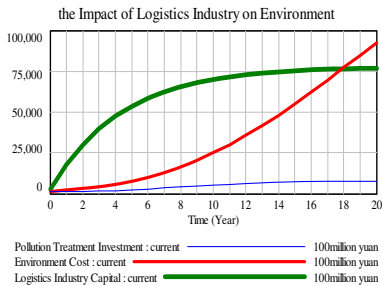


Fig. 5. The impact of logistics industry on environment

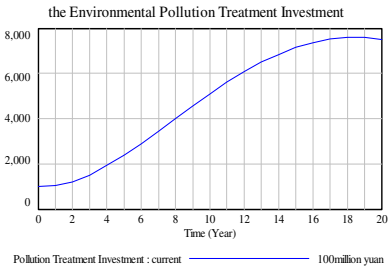


Fig. 6. The environment pollution treatment investment

From the Figure5 can be seen, the impact of logistics industry on environment, 2000-2012 logistics industry develops rapidly, the environment cost continuously improve ,that is to say, environment pollution is on the rise. From 2012 to 2020, it is going to release, while the pollution will continue. After 2012, logistics industry will develop slowly and even stagnate, because environment pollution is worsening. From Figure 6 can be seen, according to this model, it predicts that the pollution treatment investment is 7918.98 billion Yuan in 2020. So the government departments should strengthen environment protection, can also regulate reasonably the scale and speed of development of logistics industry.

5 Conclusions

Through the establishment of model of economic, logistics and environment system, with environment cost as lever, this paper discusses the impact of logistics industry on environment, and it is concluded that dynamic simulations about the impact of logistics industry on environment. In the end, this paper forecasts environment pollution treatment investment in the future. Environment pollution measures the degree with indicators, so environment cost as economic indicators is chosen; the change of environment cost can measure the pollution degree. To ensure the sustainable development of the logistics industry, pay attention to the environment protection and optimize resource allocation.

Acknowledgment. We express thanks to the Research Projects on Development Mode and Planning of Logistics Industry Cluster in Shenyang Economic Zone (Grant No. 111273).

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Method for Forecasting the Logistics Demand of Shenyang Economic Zone Based on BP Neural Network

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Abstract. Through analyzing the economic factors that affect regional logistics demand, this paper chooses the indicator for determining the logistic demand, a BP neural network model of logistics forecasting is established. Then this paper researches the forecast of Shenyang Economic Zone logistics demand, to ensure the development of economic and logistics in Shenyang Economic Zone more coordinated development, and the purpose to provide guidance for the planning, design and development of Shenyang Economic Zone logistics system.

Keywords: Logistics Demand Forecasting, The BP Neural Network, Shenyang Economic Zone.

1 Introduction

Logistics demand forecasting is to use the historical data and market information to make scientific analysis, computation and inference of the future logistics demand status, its meaning lies in the guidance and adjustment of people's logistics management activities, and take appropriate measures and strategies to seek for the best interests. In the early of this century, Chinese scholars began to study logistics demand forecasting method, at early stage, the main methods are as follows: Input-output model, regression analysis, elastic coefficient method and so on[1]. This kind of method can deal with sequencing and linear data, with the development of logistics demand forecast research, those methods is not suitable in solving nonlinear data. As the exposure of those problems, artificial intelligence technology introduce in the logistics demand forecast is considered to improve the performance of model. But now most of the documents only reviewed the forecast method, this makes no real sense. So this paper deals with the study of logistics demand forecasting in Shenyang Economic Zone, proofs the feasibility of forecasting logistics demand by BP neural network in practice.

2 Logistics Demand Indicator Chosen

In general, the determining factor influencing regional demand on logistics is the overall level of economic development of the zone[2]. The higher the level of

regional economic development is, the higher the demand for circulation of product and raw materials is, and it defines logistics quantity demanded of the zone.

The industrial structure also has a very big impact on logistics demand. The requirement quality and quantity of different industrial structural districts have tremendous variations.

The regional business is an important factor to affect the requirement of the logistics, as the more frequent a regional business is the more power it will create to bring the regional sales, as the more sales developed the logistics will be more frequent.

At present, the connection between nations and regions gets closer, with the developing commercial activities between nations and regions there will be a greater requirement for the logistics of goods and materials space transferring. It can be seen the foreign trade logistic takes a great amount of regional logistics.

Due to the increasing of people living standard, more and more forceful demand for the basic and multiple for the goods of the resident, with the increasing purchasing power of the resident, short run large number multi species dispatching activities will be more and more often, it is an important part of regional logistics.

It is an important index of fixed investments to judge an economic steady growth; the fixed investments will change into production capacity as to increase the amount of logistics. In conclusion taking the total regional production, the first industry output value, the second industry output value, the third industry output value, the consumable detail sales, the whole year average per person expenditure value of export and fixed investment as an index to effect the logistics, expressing the requirement of logistics by the regional volume of rail freight and then constructing BP neural network model with these 8 indexes mentioned before, making an forecast of logistics demand of Shenyang Economic Zone.

3 Research on Logistics Demand Forecasting of Shenyang Economic Zone

3.1 The BP Neural Network

The BP neural network includes input layer, output layer, and intermediate layer. Intermediate layer is hidden, can be one layer or several layers. Because of the introducing of hidden neurons by multilayer neural network, neural network has better capability of classifying and memory. The BP neural network learning process has two parts: positive dissemination and back propagation. In positive dissemination, information from input layer through the processing of intermediate layer to output layer, if the output doesn't achieve the desired result, then turn back propagation, the original error signal will return along the route. In this process, modify the weights of each neuron. This process will continuously circulate until the error is narrowed to the extent permitted.

3.2 BP Neural Network Structure Design

1. The network layer determination

Robert Hecht---1989 Nielson prove a three-level BP neural network can approximate any continuous function in closed interval with arbitrary precision. Three-level BP neural network can satisfy the need of logistics demand forecasting.

2. Neuron number of each layer determination

Neuron number of input and output layer can be determined by the problem. The input layer neuron number should be the number of factors which influence the economic and has strong correlation with logistics. The output number should be the number of factors which describes the logistics demand. Hidden neurons will be determined based on predecessors' experience and many experiments of your own. If hidden nodes is not enough, the network will not create complex mapping relationship, once the network training can't be finished, it can't identify the samples that didn't appear previously, so the fault tolerance is relatively low; But if hidden nodes are too many, it will make network learning time too long, but the error is not necessarily the smallest, so, designing hidden nodes number must consider many factors. Specific means is: First of all, according to the empirical formula determine primary number, then train the network with different neurons number contrast, lastly determine the ultimate neuron number.

3. Transfer function and training algorithm chosen

BP neural network gets its learning and training through transfer function and training algorithm, so the transfer function and training algorithm are very important for it. Frequently-used transfer function includes log-sigmoid, log-sig, tan-sigomid, tansig and linear function purelin. Which function will be chosen must consider the complexity, network weights, threshold number, expectation error and so on. Usually training function can choose sigmoid type function.

3.3 Data Processing

When training the network, we usually process the input and output data firstly with normalization method; it will accelerate the training speed. On the outside we process the data through reverse normalization method to make the output data in the same interval with the raw data. There are a lot of normalization and reverse normalization method can be chosen.

4 Research on Logistics Demand Forecasting of Shenyang Economic Zone

Shenyang Economic Zone include eight cities such as Anshan, Fushun, Benxi, Yingkou, Fuxin, Liaoyang, Tieling and Shenyang[3,4]. Through the central city Shenyang economy radiation and attractive, one regional economic community is created among these cities. With this Economic Zone has risen as one national strategy, the development of its integration attracts more and more attention, and if we want it to develops smoothly, reasonable planning should be carried on for its logistics network. Logistics network planning and economic development of the

Economic Zone is inseparable, they are the most important factors, because logistics demand forecasting is the foundation of logistics network planning, so using BP neural network to build Shenyang Economic Zone logistics demanding model has great significance for the logistics network planning of the zone, and will greatly promote the Shenyang economic integration process.

There are eight neurons that can be determined to input. Freight volume is considered as indicator to reflect logistics demand, so that the output of neurons has one, but in hidden according to a three-layer neural network experience equations:

$$S = M(N + 1) + 1 \quad (1)$$

S means the number of hidden nodes, M stands for input node number, and N stands for output node number. therefore the hidden nodes are determined temporarily to 17, within this range finally is determined implied node internal 11-20, According to error analysis adjusted and trained ,the optimal number of hidden nodes are determined for 12.

Tansig function is chosen as the transfer function of intermediation, because s-type transfer function usually choose in the hidden transmission [5]; Levenberg-Marquardt is chose as the training function, named trainlm. Levenberg-Marquardt algorithm converges fast its expression for:

$$X_{k+1} = X_k - [J^T J + \mu I]^{-1} J^T e \quad (2)$$

If scalar factor $\mu=0$, it turns out the approximate Hessian matrix to plan the Newton algorithm; If the scalar factor is very big, it becomes namely minuet long gradient descent method, because quasi-Newton method in error minimum point near usually can determine the convergence faster more precisely, so the purpose of this algorithm is quickly converting algorithm to Newton method. So if train successfully, error function will decrease, and scalar factor value will reduce; if trained unsuccessfully, the scalar factor value will increase. To use this method makes the error function drop to minimum value with iterative .Output functions select purelin.

Through searching and collecting relevant material to get the data. Data are normalized to domain convergence to [-1, 1] with MATLAB, and using function premmmx also can achieve it, the algorithm is as follows:

$$PN = 2 * (PN - \min p) / (\max p - \min p) - 1 \quad (3)$$

Forecasting method is the rolling forecast; specifically it is inputting 2000 - 2006 data which influence logistics demand of Shenyang Economic Zone, outputting 2002-2008 data of the freight volume of Shenyang Economic Zone. Forecasting methods are classified into a single step and multi-step. Practice proves single-step prediction is more accurate than multi-step forecast, but single-step prediction can only predict freight volume in next year, so multi-step forecast should be chose with comprehensive consideration

With the weight initialization and the network train, Fig.1 shows the training result that the requirements are satisfied after 134 iterations, and error is dropped below $1e - 5$, value for Y = 0.9984 0.998 3 0.9983 0.9997 0.9997 0.9999 0.9976 0.9972, which proves this network model is feasible.

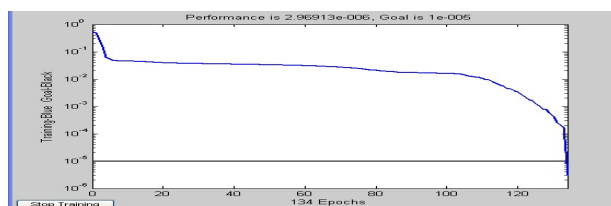


Fig. 1. Error curve

Importing data of 2007 into trained network, and then get predictive value of 2009 freight volume $T_1=[1.24756]$, use postmnmx function reverse normalization, get 90892.31 tons' freight volume of Shenyang Economic Zone of 2009, but actual freight volume of 2009 is 88929.67 tons, error rate is 2.206%. Generally speaking, it is accurate if the error rates can control within 5%, so this model has certain reference value.

Through the introduction of each index data in 2009, get the freight volume of Shenyang Economic Zone of 2010 and 2011 $T_1=[1.2301]$ $T_2=[1.5061]$. Through the reverse normalized, get 99109.292 tons' freight volume of 2010 and 111372.096 tons' freight volume of 2011.

5 Conclusion

Based on the basic theory of logistics demand and forecast, this paper analyzes some factors which have influence on logistics demand of Shenyang Economic Zone, chooses eight factors as indicators which have impact on logistics demand of Shenyang Economic Zone. Then this paper demonstrates concrete steps of forecast of logistics demand with BP neural network and does empirical research to logistics demand of Shenyang Economic Zone, which proves feasibility of applying BP neural network in forecast of logistics demand and proves that BP neural network can overcome drawbacks of traditional forecast method. At the same time, this paper provides guidance for the planning, design and development of Shenyang Economic Zone logistics system. From the prediction results, the quantity demand of the logistics in Shenyang Economic Zone grows at an average annual rate of 9.3%. Logistics in Shenyang Economic Zone need to be greatly expanded, which aims at promoting the local economic development, and then become a new growth point for Shenyang economic development.

Acknowledgment. We express thanks to the Research Projects on Development Mode and Planning of Logistics Industry Cluster in Shenyang Economic Zone (Grant No. 111273).

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Simulation and Analysis on Flow and Pollutant of Jinan Queshan Reservoir

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Abstract. Simulate and analysis on flow and pollutant of Jinan Queshan reservoir by using MIKE21 hydrodynamic templates and ECOLAB water quality templates. Simulate with four seasons, and take spring for example to simulate four cases: no water nor supply, only water no supply, only supply no water, water and supply. Simulation results show that the ammonia nitrogen degradation has seasonal changes. The reservoir forms circulation in the northeast, the ammonia nitrogen degradation is slow because of slow flow. The diffusion takes an important part in the ammonia nitrogen transportation. The research can provide a reasonable basis for the development of contingency.

Keywords: Ammonia nitrogen, Jinan Queshan reservoir, MIKE 21, concentration field, flow field.

1 Preface

Ammonia nitrogen is the main pollutions of the reservoir quoting of the Yellow River, and is the main research object of the water quality model. Using a computer software to simulate Ammonia nitrogen transporting, the calculated result is more accurate and efficient. After comparing the measurement values and simulation values, Mike 21 can simulate the ammonia nitrogen transporting correctly. There are many influence factors of ammonia nitrogen migration degradation, use Mike 21 to simulate different drainage situation of the migration of ammonia nitrogen, can reflect the effect to the flow velocity and concentration intuitively, it offers a scientific basis to the reservoir manager.

2 Introduction of Software

Mike21 software is a kind of numerical analysis software relatively advanced. Mike21 numerical calculation and analysis software is mainly used for simulation rivers, lakes and estuaries, reservoirs and other surface water flow and the gulf, coastal and ocean currents, waves, sediment transport and water environment change[1]. The software with the advanced graphical user interface and high combination of computing engine makes it widely used for many professional coastal engineering[2]. The ECO Lab is a comprehensive, ecological simulation numerical

lab, it offers from simple to complex solution and provides a series of templates, user can choose according to their specific applications. Model can describe the physical settlement process, Can also describe chemical, biological and ecological process and the interaction between state variables. A ECO Lab template includes mathematical description of the ecological system or a series of general differential equation. There are six parts in the mathematical description: state variables, constant, forcing, auxiliary variate, process, derivative results.

3 Model Building

Reservoir Situation. Queshan regulation and storage reservoir of Jinan Yellow River is located in the lower north area of the Yellow River, which belongs to the Yellow River alluvial plain. It east to the Yellow River levee, south by the original JinPu railway, north depends on north Yellow River levee. The reservoir plane nearly triangle, which is gently topography, ground elevation is commonly 23.5-24.5 meters, average library bottom elevation is 22.4 meters. Due to artificially earth-gathering, dig ponds to fish, and surface rivers flush, all round and central in low-lying along, Reed pond, swamps are everywhere. The lowest zone is in DaWu export damages, where the elevation is 22.4 meters. Around the zone, the top of the north levee is 32.6-40.0 meters, 9 meters above ground. The top of the Yellow River levee is 36 meters, near beach surface is 29 meters, 3-5 meters above ground. JinPu railway constructed elevation is about 26 meters, 2-6 meters above ground.

Reservoir waters by 1 # pumping sand bar into the sink drains through 3.2km sinking sand drains and reservoir water culverts sent to 2 # pumping station pool. Ascent to storage reservoir by 2# pump, finally send to the ground water works by steel turbocharged, the scale is 44 million m^3 / d [3].

Topographic Map Pretreatment .Terrain pretreatment is one of the important contents of numerical simulation of water dynamics, also an important link of numerical simulation development [4]. Determination of the reservoir topographic map uses existing material, determine the latitude and longitude coordinates, inducts to the software after transformation, after repeated debugging make mesh size as far as possible even, considering the grid size, grid number and computing speed, the balance between the simulated result, we will terrain profile into 945 triangular meshes, 1468 surfaces, 524 nodes. Simulation area biggest grid side is no more than 200 meters, minimum length not less than 80 meters, import and export import boundary line to add definition and outlet boundary.

Interpolation is the most important step in the terrain pretreatment, from the discrete format, the terrain of the interpolation method pretreatment are mainly grid method, the structure of the grid method and the structure of structure, structure grid phase combination. Mike 21 model involves belong to structure the grid [5]. According to the material, choose different 13 points position to interpolate, get reservoir topographic map.

4 Relevant Problems Processing

Roughness Choice. The roughness of the reservoir is related to the form, the roughness of the bottom, vegetation growth condition, water level's height, reservoir alluvial and renovation artificially buildings. The roughness value or change rule affects the drag of the equations, thus brings direct influence on calculating results [6]. In the study we use the experience value here $32\text{m}^{1/3}/\text{s}$.

Time and Space Steps. Discrete format with discrete equations should be compatible with the original equations for premise, and require its convergence and stability are satisfied. How to properly select space for computing time step will have a direct impact on processing [6]. Here after commissioning, we selected step of 10800s, simulation steps for 80.

5 Validate Model

The water temperature is an important variable of water quality, other index is relevant with water temperature [7]. According to the reference Ammonia nitrogen degradation process tend to have obvious seasonal changes [8,9]. The role of the flow has certain effect on the degradation of ammonia nitrogen, especially in having a pollution sources. The diffusion of water has a great influence to the migration of pollutants. Therefore this paper research the ammonia nitrogen migration in four seasons and different reservoir scheduling case. Spring take March 3, 2008-13 for example, summer take July 23, 2008-August 1 for example, autumn in October 2008 16-26, for example, winter to December 8, 2008-18 for example. Model validation, take on March 3, 2008-13 (spring), 2008 July 23 - August 1, 2008 (summer) on October 16-26 (autumn), December 8, 2008-18 (winter), four time data to compared measured and simulation value. Through verification results of simulation value, the standard variance is 0.0363, the simulation results is discrete low, dovetails well. The acquisition is measured around the surface 0.5 meters, simulation process without considering the layer, therefore simulation value and values have certain error. Initial error will reduce gradually for long time, but the change trend of the concentration is consistent, so the software can be used to simulate the ammonia nitrogen migration trend.

