

Zhicai Zhong  
*Editor*

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# Preface

Welcome to the Proceedings of the 2nd International Conference on Information Engineering and Applications (IEA 2012), which was held in Chongqing, China, October 26–28, 2012.

As future generation information engineering, information technology and applications become specialized. Information engineering and applications including computer engineering, electrical engineering, communication technology, information computing, service engineering, business intelligence, information education, intelligent system, and applications are growing with ever increasing scale and heterogeneity, and becoming overly complex. The complexity is getting more critical along with the growing applications. To cope with the growing and information engineering and applications focus on intelligent, self-manageable, scalable information systems, engineering and applications to the maximum extent possible without human intervention or guidance.

Information engineering and applications is the field of study concerned with constructing information computing, intelligent system, mathematical models, numerical solution techniques, and using computers and other electronic devices to analyze and solve natural scientific, social scientific, and engineering problems. In practical use, it is typically the application of computer simulation, intelligent system, internet, communication technology, information computing, information education, applications, and other forms of information engineering to problems in various scientific disciplines and engineering. Information engineering and applications is an important underpinning for techniques used in information and computational science and there are many unresolved problems, worth studying.

The IEA 2012 conference provided a forum for engineers and scientists in academia, industry, and government to address the most innovative research and development including technical challenges and social, legal, political, and economic issues, and to present and discuss their ideas, results, work in progress, and experience on all aspects of information engineering and applications.

There was a very large number of paper submissions (1845), and all submissions were reviewed by at least three Program or Technical Committee members or external reviewers. It was extremely difficult to select the presentations for the conference because there were so many excellent and interesting submissions. In order to allocate as many papers as possible and keep the high quality of the

conference, we finally decided to accept 542 papers for presentations, reflecting a 29.4 % acceptance rate. We believe that all of these papers and topics not only provided novel ideas, new results, work in progress, and state-of-the-art techniques in this field, but also stimulated the future research activities in the area of information engineering and applications.

The exciting program for this conference was the result of the hard and excellent work of many others, such as Program and Technical Committee members, external reviewers and Publication Chairs under a very tight schedule. We are also grateful to the members of the Local Organizing Committee for supporting us in handling so many organizational tasks, and to the keynote speakers for accepting to come to the conference with enthusiasm. Last but not least, we hope you enjoyed the conference program and the beautiful attractions of Chongqing, China.

October 2012

Yan Ma  
Qingsheng Zhu  
Shizhong Yang  
General and Program Chairs, IEA 2012

# **Organization**

IIEA 2012 was organized by Chongqing Normal University, Chongqing Computer Society, Chongqing Copious Prachanda Cultural Exchange Services Company, Chongqing University, Chongqing University of Science and technology, Yangtze Normal University, Chongqing University of Arts and Sciences, and sponsored by the National Science Foundation of China, Shanghai Jiao Tong University. It was held in cooperation with *Lecture Notes in Electrical Engineering* (LNEE) of Springer.

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**Part I**

**Business Intelligence and Applications**

# Chapter 1

## Requirement Analysis of Flexible Network Teaching Platform

Xing Xu, Dan Li, Chen Gang Liu and Jan Sun

**Abstract** This paper analyzes the current development of domestic and international information management system and flexible software development. This is a comprehensive analysis and comparison of the current site development and technology with the demand characteristics of this system developed, and this discusses the need for flexible network teaching platform from several aspects of the demand for system architecture, user interface requirements, and technical requirements.

**Keywords** Flexible • Network • Teaching • Platform • Demand • Analysis

### 1.1 Introduction

Network services can meet the educational requirements personally; make education to a greater degree of autonomy. Students can choose their own way of learning to make learning more effective, so that learning becomes active acceptance. The network teaching is flexible and variable, and it has no limitation of space and time and can provide education services at anytime and anywhere too [1]. But now, the most common form of teaching—classroom teaching—inevitably ignores the personality characteristics of student. So the classroom teaching cannot achieve the best learning results and sometimes may discourage the enthusiasm of learners [2].

Flexible network teaching platform is for current college traditional education and construction development of large comprehensive of network education and management platform, it will as traditional of class education of secondary and extends, Fusion teaching footage resources management, and teaching management, and

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Senate management, and students' learning and AC discussion, multiple teaching and management means, reduced teaching management cost, and improve learning efficiency, and improve campus community environment and strengthening students overall skills of purpose. Basic thoughts on the design of flexible system structure of network teaching platform is a user customizable portal access to all kinds of information services; users can be modular services project, select the module that they want to customize their own portal, and access to appropriate content [3]. Modular service items are determined by the underlying support by various functional subsystems, as well as school Web sites, providing data and business content.

## **1.2 Flexible System Structure of Network Teaching Platform**

Flexible design of network teaching platform is useful for administrative convenience and is ease of use; its features can be customized for planning and construction, and the basic requirements are as follows: Establishment of basic information and management system did not modify the platform code directly through the system in the context of data management information tables in the platform, so you can quickly customize to meet the needs of individualized teaching management platform for colleges. Other requirements are establishing basic information management system for colleges, enabling the colleges, faculty, students and teachers, professional, classes, courses, and other basic information management systems. Personal teaching system, the entire system through the management role and user permissions hierarchy, customizes and personalizes individual instruction for different management platforms, such as for permission to teach teachers to "Web answer," "question management," "student information." From a flexible network teaching platform overall, very feature-rich, strong scalable, completely master this feature requires a certain amount of time. But for a certain class of users, many less related functions, so in addition to the design of a flexible structure of network teaching platform in addition to several platforms for different users. Flexible network teaching platform is divided into a number of platforms, namely teachers' working platforms, students' learning management platforms, the Senate workload entry platform, and innovation credit entry system. Flexible teaching resources for them as part of the platform have played an important role; each has its own characteristics and innovations and enriches the functionality and scalability of the platform [4].

## **1.3 Flexible Teaching Resources Teaching Platform System**

Teachers' working platforms and students' learning platform as important components of the platform took over teaching service function. Using teaching resources platform to enrich campus network resources not only can improve teaching quality

and strengthen teachers and students of AC cooperation, but is also conducive to encourage the students with interest in learning and training students of integrated quality, and the main needs are as follows: established test bank, classified test questions, unified management; established students exercises system, students using system for exercises or for the extraction of questions composition papers under certain conditions in the library for self-test, timely understanding themselves of learning degree; established network examination system through the system from a set of volumes, examination arrangement, answer the entire process of the examination paper marking the traditional examination; established systems for statistical analysis, realization of examination questions, responses and comprehensive statistical analysis of the examination results, teachers' complete picture of student learning in a timely manner, and other information. Such as: an error rate for all the questions in the exam are statistical comparison, ease of analysis of each question, and some aspects of students' learning shortcomings.

## **1.4 Workload of Teaching Resources Platform Entry System**

Workload reporting platform is designed for teachers when the outcome of the work of entry platform falls within the scope of educational administration. This platform to improve the statistical analysis of the scientific research work of the institute provides great convenience for submitted workload of teachers every year. On current management, workload management level individuals to report at the end of all departments consolidated summary report, from administration point of view, management bodies from colleges, four-tier management structure of the Department to individuals. But the workload from the management evaluation function can be broken down into individual workload and workload assessment team in two ways. The basis of information input includes individuals and department faculties. After the basic information, the main workload processing includes workload of teaching, scientific research and subject construction: entry and statistics of the workload. The summary statistics include the various departments, subject, and personal workload statistics. Main business is to subordinate departments of the summary statistical processing workload management and assessment. Teaching workload, including research work, subject of workload statistics, as well as summary assessment of individual and team work, focuses on managing the nature of their business. Workload management module and the function summary entry system are composed of individual workload, and workload statistics is composed of two systems.

### ***1.4.1 Individual Workload Entry***

Faculty through individual workload entry system teaching, scientific research and subject construction entry, and based on the assessment methods will be recording

the workload into work summary statistics, workload required to submit confirmation of entry. Workload information can be modified prior to the submission and cannot be modified after it is filed. Individual workload entry information is divided into three parts: teaching workload, workload, and workload entry of subject construction of scientific research. Individual workload entry actions include add, modify, delete, query, submit, and other functions.

#### **1.4.2 Work Summary**

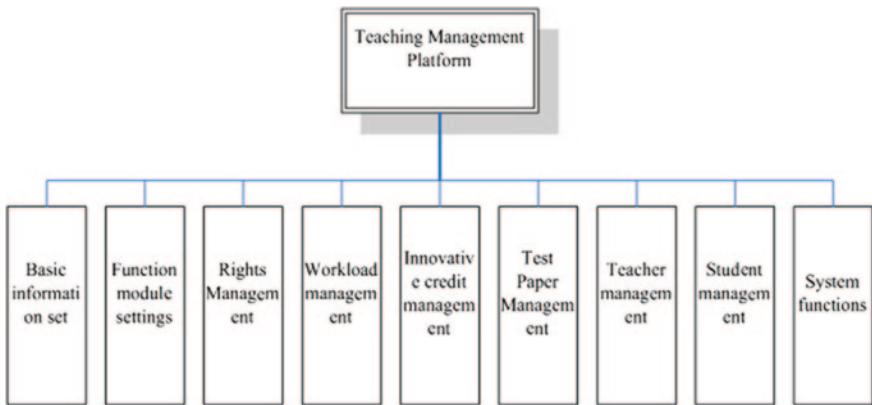
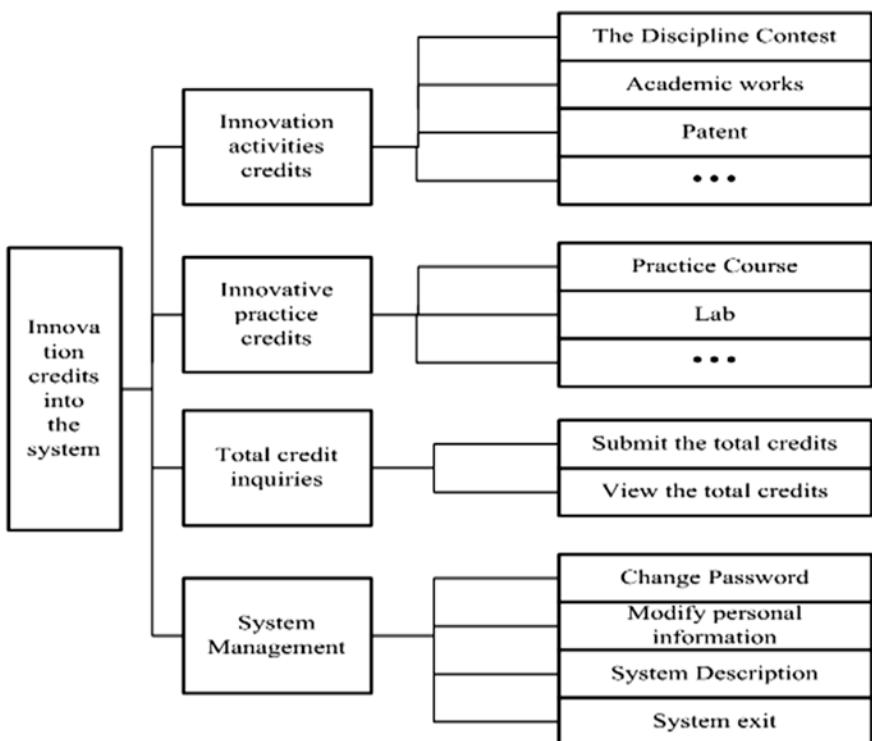
Line managers in this sector of the workload of staff submitted information, summary by individual and team statistics, respectively. Actions include individual workload statistics, team workload statistics, query, printing, and other functions. By workload of teaching resources platform entry system, you can quickly and directly report the year of various scientific research and teaching, and running the online application system for scientific research further improves the timeliness of reporting. Workload entry platform enables full management of scientific research project from the project to a conclusion, including contract management, scientific research achievements management, international management, decision analysis, information sharing, maintenance, as well as online information publishing function, and reflects the progress at each stage.

### **1.5 Teaching Resources Platform of Academic Teaching Management System**

Academic teaching management platform is the core of the platform of teaching resources, and teachers' working platform, the students' learning platform, the workload into the system, and innovation credits into the system are closely linked. Several other subsystem parameter sets, module, feature set, the permissions set on this system, by the operation of the system, can be based on other systems need to be customized to meet the needs of different permissions and different kinds of people. Academic teaching management platform module is set as follows in Fig. 1.1.

### **1.6 Innovative Credit System**

In order to cultivate the students' innovative spirit and practical ability, to encourage students to actively participate in the activities of scientific research, technological competition, and innovation in practice, the college provides innovative credit assessment per semester for students. Innovation credits undergraduate to

**Fig. 1.1** Teaching management system**Fig. 1.2** Innovative credit system

graduate qualifications necessary conditions for the recognition of credits must submit an application by the students themselves identified by the dean of the college in office in December of every year reported Office of Academic Affairs review the record. In order to facilitate innovative credit reporting, audit and statistics, under

the conditions of the existing teaching resources and platform resources, add innovation credits entry subsystem. The system consists of four modules; credits entry module of innovative activities and innovative practice program entry module are the important modules of the system, and points to students through these two modules can be reported to the activities of innovation credits. The total credits of view, submitted that the module is used to submit and view the total credits. In the management platform, you can modify the calculation of parameters of each innovation credit as well as entry instructions and statistics reported by the audit student credits. The design module of the platform is shown in Fig. 1.2 [5].

## 1.7 Demand Analysis

### 1.7.1 User Interface Requirements

User interface, depending on the circumstances meet the following basic principles on the basis of flexibility.

Style: the user interface requirements of households and Microsoft Windows product style and operating practices are appropriate to imitate the style and operating habits of the mainstream version of Outlook Express, Internet Explorer, and Office products: standard display information to maintain consistency: If the font The size of the V word, the same color, style, standard style, background color or transparent surface for the system button.

Layout: same window or dialog box control in the tab order literally from left to right, top to bottom; standard dialogs have a default button or the Cancel button.

Shortcut keys: the use of high-frequency operation to set the keyboard shortcut: the specific shortcut keys set slightly.

Error message display standards: the message to error description clearly and accurately; constructive message to be given appropriate to avoid the error occurs.

### 1.7.2 The General Interaction Principles

1. menu selection, data display, and other features should be used in a consistent format;
2. to provide meaningful feedback; the implementation of large destructive action for confirmation before;
3. allowed to cancel most operations on the data entry;
4. reduce the amount of information must be in the action between the memory;
5. to improve efficiency in the dialog, moving, and thinking;
6. allows the user to non-malicious errors, and the system should protect themselves from damage to the fatal error:

According to the functions of the action.

7. Classification and click here to arrange the screen layout; designers should be reasonable to improve the command and action organization within the cohesion.
8. Provide the help mechanism.

### ***1.7.3 Technical Requirements***

Data Integrity (Data Integrity Design Goal): The data in the database are entered from the outside world, while the input of the data due to various reasons will enter an invalid or an error message occurs. Ensure that the input data required to become a database system, in particular, is the primary concern of the multi-user relational database system. Should prevent the database does not meet the semantic requirements of data and to prevent the input and output of the error message is caused by an invalid operation or error message put forward. Data integrity is divided into four categories: entity integrity, domain integrity, with reference to the integrity of user-defined integrity. The back-end database for the project must ensure that this four types of integrity. The contract information relating to the business of economic relations, the committed transactions need to guard against loss of multiple copies in order to enhance system reliability, data, and copy and the original data [6].

Reliability Design Goal: First of all, the system requests made by the business response must be correct; is in operation within the required time, the system continuously available overall, the business logic processing, need to capture may be a variety of abnormalities [7].

Performance Design Goal: The number of users using the system of about 1,000 people need to make a timely response to service request.

Security Design Goal: It includes two aspects: confidentiality and effectiveness. The data need to be kept strictly confidential to prevent illegal way to view, modify, or delete. In addition, despite the legitimate user to login, if you do not have permission to operate, these functions must not perform their operations. To achieve the above requirements, you must apply a suitable development platform; application development goal is to create the best software in the shortest possible time. Visual Studio .NET integration on the Windows NET Framework support provides a full-featured and powerful tool, able to meet even the most complex requirements of the development team, while still available for individual developers to improve development efficiency [8].

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# **Chapter 2**

## **Cultivation of Autonomous Learning Ability-Essential Requirement for College Students**

**Yunsheng Cao**

**Abstract** Fostering autonomous learning is a topic of high relevance for current college educational policy. Most reasons imply that autonomous learning is important not only in college life but also throughout life for students. Autonomous learning means self-learning, active learning and independent learning. Under the guidance of teachers, autonomous learning of college students is the inevitable choice for students to become the masters of learning, personal development and self-improvement. Cultivating college students' autonomous learning ability presents a major challenge for teachers as well as for schools. Four aspects are summarized to enhance college students' self-learning ability. On a dominant position in teaching activities, teachers should reform teaching methods to fully embody the students' main position to promote their ability of autonomous learning.

**Keywords** Autonomous learning • College students • Creative thinking

### **2.1 Introduction**

No doubt, it is important for college students to have such a knowledge structure: the unity of specialty and erudition, the combination of arts and science, with a substantial amount of cutting-edge information about the trend of contemporary science and technology, economy and social development. All above depend on the improvement of students' independent learning ability. However, for a long time, due to the impact of various factors, the university teaching work puts too much focus on the teachers' "teaching" and ignores the students' independent

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learning. Actually, the teaching activity simply becomes the teachers' teaching activity, and students are often in a passive state. In this way, not only the students' absorption of knowledge is affected, but also the development of their personality is hindered [1]. Under the guidance of teachers, the urgent affairs in current college teaching reform are to help students to form the autonomous learning ability of reflecting the subjective consciousness, actively exerting their subjective initiative and innovative spirit of the independent learning [2].

Autonomous learning is the study of fully reflecting the dominant position of college students [3]. Autonomous learning is an important way of learning and is based on the students' self-organization, self-evaluation and self-arrangement of learning content and learning activity. Under the guidance of teachers, autonomous learning of college students is the inevitable choice for students becoming the masters of learning, personal development and self-improvement. This kind of study focuses on the creation of a certain education situation, which can stimulate the inside drive of students' active learning and instruct students to learn how to study, and separately recognize the dominant and subjective status of teachers and students in the process of teaching, as well as turn to be a kind of beneficial complement for the inadequacies of current teaching. To sum up, it has the following characteristics.

### ***2.1.1 Autonomous Learning is Mainly Based on Self-Learning***

Autonomous learning is the foundation of students' self-study, and students are responsible for their learning. It is a new learning way which is different from the traditional model teaching to prompt learning. The learners must get knowledge, skills and attitudes through the interaction between themselves and information or environment. That is to say, the learning in the traditional education is through the optimized combination of various elements of the teaching process to transfer teaching information, while the autonomous learning is in an initiative way that the learner themselves to get knowledge or information through the education media, facilities and the instructions or help of teachers [4, 5].

### ***2.1.2 Autonomous Learning is a Kind of Active Learning***

The initiative is the basic quality of autonomous learning, which corresponds to the passiveness of passive learning, both of which in the student learning activity are as follows: I want to learn and I am required to learn. I want to learn is based on the internal need of students on learning, while I am required to learn is based on the external incentive and compelling force [6].

### ***2.1.3 Autonomous Learning is a Kind of Independent Learning***

The independence is the core quality of autonomous. If the initiative is I want to learn, then the independence is shown as I can learn. Except for special reasons, each student has a strong potential and significant independent learning ability. Not only that, each student also has an independent requirement and has a desire of performing their independent learning ability, and their whole learning process in school is also the process of striving for independence and increasingly to be independent, which is the basis foundation of independent learning and making a point. Underestimating or ignoring the students' independent learning ability, and ignoring or suppressing the students' independent requirements usually lead to the continued loss of students' independence, which is a shortcoming that traditional teaching needs to overcome [7, 8].

### ***2.1.4 Autonomous Learning is a Kind of Innovative Learning***

Autonomous learning is also the process of teachers' innovative teaching and students' innovative learning; especially the students are required to improve their comprehensive quality and ability innovatively in all the aspects of the process of teaching and learning.

## **2.2 The Significance of Fostering College Students' Self-study Ability**

### ***2.2.1 To Thoroughly Promote the Teaching Principles: Teaching as the Guide, Learning as the Main Purpose***

From the current teaching practice of higher education in our country, many teachers still use the way of cramming teaching, and many students are used to blindly following the teacher's baton in learning, which lead students to the passive situation—taking notes in the class, reciting notes after class, examining notes and forgetting notes after examination [9].

Cultivating the college students' autonomous learning ability is not only conducive to actively manage their learning activities and to constantly stimulate subjective initiative and initiative spirit, but also be helpful for teachers to know the students' subject position in teaching, to guide the students to master the scientific learning method, to assist students to make a proper feedback and correction timely in the teaching, and so on. As a result of the enhancement of students' autonomous learning ability, teachers' authority will no longer be based on the students' passiveness and ignorance, and the role of teachers is no longer an encyclopedia or the database for students to use [10].