6 Result Analysis and Discussion

Discussion for Season

(1) Spring

The temperature of the reservoir water about 15 to 19 °C in spring, the simulation periods temperature is 21 °C. The discharge of inlet is $10.08\text{ m}^3/\text{s}$, the outlet is $7.5\text{ m}^3/\text{s}$. The initial concentration of ammonia nitrogen in the water is 0.157 mg/l, the average concentration in the inlet is 0.2mg/l, on the March 7 ammonia nitrogen concentration of incoming water is 0.243 mg/l, no data collection in observation on

March 8 and 9. According to the simulation result by Mike21, ammonia nitrogen concentration reduce to 0.205114 mg/l after 72 hours decreased by 15.59%. The simulation result is show on Fig. 1.

(2) Summer

The water temperature in summer is around 25°C in reservoir, the flow in inlet is 17.5 m³/s, in outlet is 7.79 m³/s, initial water ammonia nitrogen is 0.2mg/l, the average concentration in the inlet is 0.232mg/l. On the July 30, ammonia nitrogen concentration of incoming water is 0.356 mg/l, ammonia nitrogen concentration is 0.239082mg/l on August 2, decreasing by 32.84%. The simulation result is show on Fig. 2. Increasing water temperature , ammonia nitrogen degradation accelerates apparently. Temperature has an obvious influence on the metabolism of nitrifying bacteria [10]. The optimum temperature of the most nitrifying bacteria growth is 25-30 °C [11].

(3) Autumn

The water temperature in summer is around 23°C in reservoir, the flow in inlet is 20.1m³/s, in outlet is 9.53m³/s, initial water ammonia nitrogen is 0.182mg/l, the average concentration in the inlet is 0.161mg/l. The concentration in the inlet is low, it reduces from the inlet. On the October 20, ammonia nitrogen concentration of incoming water is 0.185 mg/l, ammonia nitrogen concentration is 0.174065mg/l on August 2, decreasing by 5.91%. The concentration of ammonia nitrogen in the inlet is low, it changes from the inlet, reducing gradually. The simulation result is show on Fig. 3 .

(4) Winter

The water temperature in winter is around 17°C in reservoir, the flow in inlet is 10.08m³/s, in outlet is 8.14 m³/s, initial water ammonia nitrogen is 0.185mg/l, the average concentration in the inlet is 0.2mg/l. Besides the inlet, the concentration is high in northeast. On the December 15, ammonia nitrogen concentration of incoming water is 0.206mg/l, ammonia nitrogen concentration is 0.205862mg/l on December 18, decreasing by 0.06%. Compared with the summer ammonia nitrogen degradation slow, diffusion is slower. Due to the slow velocity, pollution regiments near the inlet. The simulation result is show on Fig. 4.

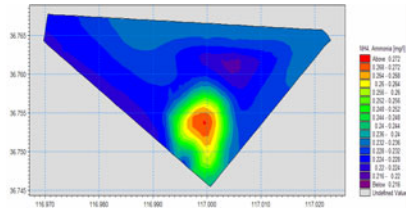


Fig. 1. The concentration field on March 10

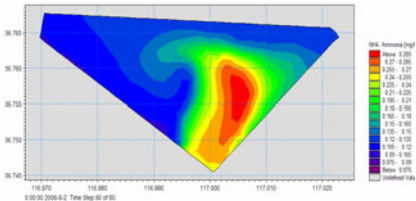


Fig. 2. The concentration field on August 2

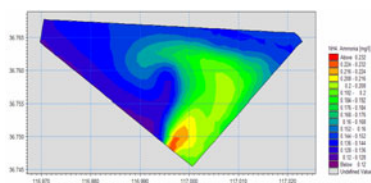


Fig. 3. The concentration field on October 25

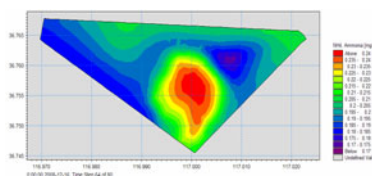


Fig. 4. The concentration field on Dec 16

Discussion in Different Scheduling Case. According to the model, simulate on March 3, 2008 to March 13. Observe the ammonia migration in 240 hours for different water supply conditions.

(1) No Water Nor Supply

Water reservoir near the mouth of the West Bank formed a counter-clockwise circulation, clockwise circulation in the middle of the reservoir, clockwise circulation in the northeastern coast of the reservoir, counter-clockwise circulation in the East coast, mainly due to topography. The velocity is low during the migration process. The distribution of ammonia concentration is influenced by topography in closed boundary conditions. The concentration in the southwest is lower than northeast, which is correspond with the distribution of water depth, where water is deep, the concentration is low. The simulation result is show on Fig. 5.

(2) Only Water No Water Supply

Only the case of water, the velocity in the inlet is fast, other parts are slow, the velocity becomes slow from inlet to the north, which rendering counter-clockwise circulation. Under the diffusion the water pollution move to the northeast, in the process of moving, the concentration reduces gradually. The concentration in the southeast is high, because of high velocity. The simulation result is show on Fig. 6.

(3) Only Supply No Water

The velocity is large, water exchanges fast, therefore the concentration is low. The velocity is faster in the southwest and northeast than other parts, the degradation is rapid. Due to the topography, a clockwise circulation is formed in the reservoir. With the largest depth the concentration is low. The concentration shows ladder-type distribution. It is high in the northeast for the low velocity. The simulation result is show on Fig. 7.

(4) Water and Supply

The flow trends from inlet to outlet, the velocity is large, forming clockwise and counterclockwise circulation in the east and west of inlet. The pollution spread to northeast and to the outlet. Through the process, the concentration of the other parts of the reservoir is low, it decreased along the flow direction, perhaps due to the self-purification [12]. The simulation result is show on Fig. 8.

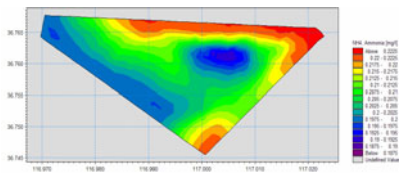


Fig. 5. The velocity field of no water nor supply

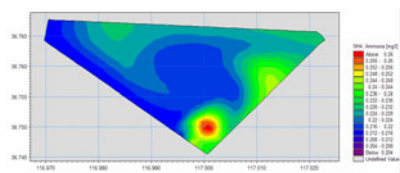


Fig. 6. The velocity field of only water

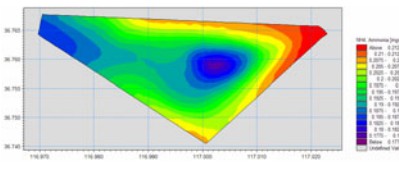


Fig. 7. The velocity field of only supply

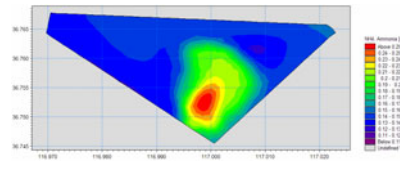


Fig. 8. The velocity field of water and supply

7 Results and Discussion

Seasonal simulation results show that the degradation of ammonia in Queshan reservoir is seasonal. Ammonia degradation is summer>spring>autumn>winter. There may be inconsistent with the water temperature because of the supply in spring and autumn. The concentration of ammonia in the reservoir shows ladder distribution, south lower than north, west lower than east, may be affected by reservoir topography. With the four different water supply situations and the comparison of ammonia degradation, we understand that the velocity and the concentration of the inlet take an important part in the degradation, and have spread to northeast. Therefore the manager should control the velocity and the pollutant concentration. The concentration is concentrated near the inlet, the diffusion of the flow plays an important role in migration, so control the water flow can reduce the diffusion of the pollution. It forms circulation easily in northeast, the concentration of ammonia is high.

8 Conclusion

- (1) Simulate and predict concentration of ammonia by using Mike21 can see the ammonia transport intuitively, the results proved scientific basis of ammonia pollution for the manager. The software can predict the ammonia pollution migration and proliferation, and thereby provide a reasonable basis for the development of contingency .
- (2) In different water supply conditions, the ammonia transport direction is consistent with the direction of velocity. The pollution migrates to the northeast and diffuses to the outlet, the velocity is slow in northeast, so the concentration is high, which is prone to eutrophication.

(3) The water temperature of the reservoir is summer>autumn>spring>winter, the degradation of ammonia is summer>spring>autumn>winter. Through the analysis of simulation, with the seasonal changes, higher water temperature, higher concentration.

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The Research of Peer-to-Peer Wireless Network Based on Open Source Linux Routers

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Abstract. In this paper we present our work towards deploying a community wireless network with ad hoc communication and routing between its elements. We describe our network model and implementation of wireless routers, while motivating decisions and pointing out open issues. The main advantage of our approach is the low deployment cost and inherent flexibility in terms of adapting the network configuration with little or no human intervention, which in turn can be exploited to support the dynamic addition, removal and mobility of network elements.

Keywords: Linux, peer-to-peer, wireless.

1 Introduction

The deployment of infrastructure-based wireless networks has been straightforward and cost-efficient since wireless access points based on the 802.11a/b/g standards have entered mass production. However, this is not the case for ad hoc wireless networks given that wireless routers with ad hoc capabilities are hard to find in the market and are also quite costly. Another problem is that most such platforms are proprietary and closed so that it is impossible to change internal settings let alone reprogram the network elements, for example to install a new routing or power management algorithm.

In this paper we present our work towards developing a community wireless network, which employs low-cost, off-the-shelf 802.11b/g wireless routers running a custom Linux distribution. The network operates in ad hoc mode, thereby resulting in great flexibility and reduced administration.

2 Network Model

Our approach is illustrated in Fig.1., showing an indicative configuration that comprises several stationary and mobile network elements with typical deployment options to support fixed terminal devices. It is motivated and described in more detail below.

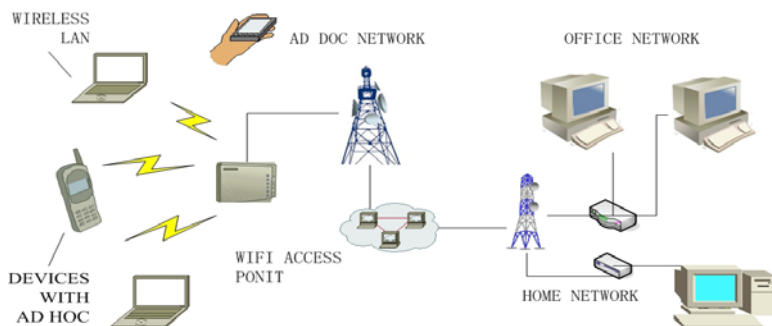


Fig. 1. Network Model

A pure ad hoc and peer-to-peer networking approach was chosen to support this functionality. This is because we wish to be able to add new network elements without having to reconfigure the ones that have already been deployed. Even though such changes can be performed using a combination of remote configuration tools and scripting, they still require human intervention and assume that all network elements are up and running during the update process. Automatic adaptation when network elements are removed or do not respond is even more important. Failures are likely to occur occasionally, e.g. due to software glitches, hardware problems, power outages, or people resetting the equipment installed in their homes by accident. Moreover, in the case of mobile network elements topology changes are the rule rather than the exception thereby making manual reconfiguration practically impossible.

In terms of end-user devices (terminals), we support two options: fixed and mobile terminals. In the first case, a device such as a personal computer or IP-enabled appliance connects to the ad hoc wireless network via a local area network. Several terminals can be connected to the network in this fashion, via the same network element. In the second case, a mobile device such as a laptop or handheld computer connects to the network via an ad hoc wireless connection to any nearby network element of the system. Mobile terminals may optionally assume the role of network elements with routing functionality, thereby enhancing robustness and increasing the bandwidth of the system. The distinction between fixed and mobile terminals is at the level of the IP protocol layer software and transparent for the applications residing on terminals.

3 Implementation of Process

The choice of the wireless technology to be used was “naturally” trivial, with 802.11b/g being the only practical option given its wide industrial adoption, high-speed potential, and support for both infrastructure and ad hoc operation modes.

3.1 Implementation of the Ad Hoc Wireless Router

We decided for the Linksys WRT54G and WRT54GS broadband wireless routers, which come with a Linux-based firmware and source code published under the

General Public License. The WRT54G device (v 2.0) features 4MB Flash memory, 16MB RAM, Broadcom BCM4702KPB MIPS CPU at 125MHz, two 10/100 Ethernet controllers and an ADMtek ADM6996 5 port 10/100 switch. The switched ports are separated into two different Virtual LANs (vlans), one for the LAN interface of the router comprising of 4 switched ports, and another intended for external Internet connectivity (WAN port).

The enhanced WRT54GS version features 8MB of Flash memory, 32MB RAM, Broadcom BCM4712KPB MIPS CPU at 200MHz. Both devices have on-board interfaces for connecting to indoor or outdoor antennas.

We also found out that several people had started developing their own branches of the firmware, with OpenWRT being a typical case [1]. Experimentation in the lab with WRT54G and OpenWRT proved that this particular hardware/software combination (henceforth referred to as the LR platform) met our requirements, and was therefore chosen as a basis for developing our own ad hoc wireless router and community network.

Routing of IP packets in the ad hoc network is dynamic, as a function of topology changes. We decided to use the Optimized Link Source Routing protocol, due to its inherent flexibility, scalability potential and reduced administration overhead characteristics [2]. OLSR is a proactive, table-driven routing protocol based on the issue of Multipoint Relays (MPRs). It is considered to be well suited for large and dense networks with low mobility rates [3]. We tested a number of different solutions to choose a stable and highly configurable implementation.

We finally decided to use the “olsrd” implementation, as it proved to be stable, lightweight and expandable [4].The internal router configuration is as follows. The LAN interface, which is attached to the 5-port switch, is identified as eth0. The switch separates the ports into two Virtual LANs, one comprising of 4 ports (LAN segment), and another assigned to the WAN port. The LAN segment is addressed as vlan0 while the WAN port is identified as vlan1. Finally, the Wireless interface is identified as eth1. In the default configuration, eth1 and vlan0 are bridged together. We decided to separate these interfaces because we assume that devices connected to the router's LAN are terminals that do not (have any reason to) support ad hoc routing. A diagram that illustrates the router setup approach is shown in Fig.2.

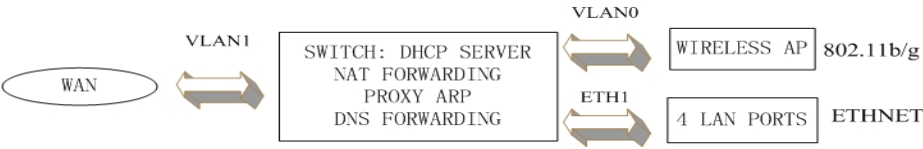


Fig. 2. The Internal router configuration

3.2 Address Management

An important requirement of our network is that routers should be able to join, quit and reappear, perhaps at another location, at arbitrary times, without the individual network elements having to be explicitly reconfigured by an administrator. At the level of IP, this means that address assignment and routing should be performed dynamically and in a location-independent manner.

Since we wanted to start the deployment we decided to adopt a static IP addressing plan, as a temporary and easy to implement solution. A registry of IP addresses and subnet addresses was created for the ad hoc network, and each router is statically assigned an IP address which uniquely identifies it on the network. Furthermore, each router is given a subnet network address for 32 IP addresses to be used in the context of its local LAN. The first address is assigned to the router's LAN interface, which leaves room for 29 IP-enabled devices that can be connected to the LAN interface of each router. Along this scheme, each router features a DHCP server that manages a pool of 29 addresses and provides automatic IP address assignment for the LAN interface, where we also activated Proxy ARP and IP Forwarding using the proc file system. Hence devices that connect to a router through the LAN interface are automatically configured. In turn, OLSR running on the WLAN (vlan0) interface is configured to advertise the subnet corresponding to the LAN segment to the rest of the system.

3.3 Controlled Network Access

The network model is kept open so that many different communities are free to join, contribute to and exploit it. However this does not imply that all participants should be allowed to access the same set of services. It is also important to guarantee that participants will not be able to exploit information that is routed via their privately owned routers. More specifically, while students and faculty should be able to use the services and applications provided by the Department and University, users who are not affiliated with the University should not be allowed to access them.

Public Internet access, via the University's infrastructure, is a typical example. Of course, nor should any participant be able to retrieve account names and passwords transmitted over the ad hoc network. Security and access control is implemented using a Virtual Private Networking approach. VPN technologies provide an efficient solution with central control of user access mechanisms. Our implementation employs the Point-to-Point Tunneling Protocol (PPTP) with MPPE128 encryption, which is supported by almost every operating system including those running on most handheld devices. The VPN server is installed on a dual- CPU (400MHz) personal computer with 192MBs of RAM. Linux was the operating system of choice and P2P was used as the PPTP server [5]. Measurements performed on the local network showed a packet encryption/decryption rate of 550Kbytes/sec, which we consider sufficient for the purpose of initial deployment.

The VPN server is equipped with two Ethernet interfaces. The first interface connects to the University LAN through which access to the Department's servers and public Internet is provided. The second interface connects to the LAN interface (vlan0) of an ad hoc router that connects the VPN server to the community wireless network. The network segment between this particular router and the VPN server was assigned an individual network address and the OLSR daemon on the router was configured to advertise the corresponding network address. Using the IP Masquerade feature provided by the Linux kernel (IP Tables) we configured the VPN server to perform Network Address Translation (NAT) between the computers attached to the VPN and the University network. NAT was necessary since the IP address pool of the

University cannot be used for the purposes of the ad hoc network for reasons of security and scalability.

With this setup, students and faculty may connect to and access the University network from any terminal connected to any ad hoc router. We have successfully tested Linux, Windows 2000/XP implementations over the wireless network. The Ad Hoc wireless network test covering the university shown in Fig.3.

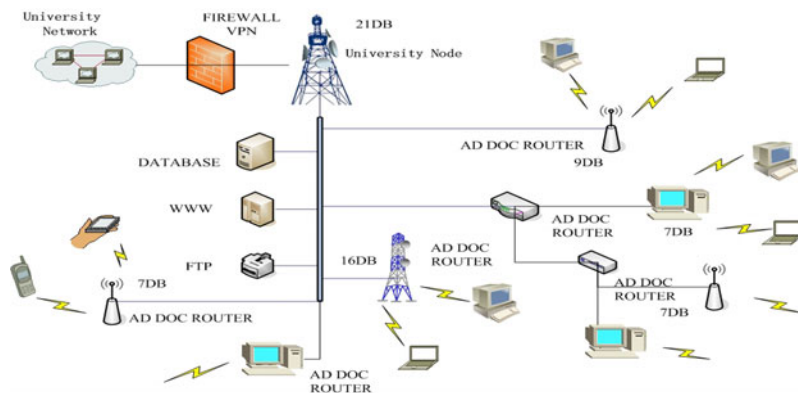


Fig. 3. The Ad Hoc wireless network test covering the university

4 Conclusion

In this paper we present our work towards deploying a community wireless network with ad hoc communication and routing between its elements. We describe our network model and implementation of wireless routers, while motivating decisions and pointing out open issues. The main advantage of our approach is the low deployment cost and inherent flexibility in terms of adapting the network configuration with little or no human intervention, which in turn can be exploited to support the dynamic addition, removal and mobility of network elements.

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Infrared Target Recognition Based on Combined Feature and Improved Adaboost Algorithm

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Abstract. To high noise characteristics of infrared image and the overfitting under high noises of adaboost algorithm, an infrared target recognition algorithm based on combined features and improved adaboost is proposed. First, the geometric features and transform features are extracted and combined, which can describe target information precisely from different aspects. Second, an improved adaboost algorithm is proposed, which adopt a stepwise method to update weights in the process of training, according to the weights distribution of samples. So it can avoid the overfitting problem of classification under high noises and ensure the stability of target recognition. Finally, some simulation experiment are done to verify the effectiveness of the propose algorithm. The results of experiments show that the proposed method obtains better performance than traditional Adaboost algorithm.

Keywords: Infrared target recognition, Adaboost algorithm, combined features, wavelet transform.

1 Introduction

With the advantages of Infrared imaging technique, such as strong anti-interference ability, high guidance sensitivity, offensive power all-day and all-wave, better invisibility, far operating distance and so on, the infrared images can provide rich target information for target recognition. Therefore, infrared image target recognition has become an important part of Modern battlefield perception, and it is the highlight and key technique in future intelligent weapons systems [1].

Common infrared image target recognition algorithms [2-4] need the binary image of target which can obtain by image preprocessing, and then extract target features from the binary images. However, the characteristics of infrared image such as low contrast, high noises, blurring and so on, result in the bad segmentation results. Ref. [5] proposed a neural-network-based transformation, using principal component analysis to maximize the representation of data variation into a small number of PCA components, without considering the segmentation results. But PCA cannot represent the higher-order nonlinear relationship among data. So Ref. [6] proposed a novel joint KPCA shunting inhibition neural network transformation. The transformation integrates KPCA and GSN (generalized shun ting neuron) classifier by combining

together the learning mechanism of kernel Hebbian algorithm (KHA) based on neural network and a back propagation learning algorithm. Ref. [7] proposed an improved fast independent component analysis (ICA) feature extraction algorithm based on one dimension search and distance function for infrared target recognition. This algorithm solved the problem of the recognition rate and the robustness decreasing with the increasing number of training image samples to some degree. Although there are some achievements in infrared target recognition, many difficulties exist in the process of recognition.

Aiming at the low rate in infrared target recognition resulting from the high noise characteristics for infrared image, we proposed an infrared target recognition algorithm based on combined features and improved Adaboost. Firstly, the geometric features and transform features are extracted and combined. Then, an improved Adaboost algorithm is proposed, which adopt a stepwise method to update weights in the process of training, according to the weights distribution of samples. So it can avoid the overfitting problem of classification under high noises and ensure the stability of target recognition. The experimental results show that the proposed method obtains better performance than traditional Adaboost algorithm.

2 Fusion Feature Extraction

Generally, the amount of original image data obtained by data acquisition subsystem is large, and the original image data cannot reflect the essential characteristic of the target. These two aspects result in large data redundancy and low recognition efficiency in classification. For effective target recognition, it is necessary to analysis original image data and extract features which can describe the essential characteristics of the target by some transformation. Meanwhile, the selected features should make the difference among that of samples in the same class small and the difference among that of samples in different classes great. We construct the criteria function as follows:

$$J = \frac{D_b}{D_w} = \frac{d(S_b)}{d(S_w)}. \quad (1)$$

Where, S_b is the between-class scatter matrix, S_w is the within-class scatter matrix, D_b and D_w describes the difference degree distribution of between-class and within-class respectively.

Zhang [8] introduced nine feature vectors for classification, but not all of them represented the essence features of infrared target. So we analyze them and select some useful features such as complexity, length-width ratio, mean contrast, the ratio between the number of partial brightness points and the number of total target points, compactness, according to the criteria above. In addition, we also extract the invariant moments feature based on wavelet transform.

These two kinds of features represent image from different aspects, so we combine them to a feature vector $\Phi = (\phi_1, \phi_2, \dots, \phi_i, \dots, \phi_s), (1 \leq i \leq s)$. The combined feature

can represent the infrared target precisely and comprehensively, which is helpful for the following target recognition.

2.1 Infrared Target Recognition Based on Improved Adaboost

Adaboost is a general strategy for learning classifiers by combining simple ones. The idea of adaboost is to take a weak classifier- that is, any classifier that will do at least slightly better than chance - and use it to build a much better classifier, thereby boosting the performance of the weak classification algorithm[9]. Adaboost algorithm is successfully when the samples are noisy by low noises. However, if the noise is higher, adaboost algorithm will over-focus on some classes and trifle with other classes. Therefore, using the final prediction rules on test samples, the error-rate may increase significantly, and the problem of overfitting comes.

Due to the particularity of infrared imaging, though robust target features are extracted, it is hard to avoid the noise existing in the final features. To avoid the overfitting, an improved adaboost algorithm is proposed which adopt a stepwise method to update weights in the process of training, according to the weights distribution of samples. Specific process is described as follows:

- 1) After training r times, we get a set of weights $w_r(x_i, y_i)$
- 2) Section the weights between the maximum value $Max = \max(w_r(x_i, y_i))$ and the minimal value $Min = \min(w_r(x_i, y_i))$ into K subsections $S_j, j = 1, \dots, K$
- 3) Record the number of the samples falling into each subsection, noting as u_j , and compute the proportion of u_j in the whole sample space, noting as p_j then, update the weights distribution in this subsection as $p_j w_r(x_i, y_i), j = 1, \dots, K$

According to above improvement, a infrared target recognition framework based on improved adaboost algorithm is proposed. We take K-nearest neighbor classifier as weak classifiers. The final classification and recognition process is described as follows:

Input: Feature sets of training samples $\{(x_1, y_1), \dots, (x_n, y_n)\}$, label tag $y_i \in \{-1, 1\}$, iteration times $Iter$

Initial: Set weights of all samples as $w_t(i) = 1/n, i = 1, 2, \dots, n$, and iterative $Iter = 1$

Iteration :

Normalize weights $norm\_w_t(i) = w_t(i) / \sum_{i=1}^n w_t(i)$, and learn weak classifier

$h_t(y_i)$

Compute the error $\mathcal{E}_t = P_{r-norm_{w_t}}[h_t(x_i) \neq y_i]$ of basis classifier

Suppose $\alpha_t = \mathcal{E}_t / (1 - \mathcal{E}_t)$, and update weights with the above improvement rules,
 $t = t + 1$

If $t > T$ or $\mathcal{E}_t > 0.5$, then stop. Otherwise, turn to the beginning of iteration.

Output: the final integrated classifier $H(x) = \arg \max_{y \in Y} \sum_{t: h_t = y} \log \frac{1}{\alpha_t}$.

3 Experiments and Analysis

The infrared target images used in experiments are generated by modeling software and simulation software. The database consist five kinds of plane targets with different models. Each class has seventy sample images. To verify the effectiveness of the proposed algorithm, we do two group experiments based on 10-fold cross-validation method.

Experiment 1: recognition results of different features

Table 1. results based on different features using improved Adaboost

Features	Recognition rate
Invariant moments	76.12%
Five feature selected from Ref. [8]	80.48%
Moments based on wavelet transform	82.13%
Combined features used in proposed algorithm	84.06%

From Table 1, we can see that, the recognition result based on combined features in our method is better than that based on single feature. That is because combined features can precisely represent target characteristics of target, which increase the stability of the classifier training based on these features. That's to say, the performance of a recognition system is not only determined by classifier, but also affected by the number of features extracted to describe the infrared target and the ability of the feature to represent the target information.

Experiment 2: recognition results of different classifiers

Tabel 2 shows the results of different classifiers, such as K-nearest neighbors classifier, BP neural network, traditional adaboost and the improved adaboost in our paper based on the combined feature.

Table 2. Results of different classifiers using the combined feature

Algorithms	Recognition rate
KNN	69.00%
BP neural network	80.00%
Traditional adaboost	78.64%
Improved adaboost	84.06%

As is shown in table 2, the proposed improved adaboost algorithm obtained better performance than other classifiers, even with more than ten percent higher under the same conditions. Moreover, the result is superior to the traditional adaboost, and the main reason is that the improved adaboost is robust to high noises, which increase the classification performance.

As we can see from the results above, infrared target recognition is affected by the methods of feature extraction and classification. A good classification algorithm matching with poor features (many redundant features and poor representation ability) might lead to a low recognition rate. It is the same in reverse. Therefore, it's necessary to take these two factors into account, and select good features, combining with high performance classifier. It's the only way to ensure you obtain the ideal recognition results.

4 Summary

The characteristics of infrared target image often result in the low recognition rate, so an improved adaboost algorithm is proposed to recognize the target from single-frame infrared image under sky background. The combined features of geometric features and transform features can describe target information precisely from different aspects. The improved adaboost algorithm that adopt a stepwise method to update weights in the process of training, according to the weights distribution of samples can avoid the overfitting problem of classification under high noises and ensure the stability of target recognition. Some simulation experiment results show that the proposed method obtains better performance than traditional adaboost algorithm.

Infrared image of target recognition is a very complicated engineering. In practice, such as the change of terrain or climate, electronic jamming and the change of target motion, will bring up kinds of problems in this field. Therefore, there are many meaningful and valuable problems to be studied further in the field of infrared image target recognition.

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Image De-blurring Using Sparse Representation and Iterative Algorithm

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Abstract. Based on sparse representation theory, a sparse regularized image de-blurring model is proposed to restore the blurry image. The gross error function between estimation image and blurred image is used as data fidelity term and non-smooth regularization term used for constraining the sparse representation coefficients over the sparse dictionary. A non-negative term is also added to ensure the positivity of the restored image. A multi-variable splitting fast iterative algorithm is proposed to solve the above model numerically so as to decrease the computational complexity. Experimental results show that the proposed model and its numerical algorithm significantly improve the de-blurring performance.

Keywords: sparse representation, variable splitting, alternating direction multiplier method, image de-blurring.

1 Introduction

The motions of camera and scene, defocus and mechanical vibration of the camera which often blur the image, with all kinds of disturbances in the process of image acquisition and transmission cause the blurred image. For digital image, if we assume the noise is additive, and the sensor is linear, the image degradation model can be formulated as follows:

$$y = Hx + n. \quad (1)$$

Where x is original image, H is the degradation operator, n is additive noise, and y is blurry image. The task of deblurring is to estimate x from the blurry and noisy observation y .

For image de-blurring, the current scholars have proposed some model and algorithms, such as Wiener Filter, Lucy-Richardson method [1]. However, the results from these methods often appear double image. Ref. [2] combining Fourier transform and Wavelet transform, proposed a ForWaRD method. Chan proposed a TV-L model in [3]. Comparatively, TV-L model got a better result, but the contrast of estimate image changed. Bioucas-Dias [4] proposed a GEM algorithm for wavelet-based image restoration. Vonesch [5] proposed a fast multilevel algorithm for wavelet-regularized image restoration. For wavelet describe image from only three directions,

in some case, it does not satisfy require of image de-blurring. Patel [6] used shearlet to restore image and obtained better result than the method based on wavelet.

Using sparse representation prior, we proposed a sparse regularized image de-blurring model, then based on alternating direction multiplier method, proposed a multi-variable split fast iterative algorithm to solve the model. By variable splitting, the original problem is transformed into solving three simple sub-problems iteratively, thus computational complexity is decreased rapidly. The experimental results show that the proposed model improves the de-blurring performance according to the sparse regularized term which matches the geometric feature of the image and the non-negative constraint. With the fast iterative algorithm, the speed is highly increased.

2 Sparse Regularization Image De-blurring Model

Given an image $\mathbf{x}$, and dictionary Φ composed of L atoms $\varphi_i \in R^N$. Then, $\mathbf{x}$ can be represented as a linear combination of the atoms in Φ , written in the matrix form as follows:

$$\mathbf{x} = \Phi \alpha. \quad (2)$$

For an natural image, almost all the pixels are non-zero, but transform it into a proper sparse domain, there exists a sparse representation of image $\mathbf{x}$, i.e. $\|\alpha\|_0 \ll N$.

Based on the sparse representation prior and degradation model(1), we construct the image deblurring model on sparse representation coefficient α :

$$\alpha^* = \arg \min_{\alpha} \frac{1}{2} \|\mathbf{H}\Phi\alpha - \mathbf{y}\|_2^2 + \iota_C(\Phi\alpha) + \tau \|\alpha\|_1. \quad (3)$$

Where, the first item is data fidelity term, the second item is non-negative constraint term, and the third item is sparse penalty function. ι_C is indicative function of convex set C to constraint the pixels non-negative. τ is regularization parameter to prove the tradeoff between regularization and fidelity term. Minimize the above model, we can estimate the deblurred image $\mathbf{x}^* = \Phi \alpha^*$.

3 Multi-variable Splitting Fast Iterative Algorithm

Variable splitting can go back at least to Courant in the 40s. In recent years, this rationale has been recently used in the split-Bregman method [7], which was proposed to address constrained optimization formulations for solving inverse problems. Based on variable splitting, we split the variable α into three variables α, u and v , each to serve as the argument of each of the three transform the complicate problem. This idea has been used in several image processing applications. A variable splitting method was used in [8] to obtain a fast algorithm for TV-based image restoration.

Now, we introduce augmented lagrangian method simply. Consider a linear equality constrained optimization problem

$$\min_{z \in R^n} E(z) \quad \text{s.t.} \quad Hz - b = 0. \quad (4)$$

Where $b \in R^p$, $H \in R^{p \times n}$, i.e. this problem consists p linear equality constraints. Then, the augmented lagrangian function for this problem is defined as

$$L_A(z, \lambda, \mu) = E(z) + \lambda^T (b - Hz) + \frac{\mu}{2} \|Hz - b\|_2^2. \quad (5)$$

Where λ is a vector of lagrange multipliers and μ is the penalty parameter.

According to the following definition, we transform the problem(3) into the form of problem(4),

$$z = [\alpha, u, v]^T, b = 0, H = [G - I], G = [\Phi \ I]^T \quad \text{and} \\ E(z) = f_1(\alpha) + f_2(u) + f_3(v). \quad (6)$$

Then, we use a non-linear block-Gauss-Seidel technique to solve the minimization optimization problem by alternating minimization with respect to α, u and v , while keeping the other variables fixed. Thus, we obtain the final iterative formulation(7) which has lower compute complexity.

$$\begin{cases} \alpha^{k+1} = \arg \min_{\alpha} \frac{1}{2} \|H \Phi \alpha - y\|_2^2 + \frac{\mu}{2} \|\Phi \alpha - u - p_1^k\|_2^2 + \frac{\mu}{2} \|\alpha - v - p_2^k\|_2^2 \\ u^{k+1} = \arg \min_u \iota_c(u) + (\mu/2) \|\Phi \alpha^{k+1} - u - p_2^k\|_2^2 \\ v^{k+1} = \arg \min_v \tau \|v\|_1 + (\mu/2) \|\alpha^{k+1} - v - p_1^k\|_2^2 \\ p_1^{k+1} = p_1^k - (\Phi \alpha^{k+1} - u^{k+1}) \\ p_2^{k+1} = p_2^k - (\alpha^{k+1} - v^{k+1}) \end{cases}. \quad (7)$$

The Complete Algorithm is Described as Follows:

Step1: Initialize dictionary Φ , regularization parameter τ , penalty factor μ , maximal iterative times N_{outer} , maximal inner iterative times N_{inner} , $p_1^0 = 0$, $p_2^0 = 0$

Step2: For $k = 0$ to $k = N_{outer} - 1$

For $m = 0$ to $m = N_{inner} - 1$

Execute the first three sub-formulations in (7);

End

$$\alpha^{k+1} = \alpha^{N_{outer}-1}, u^{k+1} = u^{N_{outer}-1}, v^{k+1} = v^{N_{outer}-1};$$

Execute the last two sub-formulations in (7) to update parameters;

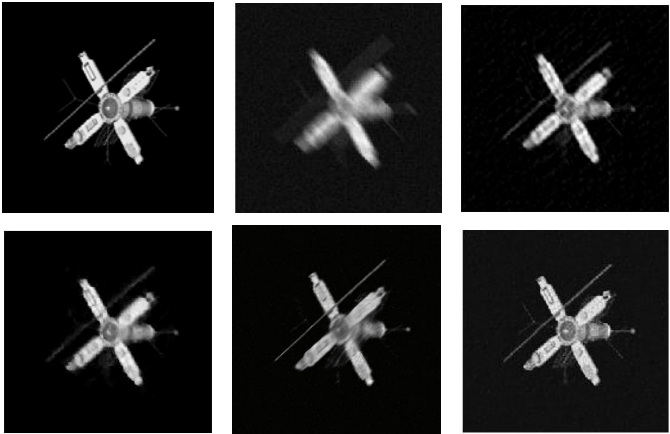
End

Step3: Output the estimated image $x^* = \Phi \alpha^*$

4 Experiments and Analysis

To verify the applicability of proposed algorithm, we construct several simulations, and compare the performance of different algorithms. To evaluate the result objectively, we adopt the blurred signal-to-noise ratio (BSNR) and improvement in signal-to-noise ratio (ISNR), signal-to-noise ratio (SNR) for restoration quality assessment.