### ***2.2.2 Conducive to the Improvement of College Students' Comprehensive Qualities and the Cultivation of Creative Ability***

The university period should be not only a period during which people's potential could be developed continually, but also a key period for a person to become a high quality professional. And from the process of knowing, it is also the best period of innovation. On the one hand, college students have been equipped with relatively mature abstract thinking and image thinking ability; on the other hand, their self-awareness will be developed rapidly and gradually become mature at the university stage. Through self-awareness, they can evaluate their own whole psychological characteristics, analyze the advantages and disadvantages of their own interest, motivation, personality and so on, and strive to make it to be perfect. Self-learning has the characteristic of independence, active, innovation, harmony and so on, which happen to coincide with the college student current learning trait and personality development.

### ***2.2.3 Conducive to Cultivate the Thought of Lifelong Learning for College Students***

In today's learning society, accompanied by the gradually expanding of total knowledge and accelerating of the knowledge renewal speed ceaselessly, each member is required to be in the continuous learning. However, people cannot master all the knowledge, which requires the fostering of lifelong learning thought. As the backbone of future society, contemporary college students' further need to foster the lifelong learning thought. In order to cultivate this thinking, firstly they must have a certain ability of autonomous learning, because the lifelong learning contains the ability of problem finding, knowledge selection, knowledge comprehension, knowledge innovation and so on.

## **2.3 The Approach of Cultivating College Students' Autonomous Learning Ability**

### ***2.3.1 To Shape Good Personality***

The so-called personality refers to other subjective factors except knowledge and ability of learners. The countless facts of human creation ability indicate that developing good personality quality has become the key to bring up the creative person. However, in the long term, with examination-oriented education

background, we emphasize on one-side intelligence factor, seriously neglect the cultivating of students' personality quality, which is the important reason for causing the shortage of the creative talent in China. All forms of education at all levels, especially the higher education, should base on the following aspects to raise the student good personality.

### **2.3.1.1 To Stimulate College Students' Learning Motivation**

One can learn something only when he or she is willing to learn, and the prerequisite for the formation of learning ability is the learning motivation. Therefore, first of all, it is required to stimulate students' need. Teachers should pay more attention to the things that can stir students to learn some knowledge, then they can impart knowledge to students; or they can make a decision about the teaching activities according to the needs of students. Secondly, let the students set specific goals. It is one of teachers' tasks to make students expect and arouse their desire by helping students to make an encouraging and practicable goal that the students will spare no efforts to achieve their goals. Moreover, the effect of teaching can be enhanced by motivating the talents and promoting the backwards.

### **2.3.1.2 To Toughen College Students' Learning Will**

Just as Einstein said "the excellent personality and an iron will are more important than wisdom and knowledge", it shows that strong will and inflexible spirit play a significant role in the success of a person's creation activity. Good will mainly contains conscientiousness, decisiveness, persistence and self-control in learning activity.

### **2.3.1.3 To Develop Creative Thinking**

All human creative activities are inseparable from the creative thinking. So, the cultivation of students' creative thinking ability is the cultivation of creative talents as an important link in teaching and an important task in the work.

Cultivating students' creative thinking should be infiltrated into every aspect of teaching. Teachers should impart creative thinking methods to students during the period of knowledge teaching. When a teacher imparts students the basic knowledge, concept and law, he should consciously analyze how the problems were proposed, analyzed and solved by predecessors. He should let the students experience the hardships of exploration and grasp the thinking and new ideas to create new concepts and new things. The teachers should be good at exposing the contradictions, addressing good questions and consciously inspiring students to think independently.

### ***2.3.2 To Reform Teaching Method***

On a dominant position in teaching activities, teachers should reform teaching methods to fully embody the students' main position in the course of teaching, so as to promote their ability of autonomous learning. The following teaching method should be paid more attention to:

**“Discovery” Type Teaching Method** In the conventional teaching, teachers often tell the answer of the question to students firstly, and then get the students to remember, and help them understand after that. In “discovery” teaching, teachers’ role is to inspire the enthusiasm of the students, to guide the students to think, to explore, to discover and to obtain new knowledge from interior attributes, changing laws of existing things Peter Klein said in “everyday genius”: “The children could learn best when they find primitive rules by themselves under help”. What worth mentioning is that in the process of finding, since the target is often not clear and what to find and what likely to be found are uncertain, some of findings that the students make will be unexpected for teachers. Teachers should be careful and pay more attention to the unexpected discoveries so as not to smother students’ finding and stifle students’ initiative. Teachers should bear in mind “the mind is not a vessel to be filled, but a fire to be ignited.”

**“Task Driving” Teaching Method** “Task driving” teaching method is a kind of students’ autonomous learning method with teachers to guide. It breaks the traditional teaching method which pays attention to step by step learning and the accumulation of knowledge. This method aims to complete a task as a drive to carry out teaching activity, not in accordance with the order from easy to difficult according to teaching contents. Upon completion of the mission in the process, it helps to develop the students’ self-study ability, creative spirit and cooperative consciousness.

### ***2.3.3 To Reform the Examination System***

The test is a powerful tool in education evaluation which is generally considered more equitable measuring means. It can play a strong guiding role on educational activity. The scientific and rational examinations which encourage innovation can ensure the quality of education and promote students’ autonomous learning ability. The current university examination system has many problems, such as ignorance of individual differences, unfocused examination content, single examination form and method, more restrictions on proposition and scoring. All above hinder the cultivation of students’ autonomous learning ability. So, test reform must be undertaken.

Firstly, to stipulate the examination content and key points according to the aim of education and training requirements. Facing the information age, college students need to acquire new knowledge constantly to satisfy the requirement of the

cultivation of students' innovative abilities, broaden their knowledge and explore actively. Students need to have more autonomy and free time. This requires concise and practical examination content with outstanding key points.

Secondly, to adopt a flexible form of examination and examination method. It is required to adopt adaptive and diversified examination form and method. For example, in the humanities examination, it is practical to adopt the combination of written and oral examinations, close examination and open-book examination method.

Thirdly, to play a guiding role of proposition and grading on cultivation of students' creative thinking. For proposition, in order to reduce the students' burden of memory and promote the cultivation of innovation ability, it should be in accordance with the specified test content and be focused on the scope of proposition. Memory test should be few but good.

### ***2.3.4 To Cultivate Self-learning Ability***

Self-learning ability refers to a kind of ability of independent learning with which learners could study without the help of a teacher. Russian literary critic Sarov said "who cherishes the life with thoughts, who can clearly understand that only independent learning is a real learning.....". With the development of modern science and technology, what we do not know will be more and more. Even if a student graduated from the University, the knowledge he owns is only one-tenth of all needed in his lifetime. Other knowledge need to be learned independently. Therefore, every college student must strengthen self-learning ability and form self-study habit. School students to cultivate self-learning ability could try to do the following:

**To Set up the Independent Learning View.** The initiative is the basic quality of self-study. Students must learn by themselves. If they are lack of learning consciousness of their own, self-study also cannot be sustained.

**To Draw up a Self-study Plan.** Without the learning plan, study is vulnerable to the interference of external factors and easy to be affected, and there is no plan to lack of motivation for learning. Therefore, a clear learning objective and scientific study plan must be made according to their ability level. Study on time every day, and ensure it unshakable that a self-study habit will be formed.

**To Ensure Self-study Time.** Students should make full use of spare time. The preview can be arranged before class. If students find some problems puzzled in self-study, they can listen to the teacher in class with a destination or address initiative questions. Thereby the class efficiency could be greatly improved.

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# **Chapter 3**

## **Study of Educational Counseling Based on Context**

**Wenjuan Xiao and Hua Fan**

**Abstract** The existing evidence shows that in the process of education, an increasing number of students have difficulties in learning, emotion, interpersonal skills, and behaviors, which are affecting their academic and social development. If we do not take overall and effective measures, these difficulties may inflict more serious psychological problems for students. The purpose of this paper is to analyze the effectiveness of school counseling in the education process by analyzing the context. By undertaking a comprehensive assessment on the counseling effectiveness, we proposed a transfer in school counseling perspective and the establishment of a comprehensive intervention to guide schools' research on their counseling courses and the contents.

**Keywords** Context perspective • Educational counseling • Comprehensive evaluation of effectiveness • Intervention models

### **3.1 Introduction**

Context means the language environment, including linguistic factors as well as non-linguistic factors. Factors that are related to the use of words such as context, time, space, scenarios, objects, and words premise are all contextual factors. In the current situation of context research, different disciplines as well as different academic schools' definition on context and its basic content are not identical. Mr. Wang Jianping gave the definition from the perspective of pragmatics [1]: Context is people's understanding and use of languages in language communication depending on the various manifestations of the context of the words or rhetorical subjective factors. The educational counseling system stems from coaching. Through teaching students in learning and relying on senior education industry experience and through the integration of domestic and foreign teaching experience

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and professional teaching techniques, it helps students to overcome learning difficulties and obstacles and get the core skills of learning to achieve rapid increase [2]. However, as for language teaching, educational counseling methods did not reach the desired results. Through the use of systemic/ecological methods, school psychologists make an analysis between family members, students, and educational personnel issues and needs, especially in the case of students and counseling. From a system perspective, psychologists are better able to locate and handle conflict and mitigation in the educational environment and decrease the risk of escalating mutual exclusion and negative reactions. In order to find a better way of educational counseling, by using the contextual environment to do counseling, this paper aims to research the effectiveness of educational counseling.

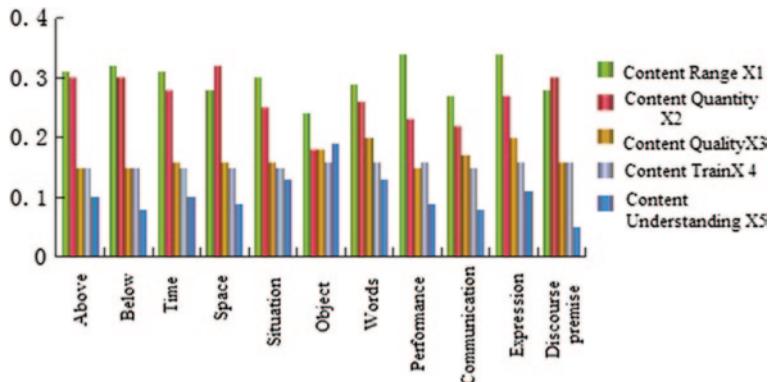
### **3.2 Educational Counseling and Elastic Model from the Perspective of Context**

The development of students' educational counseling is considered a long-term, complex, and dynamic process. Context and individual variables are in the way of a deal to shape the unique education curriculum. The complex interactions between the various sets of risk and resilience have identified (protective and negative) factors. The flexibility is now seen as a process rather than as a static with special skills. It is defined as a dynamic process and the ability to combine the inherent positive and specific contextual features, which can contribute to better development outcomes and adverse family or broader social background. In contrast, in the continuing negative experiences in the environment within the scope of the school context of additional risk factors, the cumulative on students' educational counseling has a negative impact.

According to the research data, the following variables seem to contribute to the implementation and effectiveness of educational counseling in context [3]: (1) educational counseling program development, guidance, and evaluation; (2) the quantity and quality of context in family, school staff, and community collaboration; (3) the range of counseling and education services; (4) the training and supervision of teachers; (5) coordination to avoid duplication of educational services; (6) counseling empirical support intervention and the use of appropriate assessment strategies; (7) the use of the program of counseling evaluation results and continuous improvement of education and the use of evaluation results of the expanded context awareness and support for psychological counseling education (Fig. 3.1).

### **3.3 Evaluation of the Effectiveness of Educational Counseling**

We make a fuzzy comprehensive evaluation of the effectiveness of educational counseling in the context. For the evaluation that has many factors, we consider only the five aspects that affect its context, as is shown in Table 3.1. Among them,



**Fig. 3.1** Educational counseling and educational outcomes proportion from the perspective of context

**Table 3.1** Educational counseling and educational outcomes from the perspective of context

	Context range u1	Context quantity u2	Context quality u3	Context training u4	Context understanding u5
Context	0.31	0.20	0.21	0.45	0.20
Context	0.25	0.33	0.25	0.35	0.38
Time	0.40	0.28	0.13	0.25	0.50
Space	0.19	0.22	0.16	0.35	0.39
Situation	0.30	0.35	0.25	0.45	0.23
Objects	0.34	0.18	0.38	0.16	0.49
Words	0.39	0.36	0.32	0.16	0.23
Performances	0.34	0.33	0.15	0.36	0.19
Communication	0.37	0.33	0.17	0.55	0.28
Expression	0.34	0.37	0.30	0.26	0.31
Discourse premise	0.28	0.30	0.16	0.56	0.05

the weight value is the combination of educational counseling and to consult an expert to be determined.

Comprehensive evaluation of the effectiveness of educational from the perspective of the context [4].

First, determine the evaluation, according to Table 3.1, we take three factors of the guidance effect, and thus, the field composed is [5]

$$U = \{ \text{context range } (u_1), \text{context quantity } (u_2), \text{context quality } (u_3) \};$$

We take four evaluation sets, and the resulting composition of the evaluation domain is

$$V = \{ \text{context } (v_1), \text{time } (v_2), \text{space } (v_3), \text{situation } (v_4) \}$$

Thus, the membership degree of the “context range” is

$$r_1 = (0.31, 0.31, 0.28, 0.30)$$

Similarly, the membership degree of the “context quantity” is

$$r_2 = (0.20, 0.38, 0.22, 0.25)$$

And the membership degree of the “context quality” is

$$r_3 = (0.24, 0.25, 0.32, 0.17)$$

So, the “fence” is composed of three factors evaluation matrix [6]:

$$R_1 = \begin{bmatrix} 0.31 & 0.31 & 0.28 & 0.30 \\ 0.20 & 0.38 & 0.22 & 0.25 \\ 0.24 & 0.25 & 0.32 & 0.17 \end{bmatrix} \quad (3.1)$$

Second, determine the weight again: from the analysis of the results of the educational counseling and the evaluation factors, and the comprehensive statistics of the comparison results, we get a variety of evaluation factors, and the weight values are shown in Table 3.1.

Weight number must satisfy the normalization requirement, which is

$$0.31 + 0.42 + 0.27 = 1$$

Fuzzy vector of weight number constituting set U

$$A = (0.31 \ 0.42 \ 0.27)$$

The comprehensive evaluation is given by [7]:

$$B_1 = A_1 R_1 = (0.31 \ 0.42 \ 0.27) \begin{bmatrix} 0.31 & 0.31 & 0.28 & 0.30 \\ 0.20 & 0.38 & 0.22 & 0.25 \\ 0.24 & 0.25 & 0.32 & 0.17 \end{bmatrix} = [0.13 \ 0.43 \ 0.36 \ 0.08] \quad (3.2)$$

Due to  $0 + 0.13 + 0.43 + 0.36 + 0.08 = 1$ , this is the evaluation results of normalization.

### 3.4 Analysis of the Results

The counselors' work is in a systematic and flexible environment, but it should also challenge the role of the stereotyped views of teachers and to avoid manual impose on their working relationship between the one-way and asymmetrical concept of intervention in the process. The counselor should be ready to challenge their own thinking, not involving teachers and experts, and their behavior has not been explored and taken to the traditional professional role of children's experience advantage. The counselor should also know the professional culture of

teachers in dealing with students with disabilities/diseases and their training limits. Provide teachers with a coherent and meaningful framework for children in difficult cases, and the counselors should support teachers' efforts and the obstacles in their classroom to promote students' learning. Ecosystem recovery ability draws all the different system resources to promote children's development and schools' achievements [8].

As noted above, based on a theoretical and psychological framework, we developed and implemented a number of projects within the school environment. The following axioms and practical principles are essential, flexible eco-systemic implemented programs in schools (Table 3.2).

The study found in our theory and practice also includes the following features as programmatic principles, contributing significantly to the success of school-based intervention: comprehensive, flexible, and responsive intervention, which is the organization of context and which is long-term, but not for the "quick fix."

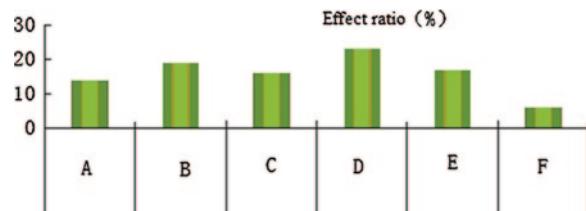
In short, the contemporary study proposes that the following questions challenge the traditional school psychology practice [9]: (1) pay more attention to social and contextual/situational factors, which is necessary in order to understand the behavior and symptoms of reaction and students' difficulties in school adjustment; (2) a comprehensive factor means connecting individuals and families and school dynamics symptoms/deficits/disorders; (3) there is no clear connection found between the assessment and treatment, suggesting that a formal diagnosis and classification are unnecessary; (4) other treatment is more dependent than the traditional psychological treatment; (5) services should be in a natural environment rather than delivered in the clinic; (6) direct service providers and educators seem to be the trained experts in changing agents and in cooperation; (7) effective psychological services in crisis situations within the school; (8) prevention can be provided through the supply of social and educational support; multidisciplinary team approach has been considered to help professionals to share their expertise and knowledge (Fig. 3.2).

Although the existing barriers in providing comprehensive intervention model in the educational environment is considered to have a lot of stakeholders (parents,

**Table 3.2** Data of the results of implementing ecosystem in schools

	Method	Effect ratio (%)
A	A change based on performance	14
B	Individual context-centered approach	19
C	Multi-level intervention (cognitive, emotional, behavioral, and academic level)	16
D	A variety of psychological techniques to deal with children's problems: behavior, psychodynamics, psychological education	23
E	Dynamic assessment	17
F	Special attention from the school	6

**Fig. 3.2** Data proportion of the results of implementing ecosystem in schools



teachers, special education teachers, peers, etc.), an effective school mental health practice is not yet have the subject of the importance of research to promote such participation at the school level.

### 3.5 Conclusion

In order to assess the effectiveness of educational counseling in the context environment, this approach emphasizes the “expert-centered model” and is essentially based on the medical example. It underestimated the context having a series of contextual risk factors, which affect a child’s response and therapeutic effect. The new model of school counseling education draws on a range of theoretical and empirical work to propose a more systematic and inclusive approach. Through the use of a variety of psychological techniques and from the perspective of flexibility and authority, it seems that in the field of school psychology, paradigm shift is in the main components of inclusive psychology and education framework. During the intervention, counseling in the context of the education system has a positive view. The theoretical basis of education inclusiveness and that the inclusive school psychologist based on the child and family are both considered to constitute a useful framework for flexible programs to address students’ difficulties and to have a more comprehensive development.

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# **Chapter 4**

## **Lifelong Education of Physical Education Teachers**

**Chun Mei Bai**

**Abstract** The goal of lifelong education was to improve physical education teachers' quality and individual ability, from this continuing education point of view on sustainable development of the professional physical education teachers' in-depth thinking, and lifelong education put forward specific improvement measures for PE teachers by providing a reference.

**Keywords** College • Physical education teacher • Lifelong education

### **4.1 Introduction**

University physical education teachers who are specialized in the educational background can determine the following long-term tradition "A Good training and education", to dwell on the intricacies of professional understanding [1]. PE teachers should have a certain level of motor skills; if not, they should know about the traditional education system; the eyes too much on teacher education project to a "sports technology" on the cover of the PE curriculum if they have educational value. Cultivation depends on education, and education lies in teachers. The political and ideological level of physical education teachers, business skills, and cultural enrichment had a direct impact on the development of students. To meet the requirements of the times, physical education teachers must continually improve themselves as well as their quality through continuing education.

Lifelong education and social development in response to emerging issues and proposed means of a measure, on the one hand, due to the rapid development of modern science and technology, many new knowledge, and new theories continue to permeate sports science; on the other hand, the reform of school physical

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education is deepening the reform need to change our ideas, updating knowledge, and strengthening understanding. On the whole, physical education teachers in the lifelong education can improve themselves and their teaching quality, to promote the development of school sports as an important measure.

## 4.2 Theory and Objectives of Lifelong Education

Lifelong education theory, that is, the formation and development of thought, not only has its own history, but also has a rapidly changing social, economic, and political background, and it is also the product of the development of modern society. After World War II, especially after half of the 1950s, some developed capitalist countries, economic growth, international competition, therefore, commonly used by modern science and technology to improve labor productivity and develop education, development of intelligence. However, the traditional education system does not include pre-school stage, and this stage is an important period for the development of human resources and does not include adult education students after graduation, and these realities must be re-educated workforce to keep pace with the rapid development and a significant increase in scientific knowledge and technology, to adapt to social needs.

Adult contemporary French educator, an active advocate of lifelong education theory, and theoretical founder Paul Lengrand in the “Introduction to life-long education”: education cannot stop in childhood and adolescence, as long as people still alive, should be to continue the. Education must be to do that, to adapt to the continuity of individual and social requirements. He made lifelong education in detail and had a major impact internationally on the fundamental value of adult education orientation. Paul Lengrand sees the shortcomings of traditional education system in a rapidly changing society. He advocated the establishment of an integrated lifelong education system to replace a number of governments to promote the implementation of specific measures for lifelong education.