Experiment setup: motion blur: degree=45, length=20, and noise variance is set to make BSNR=20dB.



(a) original image (b) blurry & noisy (c) Winer (d) ForWaRD (e) Lucy (f) proposed algorithm

Fig. 1. The estimation results of several algorithms under motion blur

Fig.1 gives the results of the proposed algorithm comparing with some common methods. Table 2 gives the quantitative comparison of them under different noise levels. As can be seen from them, wiener method can restore the fine structures, but suffered from over-fitting; ForWaRD[2] method and Lucy method[4] generate fewer ripples, but they cannot restore the fine structures of original image. The proposed method significantly improves the deblurring performance for the sparsity regularized term which matches the geometric feature of the image and the non-negative constraint.

Table 1 lists the quantitative performances comparisons between these methods evaluated by ISNR and SNR. From the table, we can see that the proposed method performs better than others under different noise levels, indicating its robustness in the existence of noise; as the BSNR increases, the restoration quality with proposed method increases, which coincides with the aforementioned theoretic analysis.

Table 1. The quantitative comparison of the estimate results of several algorithms

Methods	BSNR=5		BSNR=10		BSNR=20		BSNR=30	
	ISNR	SNR	ISNR	SNR	ISNR	SNR	ISNR	SNR
Winer	5.64	6.11	8.38	8.86	10.46	10.94	12.02	12.5
Lucy	5.62	5.9	8.57	8.98	10.85	11.22	11.78	13.89
ForWaRD	6.37	6.84	8.66	9.13	11.41	11.89	14.07	14.55
Proposed	9.56	9.98	10.53	11.01	12.78	13.96	15.15	15.63

5 Summary

Based on sparse representation framework, we constructed the sparsity regularized image deblurring model, making the sparsity constraint of representation coefficients as non-smooth regularization term, and adding the non-negative term to ensure the positivity of the restored image. According to the idea of variable splitting, we proposed a multi-variable splitting fast iterative algorithm to solve the above model numerically. Experimental results show that, the proposed model significantly improves the de-blurring performance, and with the good convergence of fast iterative algorithm, the speed is highly increased.

Although desirable results are obtained according to the proposed method, there are still some aspects for improvement, for example, finding the optimal sparse representation dictionary. We believe a proper representation or transformation for image will be a profound improvement of the deblurring result in the long run.

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The GIS-Based Research on the Managerial Decision Support System for the Eco-environment Water Requirement of Qingyi River Watershed

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Abstract. Applying the object-oriented programming idea of Visual Basic 6.0, according to the temporal-spatial variation of the Qingyi River water environment, the region integrity, the typicality of the studied factors and the information access, and with the aid of previous researches and the advanced ArcGIS platform, a mathematical model of ecological water requirement (EWR) as well as a decision support system (DSS) for the Qingyi River watershed was designed and developed. Human-computer interface, the database subsystem and model database subsystem were debugged and improved to launch the practical application of spatial function analysis and the theory research of the calculation, assessment, prediction and control of the EWR for the Qingyi River watershed. They are important to advance the transition of the water exploitation, planning and management of the typical eco-environmental vulnerable region in the upstream of the Yangtze River and to accelerate the modernization and informatization of water resources management and the eco-environment recovery and reconstruction.

Keywords: ecological water requirement, decision support system, GIS, Qingyi River watershed, Ya'an.

1 Introduction

In the water resources exploitation, emphasis has been laid on the need for manufacturing activity and domestic use, while little attention was paid to the ecological utilization of water and the interdependence between water conservation and eco-environment, resulting a series of water environmental problem [1,2]. It is human being's goal in this century to ensure the ecological cycle and sustainable utilization of water resources, to reconstruct the eco-environment and to balance the ecological water requirement (EWR). The study on EWR that started in 1940s focused on the water environment crisis caused by over exploitation to determine the EWR for a river, so that the proper condition and the safety of the water environment

could be ensured [3]. Rivers, an important ecosystem in nature affected largely by human activities, are frequently chosen as the subject to study EWR, and those studies mainly concern the calculation method of the EWR in the watershed [4,5]. Rivers not only have to maintain its own basic eco-environmental functions, but also provide water for the industrial and domestic use within the stream basin. Thus, the EWR for the watershed includes that both for the channels such as lakes, river mouth, wetlands, and outside the river channel animals, including plants, towns and for the over exploited groundwater [6]. Therefore, the calculation of the EWR involves the gathering, analysis and dealing of a mass of data, making it very inconvenient if apply the conventional method. The development of digital information and monitoring technology promoted the combination of the conventional methods such as physical verification and the remote sensing technology GIS [7]. GIS can provide a support platform for analysis and decision-making as well as implement the gathering, storing, management, inquiry and analysis of the space and attribute data related with spatial geographic distribution [8,9].

In this study, according to the actual conditions of the Qingyi River water environment, applying the Visual Basic 6.0 and the advanced ArcGIS system platform, decision support system (DSS) of Qingyi River watershed will be designed and developed, and using the system to launch the calculation, assessment, prediction and control of the EWR for the Qingyi River watershed.

2 Overview of the Studied Area

Qingyi River flows through Ya'an, taking in branches including Fenjiang River, Longxi River, Zhougong River and Gaochang River into Dadu River at Caoxie river crossing in Leshan, with a 284 km long main stream channel, a stream basin of 13744km², a natural fall of 3680m and an average channel gradient of 12.9‰. It is well-drained with numbers of branches including seven large branches that each covers an area greater than 500 km² and are distributed mainly in its upstream. Within the territory of Ya'an, the main stream channel of Qingyi River flows 184km long, covering a stream basin of 10053 km², with a natural fall of 3550m, an annual rain fall of 14.79×10⁹m³ and an average annual flow of 469m³/s out of Ya'an. With the development of the economy and hydro-electricity, etc, Qingyi River is impacted to some extent, mainly embodied in the forest destroy, the water and soil erosion, the deteriorating water quality (WQ) and the drying of the river.

3 Main Functions of the System

- (1) Spatial information inquiry and analysis to provide assistance in decision making;
- (2) Classification for spatial data editing and management;
- (3) Space analysis function that contains buffer zone analysis, proximity analysis, crossing analysis and overlay analysis;

- (4)Thematic mapping and bidirectional inquiry for graphic data and attribute data;
- (5)The management functions of attributive database including management for database construction and data table, inquiry in different form, and data entry and editing.
- (6)Visualization for the outlet of the data analysis table of EWR and WQ associated health risk;
- (7)Element related statistic analysis for data of water quantity and WQ.

4 System Constructions

The DSS of the EWR for Qingyi River watershed is consisted of six sectors: the management of spatial data and attribute data, the subsystem for the assessment of the EWR in channel, the subsystem for that out of channel, the subsystem for the inquiry of EWR, renewal basic data and evaluation subsystem for WQ safety.

The Realization of Spatial Database and Attribute Database. Database included spatial database and attribute database: spatial database mainly contains graphs of land use, watershed distribution, hydraulic engineering facilities scatteration, WQ actuality, and raster data processing; attribute database basically included hydrographic data, for example, water environment situation (flow drying, sediment, WQ), flow-through, sediment concentration, sediment transportation and water resources features. Meteorological data contained evaporation, precipitation and their annual distribution. And water ecosystem database mainly embodied the situation of phytoplankton, zooplankton, fish resources and the basic state of the stream basin.

In attribute database management, Visual Basic development environment was applied for interface design and editing, ActiveX Data Object (ADO) was used for the communication with bottom database, and geographic information pack, Map Objects was used for its geographic information providing function.

Microsoft Access 2003 was applied as the background database for attribute database and Visual Basic 6.0 was set as the basic function and a primary development environment for interface design, based on the object-oriented programming idea; ADO was employed as junction for data access between the interface database and the background database. The object library ADO provided a single and consolidated programming tool that offers data access to both relational database and non-relational database, and supported the Jet database engine and ODBC database.

Evaluation Subsystem of the EWR for Channel. The subsystem sector was shown in Fig. 1 where secondary inquiries were supported by databases for specific topics. According to different inquiries, the system will automatically find the corresponding special graph database and attribute database. For instance, two analysis models, R2 Cross and Changchun Zhang model were set in the subsector of EWR for aquatic creatures, which users can choose at their own will.

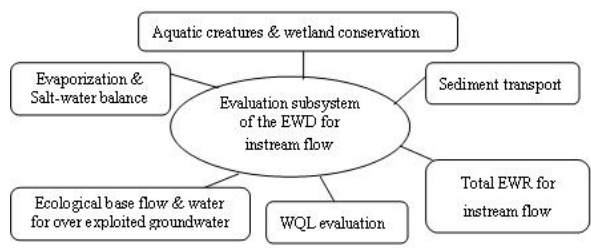


Fig. 1. Evaluation subsystem of the EWR for channel

Evaluation Subsystem of the EWR Outside Channel. This model is to evaluate the EWR calculation for forestry, fishing industry, animal husbandry, other livestock, urban environment and agriculture etc. and details are shown in Fig. 2. EWR for urban environment refers to water deliberately supplied to maintain or improve the eco-environment in urban area.

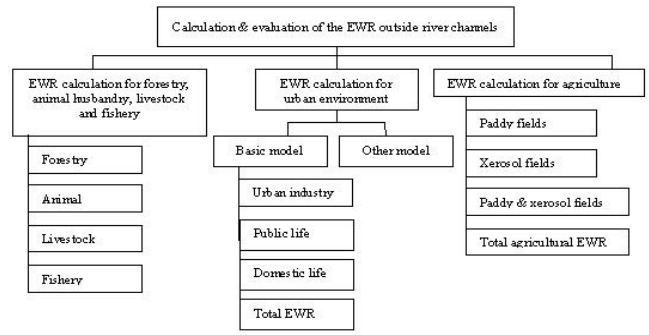


Fig. 2. Evaluation subsystem of the EWR outside river channel

Inquiry Subsystem of the EWR for Qingyi River Watershed. The subsystem contains 12 sectors including sectors for the supply-demand analysis of water resources in Qingyi River watershed, the ecological flow distribution for the main stream and first-level branches of Qingyi River, for the rivers in the seven counties and Yucheng city zone in Ya'an and that for cascade hydropower stations along Qingyi River watershed, the EWR assessment for Yucheng city zone outside the river channel, the EWR allotment for Yuxi River in Lushan County and that for Daxinao hydropower station in Baoxing County etc. The 12 sectors mainly enumerated some calculation results obtained in this research in the form of table and graph, for the users' convenience to know the situation of the EWR distribution for Qingyi River watershed.

Renewal Basic Data. The subsystem can keep up-to-date the information like water system, precipitation and water use index etc. Water system basic information inquiry is to primarily accomplish the basic information inquiry and renewal for five sectors: names of rivers, the level of branches, the watershed area, the average annual flow length and the total length of river channels in the Qingyi River watershed. In this

way the system provides more intuitive understanding of water systems in Qingyi River watershed, and helps with more prompt distribution and management of river EWR.

Evaluation Subsystem for WQ Safety. Qingyi River serves as a drinking water resource for Ya'an and Leshan City etc. However, several contamination accidents occurred in the Qingyi River watershed recently, posing great threat to the residents' domestic life and manufacturing activities. For example, in 2004, a large scale of white foam presented on the Qingyi River surface with a pungent odor of alkaline, as a result of the long-term illegal wastewater discharge from some paper factories in the upstream areas and the serious contamination left 250,000 residents in Leshan City in short of water supply [10]. In 2008, the discharge water from Tongtuo hydropower station and Yucheng hydropower station due to inspection and maintenance gravely polluted Qingyi River, trapping the whole city of Ya'an out of water supply [11]. Therefore, an evaluation system for WQ safety is added to this study. And this system sets *sanitary standard for drinking water* (GB 5749-2006) and *quality standard for surface water environment* (GB3838-2002) as its evaluation standard and provides management information by inquiry to attribute database and graph database.

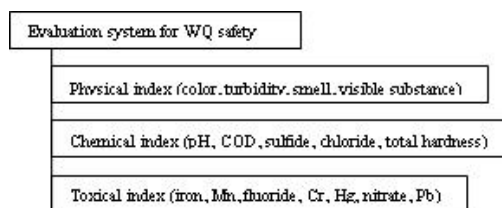


Fig. 3. Evaluation system for WQ safety

5 Conclusions

This study analyzed the general condition in the watershed and the rivers' current function state, calculated and evaluated the minimum flow that meets the EWR inside the river channels of the Qingyi River watershed within Ya'an city, so as to determine the proper EWR for the survive of those eutotamic creatures, especially fish in Ya'an city. Quota method was used to calculate the EWR for areas outside the river channel and to do the analysis, evaluation and prediction for the supply and demand analysis of water resources. The EWR demonstration for Qingyi River watershed and the DSS was designed and developed under the concept of the health of the watershed system, and the EWR calculation and evaluation for branches as well as for main streams of Qingyi River watershed in Ya'an was carried out, by considering for the first time the concept of sustainable development, system theory and temporal-spatial variation, combined with ecology, hydrology, zonality theory, water recycling and hydrological balance theory. The EWR calculation results obtained in this study will serve as a key index for the water use amount in the seven counties and Yucheng Region. And the EWR control should always be taken into consideration along with the economic development and hydropower exploitation to promote the harmonious development of human beings and nature.

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The Research on Cost Estimate of Engineering Maintenance Based on Neural Networks

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Abstract. This paper analyzes the basic idea of neural networks, and proposes the advantage which is the nonlinear reflection ability of artificial neural networks for cost estimate. When nonlinear relation between cost influencing factors and cost is set up, it can be implemented with artificial neural networks. It also studies application of artificial neural networks to structure cost estimate model; A model based on artificial neural networks to determine armored car reliability and maintenance cost correlation is presented and its correctness and validity is verified. Finally some suggestion of the model is further discussed.

Keywords: artificial neural networks, engineering maintenance, cost estimate.

1 Introduction

Along with the high technology development and the thorough application in modern weapon equipment, the fast improvement of the technical & tactical performance of weaponries is significantly. However.

It is becoming increasingly difficult to estimate and control the expense, under condition of insufficient defense spending, the contradictions of growth in cost demand and supply is gradually complicated. To maximize the defense investment return, it is essential that proper investigation, research and analysis of costs for equipment, including research and experimentation, procurement, maintenance, transportation and storage should be taken to find effective management. To study and analyze the growth law of equipment maintenance cost and to establish scientific effective cost estimate methods and models, by which the performance evaluation of equipment and cost are compared with each other, can give an effective means for decision-making departments to control the modernization level of weaponry budget and financing plan, as well as the cost control.

2 Basic Ideas of Neural Networks

Neural networks' basic unit is neuron, which are the simplification and the simulation of biological neurons.

A typical neural model mainly consists of five parts as shown in figure 1.

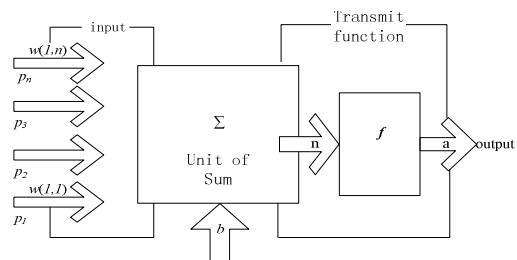


Fig. 1. Nerve cell model

- ①Network input: p_1 、 p_2 ... represent the input neurons.
- ②Network weights and thresholds: $w(1,1)$, $w(1,2)$, ..., $w(1,n)$ represent network weight and show the connection strength between input and neurons. b represents neurons thresholds whose scalar quality is 1×1 . Both weights of the network and the threshold are adjustable. Because of neural network with dynamic weights and thresholds, Neurons as well as neural network is able to show its unique behavior.
- ③ Summation unit: Summation unit calculate the weighted sum of the input signal, which is the first course.
- ④ Transfer Function: In Figure 5-2, f represents transfer function or excitation function of neurons, which is used for the function calculation of summation unit results. To get the output neurons is the second course.
- ⑤ networks output: input signal is weighted sum and transferred function by neurons to get the final output, $a = f(wp + b)$

Neural network is composed of multiple neurons in accordance with certain organizational forms which is a complex interconnected system, in which Interconnection pattern between cells affect the nature and function of the network.

The network structure can be divided into forward network , feedback network and others according to the network [1]. BP network is a feedforward network, as the structure is shown in Figure 2.

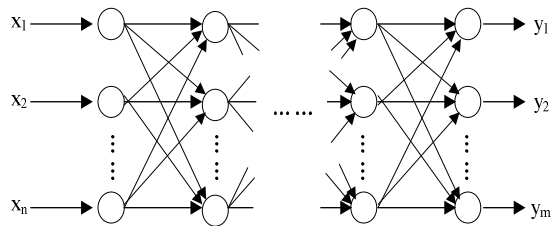


Fig. 2. BP Neural Network structure

The main features of BP network model are as the following aspects [2] :

Non-linear mapping capability: Neural network can approximate to arbitrary accuracy any nonlinear continuous function. Many problems of the modeling processes are highly nonlinear problems.

②Parallel distributed processing approach: In neural networks, store information is distributed and parallel processing, which makes it a strong fault tolerance and fast processing speed.

③Self-learning and adaptive capacity: when neural network is training, it can regularly extract knowledge from the input and output data which is input to the weight of network, making it a generalization, that is to say, and this set of weights can be applied to the general cases.

④The ability of data fusion: Neural networks can handle both quantitative and qualitative information, so it can use traditional engineering techniques (numerical calculation) and artificial intelligence techniques (symbolic processing).

⑤Multivariable system: Number of input and output variable of neural network is arbitrary and provides single-input and single-output systems and multivariable system with a general description, without regard to the issue of decoupling between the various subsystems.

3 The Study of Correlation between Equipment Reliability and Maintenance Costs

Clearly, there is relativity between equipment reliability and maintenance costs. Better reliability, lower maintenance costs, but this relationship is nonlinear correlation because it is difficult to express the correlation between equipment reliability and maintenance costs by a straight or curve line or a clear set of equations. In addition, as equipment reliability and maintenance costs are two different things, the data reflects the heterogeneity of characteristics. Because of BP neural network with excellent features, reliability parameters can be used as input and maintenance costs as the output to establish the maintenance cost estimate model. The following part present some examples for the application of neural network in the process of modeling the cost model in detail.

A. *Sample Selection and Data Processing*

To collect faults and maintenance cost data of a certain type of eight equipments by research and analysis to find that maintenance costs are mainly produced in the control system 、 transmission 、 mobile system. Therefore, to study a cost model whose independent variables are the average time between failure (MTBF)of these three systems, and sort out the failure data, control system MTBF 、 drive MTBF 、 operations system MTBF and maintenance data of these eight equipments can be obtained like in Table 1.

Modeling by BP neural network must have enough typical samples; need to evaluate the performance and generalization ability of the model. Sample data were randomly divided into training samples and test sample. Seven equipments should be used in the model to train the network, using the other one to test the model's generalization ability.

Table 1. MTBF of subsystems and maintain costs

No.	MTBF	MTBF	MTBF	maintain costs
1	7.799	20.916	7.669	132670.15
2	5.695	17.323	5.470	235039.96
3	6.013	19.042	5.273	198759.91
4	6.837	23.389	7.168	147623.28
5	6.636	19.041	6.440	183855.06
6	5.835	18.062	5.380	216899.94
7	6.452	21.276	6.198	173191.60
8	7.294	22.061	7.414	143146.72

Since BP neural network the hidden layer generally uses tansig to transfer function, in order to improve training speed and agility, and to avoid tansig saturation function effectively, the general requirements of the input data values are between 0 and 1, which requires the data normalized. Generally, different variables should be normalized respectively; some variables with similar nature can be normalized together. If the output layer node uses tansig to transfer function too, output variables have to have the appropriate pretreatment. Therefore, the training data samples and test samples are normalized by following formula, so the range of data should be [-1, 1], to ensure that all handing capacities have the same normalized ratio.

$$P_n = \frac{2(p - \min p)}{\max p - \min p} - 1 \tag{3-1}$$

The result is as Table2 shows.

Table 2. Unitary data about MTBF of subsystems and maintain costs

No.	MTBF	MTBF	MTBF	maintain costs
1	-0.721	0.727	-0.735	-1
2	-0.953	0.330	-0.978	1
3	-0.918	0.520	-1.000	0.291
4	-0.827	1.000	-0.791	-0.708
5	-0.850	0.520	-0.871	0.000
6	-0.938	0.412	-0.988	0.646
7	-0.870	0.767	-0.898	-0.208
8	-0.777	0.853	-0.764	-0.854

B. Preliminary Design Model

The model design is an iterative process because optimized network model design is not in one step you need to constantly adjust the course of the training model parameters. First, establish a preliminary network model, the specific design work

including: network layer design 、 nodes design 、 transfer function and determine the selection of learning algorithms and so on.

① Network layer design

The design of the network layers is the critical for reasonable network model. Theoretical proof: BP network with a hidden layer (using tansig to transfer function) can realize any arbitrary function approximation, at the same time, with a single hidden layer feed forward neural network can map any continuous function, and it is generally up to two layers of hidden layer except discontinuous functions which require two hidden layers.

General approach is to set up a hidden layer, when there are a lot of hidden layer nodes which still can not improve the network, and then add a hidden layer, where it uses three network structures.

② Network nodes Design

Nodes of model selection: input vector for the action 、 traditional and manipulation of three subsystems MTBF, the output vector for the maintenance costs, so the number of input neurons is 3, the output layer neuron number is 1, the network model is $3 \times n \times 1$, n for the neural network hidden layer neuron number. The number of nodes in the hidden layer has an impact on artificial neural networks performance.

Hidden nodes and learning capacity are too limited to store all the law of training samples; hidden nodes are so many that network training will not only increase time and store the irregular information of the sample such as interference and noise, but also reduce the generalization ability.

General approach is to take care test method, by the following empirical formula to determine [3]:

The general method is to gather the law of trying, Confirmed by the following experience formula [3]:

$$m = \sqrt{n+l} + \alpha \quad \text{Or} \quad m = \sqrt{nl} \quad (3-2)$$

M is number of nodes in the hidden layer, n is input nodes, l is the output nodes, α is the adjustment constant, between 1 and 10. The number of hidden layer neurons, m, and the initial value is 4, $3 \times 4 \times 1$ is the three-tier network architecture.

③ Transfer function design

Transfer function is a core of neuron and network. Network capacity and efficiency to solve problems related to the network structure, depends largely on the network transfer function. Transfer function controls activation of the output by input; converses input and output by function; transforms infinite domain of input into a specified limited range of output. Common function of neuronal function has a simple linear function 、 tansig function 、 logsig function and so on.

Transfer function used in the model are as follows: the input layer using tansig function (S-shaped hyperbolic tangent function), in the middle with logsig function (unipolar S-shaped function), the output layer activation function purelin linear function (linear function).

④ network learning algorithm

Gradient descent learning algorithm is used here, changes in the value of each weight to add a proportional amount of the previous weight change, and in accordance

with back-propagation method to generate new weights and thresholds, and the error decreases along the gradient direction.

Changes in the output layer weight, from the i-k-input to output weights are:

$$\Delta w_{ki} = -\eta \frac{\partial E}{\partial w_{ki}} = -\eta \frac{\partial E}{\partial a_k} \cdot \frac{\partial a_k}{\partial w_{ki}} = \eta (t_k - a_k) \cdot f'_{2k} \cdot a_{ki} = \eta \cdot \delta_k \cdot a_{ki} \quad (3-3)$$

C. Model Training and Adjustment

BP network training is to adjust network weights and threshold continuously through the application of the principle by information forward transmission and error back propagation. The sum of squared errors between the output value of the network model and the output value of trained samples is the minimum or less than some expected.

When the training times are up to maximum or the sum of squares of errors are less than the expected, training will stop. Research and analysis find that when the models take 5 hidden nodes, the network can converge to train up to 8000. After repeated testing, when the number of neurons in the hidden layer is 4, the sum of squares of errors are less than the expected and meet the requirements after 3123 times training, neural network training will distribute knowledge and information in neurons links. During training process, the main training parameter values are: 4500 times are the maximum training times, the sum of squares of error index is 0.02.

The sum of squares of errors of network curve with training times which is shown in Figure 5-4.

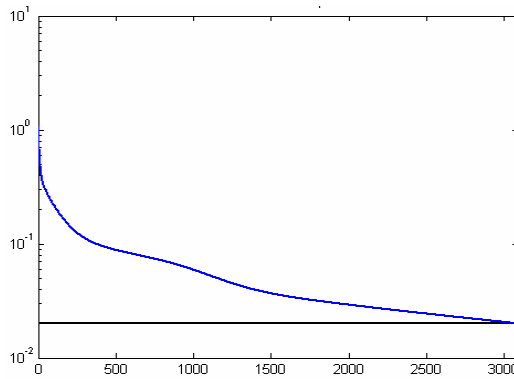


Fig. 3. Error square sum change curve along with training times

D. Model Checking

Model checking requires multiple sample models to calculate the variance and mean square error. The primary and fundamental task of training the neural network is to ensure that the trained network model has good generalization ability of the non-training sample, which can get effective approximation of the inherent laws. If the error for each training sample is small, it does not mean that the model has been close

to the inherent laws in the training samples. It is meaningless that only the figure of the error of training sample is given without the figure of non-training sample. It need analyze the generalization ability of the network model, represent and evaluate through non-training sample error.

When non-training Sample error is small or within the expected, it is generally believed that the establishment of the network model has been effective in approaching the law inherent in the training sample, otherwise, it is on the contrary. Because of the actual situation, the collected sample data is relatively small, so the eighth car is used to test the network model. Forecasting and Simulation of trained network by sim function can obtain $y_1 = -0.7824$, and then return to operate simulation of this predicted value and finally to verify the model.

The comparison between Simulation predicted value and actual value is shown in Table 3.

Table 3. Emulational forecast value versus real maintain costs

	MTBF	MTBF	MTBF
NO.8 MTBF	7.294	22.061	7.414
Real expenses C1	143146.72		
Predicted value of the neural network	-0.7824		
Predicted value C2	143807.99		

The test results meet the requirements, indicating that the neural network has good generalization ability. As the less current sample data, the model focuses on study correlated neural network models by method.

4 Summary

In this paper, it studies the application of the neural network in establishing cost estimate models, modeling armored vehicles reliability and maintenance costs by neural network. it takes manipulate the system 、 transmission 、 three-part action system MTBF as input, armored vehicles, repair of maintenance costs as output to establish three layer networks. Training data of seven cars is tested by the trained samples network, the comparison between simulation estimates and forecasts value is done. If the relative error is 0.46%, the model meets the requirements. Network structure needs to apply or pre-design heuristic algorithm in the training process to update, which is difficult to ensure optimal network structure, and over depends on learning training sample data, etc... All these problems have to be solved in the days ahead.

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Analysis of the Relationship between Chinese E-Commerce and E-Government

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Abstract. E-commerce and e-government is a hot topic today, in practice they are often managed separately, but in fact the two are inextricably linked there. In this paper, similarities and differences between e-government and e-commerce start point and the interaction, the more comprehensive treatment of the relationship between e-government and e-commerce.

Keywords: e-commerce, e-government, Relations.

1 Introduction

At the beginning of 20th century, early 90s, the U.S. initiated the "information super highway" project actively promoted in the world information highway of the five applications (e-government, e-commerce, distance education, telemedicine, electronic entertainment), the e-government, E-commerce were classified as first, second. Information can be seen in the construction of the whole society in an important position. However, people in the e-government, e-commerce concepts to understand and use, there are great differences and confusion. Some people think that e-government is the largest e-commerce [1] Some scholars believe that: E-commerce includes not only e-commerce between enterprises (B to B), business and consumer e-commerce (B to C) outside the , And between government and business e-commerce (G to B) and the Government and consumer e-commerce (Gto C) and so on. E-government and e-commerce understand how the relationship between e-government and e-commerce for the development and operation to provide guidance, is of great practical significance.

2 First, E-commerce and E-Government Analysis of the Difference Between

Different Concepts of e-commerce and e-government. E-commerce refers to the use of the Internet and modern communication technologies to any form of business operation, management or information exchange. Including business-to-consumer e-commerce (business to consumer, BtoC); e-commerce between enterprises (business to business, BtoB; business-to-government e-commerce (business to government, BtoG); consumer e-government (Consumer to Government, C2G); consumer to consumer e-commerce (consumer to consumer, CtoC) five parts.

E-government (e-government) is a country at all levels of government agencies or related organizations by electronic means in public administration and government affairs. Consists of three components: (1) government e-government (government to government, GtoG); (2) government-to-business e-government (government to business, GtoB); (3) Government to citizen e-government (government to citizen, GtoC). Only a few countries, some government agencies to achieve the GTOG, GTOB and GTOC, such as the U.S. Department of Education Web site can look to the government-funded project, the Los Angeles city government will provide the public with electronic maps of environmental information for the inquiry; Singapore's e-Civic Center Allows the public easy access to health care, business, laws and regulations, traffic, family, housing, employment and other online information and services.

The Nature of e-commerce and e-government are Essentially Different. The main e-Government, e-commerce are the main enterprises; the core of e-government services, the core of e-commerce trade. E-government aims to implement the use of electronic means of public administration, the government provided to the community and services for the electronic management objectives. [2] it is only changes in work methods and means, will not change the essential nature of government work. Similarly, e-commerce is only used for business electronically, only the means of change and innovation activities, nor change its nature.

E-commerce and e-government for Different Purposes. The fundamental purpose of e-government is through electronic means to improve government management and service quality, efficiency and social benefits. Such as the construction of appropriate management information systems and office automation systems to the government's work efficiency and quality improvement to adapt to rapidly changing external environment needs; building a reliable, efficient and integrated government information networks, government services will be fast, convenient, Passed cheap to every citizen, to reduce management and service citizens receive government pay the economic and time burden. The fundamental purpose of e-commerce on the Internet to create a all day, without geographical restrictions, secure and reliable online trading market, commodity marketing through the Internet, thereby expanding the scope of the market and create more business opportunities for enterprises to make more satisfied consumers.

The Performance of e-commerce and e-government are also Different. E-government is the government agency handling all types of government business in a new model, of course, to follow a government emphasis on the handling of government affairs and regulatory uniformity, it showed unity; and e-commerce activities, different Provide products and services there is a big difference, there are also facing very different market, so e-forms are diverse.

3 Second, E-Commerce and E-Government Relationship

As e-government and e-commerce depends on a common information infrastructure and social environment, both in information technology, security, there are still common.

Both Rely on a Common Information Infrastructure. E-government and e-commerce must be by means of computer network technology, database technology, software development technology to realize its function. E-government requires not only within government departments to achieve information sharing and real-time communication, among government departments to achieve the same time, government departments and the public, two-way exchange of information between enterprises; e-commerce also requires all departments within the enterprise, the enterprise and its partners , exchange of information between consumers, so they require a network, network technology is the basis for information exchange and sharing.

Both Require Safety Technologies and a Sound Legal Environment. E-government sensitive information involving state secrets, need access control, intrusion prevention of illegal users, information encrypted transmission, electronic digital signatures and network firewalls and other technical means to protect its security. Confidential business e-commerce, payment information, electronic trading and other sensitive information also need the technical means to protect its security. Both also need a good legal environment, if there are illegal things happen by law to provide protection, such as the "Republic of China Regulations on Protection of Computer Information System Security", "PRC Computer Information Network and the Internet security protection and management method " , "National Security Law, ""Law on Guarding State Secrets, " and so on.

Have to Use e-government and e-commerce Online Payment Methods. The form of online payment by electronic money on the Internet is through Internet banking for the funds transfer, the information age an important settlement. Government payment of benefits to the community for funds can be moved online, is a typical and important e-government activities. The e-commerce, customer inquiries through the network to a commodity purchase contract signed with the business to be in line to the merchant payment complete the transaction. Online payment is also an essential key to electronic commerce. [3] Thus, to be used in e-government and e-commerce online payment, but with a little too much with it.

E-commerce and e-government Concept in the Service have in Common Whether e-commerce (e-commerce) or Electronic Government. (e-government) is that they are fundamental to the whole heart and soul "E" serve the people, this is a new form of modernization under the "service people " a new understanding of . Both directly with service, efficiency, interactivity and the advantages of transparency can reduce the cost of access to information. [4] The implementation of e-government can save people a lot of time and money, but also to change the traditional shortcomings of government; the implementation of e-commerce can make the parties to the transaction cost of information exchange, but also allow producers to provide consumers with faster, direct services.

4 Conclusion

By this analysis, we recognize both the nature of e-government and e-commerce distinction, have close contact. And both with each other to promote the joint development, the Government's development of e-government can not only promote the B to G, B to C e-commerce development, and, through the establishment of online professional trading market, to spur economic development and e-commerce market Construction. In order to develop e-commerce, CA certification system development and the national certification system, online payment system development and application of policies and regulations related to the establishment and improvement, management system and operation mechanism of the reforms have made some progress, which for e-government Provide a good technical and legal protection. In the constant increase in the information society of today, we not only strengthen academic research, in theory recognize similarities and differences between e-government and e-commerce and contact, but also to take effective measures, in practice, e-government and e-commerce to promote the coordinated development And common prosperity

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On the Study of Human Resource Management of Small and Medium-Sized Enterprises on the Background of Postfinancial Crisis Times

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Abstract. The international financial crisis affected the healthy development of some small and medium enterprises our country, also exposed the problems to be solved in the development of small and medium-sized enterprises. How to solve these problems in the Postfinancial Crisis Times lies in the innovation of enterprise human resources management. This paper analyzes the main problems of the medium-sized and small enterprises financial crisis under the influence of the human resource management, and proposed countermeasures for the implement human resource management.

Keywords: The Postfinancial Crisis Times, small and medium-sized enterprises, human resources management, countermeasures.

1 Introduction

2008-2009, under the impact of the international financial crisis "in generations", many domestic enterprises' production management met unprecedented predicament, especially extremely severe tests for many small and medium-sized enterprise. With different degrees of manage difficulty, profit decline, and cash flow nervous, or even collapse phenomenon. This rare financial crisis makes small and medium-sized enterprise widern their knowledge of huge risks contained in globalization economy era operation, give a vivid risk awareness lesson to small and medium-sized enterprise. In a financial crisis era, how to draw lessons from the financial crisis, adjust strategy to realize the sustainable development of stable for small and medium-sized enterprise? The key is the small and medium-sized enterprise must take risk awareness throughout, specifcily reflected in fund management, marketing management, personnel management[1]. And to see opportunity in the very background for the machine, turn the crisis, we must complete following five jobs:

design new five business model, innovate independently and proceed brand building, and integration and talent cultivation[2]. And one of the most key is the scientific management of human resources and effective innovation. But currently, human resource management of small and medium-sized enterprises is very weak, such as the loss of talented people, high use of low-level talent human resources management issues generally occurred in small and medium-sized enterprises, the human resources management increasingly becomes the bottleneck of sustainable development.

2 First, Problems Appeared in Small and Medium-Sized Enterprise Human Resources Management

The Thin Consciousness Small and Medium-Sized Enterprise Owners and Top Managers Human Resource Management. In the era of knowledge economy, the human resources management has become the core of enterprise management, and decides the enterprise's rise and decline. Especially the "century" financial crisis, fully proved this point. The issues of small and medium-sized enterprises completely exposed in the impact of this financial crisis impacted by human resources management. Many corporations cannot effectively turn labor resources into coping with crisis of human capital, even only through layoffs or shutdown to cope with the crisis. Quite part of small and medium-sized enterprise executives didn't realize the importance of human resource management of small and medium-sized enterprises, and most without a dedicated human resources administration departments, even with these departments, but in the exercise of functions, there are still some problems, such as the overall quality is not high, and lack of professional personnel, good or systematic vocational skills, etc.