As the only original idea, the goal of lifelong education was to change the people, making it free from the threat of reality, which enhances the understanding of society, to adapt to the current society. Lifelong education can also make people happy and ultimately will improve their quality of life. Potential targets for lifelong education are fostering the autonomy and independence of people to develop their ability to learn and relying on the basis of learners to achieve knowledge, ability, and a variety of esthetic unity of purpose. Lifelong education is not only remaining in the academic discussion, but also combined with government action, and through legislation, administrative government can do all kinds of efforts they have been realized [2]. Having seen the investment as long as the government hopes to achieve by reason of some goals, which in turn inspired by the public, it will be lifelong education for continued support.

Modern universities and lifelong education of teachers to pursue professional development of sports as the goal, it emphasizes sports and comprehensively improves the quality of teachers, rather than the pursuit of the number

of development goals. Subjectively, it guided the concept of lifelong education, job training rather than the traditional concept as a guide; as the objective, it requires physical education teacher should be learning the subject, only the learners become participants rather than spectators of the premise, the learners have the opportunity to ask questions and can express themselves in the discussion of the problem in view, to achieve both teaching and learning, and ultimately to enhance the quality of physical education teachers, and physical education teachers promote the development of personal ability [3].

## 4.3 PE Teachers the Principles of Lifelong Education

Lifelong education of PE teachers should be based on the “PRC Law on Higher Education”, “Teachers Law of the People’s Republic”, and other regulations, combined with higher school education and teaching development and the actual needs of the school in line with the actual development of continuing education training programs for teachers [4]. Specifically, the principles are as follows:

### 4.3.1 *Adhere to the Principles of Long-Term Comprehensive*

The quality improvement of physical education teachers should focus on the future reform and development of physical education, PE teacher professional development from the development of long-term planning of manpower, macrothinking of continuing education needs of physical education teachers, teaching staff in schools within the framework of construction planning, combined with the discipline construction sector, the academic team building, and technical posts of teachers and other factors to consider developing a comprehensive long-term planning and annual teacher training teacher education programs, specifically learning time for each teacher education, specific purpose, and discipline, to avoid the blindness and random teacher training sex. With respect to key disciplines, young teachers and excellent teachers continue to give priority to education and training and professional development in accordance with its rules and characteristics of physical education, scientifically formulated to adapt to long-term development of PE teachers in curriculum and teaching plans.

PE teachers' college lifelong education should focus on the general physical education teachers to improve the overall quality, not only concerned about one aspect but also neglected the other, from the thinking of German training, professional knowledge, education and scientific research ability, artistic and other aspects of comprehensive consideration. Professional quality training is provided to teachers in order to broaden the basic knowledge and expertise-based, cutting-edge focus on acquisition of subject knowledge and improve teacher use of modern means of science and technology to carry

out teaching and research capabilities, such as upgrading the sports teacher of foreign languages, and strengthen operations of foreign teachers' ability to communicate, adhere to long-term comprehensive integrated PE teachers to enhance the level and ability.

#### ***4.3.2 Adhere to the Principle of Lifelong Education Feasibility***

It should be a people-oriented spirit. Consciousness of teachers promotes the creative spirit; the capacity-building is a key to the pursuit of individual development of teachers, especially PE teachers for professional development. To improve the knowledge structure of PE teachers, educational ability, research ability, PE teachers should pay attention to updates, advanced educational theory, educational philosophy, and the humanities, ethics, and other aspects of training. In order to achieve this, develop a training program before the full investigation; solicit opinions from all sides before the formal implementation; organize relevant personnel to study; implement the designer's intentions into conscious action; and finally ensure the smooth implementation of lifelong education programs.

#### ***4.3.3 Strengthen the Monitoring and Assessment Efforts***

A good education program in order to meet the specific needs of the higher authorities and the management can take a variety of ways, from the university reality; can take the form of the forum to communicate; and solicit opinions from all sides. Forms can also be carried out by questionnaire. The basis of the feedback program—life science education program—in the late adjustment, is to constantly enrich and perfect the process. Summarized in real time around the implementation of the plan principles for the implementation of the issues reflected in the process of scientific analysis, improvement and added that the experience of advanced fusion of absorption, according to the new features of the educational situation and adjust and enrich. Create a democratic and harmonious atmosphere, so that teachers actively participate.

The appraisal is the final link in the process of teacher training; assessment of the content is the result of the work of teacher training; the purpose is to ensure the smooth implementation of the process of teacher training; assessment can meet a variety of incentives to be effectively implemented. For example, the training of teachers to improve teacher pay linked to promotion; can be paid to learn, test results and teacher's job promotion, linked to annual appraisal. Gradually, a scientific and reasonable evaluation system was established in order to improve PE teachers to participate in lifelong education initiative.

## 4.4 PE Teachers the Main Way of Lifelong Education

Commitment to continuing education in college sports has its own unique advantages and conditions, especially in sports academies; it is an education center and is the research center for wide range of disciplines, teaching force; it will be physical education teachers into the school of continuing education within the training plan, is the most formal sports to education mode. PE teachers can implement in many ways the concept of lifelong education.

### 4.4.1 *Independent Study*

PE teacher education self-study is an important way. According to their needs and circumstances, teachers set self-study program, a purpose, and can learn step by step, and this means lifelong education should be given full attention.

On the one hand, university teachers can take advantage of their free time, such as winter, summer, effectively saving the cost of education, independent study that addresses the learning of the engineering teacher conflicts, but also to make up for the shortcomings of inadequate funding for lifelong education; on the other hand, through daily teaching, research activities, to take collective classes, workshops, observation, and teaching activities, teachers can combine their own teaching, training, and research, targeted to carry out independent study and research, through academic reports, lectures, to strengthen its quality improvement.

### 4.4.2 *Training*

Training is an important means of lifelong education, with flexible features, but also improves the level of physical education teachers an important means of business. Various forms of training include full-time and semi-full-time and include other topics; there are amateurs; training content can be specialized knowledge, or non-professional knowledge; training can be a degree-level education, as well as non-diploma education. However, the training of lifelong education is necessary not only to meet the needs of teachers at different levels, but also to the development of society, and with the requirements of education reform, the training will add a new and reasonable content. In-service training should help raise the level of PE teachers in the business, but also help teachers do their job; teachers can take the form of full-time education and training is not released in the form of a combination, can also take short-term training and long-term training in the form of a combination. Meanwhile, in order to mobilize, more physical education teachers who participated in training to lifelong education should meet a variety of incentives to take appropriate measures, such as paid leave, reimbursement of travel expenses, scholarships, grants, and so on.

#### ***4.4.3 Distance Education***

First, with the continuous improvement in education infrastructure, computers, the Internet and other new technologies, multimedia-based, electronic communications, network systems based on technologies such as next-generation distance education system have been formed, to effectively overcome the traditional education in space, time, education, environmental constraints, interactive, networked, real-time, comprehensive and adaptive features; secondly, in order to make PE teachers to set a self-study and to overcome some learning difficulties, the onerous work of teaching may be training so that they do not have time to go out, even take part in a training, and I often have to take a human and financial, which for many remote and economically backward areas causes great difficulties for teachers to further expand the educational imbalance between regions, and a network education and training can effectively resolve these conflicts.

In the specific implementation of distance education, the first should be noted is the choice of teaching content. Receiving training and having close contact between those working form a two-way communication. Before you can start the training needs, survey must be conducted to establish such a link, let them know the important role of training. The actual need of the teacher was to design curriculum and training methods; secondly, we must build a good online teacher training management platform. Online teacher training management platform built to achieve the training objectives is an important way to ensure that sustainable training is a prerequisite, such as online classrooms, teaching videos, a series of training courses, excellent teacher training case base, staff and student exchange area, the effect evaluation.

### **4.5 Conclusions**

In our country, there are large numbers of PE teachers and there is more reasonable student-teacher ratio. However, the number is hidden and it is difficult to guarantee the quality of the problem. In terms of educational background or title level, there is still a large gap between developed countries on lifelong education of PE teachers. In general, the university PE teachers are the one who faces the problems. This paper discusses the goal of lifelong education; PE teacher made several principles of lifelong education and gives some specific ways to implement the realization of the concept of lifelong education and hope for lifelong education, to establish a high level of university PE teachers more qualified for the state transportation personnel.

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# **Chapter 5**

# **College Practical Teaching of Civil Engineering**

**Yuhai Chen, Huabiao Wang and Fengxiao Li**

**Abstract** The article analyzes the importance of practical teaching section of civil engineering in local colleges and universities and expounds reform and practice of practical teaching section of civil engineering specialty from aspects of wide-borne education, practical teaching, practical hands-on capability, practical working ability and so on.

**Keywords** Civil engineering • Specialty • Practical teaching • Education reform

## **5.1 Reform Practical Teaching of Civil Engineering Specialty and Improve Students' Specialty Cognitive Competence**

The goal of educating civil engineering specialty is to culture senior applied engineering talents in civil engineering production line. Students' engineering practical ability is an important indication in measuring the teaching quality of civil engineering specialty [1, 2].

Fostering scientific and perfect practical teaching system is the core of civil engineering education.

Certain problems exist in traditional practical teaching section. First, practical contents do not harmonize well with class teaching contents. Many civil engineering courses are taught based on experience in site operations. Practice is arranged before or after lessons in traditional teaching plan. Because of the large amount of students and shortage of instructors, students cannot make clear

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which contents are the key points and which contents are related to contents of courses, resulting in disjoint of practice and courses. Second, practice time cannot be guaranteed. In the process of practice teaching, students are mainly managed by teachers who have much theoretical teaching task and students have bad self-management and initiative to practice, so they fail to attend the construction site or leave early. Third, it is hard to find practice sites. Most colleges do not have fixed practice sites. With the doubled increase in enrollment and frequency of practice, and many requirements and restrictions, it is a critical task to find practice sites. In a word, it is fairly important to reform practice teaching method.

### ***5.1.1 Integrate Practice Methods and Merge Classroom Teaching Contents***

Centralized practice has a little effect in production practice and graduation practice. After research, we decide to combine centralized practice and decentralized practice. Practice is arranged in the holiday or certain period of courses, while practice contents are broken down. Practice should be in accord with follow-up contents of courses to let students know the key points of practice, what to know, how to do and why to do. Students' attitude toward practice has been changed evidently after the implementation of the new method.

### ***5.1.2 Integrate Practice Contents and Highlight Key Points of Practice in Each Phase***

Students should be aware of practice before the study of professional courses. Through it, students can have a better understanding of civil engineering, strong sense of construction, learning ideas of combination of theory and practice and basic ability to analyze and solve practical problem of this field.

In this phase, construction management practice stands out. Management practice is an important phase in training site operation engineers and also improving students' understanding of practice. In this moment, students have been equipped with certain professional theoretical knowledge, which is needed to be examined and developed in the process of practice, providing necessary practice basis for follow-up professional courses. At the same time, students have acquired basic engineering and organizational management ability after preliminary site engineering training.

Graduation practice is one of the most important practice teaching sections in the teaching program of this specialty. Through graduation practice, students should visit, investigate and research certain project similar to the topic of graduation design, get to know the panorama of the unit construction in detail in the

construction sites, master the compilation procedures and main contents organized and designed by unite construction and also understand and master related situations and materials to improve the understanding of the topic of graduation design and make necessary preparations for graduation design.

## **5.2 Reform Experimental Teaching of Civil Engineering Specialty to Improve Experimental Hands-on Ability**

### ***5.2.1 Conduct Interacted Experiments***

Construction Materials, Material Mechanics, Concrete Structure and other courses have set experimental items on concrete, dwag and so on, breaking interacted experiments between subjects. It leads students to get in touch with project structure through the experiments on raw materials, mechanical properties and combined composites. It also improves students' project ability by enabling them to master professional rudiments and basic theory. This kind of interacted experiment requires teachers of different courses to cooperate vertically and connect laterally and constitute reasonable experimental teaching program.

### ***5.2.2 Intensify Application Experiments***

Construction Materials, Building Architecture and Civil Engineering Construction involve repeated and independent teaching contents of proof-water materials. Proof-water materials can be combined with actual application in the project through certain types of experiments. These experiments can help students master the properties and functions of the proof-water materials and operational procedures, help acquire market information, train students' hands-on ability and improve students' ability to adapt to the market environment and market development. These experiments are not complicated, but needed to be adjusted in teaching contents.

### ***5.2.3 Advance Open Experiments***

Laboratories are used for students to conduct all kinds of practical and creative activities. Open experiment can train students' originality, satisfy the objective demand of improvement of teaching quality in civil engineering education, culture talents with creativity and achieve quality-oriented education. Open experiment is also an effective way to train students' practical skills and educate talents with

creativity. Students can obtain all-around training and practical exercise through participation in designable and comprehensive experiments and other scientific research activities. These experiments and activities play an important part in improving experiment teaching quality, enhancing quality-oriented education and training students' scientific research capability and practical hands-on ability.

#### ***5.2.4 Carry Out Experimental Techniques***

Soil Mechanics, Civil Engineering Construction and Civil Engineering Budgetary Estimation involve repeated teaching contents of earth volume calculation and allocation. They belong to the scope of basic skills training but not experimental projects. They can be adjusted to construction courses and combined with project to conduct comparison of scheme, construction period, cost and resources to increase management contents of construction project. They can also be combined with network plan technology to arrange operation time to train students' ability of scientific management and ability of overall development.

### **5.3 Reform Design Teaching of Civil Engineering Specialty and Improve Students' Ability of Design in Mind**

Civil engineering courses in our department account for 14.3 % of the whole teaching weeks. This is the most effective and comprehensive training for students to apply basic theory of project design, solve actual production problem and enhance their ability to adapt. It enables students to develop their personality and creativity to be talents with strong sense of project and project ability.

#### ***5.3.1 Expand Relevance of Course Designs***

It is necessary for each course design to emphasize the function of the subject, but should be moderate. Some knowledge in the subject is old or not and whether it is duplicated or connected to relevant curriculum knowledge should be pointed out to make sure that students can get knowledge-coherent and systematic exercise.

#### ***5.3.2 Highlight the Truthfulness of Course Design***

Past course designs are made according to contents of course, rightly done in spite of wrongness, which is not based on actual project, but separated from society

demands. Students do not have flexible basic skills in handling problems. Steel and reinforced concrete structure designed course should not only focus on actual application, but also broaden scope of knowledge, while weaken its professionalism, enabling students to master common method of structural calculation and computation program of different types of plates, beams, frames, trusses, wire frames, steel frames and other structural computer operations and to understand the structural requirements. In addition, to improve students' overall qualities and practical ability, more site operation course designs should be open, which is also the demand of the society.

### ***5.3.3 Strengthen the Diversity of Graduation Designs***

Past graduation designs are always set false but done rightly. In order to regulate design and guarantee the quality of design to conduct a comprehensive training and examination of students' knowledge, true assignments should be made. Topics of graduation designs should not follow the same pattern. Students and teachers cannot develop their originalities, and there is no detailed and specific standard for instructors. Topics of graduation designs should be diversified and developed, in architectural design, project construction, project supervision, economy analysis, project management, research paper and so on. Students should be active and have the opportunity to select topics of different types, levels and market demands according to their favor, specialty and ability. Students' initiative to select, provision by society and selection by instructor, should be combined.

## **5.4 Reform Practical Teaching of Civil Engineering to Improve Students' Practical Hands-on Ability**

### ***5.4.1 Basic Practice Platform with Orientation of Regular and Diversified Specialty Scientific and Technological Races***

The platform has a large coverage. The design of the activities is a combination of professionalism, fun and manual operation, creating fun in the process of teaching. The specialty technology races contain Bridge Design and Drawing Race, Membrane Structure Race, Building Structure Model Race, Shock-absorbing Interest Design Race, Architecture Photography Race and so on. Through the basic practice platform, students' interest and love for their own specialty are fostered. At the same time, the basic sense of project is built up, and their practical abilities are trained. The platform mainly applies to first-grade and second-grade students.

#### ***5.4.2 Subject Innovation Platform with Orientation of Specialty Races***

Examples are University Structure Design Race, University Architecture Design Race, University Measuring Race and so on. The platform mainly applies to those students who have a higher level of specialty basic knowledge. The platform aims to strengthen students' project practical capability and overall operational ability through teamwork, laying a solid foundation of engineering project design and application for students. The platform mainly applies to second-grade and third-grade students.

#### ***5.4.3 Scientific and Technological Research Platform with the Direction of Scientific and Technological Races and Research Project***

The main objects of the platform are project research team and subject research team. The platform encourages these teams to participate in school level, provincial level and national level Challenge Cup—university extracurricular scientific and technological work race, tutorial or corporate project research, etc. to enhance the cooperation of production and study research. It also lays stress on students' personality development and trains students' innovation and practice ability through project practice featured with scientific and technological development and new technology application. The platform mainly applies to third-grade and four-grade students.

#### ***5.4.4 Profession Experiencing Platform with Orientation of Internship and Entrepreneurship***

The platform mainly applies to graduates. Universities should provide students with opportunities of corporate internship and entrepreneurship, for example, creating more employment internship bases and university entrepreneurship parks for students to experience real work. The process can better promote the formation and development of students' profession capabilities and cultivate skilled and qualified talents adapting to the post. It helps students transform from average students to graduates with profession skills and then to skilled talents with specific profession capabilities.

#### ***5.4.5 Relying on Corporations to Create the Extracurricular Practice Platform Integrated with Production and Research***

Students' extracurricular time, holidays and summer and winter vacations should be incorporated into the operational system of production and research to organize students to participate in social practice activities, directly engaging in corporate

production and operation business, thus improve students' ability to adapt to the society and real work. Social practice should be systematically arranged for students in summer and winter vacations. Each student may have professional and social practice task with specific requirements for students, which is devised by professional teachers and carried out by teams. Under the permission of the corporations, students should generally spend more than two to three weeks doing the practice activities for sure of the effect. After vacations, students should exchange their ideas and experience to learn from each other. This model can help students get to know all professions provided by different corporations and put the theories into actual working post. The practice experience can not only help students to have a better understanding of the knowledge they have learned, but also lay a solid foundation for new knowledge. Meanwhile, a good cycle of learning-practice-relearning-practice is formed.

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# **Chapter 6**

## **Teaching Reform for University Computer Information Technology Curriculum**

**Bin Zhang**

**Abstract** Currently, our country's basic computer education reform is in an important turning point, a transition to the starting point of information technology education popularization is from university to primary and secondary school. Since in primary and secondary schools, there are "information technology education" courses, how to reform the university information technology, how to reflect the course of information technology education in university, how to link primary and middle schools education, how to follow the rapid development in information technology, all of these are urgent in basic computer teaching reform in colleges and universities.

**Keywords** University computer • Information technology • Teaching • Current situation • Strategy

### **6.1 Foreword**

With the rapid development in information technology, computer and network have come into people's work and life deeply and to be familiar with and master the basic knowledge and skills of computer information process technology is one of the essential conditions to be qualified for the job and adapt to the social development. Just like the higher mathematics and university physics, computer information process technology is a public basic course that the high school must offer. Recently, with the rapid development in computer information technology and increasing popularity of computer application, Chinese middle and primary schools have gradually opened the course of information technology, which makes the high school freshmen to have some basis for the computer knowledge and operation. In this situation, how to correctly position the university computer information

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technology curriculum, organize course contents and the model of teaching and make up the differences of knowledge and skills of zero point and nonzero starting point students is a task that we need to strive to study and solve [1].

Recently, Chinese middle and primary schools have gradually opened the course of information technology, which makes the high school freshmen to have some basis for the computer knowledge and operation, and then, how to correctly position the university computer information technology curriculum? We need to pay attention to the following points:

First, clear and define the differences between university learning and high school learning. The university learning process needs more information technology which means not only learning some simple computer basic knowledge and skills but also paying more attention to cultivation of college students' thinking ability, innovation ability and autonomous learning ability. In the teaching process, many undergraduates may have a doubt that computer information technology curriculum is to learn some basic computer skills which have been taught in junior high and high school. In addition, many undergraduates also think to know how to operate the computer is enough, and there is no need to learn theoretical knowledge. As for that, before classes begin, teachers must let undergraduates understand information technology is not equal to computer operation and they need to constantly excavate their innovation ability and thinking ability.

Second, colleges and universities teach according to subject classification, and different subjects require corresponding information skills. In addition, different subjects require different information skills, but middle and primary schools have just taught some basic concepts and skills, so schools need to further cultivate students' ability to use information technology to learn professional curriculum in university study [2].

Third, as information technology has a very wide range and update quickly, which can help undergraduates understand the newest current information technology at home and abroad to keep up with the pace of the development era, it is necessary for undergraduates to learn knowledge and skills of information technology.

Through this course, teachers must help students get the ability to obtain, analyze and use information, cultivate their good information literacy, encourage undergraduate to take information technology as a method for their lifelong learning and cooperative learning to lay a good foundation for adapting to the future study, life and work.

## 6.2 Current Situation of Teaching of University Computer Information Technology Curriculum

At present, current situation of teaching of university computer information technology curriculum is mainly displayed in the following points:

First, college students' computer level is uneven. As we all know, college students are all derived from various provinces where the level of economic

development and education is not balanced, so the popularity and speed of computer knowledge are also different, which make the freshmen to have big otherness in computer basic knowledge level. Even in the same class, students' computer basic knowledge and operation application ability are still different. Some students have been able to use the computer skillfully, while others have never seen a computer. Students with good foundation and high level generally reflect that the content is not enough and hope teachers to teach more. But those students with weak foundation reflect that it is difficult to understand teacher's normal teaching, which make each side has complaints. That college students' computer level is uneven, which has increased teaching difficulty. What is more, with the popularization of computer knowledge, more and more freshmen have once used the computer; if we still use the traditional teaching mode, there will be some negative effects.

Second, in most Chinese colleges and universities, computer information technology teaching materials adopt the book university computer information technology tutorial with single target and multifarious content. The situation increasingly does not adapt to the teaching characteristics of different disciplines and majors. It is difficult to achieve teaching goals of different subjects without reforming the traditional teaching mode.

Third, the curriculum content is more, and lesson is little. Generally speaking, college students' computer information technology curriculum includes principle of computer form, computer network, computer software, multimedia technology, database and information system and other course knowledge, and knowledge capacity is great, but universities only allocate very little time, which makes students feel that the contents are so much that it is difficult for them to understand and absorb the knowledge. The situation will cause two tendencies that students with good foundation want more knowledge, while students with weak foundation feel hard to learn.

### 6.3 How to Reform Teaching of College Computer Information Technology Curriculum

Through the above situation, the traditional teaching mode has not been able to satisfy the existing teaching requirements, so it is imperative to reform teaching of college computer information technology curriculum.

First, use the multimedia teaching. In the teaching practice, the teacher is a guide to students' learning and also the promoter for the students' exchange and the advocate of students' learning interest. Modern multimedia technology is the best tool for teachers to play the leading role. With multimedia, teachers can show students the work principle of computer CPU, virtual memory principle and some boring, drab, abstract and difficult knowledge, which makes the work mechanism process and visualization so that it is convenient to students to understand. In addition, multimedia technology can provide students colorful and illustrated interface, which breaks

the traditional teaching mode like teacher speak—students remember—recite after school, and the expression of teaching content is more intuitive.

At the same time, teachers also need to note using method of multimedia technology. If they only transfer all of the knowledge, that will make it hard for students to focus on priorities and impression is not deep just like watching movie. So, teachers need to supplement some traditional teaching methods to combine two ways organically to improve teaching efficiency radically.

Second, improve the teaching content. The refresh rate of Introduction to Computer Technology is so fast that no matter hardware or software changes quickly. However, university teaching content is always relatively slow. So, the model of teaching for Introduction to Computer Technology should not only grasp the teaching material, it should be based on it, while not get bogged down in the teaching [3]. What is more, we need to properly update the teaching contents and permeate new ideas, new methods and new knowledge. In theory teaching, teachers can appropriately collect some new products and technology that are not mentioned and show them in class. For example, when teaching mobile communication system, teachers can combine with the actual situation and explain present most popular 3G technology, which can greatly improve students' interest in study and learning initiative.

Third, implement the layer teaching. The layer teaching in teaching process means determining teaching goals of different levels from students' actual conditions and arranging different levels of teaching contents and teaching tests. The teaching method can create learning interest in different students and obtain something so as to accomplish the teaching task. Universities should first classify students according to arts and science to make students study the content selectively, and teachers can also teach them selectively. Then, schools can arrange different learning goals that should be achieved by all levels of students in teaching activities according to different situations of students' computer basic knowledge to enrich their knowledge structure so that they can adapt to future informatization social environment.

Fourth, complete the teaching evaluation. In the course system, curriculum evaluation plays a role of quality supervision and incentive guiding. In the teaching process of university computer information technology, we need to timely evaluate the teachers' teaching and students' learning, which can get the two-way information of teaching and learning, find the issues on time and adjust the teaching method to improve the teaching quality continuously. Introduction to Computer Technology is a practical course, and teachers must evaluate student's study and operation on time and couple back information, so students have a correct understanding of their own learning and continually get feeling of success to increase confidence and improve the learning interest.

In a word, the major objective of Introduction to Computer Technology is to cultivate students' application ability of information technology and to obtain analysis and process information with modern information technology. University computer teachers should fully combine characteristics of this course and use all sorts of software and hardware resources to help undergraduates firmly master the

operation ability and the innovation ability that are needed by information society. Only if the contemporary university students' information literacy is comprehensively improved, can the overall quality of Chinese society be improved so that we can have a brighter future!

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# **Chapter 7**

## **Study of Computer Teaching in Higher Vocational Colleges**

**Hai-mei Liu and Yuan Zhang**

**Abstract** With the development and progress of the society, the rapid development of computer application technology makes application fields of computer constantly expand. And the computer has become all walks of life, an important tool to computer application knowledge, which improves the ability of using the computer. Higher vocational education aims to cultivate production, service first line of high-quality personnel, so, students must master the solid foundation of computer skills. However, the current stage of the higher vocational teaching computer not satisfactory, this paper discusses on this theme, which has certain practical significance and guiding significance.

**Keywords** Higher vocational colleges • Computer teaching • Current situation • Strategy

### **7.1 Introduction**

It is known to all that computer education not only allows students to get to know the advanced information technology, but also is good for students to cultivate comprehensive qualities. In addition, it can motivate students to pursue advanced scientific technologies, arouse their innovation awareness, improve their activity to learn new knowledge and cultivate their ability of independent study. Moreover, computer knowledge enables students to have strong hands-on ability, quick thinking, wide interests, broad mind and a broad spectrum of knowledge. Therefore, it is an important content for the quality education for all majors in higher vocational colleges to do well the propagate education of computer. However, the computer teaching in higher vocational colleges in present phrase is far from satisfaction. This paper makes explorations with this theme, which has certain

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actual meaning and guiding meaning [1, 2]. Therefore, it is an important content for the quality education for all majors in higher vocational colleges to do well the propagate education of computer [3].

## 7.2 The Present Situation of Computer Teaching in Higher Vocational Colleges

With the rapid development of the modern computer technologies, the computer application changes for the better day by day. The information amount is on the increase rapidly [4]. This has brought out higher and higher requirements for the computer teaching in higher vocational colleges. However, seen from the present situation, the computer teaching in higher vocational colleges has a series of weaknesses, which has seriously affected the efficient improvement of the teaching efficiency.

### 7.2.1 Slow Renewal of Teaching Content

At present, most of the higher vocational colleges have adopted the teaching materials that cover the outline of national First Grade Level B examinations when teaching the course of computer. Considering that the First Grade Level B examinations are all over the country, the assessment usually lags behind the existence of new computer technologies. In addition, the teaching content often has a relatively long renewal period [5]. This is not beneficial to the cultivation of the new knowledge and new technology abilities for students. Moreover, it will make students have lower interest in learning. Their learning activity and initiative are not strong, not to mention the cultivation of their innovation abilities [6].

### 7.2.2 The Teacher Mode is Over Traditional

In present phrase, the computer basic course in higher vocational colleges basically adopts the traditional teaching model, in which the theoretical lectures and computer operations are separated. Computer teachers explain computer theories in class while arranging the students to conduct computer operation. This kind of teaching mode has the weakness that theoretical teaching and practical operation are separated, which is not beneficial for the students to grasp the theoretical knowledge learnt in class in time, nor is not good for students to strengthen what they have learnt. In this case, the class utilization ratio is lowered. It fails to arouse the subjective activity of student, making the students' learning passive.

### ***7.2.3 The Teaching Goal is Single***

It is known to all that the basic goal for computer teaching in higher vocational colleges is to help students to pass certain computer application ability examinations successfully. It usually refers to the computer application ability test in all provinces or the national First Grade Level B examination as well as all kinds of computer high new technology examinations and so on. The whole teaching serves for the single examination goal. This has made the examinations the “theses” for our teaching. Teaching still serves for the examinations. This teaching goal results in the situation that although students have passed the examinations, they do not have strong ability to apply the computers in the real sense. Some students even fail to set the basic forms of the graduate thesis.

### ***7.2.4 There is no Enough Attention Paid to the Quality Education***

With the increasing popularity of the Internet and the rapid development of the computer technology, all kinds of computer content are filled with the network. Among the information, there are all kinds of harmful information. A lot of higher vocational colleges fail to pay enough attention to the quality education of the students. In this case, the students are lack of certain ability to distinguish between good and bad. They cannot resist the harmful information on the network. Therefore, it has been an important part in the computer course to raise the defence awareness of students towards the harmful information on the computer as well as to cultivate their good social morality.

## **7.3 How to Improve the Present Situation of Computer Teaching in Higher Vocational Colleges**

How the computer teaching for higher vocational colleges under the new circumstances and how the computer teaching for higher vocational colleges under the new requirements can be improved. The key to the improvement is shown as the followings:

### ***7.3.1 To Have the Position of the Teaching Goal Accurately Fixed***

The teaching goal is the starting point and foothold for the teaching activity. It has such functions as guidance, adjustment, motivation and evaluation. The

computer teaching in higher vocational colleges should cultivate their students to be fully equipped with the computer culture qualities and excellent social morality. In this case, the students can be promoted to be equipped with solid computer operation ability. They are able to operate word and excel as well as the PowerPoint very skilfully. In addition, the students shall be made to fully grasp the application of basic software on office automation and website basic operations. Considering that the current information technology is flourishing with each passing day, the computer teaching mainly aims to cultivate the lifelong learning ability of the students. Only in this way can it keep with the time paces and never be out of the time.

### ***7.3.2 To Arrange the Teaching Content Reasonably***

The computer course in higher vocational colleges belongs to the practically oriented curriculum. It is the type of “the application of tools”. The attribute to the curriculum not only requires teachers to pay attention to the lecture of theoretical knowledge when arranging the teaching content, but also attaches importance to the cultivation of practical application ability as well as the innovation ability of the students. Therefore, the teaching content of the computers in higher vocational colleges should be equipped with the following four characteristics:

It should be equipped with the computer theoretical knowledge that meets the requirements of the education in higher vocational colleges. The concepts should be popular and easy to understand;

It should usually aim at cultivating the application ability of the students;

The content should reflect the new achievements and new trends relevant to the computer technologies;

The teaching content should proceed in an orderly way and step by step. It should start from the easy aspects and then to the difficult ones, which should meet the cognitive rules of the students. In all, the teaching content arranged by the teachers should reflect the new trend of the computer technology development so as to let students grasp the new knowledge and new technologies. Only in this way can the students be equipped with the ability to apply computers to solve practical problems.

### ***7.3.3 To Actively Reform the Teaching Mode***

The current computer teaching mode is a traditional teaching mode. As for the traditional teaching mode, it refers to the situation that teacher has accounted an absolute leading status in class, while students are in a passive condition. This does not go with the education of new times. Considering the circumstances, teachers should reform the teaching mode. On the one hand, teachers should

introduce the multimedia technologies and the multimedia software and so on. A series of information teaching methods enable the teachers to rely on not only the blackboard and the textbooks. On the other hand, teachers are able to adopt the task driven methods so as to motive the learning interests of the students. That is to say, the teachers can announce a few tasks in class. For example, the teachers can let the students to accomplish a piece of word typesetting or the excel treatment and so on all by themselves. Proceeding to the next step, the teachers can set the students into groups and let them accomplish the learning tasks. Of course, these tasks should be changed according to the actual teaching circumstances. With the deepening of the teaching, the tasks should be connected to the future positions of the students step by step. In this way, it can show the value of the education in higher vocational colleges.

#### ***7.3.4 To Greatly Strengthen the Network Education***

In the current society, the information on the network is expanding in an amazing speed. At the same time, the information on the network is open to all kinds of people. Therefore, the computer teachers in higher vocational colleges should have network education to the students. On the one hand, teachers should explain clearly the advantages and disadvantages of the network to the students. In addition, they should encourage the students to make use of the good aspects and get rid of the harmful information. On the other hand, the teachers should arrange some learning tasks that can be accomplished using the network. In this case, the students are able to get into the network with a purpose. In addition, they are able to accomplish their tasks using the computer knowledge they have learnt. In this way, they are able to achieve two things at one stroke. The students are not only able to get contact with the network, but also able to strengthen the computer knowledge.

#### ***7.3.5 To Actively Reform the Evaluation System***

As an important link in the teaching activity, examinations are the directions of the teaching process. However, we should not take examinations for the examinations. We should see it as a method to evaluate the students. At the same time, we should not only examine the learning and understanding degree of the students to the computer theoretical knowledge, but also examine the practical application ability. Only in this way can the learning and understanding degree of the students to the computer technologies be tested. On the other hand, the teachers should arrange some learning tasks which are able to be accomplished using the network. In this case, the students are able to get into the network with a purpose.

## 7.4 Conclusions

Computer course is a compulsory basic course in the education for the higher vocational colleges. In the twenty-first century, the computer technologies are developing in a rapid way. In this age, we should arrange the teaching goal in a reasonable manner. We should select the teaching content and adopt the efficient teaching methods and modes. We should modify the way of teaching to suit the special requirements of each class or case as well as shooting the arrow at the target. That is to say, we should have a definite object in view. Only in this way can the talents with high qualities be cultivated so as to meet the development of modern society.

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# **Chapter 8**

## **Higher Vocational Education Quality Monitoring System**

**Changhong Wei**

**Abstract** Development and utilization of teaching quality monitoring system for higher vocational technology education can improve the level of teaching management, teaching quality, and quality management, making the management of the teaching quality of higher vocational technology education easy in the modern information society with network real-time monitoring standardization and harmonization. Data sharing and real-time monitoring reduce the work strength of the personnel management and all related activities.

**Keywords** Higher vocational education • Education quality • Monitoring system

### **8.1 Outline**

At present, on the international stage, the enlightenment about the quality in higher vocational technology education is done by observed exploration and research on total quality management including evaluation and examination [1]. Enlightenment about the development of higher vocational technology education is still at the primary level in China. There are many disadvantages, and the structure of the systematic management mode needs to be corrected and improved [2]. Most of the quality monitoring processes are random enlightenment inspection and emergency measures to enlightenment, including high random. The feedback on education enlightenment has not been transferred to the related department fully and effectively because of the lack of systems such as institutionalization and standardization, objective of the operating system, real-time monitoring, and control of the whole process [3]. Therefore, exploring and exploiting the network real-time monitoring system of quality is the inevitable choice of enlightenment

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about the quality improvement of the school education and higher vocational and technical education, to strengthen the competitiveness of the school, thereby to develop higher vocational technology education, and continue to improve the level of social requirements [4].

## 8.2 Research Programs

### 8.2.1 Monitoring Principle

The system takes note of the quality of teaching students, teachers, and professional skills, such as information collection and analysis, and then provides simple output parameters as a reference for the evaluation index system of teaching quality evaluation on the basis of the collected information through calculating and comparing the effect of the key link of teaching in the process of teaching quality evaluation, and analyzes and organizes related information of a system through the feedback to the related functional departments and related department, and takes proper measures to correct the deficiencies and defects in accordance with the information to achieve zero-defect process monitoring and management Fig. 8.1.

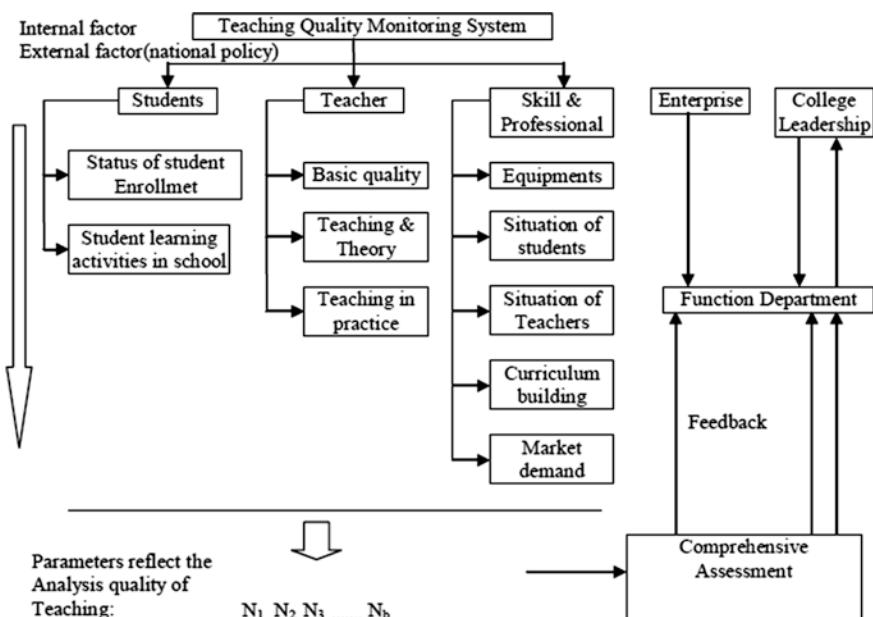


Fig. 8.1 Teaching quality monitoring system

### ***8.2.2 System Components***

Teaching quality monitoring system for higher vocational technology education consists of three subsystems: the teaching quality data acquisition subsystem, teaching quality evaluation subsystem, and the teaching quality data analysis subsystem.

The teaching quality data acquisition subsystem collects information about literacy education influence in the process of teaching and it is divided into three modules.

Students data acquisition module: includes basic information data collection and the present situation of the enrollment of students in school's learning activities.

Teacher data acquisition module: includes data collection of basic quality of teachers, teaching theory and teaching data research, and teacher's classroom teaching practice.

Skills and professional details data acquisition module: data collection equipment, course construction, and the current situation of the students, the teachers, and the market demand.

The teaching quality evaluation system is mainly based on the data acquisition system of the key links and information collection. In order to correctly evaluate the reasonable requirements, first of all, information collection and evaluation model must be accurate. Through the evaluation results, we can know the good or bad environmental influence of the critical aspects on the quality of teaching.

The teaching quality data analysis is the information collection and analysis subsystem of data acquisition subsystem; it automatically analyses the data, prints the quality of teaching management, processes information, and then creates a feedback mechanism.

### ***8.2.3 The Establishment of Monitoring Model***

#### ***8.2.3.1 The Project of Teaching Monitor***

Usually, the above-mentioned system components that accomplish the teaching quality monitoring objects in general are used in the teaching quality monitoring process. There is a sequence of priority and supervision. More important is that there is a change in the teaching objectives, policies, and the market situation, by changing the monitoring system.

#### ***8.2.3.2 The Establishment of Monitoring Model***

Teaching quality monitoring system for higher vocational technology education is a very complex problem; in order to solve this problem, we usually use analytic

hierarchy process (AHP). Assuming that a system has a hierarchical structure, and the same layer directly affects the adjacent by the terms of the next layer of conditions. There is a problem, How naturally it can make the effect to the level out of the “basic conditions”? (in the highest levels of the terms and conditions) Considering the correct hierarchical structure, and the structure, function and many properties that we have expected, we first provide a method, and this determines the cross-layer influence indirectly and affect the different levels directly. First, we analyze this problem from easy to difficult layer by layer; for example, the teaching quality of the higher vocational technology education infects the students, teachers, and professional skills and the three factors. Students’ behavior and learning activities affect the quality and quality; the basic quality of teachers, teaching theory, and the quality of classroom teaching influence quality; skill and professional lecturer equipment state, curriculum construction, lecturer, and the market demand, etc. Of course, we can also divide the above-mentioned factors according to another method.

Using AHP method for establishing basic level of teaching quality monitoring point of view of the higher vocational technology education can be represented by a tree structure. Suppose that we are looking for methods, this method is the first comprehensive investigation into the different characteristics of the object, and it compares the value of choice. Is this a creative idea? If yes, How can we draw through the calculation of the object priority number? We have the following level as a tool to study the problem.

There are usually different characteristics of different hierarchies; according to teaching quality monitoring schematic, we divide the model to  $A$ ,  $B$ ,  $C$ , and  $D$ , four factor layers, and  $P$  means destination layer; the structure and function differ from layer to layer. High-layer function commonly relies on low layers, and the basic questions in the hierarchy are about high-layer’s comprehension. This comprehension is not directly from every layer’s elements, but from interaction between different layers in hierarchy. First of all, we assume that there are  $N$  elements  $C_1, C_2, C_3 \dots C_n$  on a layer, the effect of one element of upper layer can quantize qualitative questions to comparison matrix; it compares every two significant degrees and forms a reciprocal matrix (Table 8.1).

$C_i$  and  $C_j$  have influence on their levels above, and  $a_{ij}$  is represented by the influence ratio

$$A = (a_{ij})_{mn} \quad a_{ij} > 0 \quad a_{ji} = 1/a_{ij}$$

If  $a_{ij} \dots a_{jk} = a_{ik}$ , then it is said that they have consistency; weight vector:  $AW = \lambda w$ , where  $\lambda$  is the largest eigenvalue and  $w$  is weight vector.

Measure of comparison:

$a_{ij}$  meaning

1, the influence of  $C_i$  is the same as  $C_i$

3, the influence of  $C_i$  is a little stronger than  $C_j$

**Table 8.1** Numbers of RIs

$n$	1	2	3	4	5	6	7	8	9	10	11
$RI$	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

5, the influence of  $C_i$  is stronger than  $C_j$

7, the influence of  $C_i$  is a lot stronger than  $C_j$

10, the influence of  $C_i$  is the strongest one of  $C_i$  and  $C_j$ .

Then

$$a_{ij} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, \dots\};$$

$$a_{ji} = \{1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9, \dots\};$$

Consistency index:  $CI = (\lambda - n)/(n - 1)$ ;  $CR = (CI/RI) < 0.1$ .