Imperfect Human Resource Training Mechanism, and the Lack of Long-Term Talents Cultivation Planning. Due to the scale of the small and medium-sized enterprises is small, and lack the necessary funding, added in the fierce competition in the market, small and medium-sized enterprises difficultly contend against the multinational companies, lack of confidence, they often take short-term management behavior, not take efforts in training. Due to the large personnel fluidity of small and medium-sized enterprise, the investment training was too risky, so they worry about training talents cannot serve yourself. Even some small and medium-sized enterprise consider that the talents are too many to the market, so they can get talents from the market recruitment. Even there are some enterprise training they often use is the short-term training and emergency training, but their training lacks of systematic and long-term planning, can not form a scientific training system.

Insufficient Incentive Mechanism, Desiderately Complete Performance Evaluation Mechanism. Good incentives for staff's job enthusiasm, working efficiency enhancement enterprise competitiveness has a positive role. At present, the problems in small and medium-sized enterprises is: one is the salary incentive system is not scientific. The characteristics of salary reward determines it is hard to promotion space after a certain level, also hard to follow enterprise's development by the proportional increase, and employee cannot enjoy the results brought by enterprise development. And the salary level in small and medium-sized enterprise is relatively

low, hard to compete with large enterprises. In addition, from internal incentive perspective, among different jobs and employees in general post, the pay gap is not reasonable, not embodying the differences among different jobs, nor reflects the difference among different employees. The other is the unreasonable performance evaluation mechanism. Many small and medium-sized enterprises' checking for employees is only stay on completion with enterprise superiors and degree of efficiency as the task assessment standard level; uncomprehensive evaluation methods selection can not adapt to this enterprise; with the addition of some enterprises' unstable appraisal standards, interpersonal influence caused by excessive rewards such as unfair, eventually lead to efficiency and fair imbalances.

Weak Construction of Enterprise Culture. For many small and medium-sized enterprises, enterprise is just a machine for the production of profits, top management personnel machine will focus on staff and production process, focusing on the strict control of production efficiency and labor payment, but ignore the construction of enterprise culture, not paying attention to the formation of modern enterprise culture core value idea, often caused the malposition of personal values and the enterprise concept, thus, making the workers lack of enthusiasm and initiative for improving professional skills, and the enterprise's identity is not strong, affects the healthy development of enterprise, restricting enterprise capability against risks.

Second, The Analysis of Countermeasure of Small and Medium-Sized Enterprise Human Resources Management In Postfinancial Crisis Background. The current international financial crisis is still in diffusion and spreads to global economic entity, and the impact and the damage was enlarged, to our country economy development negative effects will further appear, the small and medium-sized enterprises will face demand and increasing the difficult situation competition "dual extrusion". Based on this, the small and medium-sized enterprises should reinforce the human resources management and innovation, formulating specific measures and countermeasures for the machine, to turn the crisis, and achieve yet fast development.

Implementing People-Oriented Humanized Management Concept. The human capital is the most important capital for enterprises, and the key to obtain competitive advantage. This requires the small and medium-sized enterprises to strengthen and improve in the process of human resource management "humanism" and corporate interests and employee benefits, to strengthen the idea of combining "with employees for this" management. Pay attention to employee's self-fulfillment and development, and employee's subjectivity and participation, treat staff as the first element. Revolve around fully used and the development of human resources to develop management activities, arouse people's energy and innovation spirit to realize the comprehensive and free development.

Building Characteristics System of Personnel Training and Career Planning. Limited by enterprise scale and funds conditions, small and medium-sized enterprises may, in light of its conditions, build up human resource training system with characteristic of oneself and pertinence. For example, combine staff's own quality condition, regularly sending employees to participate in various types of training and workshops, turns in training by classification. To enterprise's management, can arrange enterprise management, financial management or other management

knowledge training. With these measures, staff had a platform for their own development and improvement, and their work enthusiasm greatly enhanced. In addition, combined with the enterprise's cultivation planning, and with enterprise development goals, help people determine their career development and make personal development goals consistent with the enterprise development goals.

To Establish and Perfect the Reasonable Incentive Mechanism and Scientific Salary System. The first is to adopt flexible compensation mode, in addition to basic material incentive, even the salaries, bonuses, stock option, dividends and other incentive forms combine organically, play the best role to material incentive. The second is to pay attention to the spiritual stimulation to employees, create good working environment and interior atmosphere, make staff love enterprise, and happy to dedicate; the third is to establish a science fair evaluation mechanism, and accomplish evaluation in place, rewards and punishments in place, arouse the enthusiasm of the employees.

To Build Excellent Enterprise Culture. Enterprise's development power and cohesion comes from the enterprise culture, and it can make the staff and the pursuit of the company together tightly, so that each employee produce the feeling of belonging and honor, through the enterprise culture cultivation, management culture mode, and accelerate employees formed the common values and our common behavior standards, thus maximizing employee's enthusiasm and initiative. Small and medium-sized enterprises should attach great importance to the enterprise culture of the mold, the excellent enterprise culture construction to shaping corporate image, as people, promote the enterprise condense enterprise quality, promote enterprise development important ways, and actively explore, unceasing conformity to ascend, cultivate unique corporate culture, and promote enterprise's health coordinated development [3].

The Implementation of the Colleges and Universities Combination Mode, Treat Colleges As Cultivation Base of Small and Medium-Sized Enterprise Talents'. Small and medium-sized enterprises should actively promote the school-enterprise cooperation, and promote the combination of producing and learning, for the development of small and medium-sized enterprises provide personnel and technical support. At present, China's small and medium-sized enterprise should according to "resource sharing and complementary strengths, with bear responsibility, mutual benefit and win-win" principle, perfect cooperation mechanism, innovate cooperation mode, actively carry out a comprehensive and many forms, multiple level the school-enterprise cooperation, to cultivate a group of quality excellent talents for enterprises' development needs and rational structure [4].

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Prisoner's Letter Checking Algorithm Based on Bayesian

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Abstract. Letter which is restrained strictly, is very important for the communication between prisoners and his family. How to check letters automatically to protect the privacy of prisoner based on the security is the aim of this paper. Checking the letters without human is an important topic, which will offer great power to the Informationize construction of prison. Because of the high processing speed of computer, the intelligent algorithm based on Bayesian not only increases the efficiency but also saves the labor resource.

Keywords: Free letter communication, letter checking, Bayesian algorithm.

1 Introduction

Free communication and secret communication is the basic right of every citizen, the letters of prison should be checked is a rule written in prison law also, the conflict is difficult to be solved the existed problem in letter checking system only by laws. The prison law makes some special rule, the prisons are allowed to communicate with other people, but they letters should be checked by policeman in jail. The letters which may bring trouble to the prison security could be detained. The letters written to the prisons' higher authorities and judicial authority should not be checked. The citizen's free communication right and secret communication right contains two aspects: the first is free communication right, citizens have the freedom during the process of communicating with other people through letters, telephones, fax, Email and other. The second is secret communication right, any group or person should not steal information of other citizen's letter content. The prison law is not compatible with constitution; first, constitution doesn't authorize the letter checking right to prison authority. Second, "obstacle to reformation" can't be the reason of detaining letter. Third, the checking way is not rational enough. The dilemma makes it difficult to solve this problem only from law aspect. It is necessary to use some advanced way.

2 Bayesian Theorem

Bayesian Theorem is a theorem of probability theory originally stated by the Reverend Thomas Bayesian. It can be seen as a way of understanding how the probability that a theory is true is affected by a new piece of evidence. It has been used in a wide variety of contexts, ranging from marine biology to the development of "Bayesian" spam blockers for email systems. In the philosophy of science, it has been used to try to clarify the relationship between theory and evidence. Many insights in the philosophy of science involving confirmation, falsification, the relation between science and pseudoscience, and other topics can be made more precise, and sometimes extended or corrected, by using Bayesian Theorem.

Bayesian theorem provides a way to calculate the probability of a hypothesis, here the event Y , given the observed training data, here represented as X

$$p(Y | X) = \frac{p(X | Y)p(Y)}{p(X)} \quad (1)$$

This simple formula has enormous practical importance in many applications. It is often easier to calculate the probabilities, $P(X | Y)$, $P(Y)$, $P(X)$ when it is the probability $P(Y | X)$ that is required. This theorem is central to Bayesian statistics, which calculates the probability of a new event on the basis of earlier probability estimates derived from empirical data. The following section explains the different ways of performing statistical analyses using the classical and the Bayesian statistics [1,2].

Using the assumption for independence, according to (1), the joint probability for all n features can be obtained as a product of the total individual probabilities

$$p(x / y) = \prod_{i=1}^n p(x_i / y) \quad (2)$$

Inserting (2) into (1) yields

$$p(Y | X) = \frac{\prod_{i=1}^n p(x_i / y)p(Y)}{p(X)} \quad (3)$$

The denominator $P(x)$ can be expressed as

$$p(x) = \sum_{k=1}^m p(y_k) \prod_{i=1}^n p(x_i / y_k) \quad (4)$$

Inserting (4) into (3) the formula used by the Naive Bayesian Classifier is obtained

$$p(Y | X) = \frac{\prod_{i=1}^n p(x_i / y)p(Y)}{\sum_{k=1}^m p(y_k) \prod_{i=1}^n p(x_i / y_k)} \quad (5)$$

3 Intelligent Letter Checking Algorithm Based on Bayesian

The new checking algorithm refers to many areas of computer science. The algorithm is described as follow.

(1) Information recognition.

Convert the manuscript into characters that can be recognized by computer. This is a topic in Pattern Recognition. Pattern recognition is a research area that studies the rules and operations, and the design of systems that generalize knowledge from samples and to do prediction. It has been widely used under the names machine learning, classification, diagnosis, etc. Important application areas are image analysis, character recognition, speech analysis, disease diagnostic, human identification, market prediction and the like.

(2) Word segmentation.

Because of the characteristic of Chinese, there are no obvious signal between words in a sentence, so the word segmentation is more difficult than English. There are two ways to do so, the first is splitting the words based on the dictionary, match the Chinese string with the words in dictionary, the second one is analysis, split the words based on grammatical form of Chinese[3].

(3) Feature selection.

A letter is mapped into feature space after preprocessing, but the large number of the features and useless word for classification decrease the efficiency [4]. So it is necessary to decrease the number of features. Only the features that could make contribution to the classification are left to be the final features, the words like "so", "very", etc are neglected. Select features from the original feature space $T = \{t_1, \dots, t_s\}$ into $T' = \{t_1, \dots, t_{s'}\}$, $s' \ll s$, s is the dimension of the original space, s' is the final dimension of after selection. The rule to the selection is increasing the prediction precision.

(4) Text classification algorithm.

Here we choose Bayesian to be the classification algorithm. It calculates the probability of the letter to all the classes, in prison checking problem there are 2 classes, qualified and unqualified.

Step1. Every letter is represented by a n dimensional space $d = (d_1, d_2, \dots, d_n)$, d_i is a attribute of letter.

Step2. C_1 and C_2 are two kinds of letters, qualified and unqualified. The probability of letter belongs to C_j is

$$p(c_j|d) = \frac{p(c_j)p(d|c_j)}{p(d)} \quad (6)$$

The equation 1 is given the letter d , the probability of d belongs to c_j . So the problem is converted into calculate the $p(c_j|d)$, the class which has the maximum $p(c_j|d)$ is the letter's class.

If all the features are independent, then

$$p(d|C_j) = \prod_{i=1}^n p(d_i|C_j) \quad (7)$$

4 Further Research

Some experiments have been done to show the performance of Bayesian algorithm, there are some potential risks behind the high testing precision.

1 The uncertainty of numbers. The numbers are neglected during the feature selection process. The number may mean something.

2 The words order. Just like a puzzle, the words read in different order have the different mean. But the Word segmentation process only split the word from the beginning to the end.

3 There are only 2 results, qualified and unqualified. The testing precision is not perfect, multi-layer classification may solve this problem. Only the letters definitely qualified are filtered, others should be checked.

4 Secret words. Secret words are difficult for machines; the secret words should be put in a single database.

5 Conclusion

This paper tries to solve the prisoner's letter checking problem based on pattern recognition and text categorization in machine learning. Solving from this angle is profound to the prison's informationization. The Bayesian algorithm is popular way to solve text categorization problem such as spam, different algorithm means different performance. The further research on this problem will definitely influence the further of china's prisons.

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Position Selection Algorithm before Civil Servant Exam Based on Margin Tree

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Abstract. civil servant examination is a hot topic in this few years in China, most of people focus on the good working condition and salary, whether the personal quality fit the job or not that will determine the interviewing score and future is often neglected, there are also no standards to refer, because of the desire of high precision, in this paper we design a margin tree algorithm which can be used to predict the position for you to choose only depend on your personal quality to solve this problem.

Keywords: civil servant exam, position selection, margin tree.

1 Introduction

Civil servant examination is very important for the country to select qualified workers to help the government to deal with the affairs related to government management. Different positions need different people with special talent, during the interviewing process, some of the tests and related questions are put forward to get the most qualified ones. Which position fit you, how to determine a post is still a question.

How to choose a suitable post in a scientific way is an interesting topic, some intelligent algorithms are proposed to solve this problem. Based on the characteristics of it, here we choose margin tree [1], which large margin of SVM is used to be the heuristic to generate a decision tree with high generation capacity [2].

This paper has the following organization. Section 2 briefly reviews the concept of margin tree. Section 3 proposes the predict algorithm based on margin tree. And the last section briefly concludes this paper.

2 Margin Tree

Decision tree induction learning has become one of the most popular tools for machine learning, data mining and text classification. It is a very important inductive learning method. Given a training set, a general procedure for generating a decision

tree can be briefly described as follows. The entire training set is first considered as the root node of the tree. Then the root node is split into several sub-nodes based on some heuristic information. If the instances in a sub-node belong to one class, then the sub-node is regarded as a leaf node, else we continue to split the sub-node. This process repeats until all leaf nodes are generated.

The main idea of the margin tree algorithm is as follows. For a given dataset with multi-class, it first converts the multi-class problem into two-class problem using the large margin, relabels each sample positive or negative. Then for each two-class problem, margin tree uses traditional inductive algorithm to generate a decision tree which splits a dataset into two subsets for the further induction. So each stage it generates a decision tree, do this recursively, the tree is obtained finally.

Here we use inverse problem to be the heuristic. For a given dataset of which no classes labels are assigned to instance, we can randomly split the dataset into two subsets. Suppose that one is the positive instance subset and the subsets can be separated by the way of SVM. Then we can get the margin. Obviously the calculated margin depends on the random split of the dataset.

3 SVM Inverse Problem

It is an optimal problem. We mathematically formulate it as follow. Let $S = \{x_1, x_2, \dots, x_n\}$ be a dataset and $x_i \in R^m$ for $i = 1, 2, \dots, n$, $\Omega = \{f \mid f \text{ is a function from } S \text{ to } \{1, -1\}\}$. Given a function $f \in \Omega$, the dataset can be split to two subsets and then the margin can be calculated by SVM. We denote the calculated margin (the function) by $M \arg in(f)$. Then the inverse problem is formulated as

$$\text{Maximum}_{f \in \Omega} (M \arg in(f)) \quad (1)$$

Due to the exponentially increased complexity, it is not feasible to enumerate all possible function in Ω for calculating their margins. It is difficult to give an exact algorithm for solving the optimization problem (1). Some optimal algorithms are proposed to decrease the time complexity of it. Clustering algorithm helps to decrease the number of clusters, the algorithm based on the relationship between a global margin and cluster to cluster margin make it more efficient[3,4].

The solution based on clustering algorithm helps to separate the dataset into several clusters, then enumerating all the possible cases, finally a maximal margin is gained from all the margins get from all kinds of partitions. The key of decreasing the running time of clustering enumeration algorithm is to decrease the number of clusters. The relationship between every cluster to cluster margin and a margin gained from the whole dataset is also considered in the new algorithm. If a cluster to cluster margin is smaller than a global margin, the two clusters should be merged [5].

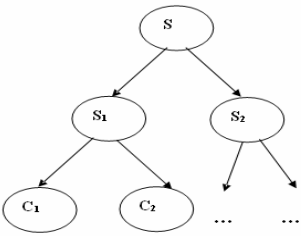


Fig. 1. Margin tree algorithm

Figure1 shows the process of margin tree classification. The dataset S is separated into two parts S_1 and S_2 based on the largest margin, and then the separated parts will also be separated into 2 parts until reach the termination condition. The high generation capacity of SVM makes the generation capacity of margin tree also high.

4 Position Selection Based on Margin Tree

Margin tree generation process is described as follow. Samples S are selected from the civil servants who fit the job good in different positions, the feature space of the sample is $U = (\text{language organization, generalization, logic, performance...})$, it is described as $U = \{u_1, u_2, u_3, u_4, u_5, \dots\}$. The positions are described as $C = \{c_1, c_2, c_3, \dots\}$. The dataset $S = \{s_1, s_2, s_3, \dots, s_n\}$

- (1) Separate S into 2 parts S_1 and S_2 through largest margin of inverse problem of SVM.
- (2) $S = S_i (i=1,2)$
- (3) If the percentage of certain position is higher than φ , the partition process of this dataset terminates, if no partition needs to be separated, goto(4) ,else goto(1)
- (4) End.

In this algorithm, if the percentage of certain position is higher than φ means in this partition, more than φ of the people have the same or similar position. So we can approximately treat them as the same position. Every margin between partitions means the different degree between them, if the margin is larger, the different degree is larger. The separation hyper-plane means one characteristic such as courage, logic, etc. An example is shown below as figure 2.