Operate: We construct reciprocal matrix through the influence degree among the lower levels points to points as we thought:

$$\begin{matrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \ddots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{matrix} \quad (8.1)$$

Systemize:

$$\begin{matrix} a_{11}/A_1 & a_{12}/A_2 & \cdots & a_{1n}/A_n \\ a_{21}/A_1 & a_{22}/A_2 & \cdots & a_{2n}/A_n \\ \cdots & \cdots & \ddots & \cdots \\ a_{n1}/A_1 & a_{n2}/A_2 & \cdots & a_{nn}/A_n \end{matrix} \quad (8.2)$$

Label:  $A_1 \dots A_n$  is the summation of each vector group in the matrix.

To further systemize, counting up each row vector in (8.2), the answer is  $B_1 \dots B_n$ .

$$B_1 + B_2 + B_3 + \cdots + B_n = C$$

So we can get the calculation of each representative value of monitor point:  $B_1/C, B_2/C, \dots, B_n/C$

If the hierarchy has more than one layer, we have to work on the operation of the combination weight vectors:

$$W(s) = W(s)W(s-1) - W(3)W(2)$$

Among those data,  $W(k)$  is a matrix based on column vector that can be defined as weight vector from  $K$  layer to  $K-1$  layer.  $W(s)$  is the combined weight vector of  $S$  layer. Finally, we have to check the consistency of combination. We can work on the process layer by layer and if the index consistency of  $P$  layer is  $CI(P)$ , ...  $Cin(p)Cn$  is the number of  $P-1$  layer and the index of random consistency is  $RI(P)$ , ...  $Rin(p)$ .

When we define  $CI(p) = [CI(p) \dots Cin(p)] \cdot w(p-1)$

$RI(p) = [RI(p) \dots Rin(p)] \cdot w(p-1)$ ,

we can get the combined consistency rate of the first layer of  $P$ :  $CR(p) = CR(p-1) + /RI(P)$   $P = 3, 4, \dots, S$ .

It cannot define as passing the check of consistency until we get  $CR(S) < 0.1$ . We have to go back and revise the process.

### 8.3 Conclusion

Especially in the modern information society, how to use the computer communication network and modern analysis method to do collection, processing, analysis and feedback process of higher vocational and technical education is a key issue. Based on some successful experience, we should develop a positive, institutionalization and standardization, real-time monitoring teaching management system in higher vocational and technical schools. Because of this, our higher vocational and technical college experiment device can enlighten the research and development of the quality monitoring system of the higher vocational technology education.

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# Chapter 9

## Universities Teaching Resources Based on Semantic Grid Portal Construction

Changlong Hu, Wei Liu and Jidong Zhang

**Abstract** This paper discusses the college teaching resources based on semantic grid portal construction, which starts from the system architecture and explains how to construct a grid portal application that can support learning service in the area of semantic retrieving of teaching resources on the basis of description of the teaching resources based on semantic and use of grid technology in service-oriented architecture (SOA) to improve the structure of teaching grid portal system.

**Keywords** Semantic description • Grid portal • Teaching resources

### 9.1 Introduction

The use of grid technology in Web-based instruction has become a research hotspot; some scientific research departments, institutions of higher learning, commercial corporations and even higher education institutes have invested a lot of man power and material resources for research and development [1]. For example, European proposes a “European teaching grid framework (ELeGI),” and China has put forward building “China education scientific research grid (ChinaGrid)” and “the national basic teaching grid.” After building a basic teaching grid framework, the high-level application of teaching grid becomes cutting-edge research; this research will combine the research result of traditional network teaching, and it will improve the network teaching research to a new stage [2, 3].

The university teaching resources grid portal model expounded in this paper is based on the above idea to research [4]. On the one hand, this paper has realized the generalization of university teaching resources object described by standard ontology language RDF and OWL. On the other hand, it has improved on the basis of the former and proposed the ontology molecular concept which is suitable for the description of

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college teaching resources and the inherent knowledge in the body of resources and relative knowledge and realized fusion of the changeable college teaching resources and grid portal on the basis of semantic, which makes a beneficial exploration in the university teaching resource for user's better transferring and interacting.

## 9.2 Universities Teaching Resources Portal on the Basic of Semantic

### 9.2.1 *System Architecture*

Nowadays, the research on teaching grid is in the beginning stage. The key point of research is on the study of teaching grid architecture. For example, the literature gives the teaching grid architecture and proposes imagination of special middle-ware for teaching grid; the literature is developing LMS on the foundation of grid and composing teaching grid structural framing. The literature proposes imagination of teaching grid portal.

We settle teaching grid structural framing and portal of teaching grid on founding of these researches. Course evaluations and education resources will be constructed through the semantic ontology and then the resources are integrated through the semantic grid portal and are offered to users. It aims to break the restrictions of time and space, support resources sharing and learning collaboration and provide personalized and adaptive learning environment. The current network technology can only support the lower levels of learning resources sharing and learning activities' simple collaboration, and it still has many unsolved problems, including how to realize sharing resources and cooperation study in a distributed, autonomous, heterogeneous network environment, how to make semantics tap its potential in system, how to construct the essential components portal of a grid environment and how to regulate and simplify the environment of development. Therefore, this paper proposes a platform system structure on the basic of grid semantic.

### 9.2.2 *The Grid Portal Based on Service-Oriented Architecture*

Analyzing the teaching grid system, on the basis of the characteristics of the network teaching and the structure of the network teaching system, makes as much use of the service-oriented architecture (SOA) in using the grid technology and gives a more reasonable teaching grid portal system structure. SOA makes the loose coupling between learning partners possible and provides higher abstraction in the form of open interface. Semantic grid technology can promote learning resources sharing and interconnected interoperability of all kinds of learning support system in higher level, to make it easy to use the existing resources and services and to

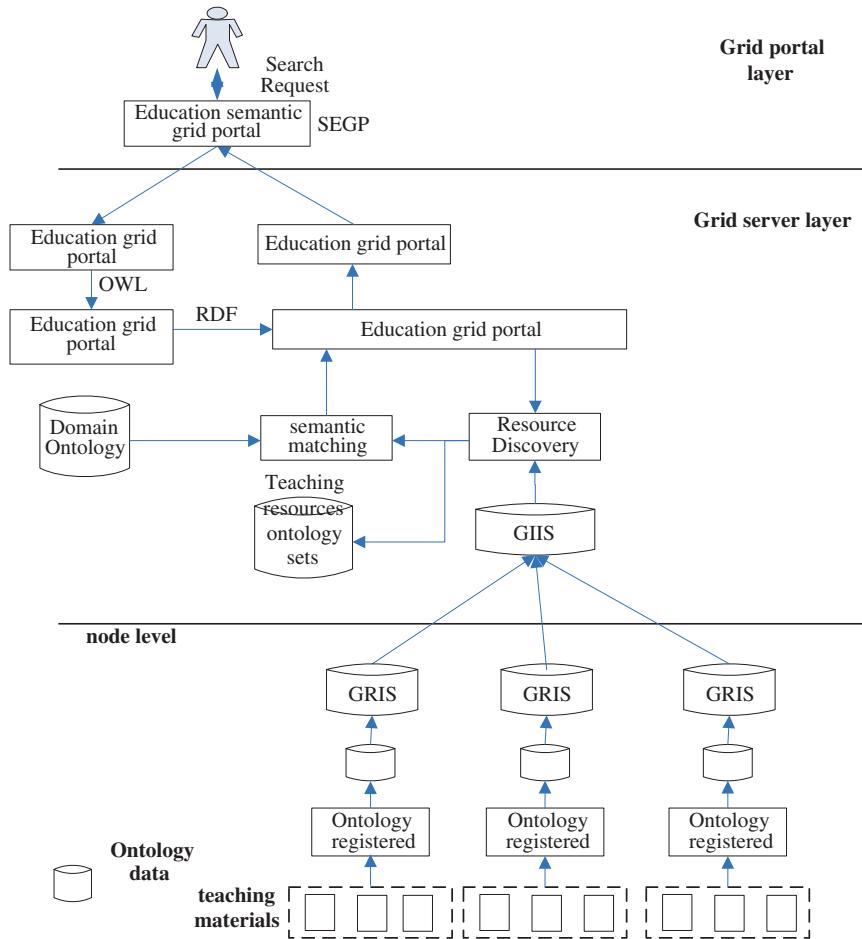
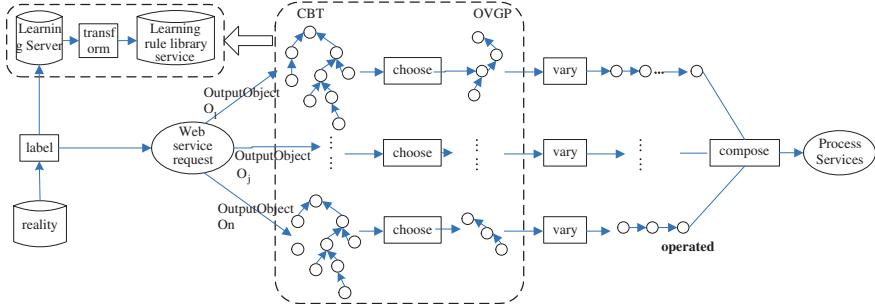


Fig. 9.1 The grid portal based on SOA

construct a new service dynamically and transparent, which gathers and coordinates resources in a flexible way. Dynamic grid computing environment is autonomous entity, heterogeneous and distribution, and this is a kind of environment that cannot be agreed beforehand; consequently, cooperation relations must be able to be selected, negotiated, established and monitored dynamically. In order to gather grid components and resources effectively, we not only need SOA model, but also require the relative functional, available information and the information of different components interface information to have consistent interpretation which can be understood and dealt by the machine. As shown in Fig. 9.1.

Through the identity authentication and other security technology to prevent illegal users through Internet use or get any resources of the grid we can, guarantee the security of data. Meanwhile, by using the technology of access control and data



**Fig. 9.2** Teaching resources description on the basic of semantic

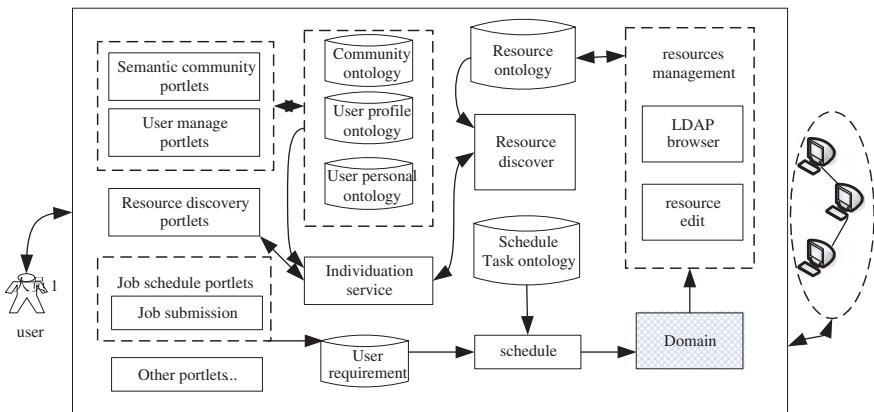
hiding, users can only get the allowable information and knowledge and cannot steal unauthorized information. The grid security needs to realize security functions as follows: the user authentication, access control, billing, confidentiality, integrity, certainty and non-repudiation. The grid security also needs to realize the network flow control, load balance and congestion control, monitoring the grid resources, tasks and the state of application, providing performance evaluation and fault-tolerant processing.

### 9.2.3 Teaching Resources Description on the Basic of Semantic

Based on the semantic teaching resources description and Instructional Resources Management to classify and improve the existing teaching resources, we can get better formal description, and build semantic description model of teaching resources. Based on the grid monitoring and discovery system (trMDS) to establish a model for teaching resources register in the teaching grid, we can use this model to design teaching resources information server and implement registration, sharing and reuse of teaching resources in the grid. As shown in Fig. 9.2.

The application involves large amounts of data and computing resources and usually needs to cross the organizational boundaries to share security resources. In order to reduce the complexity of application development, general grid services layer can shield the heterogeneity of the network resources (physical resources and logic resources) and support the unity of management of the network resources, distribution scheduling and safety control and provide a platform that is convenient to use, similar to a unified operating system for the upper applied to.

Distribution resources are coupled with service. The goal of the grid is organizing all the resources and working together, by using the distribution resources coupled service can submit the resource to the top of the grid applications in the form of service.



**Fig. 9.3** Semantic retrieval of teaching resources

#### 9.2.4 The Student Model Based on Ontology

The research of student model based on ontology uses ontology framework to integrate student model and establish the domain ontology and mapping that covers the ontology, studies mapping algorithm, builds cognitive ontology, and integrates the cognitive characteristics, cognitive style and cognitive abilities into the other common cognitive student model. And then based on these models, active teaching resources recommended mechanism was proposed. As shown in Fig. 9.3.

#### 9.2.5 Semantic Retrieval of Teaching Resources

Semantic retrieval of teaching resources makes the traditional semantic retrieval expand to the teaching grid, to realize the distributed, heterogeneous semantic retrieval of teaching resources and realize the description, registration, discovery, searching, distribution, migration, reservation and recovery work of resource. Grid resource has the following characteristics: the geographic distribution of resources is very wide; resources and resources, resources and customer, customers and customers always connect each other by WAN; the quantity and type of resource are huge and required a certain degree of collaborative work resources that is dynamically changed, including resource attribute changes and copy and transfer in the grid, etc.; resources work in heterogeneous platforms and are controlled by different management strategy. In such an environment, a kind of resource discovery mechanism is needed, which does not depend on the centralized control, distributed, can be expanded, can adapt to the dynamic change of resources and has good positioning performance. Unlike the traditional distributed system which is using URI for positioning resources such as the Web, grid resource discovery

mechanism should not only consider the position information of resources, but also should consider the attributes of resources and the other semantic information.

### 9.3 Summary

This paper expounds the basis and requirements of university teaching resources grid portal construction based on semantic analysis of users' demand and experience. With semantic ontology knowledge, we make creatively try and research on the teaching resources description based on semantic and its application to teaching resources management.

Meanwhile, this paper describes the complete process of universities teaching resources grid portal system based on semantic, from requirements analysis, design to the system modeling and finally realize. In practical projects, the process and considerations of the grid portal system modeling are tried and recorded, a reference of using the semantic in university teaching resources management field is provided, and finally a unified and standard modeling approach that provides reference is formed.

Ontology knowledge in the process of teaching is a new promising field of research. It still has not appeared as a complete ontology model and the framework. How to analyze dominant and recessive knowledge in teaching process better? How to select right ontological form of the different types of knowledge? The research with a combination of universities' teaching resources which is based on the semantic and grid portal still has a lot of the unknown waiting for people to explore. With the development of research, believing that the expression of semantic study will become more and more mature, grid portal that is based on the semantic will also be better serviced in the spread of human knowledge, sharing and creating.

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# Chapter 10

## Reform and Practice of Course Setting for Music Education in Universities

Kai Cui

**Abstract** This paper sets forth from the perspective of teaching reform of music education majors in universities. It makes explorations and study on such aspects as the content setting, reform characteristics of the music education course. At the same time, it carries out practical analysis and discussion of the course setting and teaching reform thinking as well as reform methods.

**Keywords** Subject curriculum • New thinking • New distribution • Interdisciplinary • Subject infiltration • Music education

### 10.1 Introduction

Music specialty education in universities is an important composite part in the higher music normal education system in our country. How to embrace so many difficulties in home and abroad in the twenty-first century, especially how to reform our music educational ideas, concepts, and the content, system, teaching methods, way and modes of subject curriculum are problems that cry for solution currently [1].

### 10.2 Content

The content of subject curriculum is basically as the following:

Elementary skills (playing the piano, basic of acoustics, improvisational accompaniment).

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Basic theories and skills (audio visual speech recognition, musical theory, the history of Chinese music and foreign music, survey and brief introduction on Chinese traditional music, chorus conduction and music appreciation).

Composition theories and application (composition methods and analysis, harmony theoretical basis and application, orchestration for a small group of instruments, composite foundation and works analysis).

The above courses are of various types. They are the subject curriculum opened up for the music specialty education in universities in our country. However, there are still small differences in the following things [2]: class time and the depth of the content as well as the teaching forms. The reason for the differences lies in that the universities adjust the subject curriculum according to their own situation.

## 10.3 The Characteristics of Reform

### 10.3.1 New Thinking

The educational thinking in our country does not have the innovation from the fundamental aspect. It does not adapt to the requirements of the times. Therefore, we need to carry out reformation from the following aspects: the content, the form and the specific operations and so on [3]. The traditional thinking should be changed with the times. New educational thinking should be adapted with a bold mind. We should use the new thinking way to determine the teaching content and the teaching forms as well as the teaching methods.

The new thinking should “place the music education on the large education background of the twenty first century.” The new thinking should be open and practical as well as scientific. In order to study well and put into practice the future music education, open, practical and scientific thinking should be applied. In this way, we should by any means use the new thinking to drive the subject curriculum for the music specialty education in universities and colleges. In addition, we should try to develop the subject curriculum for the music specialty education in practice and make it fulfill and perfect [4].

The new thinking of reform should be first presented in the course setting of the music specialty education for universities and colleges in our country. On the basis of surrounding, the cultivation goal of music specialty education, reciprocal chiasma and interpenetration between different courses should be paid full attention to [5]. Special efforts should be made so as to cultivate well the comprehensive abilities of the students. At the same time, the setting of new courses should be scientific. It should show the time changes, and it should have high practical performance. High union of scientific performance and time performance as well as the practical performance should be shown in the new course setting [6].

The new thinking of reformation should be shown in the compilation of the teaching materials in a full manner. The content of the teaching materials should be maintained in a relatively stable basis. On this relatively stable condition and

basis, the content of the teaching materials should keep on making supplement and innovations according to the development of the society as well as the times. As the content of the teaching materials are made to keep paces with the times and the social development, students are as well able to keep paces with the times. They are able to grasp and understand the advanced knowledge and information about the subject that they are learning currently. At the same time, the content of the teaching materials should be united with the scientific performance as well as the practical performance. It is the goal that we have been pursuing to strengthen the scientific performance as well as the practical performance of the teaching materials for the music specialty education in both the universities and the colleges in our country.

The new thinking of reformation should be applied in the form of teaching in a full manner. In the past, there were a few ways of teaching. All of the ways of teaching in the past times should be changed in the contemporary society. New forms of teaching should be used. We should introduce a great deal of new forms of teaching, such as the multiple methods and the multiple diversification of thinking methods. In this way, we can carry out the teaching activities with the above mentioned methods. Under this circumstance, the students are able to be guided and motivated so that they are able to acquire knowledge and grasp the skills in a far better and new method than before.

It is an important content for the reformation of the subject curriculum in music specialty education for universities as well as colleges to maintain the goal of ability cultivation. In addition to the goal of the reformation in colleges as well as universities, it is as well the key to whether the reformation can be successful or not. The students should be equipped with the ability to learn the esthetic perception of music. The aesthetic perception of music should be strengthened in a fiercer manner. Connect both the teaching of the subject curriculum as well as the teaching practice of basic music that one is going to take for a career in the future. In this way, the students are able to grow into a music teacher who is of the “modern type” before they graduate from the universities or colleges. The students are able to have the following abilities with the innovation of reform: the teaching ability, and the organization ability, as well as the innovation ability. All of the above abilities are deserved by the students if they keep close connection with the subject curriculum in music specialty education. In addition, they are able to grow into a music teacher who is truly qualified. This kind of modern music teacher has relatively high music culture. They are as well fully equipped with comprehensive abilities. In this way, the goal of cultivation abilities can be reached.

### ***10.3.2 New Distribution***

As for the reformation development of the music specialty education in the music and art colleges as well as universities, the overall distribution should be carried out innovation. In the past, the distribution of the music specialty education in the

music and art colleges has not out of date in the contemporary society. The original structure as well as the content of teaching of the subject curriculum should by any means be adjusted and reformed. As for the reformation as well as the adjustment, it refers to the amount of the classes as well as the subsequence of the open course and so on. The courses should be added or cut to become fewer according to the structure of the subject curriculum as well as the teaching content. The sequence of the courses should be arranged in a new manner so as to adapt to the new structure of the subject curriculum as well as the content of teaching. The other content should be reformed and adjusted as well. At the same time, the content of the teaching materials should be fulfilled as well as innovated. In this aspect, cultural pluralism should be paid special attention to. This multiculturalism should be recommended. This is because “diversification has become the absolute trend for the music education development.”

In the past, the “piano teaching and research section” as well as the “vocal music teaching and research section” is very single in its form. In addition to the single form, the “piano teaching and research section” as well as the “vocal music teaching and research section” has relatively strong specialization, which is not good and should be changed. Therefore, in current times, the composite structure of the “piano teaching and research section” as well as the “vocal music teaching and research section” is changed. The “piano teaching and research section” as well as the “vocal music teaching and research section” is integrated into the piano and vocal music teaching and research section, which has combined both the piano and the vocal music. This composition section is not simply a variation in the forms. What is more important is that it has played an important role in the music education. It has very important effect on the interpenetration as well as the mutual influence between different subjects, which is able to influence the other subjects.

## 10.4 The Methods and Ways for the Reformation

### 10.4.1 Interdisciplinary and Subject Infiltration

In the first place, we should set forth in the interdisciplinary and subject infiltration. This can help students to connect what they have learnt and apply them widely on this basis.

When carrying out interdisciplinary and subject infiltration, we make brave and scientific practice with the teaching explorations of more than 10 years as well as the teaching experiences drawn by colleges and universities all over the country. It has acquired very good teaching effect.

In order to improve the ability to extemporaneous accompaniment for the students, in addition to learning what is on the book, they should do practice. They should learn knowledge of other subjects as well. This is able the effective way to cultivate the comprehensive abilities of the students.

#### ***10.4.2 The Combination, Simplification and Addition of the Courses***

In order to construct a reasonable course structure system and realize the overall optimal combination of subject curriculum, it is necessary to reorganize and readjust some traditional courses system in the past. For some courses, they can be combined and simplified. Some courses of closed relationship can be combined into a single course. In this aspect, Emile Jaques-Dalcroze, a famous musical educator and composer from Switzerland, combined systematically the following three parts: body rhythm, solfeggio and ear training and improvisation. He has founded the famous eurythmics, a method of learning and experiencing music through movement. It can be said that the course combination and comprehension have changed the previous pursuit of entity of course system.

When carrying out the course combination, we require the teaching content to be simple instead of complicated. In addition to this, the teaching content should stress the key point. The reason for this is because there are relatively many courses for the music specialty education. If there is no reformation and simplification on the teaching content of every lesson, it is very hard to complete the requirements of the outline. At the same time, it is hard to get good teaching results in practice.

In addition, we should base on the characteristics of the music specialty education and add the lesson of “playing and singing.” This lesson has combined multiple subjects such as the piano, vocal music, harmony and impromptu accompany. However, it would not cause the repetition of these courses. The lesson of “playing and singing” aims at the cultivation of the comprehensive practice and application ability of the students. It is a very important course for the music specialty education as well as an important basic skill that the teachers should be equipped with. In order to make students pay more attention to this course, we list “playing and singing” one of the content in entrance examination. Our way of doing proves to be correct through practice.

#### ***10.4.3 The Reform of Examination Form***

Make reformations on the examination forms and methods of the following three courses, the piano, vocal music and fluffed by self and sung by self. Students will have the exam content of the three courses from beginning to end without stopping. The previous pure skill examination is changed into the examination of comprehensive abilities. It not only requires testing the professional skills but also the relevant theoretical knowledge and teaching methods.

#### ***10.4.4 Reform Educational Practice and Art Practice***

It is an important link to do educational internships for the music specialty education. It can lay a solid foundation for the students to be a qualified and excellent music teacher.

To sum up, the reform of subject curriculum for the music specialty education in both colleges and universities has cultivated a great amount of abilities for students. It not only cultivates a relatively deep music culture and comprehensive music skills, but also enables the students to grasp scientific teaching theories and the relatively strong music education teaching practice abilities. At the same time, it enables the students to be equipped with certain music educational study abilities and so on. Under this circumstance, we should make explorations and brave reformation during the teaching practice so as to cultivate music educational talents of high qualities. We should keep making arduous efforts on the cultivation.

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**Part II**

**Knowledge Management Engineering**

# **Chapter 11**

## **Continuous Improvement Method of Chinese Enterprises Based on Study of Benchmarking**

**Yang Yang, Chunsheng Shi and Jian Li**

**Abstract** As a continuous increasing process of the company level innovation ability, continuous improvement is an important strategy for the company to keep competitive. This paper mainly studies the present situation and implementation methods of continuous improvement. The motivation of continuous improvement about Chinese enterprises is firstly analyzed with the help of Continuous Innovation Network (CINet) Program. The study shows that the most important motivation of Chinese enterprises conducting continuous improvement is to gain higher customer satisfaction. Secondly, the performance of continuous improvement about Chinese enterprises is studied. The research shows that production volume, safety and working conditions are the emphasis that Chinese enterprises need to focus on in the next stage. Thirdly, the methods of continuous improvement that Chinese enterprises can learn are studied by using benchmarking. At last, the specific advices for every method are put forward. The study of this paper is to provide reference for the conduction of continuous improvement about Chinese enterprises.

**Keywords** Continuous improvement • Motives • Performance • Improvement measure

### **11.1 Introduction**

Continuous improvement (CI) mainly refers to continue to do small, gradual reforms to improve the efficiency constantly. Continuous improvement is a continuous increasing process of innovation ability in company level; it combines the development of enterprise with the improvement of performance organically and can make direct and lasting contribution for the evolution of enterprise [1]. The appearance of continuous improvement theory could not be separated from quality management. Bounds divides quality

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management into four stages, namely inspection, statistical quality control, quality assurance, strategic quality management [2]. In fact, even the method of strategic quality management is difficult to cope with the business environment which is rapidly changing and highly uncertain. The fifth stage of quality management-competitively continuous improvement comes into being to meet this challenge [3].

Continuous improvement is not only limited to quality and production in workshop, but also includes innovation and business performance and learning behavior in the whole enterprise. It is not only a method of practice, but also a strategic competitive weapon. The theory of continuous improvement is gradually applied to wider areas, such as innovation or new product development [4, 5]. Bessant believes that continuous improvement is a concentrative, evolving process of innovation throughout the whole company and a key strategy that keeps the manufacturing competitiveness of the enterprise [6].

The international survey data from Continuous Innovation Network (CINet) show 37 % of the sample enterprises think it is difficult to commit to continuous improvement activities continuously, while only 22 % think it is easy to do so. In Chinese enterprises, 51.2 % of the sample enterprises think it is difficult to commit to continuous improvement activities continuously, while only 11.6 % think easy. As can be seen from the above data, it is difficult to conduct continuous improvement in enterprises, and the difficulties of Chinese enterprises conducting continuous improvement are far greater than foreign enterprises.

What kinds of continuous improvement method are more effective to improve the performance? The issue will be researched depending on the database from CINet in this paper. We hope that the research results of this paper could make people have a deeper understanding about continuous improvement activities and provide advices for Chinese enterprises conducting continuous improvement.

## 11.2 Research Model

This paper will analyze the performance that Chinese enterprises mostly need to improve in the following two aspects:

- (1) Analyze the reason for Chinese enterprises conducting continuous improvement. The reason for improvement reflects the motivation and the importance of demand that enterprises conducting improvement activities.
- (2) Analyze the level of performance that Chinese enterprises conducting continuous improvement. The performance indicators in middle and low levels are the key points to research in this paper.

The key points of this paper are the indicators that need to be improved dramatically and the performance of which is poor. The method of benchmarking will be used to study the continuous improvement methods. Blue chip companies will be selected, and the continuous improvement methods they use to improve the key performance above will be analyzed.

## 11.3 The Survey of Data and Description of Indicator

### 11.3.1 The Survey of Data from CINet

The data of this paper are all from the questionnaires designed by the working group of CINet. The working group of CINet is composed of more than 50 experts, scholars and business elites who are from 20 countries. The working group investigated 586 companies from 11 countries and regions in Europe, Asia and Australia and so on in 2003.

### 11.3.2 Indicator System

The questionnaire lists 18 indicators about motivations, 16 indicators about performances and 18 indicators about methods for enterprises conducting continuous improvement. The five-point scale of Likert is used to measure these indicators, 1 means the highest and 5 means the lowest.

### 11.3.3 Reliability and Validity

#### 11.3.3.1 Research

The reliability coefficients of various indicators are calculated using internal consistency in this paper (Cronbach's  $\alpha$ ). Cuieford considers that the number of Cronbach's  $\alpha$  means high reliability if larger than 0.7 and low reliability if smaller than 0.35 [7]. Nunnally considers that the number of Cronbach's  $\alpha$  must be larger than 0.5 at least in practical applications [8]. Wu Tongxiong thinks that the most common range of the number of Cronbach's  $\alpha$  is between 0.5 and 0.7 [9]. The reliability analysis results of every indicator are shown in Table 11.1. As can be seen from Table 11.1, the smallest number of every set of indicators is 0.796, most of them are larger than 0.8. Therefore, the indicator system of this paper has a stronger internal consistency.

#### 11.3.3.2 Validity

The validity refers to the accurate degree of the variables measured by tools, namely the accuracy. The higher the validity, the more efficient the measuring results that show the true nature of the object which is measured. During the research period of CINet, the managers of the enterprises being researched were contacted closely. The

**Table 11.1** Analysis of inner reliability and construct validity

			China	The whole samples
Cronbach's alpha	CI motivation		0.883	0.864
	CI performance		0.892	0.904
	CI method	Importance	0.879	0.796
		Usage	0.822	0.834
Cumulative %	CI motivation		70.17 %	57.25 %
	CI performance		64.62 %	58.39 %
	CI method	Importance	71.78 %	60.26 %
		Usage	64.49 %	51.10 %

respondents of the questionnaires are managers of enterprises to ensure the accuracy and validity of the research data. The method of factor analysis could also be used to examine the construct validity of the questionnaire; the results of the analysis are shown in Table 11.1. The cumulative variance contribution rates of each set of common factors are all meet the requirement larger than 40 %, [10] and the load values of the largest common factors about each indicator are greater than 0.4. Therefore, the structural validity of the questionnaire is pretty good.

## 11.4 Benchmarking of Continuous Improvement Methods

### 11.4.1 Select Blue Chip Companies

The samples are classified using the method of hierarchical cluster (514 enterprises, not including Chinese enterprises). The appropriate number of categories is determined by the curve chart (screen plot), which makes use of coefficients changing by the number of categories. The result of the analysis shows that it is appropriate to divide the samples into three categories. The result of classification is shown in Table 11.2.

**Table 11.2** Sample classification

			Production volume	Safety and working conditions	Sample size
Excellent performance	Mean	1.84	2.23		235
	Std. deviation	0.57	1.02		
Normal performance	Mean	3.44	2.5		210
	Std. deviation	0.69	0.6		
Bad performance	Mean	3.82	4.23		69
	Std. deviation	0.79	0.45		
Total	Mean	2.76	2.61		514
	Std. deviation	1.07	1.03		

### ***11.4.2 The Methods of Continuous Improvement Methods about Excellent Performance Enterprises***

Two hundred and thirty-five excellent performance enterprises are analyzed. The result shows that the most important method of continuous improvement is support from managerial staff (mean value <1.5), followed by monitoring the improvement activities (measures, follow-ups), supportive leadership, regular shop floor visits by management, face-to-face communication, work in teams/work groups, training of personnel in problem-solving tools, use of quality standard, a general problem-solving format, use of total productive maintenance, formal policy deployment( $1.5 < \text{mean value} < 2.5$ ).

The continuous improvement methods which are frequently used are as follows: use of quality standard, face-to-face communication, monitoring the improvement activities, support from managerial staff, regular shop floor visits by management, work in teams/work groups, supportive leadership( $1.5 < \text{mean value} < 2.5$ ).

The comprehensive analysis finds that the importance of these 7 indicators which are frequently used is much higher than the importance of the others. Therefore, these 7 indicators are the continuous improvement methods that need to be learned by Chinese enterprises. As shown in Table 11.3.

**Table 11.3** The continuous improvement methods of excellent performance enterprises

	Importance		Usage	
	Mean	Std. deviation	Mean	Std. deviation
Use of slogans	3.62	1.07	3.79	1.13
Training of personnel in problem-solving tools	1.88	0.80	2.85	1.02
Monitoring the improvement activities	1.52	0.57	2.17	0.91
Support from managerial staff	1.41	0.64	2.19	0.92
Incentive systems	2.74	1.13	3.58	1.18
Supportive leadership	1.70	0.76	2.47	0.94
Work in teams/work groups	1.83	0.85	2.38	1.03
A suggestion scheme	2.76	1.11	3.34	1.25
A general problem-solving format	2.35	0.98	3.19	1.18
Promotion on notice boards	2.75	1.07	3.12	1.24
Promotion through internal media	2.95	1.12	3.40	1.22
Promotion through competitions and awards	3.40	1.11	4.06	1.05
Face-to-face communication	1.76	0.83	2.16	0.96
Regular shop floor visits by management	1.73	0.76	2.25	1.04
Use of quality standard	1.89	1.03	1.84	1.10

(continued)

**Table 11.3** (continued)

	Importance		Usage	
	Mean	Std. deviation	Mean	Std. deviation
Use of total productive maintenance	2.38	1.06	3.14	1.23
Quality awards	3.25	1.21	4.08	1.16
Formal policy deployment	2.43	1.09	2.91	1.20

## 11.5 Advices for Chinese Enterprises Conducting Continuous Improvement

**Use of quality standard** On the one hand, using ISO9000/2000 or other quality standards could provide standards for employees conducting continuous improvement activities; on the other hand, it could encourage the staff to do more activities about continuous improvement.

**Face-to-face communication** The employees are encouraged to communicate with each other, and the conditions for full exchange of staff are created by enterprise. Individuals and groups at all levels share (make available) their learning from all work and improvement experiences.

**Monitoring the improvement activities** There must be an emphasis on monitoring the continuous improvement activities, and the frequency of monitoring must be ensured. The staff and team continuously monitor and measure the improvement activities and the effects, as well as the impact on the strategy or the object of department; the impact of reorganization to organizational improvement should be taken into account when planning the reform of enterprise, and it could be adjusted appropriately if necessary.

**Support from leadership and managerial staff** Leadership should pay attention to and support the continuous improvement work of enterprise frequently and correctly guide the direction of enterprise conducting continuous improvement to make it match with the strategic objectives of enterprise. All the managers could respond to the views and suggestions about improvement which were put forward by the staff timely and clearly. Managers should also serve as models and participate in the design and implementation of continuous improvement system actively. Managers encourage practice. They do not punish the employees who make mistakes, but encourage them to learn lesson from mistakes. Meanwhile, providing sufficient time, fund and other resources for improvement activities is needed.

**Regular shop floor visits by management** It could help managers find the problems existing in the shop floor timely and accurately and respond to them quickly. Being small and trivial, some problems exist for a long time. Continuous improvement starts with some preventive measures and promotes the formation of large improvement by adding them up. Managers regularly visiting the job shops could also boost the morale and enthusiasm of the staff.

**Work in teams** Continuous improvement should be regarded as activities done by staff or team rather than parallel activities. Employees and teams work efficiently in

the departments on each floor and carry out improvement activities in business the whole time. Design an organizational mechanism to make staff learning be a part of it.

## 11.6 Conclusion

The motivation and performance levels of continuous improvement about Chinese enterprises are analyzed on the base of Continuous Innovation Network program, and then, the continuous improvement methods of Chinese enterprises are studied. The following conclusions are obtained:

The most important motivation of Chinese enterprises conducting continuous improvement is higher customer satisfaction; the other important reasons are meeting customer demands, reduction cost, improving customer relations, improving quality conformance and increasing productivity.

The performances of Chinese enterprises in customer satisfaction, quality conformance, customer relations, cost and productivity are significantly good, but in other aspects like absence, supplier relations, lead times, delivery reliability, organization, cooperation and communication, administrative routines are not good, especially in production volume, safety and working conditions. Chinese enterprises meet great demands in these two elements, but the performances are not good.

Analysis shows that the enterprises which do well in production volume, safety and working conditions are in favor of the improvement methods, such as quality standard, face-to-face communication, monitoring the improvement activities, support from managerial staff, regular shop floor visits by management, work in teams, supportive leadership.

The specific policy advices about the continuous improvement methods of Chinese enterprises are put forward in this paper on the basis of the foregoing conclusions. We hope that the research results of this paper could make people have a deeper understanding about continuous improvement activities and provide supports for Chinese enterprises conducting continuous improvement.

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# Chapter 12

## Research on the Coordinated Development of Chinese Tertiary Industry

Limin Wang

**Abstract** In view of the coordinated development between Chinese tertiary industry employment structure and industrial structure, this article applies the coordinated coefficient to study the tertiary industry coordination. The results show that the coordinated coefficient has been lower for a long time. In order to maintain Chinese tertiary industry long-term stability development, we must allocate the labor resources reasonably and pay great attention to the coordinated development of the tertiary industry.

**Keywords** Tertiary industry • Industrial structure • Employment structure • Coordination coefficient

### 12.1 Introduction

At present, strengthening macroeconomic coordination development has been the main task of China's economical work. For a long time, there has been lots of incoordination in Chinese economic development, such as the imbalance between Domestic and external demand, the unbalanced proportion of consumption and investment, the unreasonable proportion of three major industries of the national economy, unbalanced development of regional economic, the imbalance between industrial structure and employment structure and so on. All these problems restrict the stability and sustainability of Chinese economic development.

Employment is the source of the people's livelihood, and increasing employment is the main task in the future. The tertiary industry is considered to be the strongest industry to absorb the labor force, so it will play a decisive role in solving the employment problem in China. By the end of 2004, the employment of the tertiary industry has taken 69.0 % of the total employment in the 30 OECD

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member countries, while the proportions in the USA and the UK are even as high as 78.4 and 76.4 % [1]. The employment share of the tertiary industry has risen from 12.2 % in 1978 to 34.6 % in 2010, increasing by 22.4 % points. But compared with developed countries, there remains a wide gap. Nowadays, many scholars have conducted comprehensive researches in terms of the issue that the tertiary industry promotes employment [2–4]; however, few existing literatures talk about the coordinated development of the tertiary industry in depth.

Petty-Clark theorem indicates that the industrial structure and the employment structure keep eternal relationship. It is necessary to probe into the issue of the coordinated development between industrial structure and employment structure of the tertiary industry. In view of this problem, this article puts forward the concept of coordination coefficient and builds up its calculation method; therefore, the balanced development situation of industrial structure and employment structure of the tertiary industry can be reflected by the coordination coefficient from the overall perspective.

## 12.2 The Coordination Coefficient Empirical Analysis

### 12.2.1 *The Definition and Formula of the Coordination Coefficient*

In order to measure the similarity degree of the industrial structure, United Nations Industrial Development Organization (UNIDO) puts forward the empirical formula of the similarity coefficient of industrial structure in 1989 [5],

$$S_{ij} = \frac{\sum_{k=1}^n (X_{ik} X_{jk})}{\sqrt{\sum_{k=1}^n X_{ik}^2 \sum_{k=1}^n X_{jk}^2}}. \text{ In the formula, } S_{ij} \text{ is the industrial structure similarity co-efficient between } i \text{ and } j \text{ region. } X_{ik} \text{ is the proportion that } k \text{ industry of } i \text{ region occupies the entire industry, and } X_{jk} \text{ is the proportion that } k \text{ industry of } j \text{ region occupies the entire industry, and } 0 \leq S_{ij} \leq 1. \text{ If } S_{ij} \text{ equals 0, the industrial structure of } i \text{ and } j \text{ region is completely different; If } S_{ij} \text{ equals 1, the industrial structure is completely same.}$$

Similarity coefficient has been applied to study the issues on employment structure in recent years [6, 7]. But the literature above only transplant the similarity coefficient method to the employment structure simply [8], it does not make the industrial structure and employment structure linked. By redefining the relevant variables, this paper combines related data of industrial structure and employment structure according to this method and puts forward the concept of coordination coefficient. The balanced development situation of industrial structure and employment structure can be reflected by the coefficient from the overall perspective [9].

Now sets  $H_{se} = \frac{\sum_{i=1}^n (S_i E_i)}{\sqrt{\sum_{i=1}^n S_i^2 \sum_{i=1}^n E_i^2}}$ ,  $H_{se}$  refers to the coordination coefficient between

employment structure and industrial structure, which describes the degree of coordinative development or balance of the regional industrial structure and employment structure, also  $0 \leq H_{se} \leq 1$ .  $S_i$  Refers to the industrial structure of the  $i$  industry, and  $E_i$  refers to the employment structure. As  $H_{se}$  becomes closer to 0, the coordination degree of industrial structure and employment structure will be worse; otherwise, it will be better and industrial structure and employment structure have good proportionality.

### **12.2.2 Empirical Analysis of Chinese Tertiary Industry**

Based on different functions, Browning and Singelman divide tertiary industry into four major categories [10], respectively, distributive services, producer services, social services, personal Services. The majority of the international researchers on the change of tertiary industry structure are based on this classification standard. Prior to 2003, according to classification standard of the National Bureau of Statistics, the tertiary industry can be divided into four parts in the broadest sense: circulation department, the service department for the production and life, the sector for improving the scientific and cultural quality of the citizen, and the sector for serving the public demand. From 2004, National Bureau of Statistics furthered the scientific division of the internal structure of tertiary industry in accordance with the relevant international standards and added information transmission, computer services, software industry, culture, sports, entertainment and other industry segments.

To measure the internal coordination of tertiary industry, the paper calculates the coordination coefficients of industrial structure and employment structure of the tertiary industry from 1993 to 2010 (as shown in Table 12.1). It was found that the coordination coefficient was lower in the most time, and it is only 0.8251 in 2010. This result indicates that the development is uneven and the overall coordination is poor within the various sectors of tertiary industry.