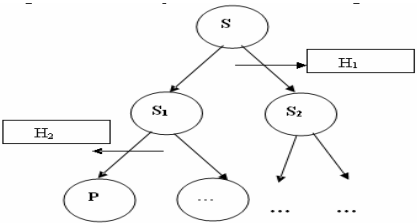


Fig. 2. An example

Figure2 is a schematic diagram after the margin tree has been trained, the hyper-plane between S1 and S2 is H1, and someone's personal information has already been mapped into feature space. If a sample finally is classified into P, it means that the job fit it may be policeman. One class means one position, with the help of the margin tree, all the samples finally are separated into one class based on the information of somebody who feel them fit the job.

5 Experiment

The experiments have been done in a small group of samples; the algorithm has shown its effectiveness and do offer a series of important suggestion to the people who intend to join the civil servant examination. Due to the uncertainty of the algorithm, it is difficult to give a testing precision.

But there are still some problems to be solved. First, the reliability of data resources is uncertain. There is no standard to estimate whether the person fit the position or not, all the samples are collected from personal feeling. Second, the fitted position is single. Because the margin is a classification algorithm, one sample only belongs to one class, but a person may fit more than one positions. Some fuzzy algorithms should be used in the further research. Third, the high time complexity makes it difficult to be used in a large dataset.

6 Conclusion

Motivate by designing an intelligent algorithm to help to deal with the position selection problem before the civil servant exam, this paper proposes a margin tree algorithm. This algorithm is practical and efficient.

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Algorithm Research on Delaunay TIN Generation and Real Time Updating

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Abstract. This paper studied an efficient and practical algorithm for Delaunay TIN generation and real time updating from mass geographic data in the environment of paralleling. For the efficient request of mass data, the paper puts forward a merging method of generating the Delaunay TIN. The method is simple and efficient. It is easy to parallel process and pipeline work.

Keywords: delaunay TIN, parallel, merge, real time updating, accelerating ratio.

1 Introduction

How to build mass geographic data DTM efficiently, is one of the issues that need to be resolved in the current spatial analysis and application fields. Delaunay triangulation is widely used in the DTM (digital terrain model) modeling. It has many advantages such as data redundancy is small, the expression of high precision, fast display, easy to update, suitable for all kinds of distribution of data representation and so on. Over the years, a large number of scholars studied on Generation and Optimization of triangle mesh, and put forward some practical algorithm[1,2]. According to the realization process, it can be divided into three categories: divide and conquer, incremental insertion and triangle growth method.

However, traditional methods remain in the serial computing model, by the computing power restriction, the improvement of algorithm is so limited that can not fundamentally solve the building of mass geographic data DTM efficiently[3]. Parallel computation using multiple processors to solve the problem, is much faster than the single-processor computing, and it also provided an opportunity for solving large scale problems. In the parallel environment, you can use multiple processors, memory and IO resources to deal with mass data effectively in a distributed environment.

In view of this, this paper will focus on the research of Delaunay triangulation construction and real-time update problems in the parallel environment. According to the efficiency of mass data processing requirement, this paper presents efficient triangle algorithms that can be centrally updated in real time.

2 The Update of Triangle in Real Time

The update of the point and line segment includes insert, delete and move. Move can be regarded as the deletion of point or line segment in the original location and insertion in the new position.

2.1 Determine the Triangle Where the Point or the Starting Point P of Line Segment in

To determine where the point P the triangle is the following 3 kinds of t can one: 1) point P in triangle t internal; 2) point P in the triangle one of fractal t the edge; 3) point P with the triangle it's a vertex superposition.

To the point where the triangle Quick Search, first of all blocks in the triangle index table to find points where the sub-block, then any of the sub-block to take a triangle (sub-block located in the center of gravity)[4]. Determine the relationship

between P points and t_0 the location. If there is listed at the beginning of this section,

one of three things, the end of the search, t_0 that is, by looking for triangles t. Otherwise, that point is located outside the triangle, then the following conditions must be: P Points in the two sides of a triangle the same side of (outer product of the same symbol value), while in the other side of the opposite side (with the other two sides of the outer product value of the opposite sign), may wish to note for the different sides of the border. The next time you want to search different side of the triangle is the adjacent triangle, the different side of the search direction is specified, so that greatly reduces the time to find points where the triangles. This has been the search continues, you can find the p point where the triangle t.

The process to use the location of the triangle $\triangle ABC$ between the point and can be used to determine the following formula:

If the vertex $\triangle ABC$, according to counter-clockwise order, then

(1) If the point P at the same time $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CA}$, the right side, then the point P is inside $\triangle ABC$

(2) If the point P is also located there to the edge of a two, then P point and the public on both sides of vertex.

(3) If the point P is only directed at the edge of a one, the point is of the edge;

(4) If the points P at the same time the two have a right to the edge, and another directed at the left edge, the point P is located outside $\triangle ABC$.

2.2 Determine the Point or Segment to be Inserted in the Affected Region

Identified in this section point or segment to be inserted in the affected region or segment specific to the insertion point, the original Delaunay triangulation does not meet the criteria of all those triangles. Remove the affected region, the original

triangle to form a cavity inside. We just need to press the counter-clockwise on the boundary of the cavity with a side of each side of stored list, it can later be based on vertex, edge, triangle topology, to reconstruct the original triangle.

2.2.1 Determine the Point P of Triangulation of the Region to Be Deleted

The impact of the insertion P point is the circum circle contains the point P region that triangle. The following job is to find the triangle, delete, and press the counter-clockwise to remove the outer edge into the edge E region in the list. Specific steps are as follows:

(1) Determined to be the insertion point P where the triangle t_0 counterclockwise will turn into three sides of the triangle edge E list;

(2) Counterclockwise order of the three vertices $V_i (i = 0, 1, 2)$ of a triangle t_0 for the following test:

Investigation to turn counterclockwise $V_i (i = 0, 1, 2)$ is a series of triangle circumcircle vertex to see whether it contains points P , if not contained, the detection of the end of the vertex; Otherwise, remove the triangle in the triangulation with which the original update Topology-related information, and remove the side of the triangle edge E in the list, and the other of the two sides E of the triangle in the counterclockwise into the side of the list.

(3) The final list from the side edges E of the area enclosed by the impact of the insertion point P is the area to be.

2.2.2 Determine the point P of triangulation of the Region to be Deleted

Will only point to all vertices of the triangle can be deleted. Specifically, the following:

(1) Find the point P where the triangle t_0 , the point P must be the vertices of the triangle t_0 , so that $t = t_0$.

(2) Counterclockwise to find t the adjacent triangles t' , the points P list on the side of adding edge E

(3) Order $t = t'$, repeat (2), until $t' = t_0$, this time from the side edges E of each list, in the area bounded by the impact of the insertion point P is the area to be.

2.2.3 Triangulation to Determine the Impact of the Regional Line $\overline{AB}$ to Be Inserted

To be inserted $\overline{AB}$ segment of the triangle area includes the following three categories[5]: (1) line $\overline{AB}$ intersects with the triangle; (2) circum circle

A , B contains the vertices of the triangle; (3) the circum circle and the line segments $\overline{AB}$ intersect or are tangent to the triangle.

The following job is to find the triangle, delete, and press the counter-clockwise to remove the outer edge into the edge region in the list E . Specific steps are as follows:

(1) The starting point to determine where the line to be inserted into the triangle, according to three sides of the triangle counterclockwise will turn into the side of the list.

(2) Determine whether the end B of the line $\overline{AB}$ in the triangle t_0 is a directed line segment $\overline{AB}$ is illustrated in the triangle t_0 , to (3) If not, then there is a triangle t_0 to the line $\overline{AB}$ with a directed edge intersection, according to the discriminant line and the line $\overline{AB}$ segments intersect the conditions to find the triangle t_0 edge e_0 intersects with the constraint line, the intersection edge e_0 , the triangle t_1 by its neighbors, and then Removed e_0 from the edge list, and except for the triangle t_1 adjacent e_0 to two sides of the other counterclockwise into the side of the list E ; and then the Chinese and another side of the intersection with the constraint line to get to the next triangle $t_2, \dots$. So again, you can find where the other B end of the segment to be inserted into the triangle t_{m-1} . Remove the side E of the list in the order of the vertices, $V_0, V_1, \dots, V_{n-1}$, they are arranged counterclockwise.

Line with the above process used in the Criterion line segments intersect.

$$4S_{\triangle ABC} S_{\triangle ABD} = \begin{vmatrix} x_A - x_B & y_A - y_B \\ x_B - x_C & y_B - y_C \end{vmatrix} \begin{vmatrix} x_A - x_B & y_A - y_B \\ x_B - x_D & y_B - y_D \end{vmatrix} \begin{cases} < 0 \\ = 0 \\ > 0 \end{cases}$$

(3) In turn, $V_0, V_1, \dots, V_{m-1}$, the following test:

Counterclockwise study of V_i ($i = 0, 1, \dots, m-1$) is the vertex of the triangle's t_j circum circle t_j series, to see whether the circum circle contains the line $\overline{AB}$ segment, or whether there are points A or B line segments $\overline{AB}$ intersect or tangent to the.

If not, then the ending point V_i of detection. If so, then remove the triangle at the same time to remove the t_j list from the border edges E , and remove the counterclockwise into the position t_j of the other two edges.

(4)The final list from the side E edges of the area enclosed by a directed line $\overrightarrow{AB}$ segment is the area of influence.

2.2.4 Triangulation to Determine the Impact of Line Segments $\overrightarrow{AB}$ in the Region to Be Deleted

Simply remove the segment $\overrightarrow{AB}$ to be associated with all triangles can be deleted. Specifically, the following:

(1) According to the center line $\overrightarrow{AB}$ in the side of the block index table to find edges $\overrightarrow{AB}$, and then find out that side of the topology of the two triangles t_0 and t_1 the edge $\overrightarrow{AB}$.

(2) Respectively find the point A and B does not contain triangles t_0 and t_1 the edges of the regional lists E_0 and E_1 .

The chain E_1 into the rear side of the list E_0 , then the region E_1 is the segment $\overrightarrow{AB}$ of the edge list.

3 Application Efficiency

To examine the practical implementation of the algorithm efficiency and application results, the choice of tens to hundreds of megabytes of 7 groups of measured data to test the algorithm. Since the program implementation is based on the preparation of massive data processing requirements, the algorithm is executed, the need to exchange data between the internal and external memory, so when compared to data in memory, the speed should be slower, but, the test results from table 1 is easy to see, the efficiency of the algorithm is still relatively high.

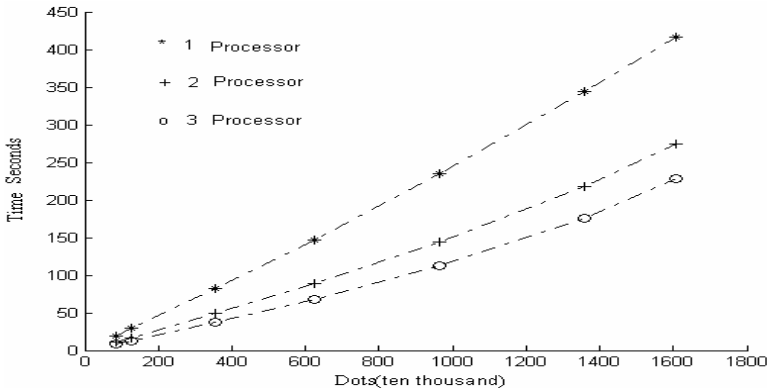


Fig. 1. Time efficiency of parallel distribution

Figure 1 shows that the algorithm has higher efficiency in the implementation, excluding I / O time, network time-consuming in a single body of data is small, almost linear relationship with the number of points, the data is large, is lower than the line Of time-consuming; With the increase in the number of processors, followed by increased time efficiency, more than linear time-consuming.

Table 1. Delaunay triangulation of different landscapes update efficiency table

Lands cape	Triangular number	Insert points time-consuming		Time-consuming to delete points		Insert the number of line time-consuming		Remove the number of line time-consuming
Hills	158195	19779	2.542	19778	2.486	39562	5.373	39557 5.283
Glacier	111405	13931	1.769	13930	1.695	27866	3.948	27864 3.875
middle of mountain	145367	18175	2.348	18174	2.296	36352	4.812	36349 4.735
Loess	134740	16847	2.136	16846	2.078	33696	4.365	33693 4.261

Loess landscape of network and update the configuration shown in Figure 2 results:

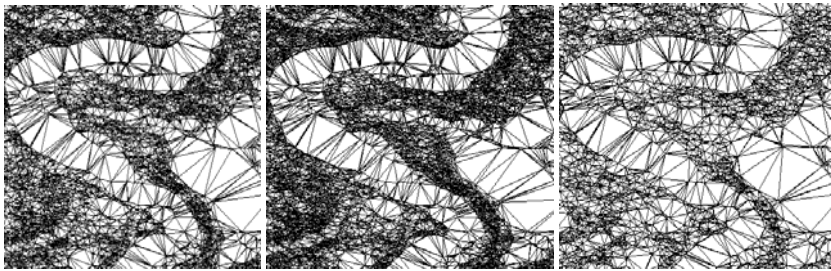


Fig. 2. The complex terrain of three-dimensional dynamic display and editing

Figure 2 shows that 1.The initial triangulation; 2.After the insertion point and line triangulation; 3. Delete points and triangulation after line. The algorithm is applied to the complex terrain of three-dimensional dynamic display and editing, modeling can be based on the DTM, read the relevant terrain data, terrain information to achieve real-time updates. The simulation is of great significance terrain.

4 Summary

Delaunay triangulation of digital terrain model is an important means of representation and analysis and processing. Based on the parallel processing of

massive data requirements, a method for merging network structure is proposed. This method applies to both single and multi-threaded concurrent serial processing, but also applies to multi-machine parallel processing, especially for pipeline operations. Thus, the algorithm has wide applicability and excellent efficiency tap the potentials of the current application is becoming more widespread mass data processing is very meaningful.

The algorithm can be dynamically updated in real time triangulation of points, lines and other elements, so the model can be easily edited in real time, and a variety of engineering calculations and analysis, such as fractal dimension, the calculation of earthwork excavation and filling, through visual analysis, Contour tracing and overlay with other design models and animation three-dimensional perspective roaming applications. Achieved by this triangulation algorithm terrain analysis module can be used in digital terrain environment simulation. Practice shows that the algorithm has high efficiency and strong stability.

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Performance Simulation of Hybrid Power Tactical Vehicle Based on AMESim

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Abstract. AMESim is one kind of remarkable software which is used to solve the practical problems on modeling, simulation and dynamic performance analysis of hydraulic /mechanical system. Use MATLAB and AMESim to simulate and analysis, the simulation results show that the performance of the hybrid tactical vehicle is superior of the prototype tactical vehicle.

Keywords: AMESim, tactical vehicle, hybrid electric vehicle, performance simulation.

1 Introduction

AMESim(Advanced Modeling Environment for per-forming Simulation of engineering systems) is an excellent software which is developed by France Imagine company in 1995 to solve the actual problem such as hydraulic and mechanical system modeling, simulation and dynamic performance analysis. AMESim software achieved the interface using C language and realized the algorithm by FORTRAN language,which do not need other commercial software for support.

The series of AMESim software include AMESim used to carry system design through, AMESet used to create applications, AMECustom used to model the library and AMERun used to transfer to the customization of the end user. AMESim model library stacks up to 20 species and its submodel is more than 1,500. AMESim provides rich interfaces to connect other softwares such as Matlab, MatrixX, Adams, Simpack, VL Motion, Flux, xPC, dSPCE, iSIGHT, OPTIMUS and Excel etc. This software models aiming to principle chart and the users don't need to prepare any program code,which leads the user to focus on the design of physical system itself not to the mathematical modeling[1].

2 Hybrid Drive Type

Hybrid powertrain can generally be divided into series, parallel and parallel-series three power transmission classification. But in recent years on the basis of traditional hybrid cars, a circumscribed charging type (Plug-in) hybrid cars was derived.

2.1 Series Hybrid Cars

The series hybrid cars power flow is shown in as figure 1

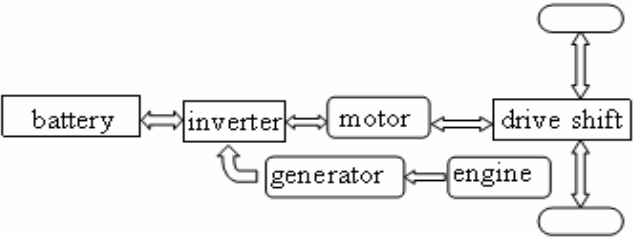


Fig. 1. Series hybrid system diagram

From figure 1 we can see that the series hybrid cars is composed by three parts of engine, generator and motor. The car move only by battery driving motor in a small load state, which can realize zero emissions. In big load state the car runs by engine,generator and motor combine driving. When in acceleration, climbing and start-up working condition, the vehicle works by the engine - electric generating units and battery commonly providing electricity to motor. when batteries are lack of electricity, generating units charge to batteries by engine.

2.2 Parallel Hybrid Cars

Parallel hybrid cars power flow is shows as figure 2. Parallel hybrid device drivies cars by engine and electric motor, which belong to two sets of systems. Engine and electric motor can independently provide auto transmission system in different torque. When the car accelerates or climbs, motors and engines can simultaneously provide power to the transmission mechanism. once the car speed reaches cruising speed, car will only depend on engine maintain the speed. Motor can be used as motor and generator. Since no single generator, the engine can be directly drive wheels through the transmission mechanism. This device is close to traditional car drive system and the mechanical efficiency loss is similar to the regular car, which gets more extensive applications.

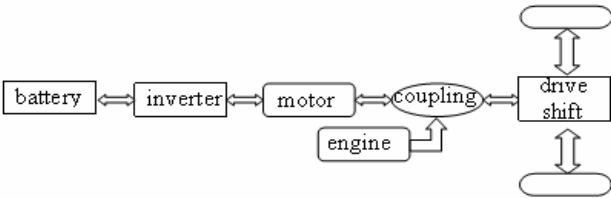


Fig. 2. Parallel hybrid system diagram

2.3 Parallel-Series Hybrid Cars

Parallel-series hybrid cars power flow is shown in figure3. the parallel-series device contains series and parallel characteristic. Power system includes engine, generator and motor. According to the difference of power devices, Power system is divided engine primarily or micro-motors primarily two kinds again. In the form that engine regarded as the main power source, motor is supplied as auxiliary power. In the form of engine regarded as auxiliary power source, it is contrary. The advantages of this structure are to control conveniently and the defect is structure is more complex.