In order to further study the coordination degree of China's tertiary industry, we measure comparative labor productivity (CLP) of different sectors within tertiary industry from 2008 to 2010 (as shown in Table 12.2). The result shows that there are relatively large differences in CLP of different sectors. In 2010, real estate industry, information transmission, computer services and software industry, the financial sector account for the proportion of tertiary industry GDP separately 11.4, 6.3 and 10.0 %; but the proportion of employees in tertiary industry only account for 1.1, 1.0 and 2.4 %; the CLP is as high as 10.1691, 6.2986 and 4.1825 respectively. Currently, wholesale and retail industry is the most important pillar industry of tertiary industry, and its GDP had accounted for the proportion 18.3 %

**Table 12.1** The coordination coefficient of tertiary industry

Years	Coordination coefficient
1993	0.6990
1994	0.6957
1995	0.6849
1996	0.6910
1997	0.6874
1998	0.6727
1999	0.6909
2000	0.6478
2001	0.6412
2002	0.6306
2003	—
2004	0.8230
2005	0.8235
2006	0.8264
2007	0.8310
2008	0.8247
2009	0.8226
2010	0.8251

**Table 12.2** The CLP of different sectors within tertiary industry

Sector	2008	2009	2010
Transport, storage and postal industry	1.6464	1.7975	1.8430
Information transmission, computer services and software industry	6.6659	6.6234	6.2986
Wholesale and retail industry	0.5133	0.4801	0.4671
Accommodation and catering services	0.7498	0.7672	0.7522
Financial sector	3.2714	3.4690	4.1825
Real estate industry	10.3870	10.0796	10.1691
Leasing and business services	0.9904	0.8082	0.7158
Research, technical service and geological prospecting	1.4750	1.5642	1.6201
Water environment and public facilities management	0.8126	0.8097	0.7944
Resident services and other services	0.6762	0.7287	0.7264
Education	0.5977	0.6352	0.6226
Health, social security and social welfare	0.9566	0.9689	0.9375
Culture, sports and entertainment	1.5425	1.6478	1.6791
Public management and social organization	0.9133	0.9130	0.9094

of tertiary industry in 2010, and the proportion that its employees takes up is as high as 39.1 %, while the CLP is only 0.4671. In 2010, within the 14 industries of tertiary industry in China, the CLP of 8 industries is beneath 1, with the minimum of 0.4671; while the CLP of 6 industries is over 1, with a maximum of 10.1691. The CLP of the most productive sector is as high as 21.7 times as the lowest one.

The tertiary industry takes the task of absorbing surplus labor force of the primary industry and the laid-off workers of secondary industry. It has been the strongest industry to absorb labor force. The fact that the CLP of 8 industries within the tertiary industry is less than 1 indicates that the internal sectors development of the tertiary industry is extremely uneven, and there is even the phenomenon that some industries have absorbed excessive labor force. On the one hand, it is because the requirement for the quality of employees is relatively low in Wholesale and Retail trade and Accommodation and Catering industry, so it is easy to absorb the transfer of personnel from other industries; on the other hand, as the new service industry, Real estate, Financial services industry and other industries, they add their products with higher value, so they contribute greatly to the growth of tertiary industry. But owing to the higher requirement for the quality of employees, these surplus labor forces of other industries cannot meet their demands for the quality of practitioners, thus limiting its ability of absorbing labor force. All these lead to the rapid development of China's tertiary industry, the faster adjustment and upgrade of industrial structure, meanwhile, the employment structure cannot keep up with the pace of industrial structure adjustment. So the inharmonious development of the tertiary industry takes place.

### 12.3 Conclusion

According to the calculation result of coordination coefficient, we can see that it has been an indubitable reality that the development of China's tertiary industry is in bed coordination. The stability and sustainability of the tertiary industry will be seriously affected, if measures are not taken to regulate the structure of tertiary industry in time.

We should optimize and upgrade the industrial structure of tertiary industry in the future, while we must take the adjustment of employment structure into account at the same time. The nature of employment structure adjustment is the optimization of labor resources allocation; also it makes full use of the basic function of the market mechanism during the allocation process of labor resources. The uncoordinated development of industrial structure and employment structure will not only result in relatively serious unemployment but also is not conducive to a new round upgrading of industrial structure. In order to maintain the long-term and stable development of the tertiary industry, we must focus on the matter of the coordination development of employment structure and industrial structure of tertiary industry, what is more, we should allocate labor resources reasonably to form a benign employment operation mechanism and promote balanced and coordinated development of internal sectors within tertiary industry.

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# Chapter 13

## Project Stakeholders Coordination Management

Yuanbo Zhu and Yunxiu Sai

**Abstract** The basic law of the development of social productive forces determines the reasonable social division of labor and forms the social productivity configuration export use division structure necessity in construction field. Project management's importance in taking effective measures to deal with division of labor causes contradiction in each link of entire project process, including contradiction between the subject and object of project management, subject, object of project management and environment, project management activities and the demonstrative efficiency. These contradictions in the project management activities specifically divide into organizational relations, interpersonal relations, object relations and physical relations. Solving this contradiction is the key to the success of construction project.

**Keywords** Stakeholder • Coordination management system • Coordination management mechanism • Institution

### 13.1 Introduction

Coordination and management have extensive applicability. For a project, the key to success is to coordinate the management of projects from the forward to the prophase planning to the implementation and completion of operation [1], each stage is inseparable from the stakeholder coordination management. Harmonious management is good or bad, directly related to the project quality and cost, time limit for a project schedule effects [2]. Harmonious management is well accomplished. It can make the whole project and organization to realize sustainable development.

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## 13.2 Project Stakeholder Coordination Management Features

Project stakeholder coordination is designed in order to achieve project objectives and to avoid the parties' dispute caused as a legal dispute in the spirit of friendly cooperation and coordination to resolve the dispute and eventually realize a win-win situation [3]. To carry out the contract and ensure the implementation of project goal, we should create good performance environment, to avoid the dispute, the parties participating in the construction of harmonious, collaboration in the atmosphere in the performance of the contract, and timely coordinate all related party relationships [4].

Among stakeholders, there is equality and rights relation that restricts each other, while maintaining their relationship as a contract [5–7]. The performance of the contract must follow a comprehensive performance and actual performance principle. During the performance of the contract process, inevitable meeting owing to various realities leads to stakeholders' working relationship coordination [8, 9]. Therefore, construction project stakeholder coordination management has the following characteristics:

### 13.2.1 A Friendly Cooperation as the Starting Point

In project construction, although participation parties according to the contract have different rights and obligations, they also have their own pursuit of profit, but it is to achieve the project goals together [10, 11]. During the implementation of the project, project total target affects of many factors, but the most important is the construction side between the sincere cooperation.

During the construction of the project stakeholder coordination process, the friendly cooperation must be maintained as the starting point, in order to maintain the interests of one party at the same time without harming the interests of the other party to achieve a win-win situation [12].

### 13.2.2 To Coordinate the Overall Situation is Heavy

Stakeholder coordination management aims to achieve organizational function and overall objective, so the manager has to coordinate the management job. He must set out from overall situation, the global interest in the first place, to promote the overall weight, and do not allow to local interests to damage the overall interests of behavior in the presence.

### 13.2.3 According to the Contract

According to the contract the stakeholders coordinate [13, 14] various projects to comprehensive, correct understanding of conditions of contract and explain the

contract terms: be familiar with the principle to determine the correct meaning of terms and the master contract, in their respective duties and rights, responsibility and risk classification principles and disputes and claims, processing methods and procedures; be familiar with the contractor bidding conditions and standards, as well as the interpretation of each part of the priority of contract documents. In coordination, according to and the use of the terms stipulated in the contract, the contract was processed with specific facts in order to prevent one-sided.

#### ***13.2.4 Based on Objective Facts***

The fact that the objective existence, that it is the stakeholder's coordination activities of the foundation, comprehensive and objective facts and not the coordination play a decisive role [15]. Any phenomenon is objective existence, and it is not due to the personal intention. And the objectivity of any management work must follow the principle. The stakeholders in the coordination of activities in the investigation of the facts should not have personal bias or prejudice, should avoid subjective and optional sex, but not to distort the facts or make up facts, and should strive for justice and true facts.

### **13.3 The Content of Project Stakeholder Coordination Management**

#### ***13.3.1 Project Organization and Owner Relationship Coordination***

Construction contractor project organization and the owners of the project contracting shall bear joint liability for performance. The project organization and the owner relationship coordination not only affect the smooth implementation of the project, but also affect the company's long-term cooperative relationship with the owner. In the course of project implementation, project organization between the owner and the occurrence of multiple business relationship. The implementation phase of the business relationship between the contents is different, so the project organization and the owners of the coordination work content are also different.

#### ***13.3.2 The Relationship Between Project Organization and Supervision Unit Coordinates***

Supervision units and construction contractor who belong to the nature of the enterprise are considered as equal subjects. In project construction, there isn't contractual relationship between them, and it is a kind of supervision relationship.

Supervision unit to the project construction supervision behavior with the identity: one is because the owners are authorized, and the other is because the construction contractor in the contract of advance to be recognized. At the same time, the national construction supervision regulations also inspect the management unit with supervision of construction regulations and technical standards implementation responsibility. Supervision engineer should not only supervise and inspect the construction contractor to fulfill the contract duty but also pay attention according to the provisions of the contract justice in dealing with claims and payment issues to safeguard the legitimate rights and interests of the construction contractor. Project organization must accept supervision unit supervision, and for its work to provide convenient, to provide the complete original records, inspection records, technical and economic information.

### ***13.3.3 Project Organization and Reconnaissance Design Contractor Relationship Coordination***

Construction contractor project organization and reconnaissance design contractor are the nature of the unit; they were associated with the owners who signed the contract, but they have no contractual relationship between. According to their contracting patterns, the difference can be integrated and can also be separated, that is, design and construction general contracting and design, construction contract, respectively. Design and construction of contract, respectively, refer to the design, construction, and equipment procurement work is contracted to design unit and construction unit. The owners were associated only with a design of general contractor, and a general contractor of construction contracts, contract number ratio design, construction contracting mode parallel to many owners and coordination of the workload reduction can play the role of supervision and contractor's multi-level coordination enthusiasm. Although they have no contractual relationship, they are drawing the supply relationship, design and construction, need to cooperate. These relations are occurring in the design work, joint review of the drawings, design changes and modifications, foundation treatment, hidden work acceptance and completion of the acceptance. In order to have a good relationship, coordination should be through close contact, mutual trust, mutual respect, encountering a problem, friendly consultation, and sometimes general contracting authority's management and coordination can also be used.

### ***13.3.4 Project Organization, Supply of Materials and Equipment Contractor Relationship Coordination***

Construction project requires the following resource supply: one was purchased from the direct contract with suppliers, to supply contracts; the other was purchased from the market, to maintain supplier-contractor relationship. At present, the main coordinates of an object are the former, should act in strict accordance

with the contract. During the establishment of the contract, before the deal with the material supplier quality system is investigated, it has achieved certification of supplier contracts. Construction project organizers want to use market adjustment supply, must know the market, use market competition mechanism, regulating mechanism and restriction mechanism.

### ***13.3.5 Project Organization and the Coordination of Government***

The government's construction project management refers to the relevant government departments on the construction project for the supervision and management. The duty of government in construction project management is to perform the function of social management; the relevant law is a basis, by the relevant government agencies to implement mandatory supervision and management. The government on the construction project management is to ensure that construction projects meet the requirements of city planning, construction and maintenance project area environment; the most reasonable use of land resources protection and other resources is maintaining ecological balance to ensure that construction projects are in compliance with the relevant technical standards and norms.

### ***13.3.6 Project Organization and Public Sector Coordination***

Because the project construction units have a very close relationship and often have a contract with the company, it should strengthen the plan and coordination, mainly for quality assurance of construction progress, collaboration and coordination of cohesion.

## **13.4 Project Stakeholder Coordination Management Mode**

### ***13.4.1 Communicate***

In general, project communication mode according to the work needs to be divided as formal and informal communication; according to the performance, it can be divided as language communication and nonverbal communication; according to the communication program, it is divided as two-way communication and one-way communication; and according to the organizational level, it is divided as vertical communication, horizontal communication and network communication. Modern project management mode of communication also includes telephone, fax, email, etc. Here is a brief analysis of formal, informal communication and language communication and nonverbal communication.

### **13.4.1.1 Formal Communication**

Formal communication includes four aspects: one is the process to achieve the project organization. In the project organization chart, the project work flow, project management flow, information flow and project implementation rules are used for the formal way of communication. There are two fixed communication ways: methods and process. Formal communication mode and the process must be specially designed, in the contract or project stated in the manual, as everyone's code of conduct. Three is the universally accepted unified compliance, as by the project organization rules, in order to ensure concerted action. Fourth is the communication of results that often have the force of law. Communication documents, such as meeting minutes, can be the formation of a contract document, legally binding.

### **13.4.1.2 Informal Communication**

Official communication and process are usually informal consultations, either in the form of diversity: on-the-spot observation, informal inspection, contact with a variety of people, have an informal discussion, attend meetings, group meetings or chat, drink tea, food and other. Through a large number of informal horizontal cross-communication, it can accelerate the flow of information, to promote understanding and coordination. Informal communication can better reflect the attitude of the people, to understand the true thoughts and intentions of the participants they know; it can reflect the project culture atmosphere; can solve various contradictions, coordinate the relation of each respect to encourage; can satisfy people's emotional and psychological needs; can make people more harmonious, harmonious, the disadvantaged persons pride and constituent warmth. It encourages people to establish a relationship to obtain the information, understand the situation and influence people's behavior.

### **13.4.2 Contract Management**

Contract management for enterprises to be standardizes the production and operation to avoid or reduce the unnecessary loss. Construction project time is long to involve an area wide, the needs of owners, contractors, supervision units at all levels and in all aspects of the close cooperation. Thus, in building project construction, process to strengthen contract management for contract bilateral friendly cooperation, do everything by rule, reduces unnecessary disputes and trouble and guarantees the smooth progress of the project.

## **13.5 Conclusion**

This article introduced the construction project stakeholder coordination management, including the construction of the project stakeholder coordination management features, contents and stakeholder coordination management approach (communication,

negotiation and contract management). These contents are construction project stakeholder coordination management system and establishment of the model of foundation.

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# **Chapter 14**

## **Research on Bicycle Rental Business Strategy**

**Qing Ye, Juanjuan Chen and Chanrong Dai**

**Abstract** with the continuous improvement of infrastructure in Chongqing University City and entrance of various colleges, the bicycle rental business in this area is booming. However, under the influence of traditional business strategies, the pressure of competition is aggravating. From the perspective of business owners, based on the social background and real conditions of Chongqing University City, this paper analyzed the weakness of traditional price-centered mode and promotion-centered mode. Based on the field investigation this paper provides marketing strategies, that to regular customers (account for 60 %) Rolling Steel Club may cooperate with college organizations to build interactive platforms for identifying customers and improving their loyalty; to loyal customers (account for 32 %) it may identify their specific needs and interests to increase their stickiness. In line with Chongqing University City and its reality, this paper designs a brand new Red Tour on Bicycle travel service, by collaborating with travel agencies Rolling Stone might explore more win-win business opportunities in tour industry.

**Keywords** Chongqing university city • Bicycle rental • Business strategy • E-marketing

### **14.1 Chongqing University Background Analysis**

Chongqing University City, established on April 4, 2003, was located in the west part of Shapingba District. It covers an area of 20 square kilometers. Chongqing Municipal People's Government aims to build a beautiful ecological environment with rich cultural atmosphere, advanced science and technology industry, comprehensive infrastructures, and open modern style with the vision to become the western region of the Advanced Training Center, Scientific Research and Innovation Centre, the International Technology Education Exchange center. From 2003 the Chongqing Municipal Government begin the build the Chongqing University City, so far a dozen

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of research institutions and colleges, including Chongqing University, Chongqing Normal University, Sichuan Fine Arts institute, Chongqing Medical University, Chongqing University of Science & Technology etc. have moved into this new area. Chongqing Municipal Government plans to accommodate 15 institutions and colleges, in the future the population in Chongqing University city, including teachers and students, will reach 15–20 million, and meanwhile accommodate social population about 250,000 people [1].

## **14.2 Chongqing University Area the Present Bicycle Industry Status Analysis**

### ***14.2.1 Chongqing University Bicycle Industry Layout Analysis***

At present the main business circles of Chongqing University include Zhuoyuexijie, Xiyongtianjie, Chenjiacqiao, as well as various institutions of higher education Commercial Street. So far this business in Chongqing University City mainly includes the Sichuan Fine Arts Institute bike shop-Giant, Chongqing Normal University Commercial Street bicycle shop, as well as rolling steel bicycle clubs, and other bike dealers, and some other non-principal pattern of the bike shop. This shows the layout of the bicycle industry in Chongqing University City is more dispersed, the main bike shops serve around business circles and the surrounding schools and social groups. In overall sales and arrangements cannot form a whole and reasonable layout that can better serve the needs of the entire University City and users?

### ***14.2.2 Chongqing University Bicycle Industry Consumption Analysis***

#### **14.2.2.1 Business Owner**

In the context of the fast and steady development of nationwide bicycle industry, the Chongqing bicycle industry will also push by its influence. At present Chongqing University shop mainly have Giant, Rolling steel and iron, and Chongqing Normal University bicycle shop the three bike shops, and the accompanying smaller rental bike for the primary purpose of non-franchised bicycle. In the first three franchised bicycle do business mainly for the purpose of sale of medium and low bike, with a small amount of rental services, and second-hand bike sale and purchase transactions and bicycle consumables or value-added products, such as retail business.

#### **14.2.2.2 Customer Group**

The main potential customer groups for the University City area bicycle are college students. According to the survey data, 60 % of the students on bicycle

demand and consumption are limited to transport as a means of leisure, travel convenience. 32 % of bicycle purchase, consumption advocating for the love of cycling and outdoor sports. In 60 % of the ordinary bicycle user survey said that consumption is the main emphasis on the bike to its higher cost and moderately priced middle and low bike or used bike. While 32 % of bicycle enthusiasts more inclined to self-assembly bicycle or mountain bike.

#### **14.2.2.3 Consuming Trend**

In year 2010, Chongqing was included as one of the sample low-carbon cities; bicycles are encouraged as important substitute for vehicles and are welcomed by most citizens. As Chongqing is a typical mountain city, bicycle demand is limited by the geographic features; however it is welcomed in Chongqing University city because it's relatively flat in this area. According to Table 14.1, the market demand grow rate in Chongqing is 116.67 %, which indicates the rapid growing scale of bicycle market. Some research also shows positive increase of bicycle sale in University City.

### **14.3 The Existing Management and Promotion Strategy Analysis**

#### ***14.3.1 Price-Centred Business Strategy***

Price is the core to the combination of the marketing strategy, product, channel and promotional strategies as the core price war. The combination of price is the core marketing strategy, product, channel and promotional strategies as the core price war. The sales model is based on the price of the starting point,

**Table 14.1** The bicycle production statistics of major bicycle manufacturing provinces (China)

Area	Annual output in		Growth rate	Data source
	2010 (10,000)	2011 (10,000)		
Tianjin	3597.5	3808.8	5.87	Tianjin bicycle guild
Hebei	229.8	427.0	85.81	Bicycle guild of hebei province
Shanghai	512.8	445.6	-13.10	Shanghai bicycle guild
Jiangsu	834.6	885.9	6.15	Bicycle guild of jiangsu province
Zejiang	1880.0	1710.0	-9.04	Bicycle guild of zejiang province
Shandong	70.2	63.8	-9.12	Bicycle guild of shandong province
Henan	13.3	41.8	214.29	State statistic bureau
Guangdong	980.0	940.9	-3.99	Bicycle guild of guangdong province
Chongqing	9.6	20.8	116.67	State statistic bureau

through a series of price cuts or forms of advertising and sales promotion to achieve the purpose of small profits but quick turnover, the main emphasis on the accumulation of sales, increase sales to achieve the purpose of increasing sales turnover.

This sales strategy, sales channels tend to be flattened to achieve through direct control of the sales terminal [2]. Use the price as the core sales model, Their marketing means and purpose is clear, Target market is clear and expand market share through price tension, such as price cuts of 5 % market share will increase 10 %, but because of this marketing strategy need the operators themselves have a certain strength, this business strategy will lead to the sale itself and will be in a passive marketing strategy. In addition, in this mode sales team is not big, relatively flat structure, which means that the price war cannot be a fundamental and long control of the market. So this sales price as the core strategy is only suitable for short-term or irregular sales patterns. In-depth understanding of the University City area bicycle rental industry found that most of the sales strategy is like a price war, usually on the basis of the original price to sell at a discount, for example, original price of RMB499 Giant mountain light bicycles, were sold at a discount price of RMB399. The consumers who were attracted to this mode mainly focus on the ability of bike as a mean of transport, which is mentioned above, 60 % of the consumer population. Therefore, the price war in the conditions of the current marketing model is not an efficient and long-lasting business strategy.