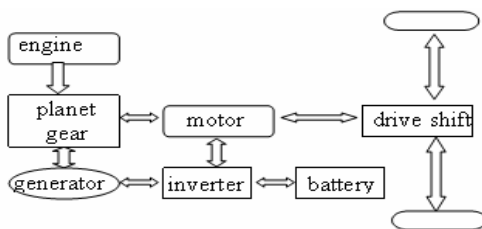


Fig. 3. Parallel-series hybrid system diagram

3 Hybrid Tactical Vehicle Modeling

AMESim modeling simulation process is divided into four steps:

(1) Rendering system basic formation picture (the drawing mode). The model of the basic elements needed is dragged from the AMESim model libraries to build simulation frame-chart of the system.

(2) Module Settings (submodel mode). After completion of basic system built, each submodel system need to set. For example clutch model is divided into hyperbolic tangent coulomb model, reset integral coulomb friction model, Dahl sticky coulomb friction model and coulomb LuGre sticky four model. Because the description and the expression are different in these models on different problems, the appropriate submodel is chose in setting stage according to the system demand.

(3) Parameter Settings (parameter model). After establishing system submodel, we set parameters for these submodels and each element. Parameter Settings is to prepare for simulation of the system. Top three steps referred to are intitule model building process. Model built is fine or not and data set is proper or not directly related to the simulation results of the credible degree.

(4) Operation simulation (operation mode). Finishing the simulation model parameter Settings, we can enter operating mode operation simulation. At the start of the simulation, we want to install various simulation parameters, including the time of starting and ending, simulation step length and solver species etc. It need to explain that any simulation software is to obtain the simulation results by iteration and the same simulation model of a different selection may get different simulation results for different simulation parameters or solver. AMESim simulation parameters and solver is set in the running mode.

4 Hybrid Tactical Vehicle Assembly Parameters

4.1 Tactical and Technical Indicators

We regard EQ2102 as the study vehicle in this thesis. The simulation technical parameter are shown in table 1.

Table 1. EQ2102 off-road vehicle simulation parameter

Parameter name	Parameter values
load quality	3500kg
front axle load	3170 kg
Medium and rear axle load	3950 kg
No-load total	7120 kg
length	7495mm
wide	2470mm
Medium axle to rear axle distance	1250mm
front axle tread	1876mm
Medium and rear tread	1870mm

4.2 Assembly Matching Parameters

In matching calculations, vehicle transmission efficiency $\eta_r=0.9$, rolling resistance coefficient $f=0.013$, air resistance coefficient $C_D=0.58$, windward acreage $A=6m^2$, pure electric trip mileage 20 kilometers, each component parameters are shown in table 2.

Table 2. Hybrid tactical vehicle components parameters

Assembly parts	Parameter name	Parameter values
engine	maximum power /kw	80
	The scope of e speed /r/min	800~2800
	power rating /kw	12
	maximum power /kw	15
motor	rated speed /r/min	750
	maximum rotative speed /r/min	3000
	rated torque /N.m	128
	maximum torque /N.m	160
	type	Li-battery
battery	electric voltage /v	300
	accumulator capacity /A.h	110
	accumulator energy /kw.h	12.5

5 Hybrid Tactical Vehicle Performance Simulation

5.1 Simulation Conditions

Simulation conditions is 10-15 mode driving cycles, As shown in figure 4.

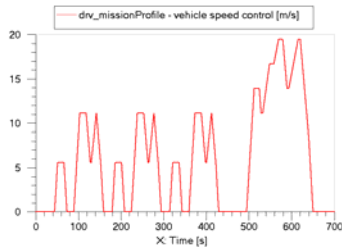


Fig. 4. Simulation conditions

5.2 Simulation and Results Analysis

a The prototype vehicle simulation
Engine power 119kw/2800r/min, the vehicle weight 7120kg, the vehicle transmission efficiency $\eta_r=0.9$, rolling resistance coefficient $f=0.013$, air resistance coefficient $C_D=0.58$, windward acreage $A=6m^2$, Five gear transmission ratio: 6.602, 3.473, 2.13,1.297 and 1.00, reverse transmission ratio 6.659. The work status of engine is shown in figure 5and figure 6 . The simulation results are shown in table 3.

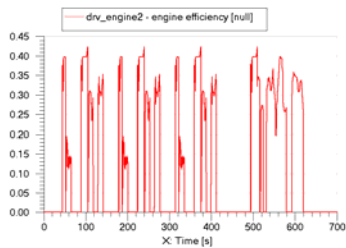


Fig. 5. Engine efficiency figure

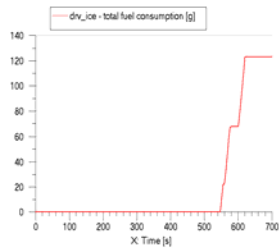


Fig. 6. Engine fuel consumption curve

Table 3. Prototype vehicle performance parameters

Performance parameters	simulation results
Fuel consumption	26.73 L/100km
Maximum speed	98km/h
maximum gradability	60%
Started acceleration time	54.5s(0-90km/h)
Overtaking acceleration time	38s(60-90 km/h)

bHybrid tactical vehicle simulation

In simulation, engine power 80kw/2500r/min, motor power 12kw/750r/min, battery 300v/110Ah, the vehicle weight 7250kg. Other simulationp arameter is consistent in that of the prototype vehicle. The simulation results are shown in fugure8, fugure9and table 5.

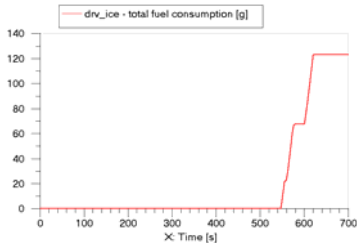


Fig. 8. Engine fuel consumption curve

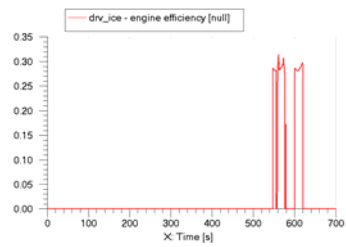


Fig. 9. Engine efficiency figure

Table 5. Hybrid vehicle performance parameters

Performance parameters	simulation results
Fuel consumption	20.63 L/100km
Maximum speed	102km/h
maximum gradability	60%
Started acceleration time	55.5s(0-90km/h)
Overtaking acceleration time	37.5s(60-90 km/h)

5.3 Results Analysis

Because in the Prototype vehicle engine power is larger and vehicle power demand is lesser, the engine works in inefficient area, the fuel economy is inferior to hybrid vehicle.

In accelerating or climbing hybrid vehicle has motor auxiliary and its dynamic performance is than the prototype vehicles.

6 Conclusion

We establish regular diesel off-road vechile and hybrid drive off-road vehicle simulation model in this paper using hybrid electric simulation analysis software AMESim of France Imagine company. The vehicle performance of various vehicles is simulated. Through comparing and analysing simulation parameters , we can obtain these conclusions:

1) Via the engine work state chart and efficiency curve graph we can be see in the whole simulation time that the work efficiency of hybrid off-road vechile is better than the prototype car.

2) In dynamic performance (such as maximum speed, acceleration time, maximum grade ability etc), hybrid off-road vehicle is better than the prototype vehicle.

3) In fuel economic performance and exhaust emission performance, the hybrid vehicle is superior to the prototype vehicle.

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Constructing the Information Management System Based on Ontology and Concept Lattices

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Abstract. Concept lattice, the main data structure in formal concept analysis theory, has been widely applied to many fields such as machine learning, knowledge discovery, information retrieval and software engineering. Ontology has become increasingly popular because it promises a shared and common understanding of knowledge domains that can be communicated between people and application systems. The main contributions of this paper is presenting applying formal concept analysis theory and ontology to construct information system of management knowledge, and the experiments shows the CPU Time in the attribute numbers, indicating that FCA is superior to ontology in building the information management system.

Keywords: information management, formal concept analysis, domain ontology, concept lattice.

1 Introduction

A domain ontology defines the set of basic terms comprising the vocabulary of the domain area and the relationships that bind these terms. As a consequence, comprehensive legislations and regulations have been devised and implemented in order to allow banks and other financial institutions to better assess credit risks and to allow supervisory bodies to enforce the building of adequate capital reserves. In order to solve this problem, semantic web technique – OWL and OWL-S, which are innovative for data discovery and service discovery respectively, have been adopted. By using this semantic web technique, the information necessary for resource discovery could be specified as computer-interpretable[1]. It will lead to the disunity of ontology construction because different domain experts adopt different views. Before the emergence of the semantic web, agents had to face the problems derived from the lack of structure characterizing much of the information published on the web.

A variety of query systems have thus appeared. The basic operational pattern of all the general query systems is to pass the user's query to a backend process, which is responsible for producing proper query result for the user. It is to describe the concept in formalization of symbol from extent and intent, and then realize the semantic information which can be understood by computer. It is to extract all connotative concepts and connections between them from formal context according to the binary

relationship so as to form a hierarchical structure of concept. It is to describe the concept in formalization of symbol from extent and intent, and then realize the semantic information which can be understood by computer. It is to extract all connotative concepts and connections between them from formal context according to the binary relationship so as to form a hierarchical structure of concept. In this information-exploding era, the user expects to spend short time retrieving really useful information rather than spending plenty of time and ending up with lots of garbage information. Customer service is a core customer relationship management (CRM) issue for a company that intends to provide its customers with better interactions and follow-up services, which often aim to improve customer satisfaction and in turn increase customer loyalty.

Task refers to goal-oriented activities. Meanwhile, domain refers to the area of task application. In this study, the task domain focuses on how employ learning objects from different publishers to compose a learning route that follows an appropriate sequence. Owing to increased advertising, media broadcasting, promotion and endorsements, organized sport is no longer only a sport but a business as well. Sport marketing is the most obvious form of commercialization in sport and yet sport events and marketing patterns have attracted comparatively little academic attention. The paper probes into building domain information system based on ontology and concept lattices in order to constructing the ontology model of e-commerce recommendation system, and to suffice the needs of theory and application in E-commerce recommendation system. Finally, we provide some numerical experiments to demonstrate the feasibility of the proposed algorithm. The experimental results show that the proposed approach can effectively recommend a travel route matched with the tourist's requirements.

2 The Knowledge Management System Based on Ontology

Personalization is a key element that facilitates the employ of complex services on mobile devices. The system then processes the refurbished database using a data-mining module, which is based on multiple minimum supports to discover implicit troubleshooting rules. Recently, fuzzy reasoning has been used in different approaches to the process. For example, a line interpolation method using a spatial information edge-direction detector has been proposed for accurate edge direction.

As one example of the importance of ontology quality consider the area of business process modeling. The description of business processes is an important first step in the development of information systems that are intended to support and implement these processes[2]. While in classical set theory elements either belong to a set or not, in fuzzy set theory elements can belong to a certain degree. More formally, let X be a set of elements. For a specific data instance, its semantic view in the ontology not only includes the components that it instantiates, but also any other components whose changes implicitly affect the instantiated components based on the implication analysis presented. X and Y denote the non-empty subsets of U .

One of the main issues of focused crawling is how to traverse effectively off-topic areas and maintain a high harvest rate during the crawling process. The complement, intersection and union set operations are performed by a negation function, a t -norm

function (typically, the minimum) and t -conorm function (typically, the maximum) respectively. In particular, the notion of *adjunction* between a fuzzy conjunction operator and a fuzzy implication operator on a complete lattice is introduced. The correspondence between a fuzzy covering and a fuzzy relation is analyzed.

Ontology $i \in I(c)$, i instantiates property p , ontology o . We say two random variables X and Y are independent if $P(x|y) = P(x)$. The variables X and Y are conditionally independent given the random variable Z if $P(x|y, z) = P(x|z)$.

$$R(x, y) = \bigwedge_j \in J (F_j(x) \rightarrow F_j(y)) \bigwedge \bigwedge_j \in J (F_j(y) \rightarrow F_j(x)). \quad (1)$$

In recent years, scientific workflows are emerging as a suitable practice to model and simulate the logical stages of a science process to create a science product. In the case that a conjunction $*$ and an implication $\rightarrow$ form an adjunction, the pair $(*, \rightarrow)$ is called an adjunction and $\rightarrow$ is called the adjunctional implication of $*$. In the following, we first give the definitions of dispensable attribute and indispensable attribute in the concept lattices. Generally speaking, there are three kinds of relationships that exist among concepts. These are independence, intersection and inheritance.

Nowadays, ontology is also a popular research topic in knowledge management, cooperative information systems, electronic commerce, information retrieval, intelligent information integration and medicine, among others. A defuzzified number is usually represented by the centroid of gravity (COG), which can be determined using the moment of area method defined as $\text{COG} = (\int_X x \mu_B(x) dx) / (\int_X \mu_B(x) dx)$, where $\mu_B(x)$ is the aggregated value of the fuzzy variable B over the universe of discourse Z . The change brings the sentence form in line with the semantics of concept subsumption in formal ontologies[3]. From ontology to be evaluated, we extract a number of such sets of three concepts and construct S1 and S2 sentences that are, according to the formal ontology as follows.

Step 1: *plug-in*, if G_o subsumes R than G_o could be plugged in place of R ;

Step 2: For each $x \in X$, find the fuzzy description ζ_x of x , which is δx in the crisp situation, by the following computations.

Step 3: *Service Search*: semantically matched “*Service_Type*”s with optional associated as the additional search conditions in the standard CSW service query.

Step 4: For $x, y \in S$, x, y are in the same class if and only if $x, y \in \delta x \cap \delta y$.

By mining the database, there are two main customer segmentations, including student and office worker customers. This article suggests that Adidas can employ marketing strategy focused on male sport products. Image processing functionality has been achieved using fuzzy reasoning methods.

3 Concept Lattices Model

A formal context is a triple: $K=(G, M, I)$, where G and M are sets, and $I \subseteq G \times M$ is a binary relation. In the case, the members of G are called objects, the members of M are called attributes, and I is viewed as an incidence relation between two. Accordingly, we write gIm or $(g, m) \in I$ expressing ‘the object g has the attribute m ’.

Formal concept analysis (FCA) has been advocated to represent and process context knowledge in such clinical domains as, for example, describing patient cases,

interpreting therapeutic decisions and representing rules. In an application environment, the notion of a concept is used as a generic mechanism to deal with a group of related objects and to associate a meaningful label with such a group[4]. An example of a context (G, M, I) is shown in Table 1, where $G = \{g_1, g_2, \dots, g_6\}$ and $M = \{m_1, m_2, \dots, m_5\}$. An X is placed in the i th row and j th column to indicate that $(g_i, m_j) \in I$. For a set of objects $A \subseteq G$, $\beta(A)$ is defined as the set of features shared by all objects in A . That is following equation 2.

$$P(x_1, x_2, \dots, x_n) = \prod_{i=1}^n P(x_i \mid D_{x_i})$$

(2)

Similarly, for $B \subseteq M$, $\alpha(B)$ is defined as the set of objects that possesses all the features in B .

Table 1. Formal context S

S	a	b	c	d
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1
5	1	1	1	0
6	1	1	0	1

Fig. 1 shows the frequency of the terms in every document. When documents of various data sources are entered, they must pass through different preprocessing methods in order for them to qualify in subsequent requirements.

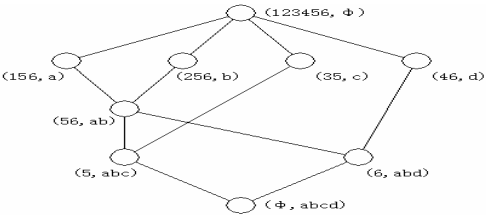


Fig. 1. concept lattices figure

First of all, we constructed an ontology to express the basic components of the FCA method, including formal object, formal attribute, formal context and formal concept. Second, concept lattices provide better foundation for knowledge processing, such as association rule discovery, intelligent search engine, semantic Web and natural language processing.

4 Constructing the Information Management System Based on Ontology and Concept Lattices

Upon changing the document content into a set of terms, the ontology construction subsystem adopts the ontology construction technology to produce document conceptual maps. According to the goal of ontology, the pivotal problem of ontology constructing is to find the concepts and relationship among concepts after confirming the field, but these are connotative in the brain or store the file of this field in actual life. The primary content of this dissertation is to apply rough concept lattices technology to obtain all connotative concepts and hierarchy of them automatically from the designated data, which is not under the influence of developer. To do so, we actually observed the context of eleven students three times a weekday, for four weeks and hence collected 660 records.

Our system runs on a Windows XP-based PC with an Intel Pentium 4 CPU at 2.8 GHz and 1 GB RAM. The system was developed using Java on Java SDK 1.4.2 platform. Denoting concept in symbol achieves formalized conceptual model.

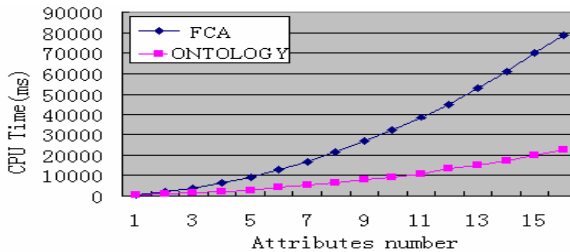


Fig. 2. Constructing information management system compared result of FCA and ontology

Fig. 2 describes the method of building information system based on concept lattices and ontology. Ontology and concept lattice model is proposed based on integrating of ontology, formal concept analysis, and is used to reduce formal context. The experiments show the CPU Time in the attribute numbers, indicating that FCA is superior to ontology in building the information system.

5 Summary

The sharing and re-using of ontology enable users to communicate with computers by using accurate syntax and semantics. It becomes an important problem on ontology application to build and present ontology. The exercise of FCA in mathematics can be used to explain classification systems. Formal classification system is capable of analyzing based on the consistence among relationships. Finally, we provide some numerical experiments to demonstrate the feasibility of the proposed algorithm.

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