### ***14.3.2 Promotion-Centred Sales Strategy***

As we concerning sales promotion the center of the group of the marketing strategy, the most important is working center on 3P (Product Place Promotion). Under this policy, the marketing mix and the main power of the marketing are from sale promotion [3]. To apply this promotion, the marketing planning and the brand marketing ability must be good, also abroad the propaganda of advertisement. Though the marketing organization mode can be change in the promotion, the way for sale can be change; this mode can be easy affected by place, the propaganda and the people that we focus on. According to investigation, there are two kinds of promotions for bicycle in University City:1 aim to promote sales, which can be used by marketer in various festival or activity. For example, usually in March or April, around Planting Tree Day or flower festival in some place to carry out planning selling; 2 by “Buy one Get one”, these are shown by the buyers buying different parts of the bicycle using big money, seller may give them some cheap consumables for free. Ex: Someone bought a bicycle by 300–500 RMB, giving him a taillight or stopwatch for free. This can not only cause buyers’ willing of buying the product, raise the willing of buyers to buy other relevant productions but also raise the level of loyalty to this production in the later period. The result of sales promotion mode must be related to advertisement and the extension. So all this need good preparation of the previous advertisement and the extension.

## 14.4 Researches and Analysis to New Business Strategy

### 14.4.1 For the 60 %-Mass Consumer Groups

Find out the high loyalty consumer groups in colleges. Firstly, cooperate with school clubs. School club is a bond of connecting the group that has the same interests and hobbies. If the operator can exploit this bond well, they can not only get accumulation of more potential customers for themselves, but also awareness to enhance the overall image of car dealers in the future groups, what's more, more consumption could be stimulated subconsciously. Secondly, establish an interactive platform with consumer groups by joining the university forum. Operators can make use of the strength of the university forum to be linked to consumer groups in a university. Forum (BBS) itself as a new means of exchange by the human population, Through this platform, operators not only able to understand the demand, but also enhance mutual contact and interaction, and Release information of some operators immediately, real-time dynamics, in order to attract more crowd attention.

### 14.4.2 For 32-Special Consumer Groups

Help to establish contacts with the bicycle enthusiasts in and out the University City. The group has a deeper spiritual and preferences needs instead of basic needs of living. We should seize the special consumer psychology demand in the face of the crowd and start marketing when start marketing. What we get from the survey is that the sensitivity of price and promotional activities of the 32 %-special consumer group is not high, so we can make use of other forms of activities to stimulate the consumption impulse of this crowd. The bicycle business operators may cooperate with communication platform of Mega Centre, such as 171 team-<http://www.717c.com/>, the most popular bike enthusiast's communication platform in Chongqing, to open featured pages about the Mega Centre. It can Not only promote the activities of the University City area, get people to attract fans outside to participate in the Mega Centre area, but also can increasing attention outside Lovers University City area car dealers.

### 14.4.3 Promotions Supported by the Third Platform

In a time of rapid expansion of information, new marketing means begin to be dominant, such as VANCL mode, Wit key mode, micro blogging marketing. So the next marketing tool is bound to be the focus of a new round of network marketing. It is not hard to know that these marketing strategies will offer a help to other platforms and groups to promote

**Table 14.2** Different cooperation with travel agencies

Way of cooperation	Product	Features	Suitable consumer group
Sale	Folding bicycle	Portable, expensive	Sold as souvenir to tourists, or to local car owners for short distance trips
	Mountain bicycle	Athletic, expensive	Sold to local consumers who show interest to red tour on bicycle
	Regular bicycle	Standard, cheap	Sold to local consumers for local ride instead of walk
Rent	Mountain bicycle	Athletic, expensive	Rented to one-time consumers

Sales promotion strategies in the area exploited by bicycle shop are still in a passive position and conventional sales model are regarded as the foundation. In a inflated time of the network extension model, the bicycle shop can draw support from the Wit key (who convert their wisdom, knowledge, abilities, and experience into the actual revenue. They let the knowledge, wisdom, experience, skills reflect economic value on the Internet by addressing issues in science, technology, work, life, learning [4])“viral marketing”. Viral marketing has a advantage of stimulating the potential demand by making each of the participants to be a potential customer for the dissemination of products [5]. What we get from the survey on the largest nationwide website named Zhubajie-<http://www.zhubajie.com/> is that many operators exploit third-party platform to promote themselves. The primary means Baidu Question, blog reproduced, micro blogging marketing, and communication in BBS forum, micro blogging marketing and communication in BBS forum are the most two effective way of marketing among them. The bicycle operators also can take advantage of these networks marketing to better dissemination of information to strengthen exchanges and expand its influence combined with the line of friendship competitions and other activities.

#### **14.4.4 Collaboration with Travel Agency: Red Tour on Bicycle**

Shapingba district has rich Red Resorts, such as Prison Zhazi, Residence of Baiju and Hongyanhun Square. As Red Tour is prevalent popular in China, business owners might cooperate with travel agencies to develop travel product featured by Red Tour on Bicycle, which can combine the tour in Chongqing University City with Red Resorts. Instead of big bus, bicycles will be the major ways of transportation, so as to advocate the Low-Carbon philosophy. Tourists will benefit not only from the visits to revolutionary sites, but also from physical practices by riding bicycles. The bicycles could be sold or rented to those travel agencies (Table 14.2).

## 14.5 Conclusion

From above, it is easy to tell that the bicycle business in University City has bright future, but the traditional business operation limits its more space for development. Starting from the analysis of social background and actual conditions, this paper gives a detailed analysis of bicycle business layout, market segmentations, and consuming trend in University City, pointing out that price-centered selling pattern and promotion-focused selling strategy are inadequate to control the bicycle market because they are vulnerable to various areas, propaganda and target customers. SWOT method is applied in analyzing Rolling Steel Club, and based on the field investigation this paper provides marketing strategies, that to regular customers (account for 60 %) Rolling Steel Club may cooperate with college organizations to build interactive platforms for identifying customers and improving their loyalty; to loyal customers (account for 32 %) it may identify their specific needs and interests to increase their stickiness. In line with Chongqing University City and its reality, this paper designs a brand new Red Tour on Bicycle travel service, by collaborating with travel agencies Rolling Stone might explore more win-win business opportunities in tour industry.

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# Chapter 15

## Research on Constraint Factors of Group Purchasing Tourism Products Online

Huijun Peng

**Abstract** The purpose of the paper is to research the constraint factors of group purchasing tourism products online in the new electronic marketing channel. The scale of constraint factors of group purchasing online was developed, and the questionnaire method was used in the study. The result shows that the constraint factors of group purchasing tourism products online include four dimensions, and the website information and perceived risk are the main obstacle factors for the tourism product's group purchasing online. There are different impacts on the constraint factors for the partial demographic and group purchasing habit factors. The website of group purchasing tourism products should take the corresponding measures according to the constraint factors to improve the consumers' intention of tourism product group purchasing online.

**Keywords** Group purchasing online • Tourism products • Constraint factors

### 15.1 Introduction

According to the data of CNNIC, the number of netizen amounts to 513 million and the internet penetration climbs to 38.3 % by the end of the 2011 in China. One of the main reasons of rapid growth of shopping online is the development of group purchasing. The number of group purchasing consumer online achieved 64.65 million by the end of 2011 in China [1]. With the vigorous development of tourism industry and the increment of people's tourism demand, group purchasing online has been an important marketing channel for the tourism enterprises. The tourists can purchase the products and services directly to the tourism enterprises through the group

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purchasing online. In this way, the costs of acquiring products have been reduced, and the common interests of both sides of supply and demand have been maximized [2].

The key of making better of group purchasing website and attracting the consumers to group purchase the products online for the tourism enterprises is to understand the consumers' behavior of group purchasing online. Most of the existing literatures about consumer buying behavior researched on the realistic consumers and ignored the non-consumers. The paper is to research on the constraint factors of group-buying online from the perspective of non-consumer, and it is a new research perspective of tourism marketing channel. The results can be a very important reference for management of websites of group-buying online.

## 15.2 Research Design

### 15.2.1 Methodology

The questionnaire method was used in the research. The questionnaire consists of three parts: sample's demographic information, sample's basic information of purchasing online and constraint factors of group purchasing tourism products online. Based on the leisure theory, perceived risk theory and technology acceptance model, the scale of constraint factors of group purchasing online was developed according to the characteristics of tourism products sold by group purchasing online. The scale included 16 items, and the 5 points of Likert scale was taken in the scale.

### 15.2.2 Sample Selection and Survey

The study selected the university students in the campus as the survey sample. The age of online-purchasing consumers mainly range from 18 to 40 years old, in which the consumers with university education have become the most active group [3]. On the other hand, the foreign survey indicates that the young tourists are the main part of tourists who are largely made up of university students accounted for the whole tourists in a ration of 38.7 % in Asia [4]. So the university students are an important segment in the group purchasing online market and an essential potential consumer for tourism products. The investigation was conducted from April to June in 2012. The respondents were screened by the questions of "Do you have the tourism motivation?" and "Have you purchased products by group purchasing online?" Only when the respondent answered "yes" for the toe questions, he was permitted to finish the questionnaire. The questionnaires were distributed to 361 students of 7 universities in China and 352 questionnaires were recalled in which 319 were valid, and the efficiency ratio is 90.63 %.

**Table 15.1** Samples' demographic characters

Item	Classification	Ration (%)	Item	Classification	Ration (%)
Gender	Male	38.63	Grade	Freshman	21.60
	Female	61.37		Sophomore	24.16
Age	Under 18	5.22	Monthly living expenses	Junior	28.43
	18–22	68.75		Senior	25.81
	Above 22	26.03		Under 600	5.47
Major	Liberal arts	58.61		601–800	27.66
	Science	41.39		801–1,000	41.28
				Above 1,001	25.59

### 15.2.3 Samples' Demographic Characters

The Table 15.1 shows the samples' demographic characters in gender, age, major, grade and monthly living expenses. From the table, we concluded that the female students are more than male ones, the main age group is 18–22 years, the liberal arts major students outnumber science major ones, the number of students in every grade nearly balances, and the students' monthly living expenses are from 801 to 1,000 with the largest group in the respondents.

### 15.2.4 Reliability and Validity Analysis of the Questionnaire

The Cronbach  $\alpha$  coefficient of the scale of constraint factors of group purchasing tourism products online is 0.833, and Cronbach  $\alpha$  coefficients of the 4 component scales lie between 0.752 and 0.826 which are higher than the critical value of 0.7. It indicates that the scale has a good internal reliability. The correlation coefficient of each item of the scale of constraint factors of group purchasing online and total scorers of the scale was significantly related at the 0.05 significance level which suggests that the scale has a good content reliability. The construction validity of the scale can be tested by the exploratory factor analysis in the next chapter.

## 15.3 Result

### 15.3.1 Respondents' Basic Information of Group Purchasing Online

The respondents who have been the netizen for more than 4 years account for 62.71 %. 68.28 % of the samples would browse webpage of group purchasing only when they need buy something. Most of the frequencies of group purchasing

online are “two or three times per month” (accounting for 46.5 %). Top three goods of the group-purchased online are articles for daily use (accounting for 54.49 %), food (accounting for 46.31 %) and entertainment and leisure (accounting for 36.29 %). 46.28 % of the samples spend 50–100 RMB in group purchasing online every time. 8 respondents have bought tourism products by group purchasing online which only account for 2.5 % of the samples. It indicates that the majority of the samples have not purchased the tourism products by group purchasing online. 87.7 % of the samples states that they do not want buy the tourism products by group purchasing online, but 46.18 % of the samples would browse webpage about group purchasing tourism products online.

### ***15.3.2 Dimensions of the Constraints Factors of Group Purchasing Tourism Products’ Online***

The exploratory factor analysis on the scale of constraint factors of group purchasing tourism products online is conducted by SPSS17.0. KMO measurement coefficient is 0.803, and Bartlett test Chi-square value is 547.17 ( $P = 0.000$ ) which shows that the data of the sample were suitable for factor analysis. Two items are deleted because of lower factor load and higher factor in two common factors after varimax orthogonal rotation for 2 times. Fourteen items are retained, and 4 common factors are extracted by using the principal component method (Table 15.2).

- (1) The first factor is named “product features” because it includes 4 items such as “The tourism products in the group purchasing website has no visibility,”

**Table 15.2** Factor load of the items

	1. Product features	2. Technology acceptance	3. Website information	4. Perceived risk
Item 1	0.646			
Item 2	0.727			
Item 8	0.572			
Item 11	0.669			
Item 9		0.684		
Item 3		0.573		
Item 5		0.675		
Item 6		0.748		
Item 6			0.787	
Item 10			0.594	
Item 14			0.631	
Item 4				0.631
Item 5				0.825
Item 12				0.588

*Note* The factor loads which are lower 0.4 are not displayed

“I have less knowledge about travel agency in other cities,” “The consumption of group purchasing tourism products online are restricted to the valid period of group-purchasing coupons” and “People around me are rarely buy tourism products by group purchasing online.”

- (2) The second factor is named “technology acceptance” because it includes 4 items such as “There are too many steps from group purchasing online to realistic travel,” “Most of the tourism products in group purchasing website are remote travel which will cost me too much time for it,” “I’m not accustomed to getting information from group purchasing website before traveling” and “I don’t like the form of package price for the tourism products by group purchasing online.”
- (3) The third factor is named “website information” because it includes 3 items such as “The tourism products’ information in group-purchasing website is not complete,” “There are no other tourists’ consumption evaluation” and “The people who buy tourism products by group purchasing online is less and the speed of becoming a group is slow.”
- (4) The fourth factor is named “perceived risk” because it includes 3 items such as “I have no sense of security because the group purchasing online and tourism are unpredictable,” “The price of tourism products by group purchasing online is higher and it isn’t safe by electronic payment” and “Traveling by group-purchasing tourism products online is a novelty and is much riskier.”

### ***15.3.3 Characters of Constraint Factors of Group Purchasing Tourism Products Online***

In general, 1–2.4 means opposition, 2.5–3.4 means neutrality and 3.5–5 acceptance in 5 points of Likert scale [5]. The Table 15.3 shows the means of total scale and 4 component scales of tourism products by group purchasing online. The total means of the scale is 3.6980, and it suggests that the factors have the larger constraint on the group purchasing tourism products online. In particular, the means of perceived risk and website information are 4.2082 and 4.0339 which are higher than the ones of total scale. The means of technology acceptance and product features are lower than the ones of total scale, but the mean of technology acceptance exceeds the critical value of 3.5. The above analysis illustrates that perceived risk

**Table 15.3** Means of total scale and component scales

	Minimum	Maximum	Mean	Standard deviations
Total scale of constraint factors	16.00	62.00	3.7834	0.6267
Perceived risk	3.00	13.00	4.2082	0.6266
Website information	3.00	14.00	4.0339	0.6723
Product features	4.00	19.00	3.5227	0.6281
Technology acceptance	4.00	20.00	2.7206	0.6527

and website information are the major constraint factors of group purchasing tourism products online, and the technology acceptance has less constrain on group purchasing tourism products online.

The above characters of constraint factors are related to the following reasons. At first, studies show that the travel expenses are the primary factor which influences the university students' tourism destination choice [6]. In present, there are payment risks for group purchasing tourism products online, so perceived risks become the chief factor for the university students who have no or little income. Then, the present websites of group purchasing tourism products have not provided enough information to the tourists, especially lacking the past consumers' evaluation of the products. On the other hand, the tourism products bought by group purchasing online cannot be consumed in weekends or holidays in general which constrains the tourists to group purchase tourism products online. Lastly, the e-consumers take the number of people in a group as the important reference to purchase [7]. But the speed of becoming a group is slow for most group purchasing tourism products online, and it becomes an important factor constraining the consumers' group purchasing tourism products online.

#### ***15.3.4 Different Characteristics of Constraint Factors of Group Purchasing Tourism Products Online***

The demographic and group purchasing habit factors' influence on constraint factors was researched by analysis of variance. The results indicate that there are differences in partial demographic and group purchasing habit factors for the constraint factors.

The factor of product features differs in the grades, monthly living expenses, years of becoming a netizen and frequencies of group purchasing online. Sophomores are most sensitive to the factor of product features because they have more leisure time, increased tourism demand and high expectation for tourism products. The factor of technology acceptance has the significant difference in monthly living expenses, years of becoming a netizen and frequencies of group purchasing and intention of browsing webpage of tourism products. University students who have less monthly living expenses, years of becoming a netizen and frequencies of group purchasing will perceive much stronger constraint of the factor of technology acceptance. The factor of website information differs in "intention of browsing webpage of tourism products." It means the students who have no intention of browsing webpage of group purchasing tourism products online think the hindrance effect of the website information is stronger. The factor of perceived risk has the significant difference in years of becoming a netizen, frequencies of group purchasing and price of purchased products every time. It implies that the students who have less years of becoming a netizen, frequencies of group purchasing and lower price of purchased products every time will perceive much stronger constraint of the factor of perceived risk.

## 15.4 Conclusions and Suggestions

The paper researched on the constraint factors of tourism products by group purchasing online and drew on the following conclusions: (1) the constraint factors of tourism product's group purchasing online include four dimensions: product features, technology acceptance, website information and perceived risk; (2) the website information and perceived risk are the main obstacle factors for the group purchasing tourism product online, and the factor of technology acceptance has little constraint effect on the group purchasing tourism products online; (3) there are differences in partial demographic and group purchasing habit factors for the constraint factors.

Based on the conclusions, the group purchasing website and tourism enterprises should take the corresponding measures according to the constraint factors to improve the consumers' intention of tourism product group purchasing online. Firstly, the group purchasing website should sell more well-known scenic spots to eliminate the consumer's anxiety about unknown scenic spots and travel agency in different place. Secondly, the website must provide more information to the group purchaser online in order that the purchasers can understand the tourism product in details. Thirdly, the tourism enterprises should design characteristic products for the group purchasing online to satisfy the demands of group purchaser online.

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# Chapter 16

## Research of Social Function About Government Under Politics and Law

**Yong Miao**

**Abstract** Since the economic reform in the last century, the people's living has undergone enormous changes. At the same time, the role of various social administrative subjects in public administration and socialization services is also increasingly important. Government functions gradually tend to be socialized in the operation and development process, implementing a series of changes in health care, transportation, health, education, environmental protection and other public welfare services. Social administration involved in the interests of the masses in the operation of the process. In order to protect the interests of the people are not violated, they would need a certain political and legal naturalization range which can ensure its legality and legitimacy. Government functions in the political and legal governance have become the priorities and hot spots of China's political reform, economic reform and social reform.

**Keywords** Government functions • Political and legal • Socialization

### 16.1 Introduction

Government functions have different tasks and requirements in different historical periods [1]. It changes with the needs of the masses of the people. Before the reform and opening up, China adopted the whole-country planned economic system [2]. The government functions imposed compulsorily administrative means to the overall management of the whole society. It now appears that management model has existed great drawbacks [3, 4]. However, in that historical circumstance, there was a certain inevitability and rationality. At present, China carries socialist market economy system [5]. It tends to mercerization in economic, democratization in politics and socialization in government function.

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## 16.2 Government Functions Socialization Theory

### 16.2.1 The Connotation of Government Functions Social

Government functions socialization originated in the western developed countries. In the 1970s, due to their own institutional reasons, the financial crisis inevitably occurred in western capitalist countries. The social welfare of the general public cannot be satisfied. At the same time, information technology developed rapidly. Communication between people broke the time and space limits and got more interaction and communication in the handling of government affairs. This brought government functions new challenges and requirements. It required public service content developed to the subtleness and pluralism. It broke the traditional one-standard and one-program management model. In order to alleviate social contradictions, the government began to reform, namely implemented government functions socialization.

In China, the government has been solely responsible for the social public services and management. With the continuous economic development, people require the social services more and more. To meet the needs of the masses, country reforms government functions. First, it transfers some public functions that society can take on from the government, to be managed by community groups, enterprises or individuals. Since the twenty-first century, China has accelerated the process of government functions socialization reform. Government takes institutional reform as a breakthrough and constantly improves the work function of market surveillance, economic regulation, social management and service. It introduces the “Administrative Licensing Law” and “Comprehensively Promoting Accordance with Implementation Outline.” It is commonly known as “another milestone in China’s political civilization.” It gives the right direction for our government function socialization.

There are two main viewpoints of the government function socialization content. The first one is to save money. The government delegates or transfers part of the government functions for the society to achieve the effect of financial restraint. Now, many western countries are working in this way. The second one is not the transfer of government functions, but discharging or returning the rights. It would really return public management functions to the community. Through the coordination of the relationship between government, society and people, it would jointly explore and research a reasonable solution, in order to achieve the demands to serve better to the people and communities. China is currently working in the second view. This is closely related to the harmonious society in China and more in line with China’s basic national conditions. Our government socialization function mainly gives the authority and responsibility to the industry associations, grass-roots mass self-regulatory organizations, private non-enterprise units and the organization of public management functions to assist the government to improve its functional services.

Where the powers of the social administrations who take commitment to public management and service functions come from, it is the problem that experts

of political science and sociology have to think about currently. By analyzing the current status quo of society and scholars of the theory, it summarizes the main source of power of the social administration. There are mainly two aspects. The first one is commissioned by the government or identified by law. With the reform of the country's political system, some of the social administrations have gradually gained more and more power. They played a more important role in society, to assume more social responsibilities and obligations. As the Accounting Association, it is directly authorized by the "CPA Law." Persons passing the accounting qualification examinations and engaging in the audit work for more than 2 years can register and manage it. The second one is to determine its powers of its own organization. Its members negotiate and reach agreement commonly. Its source of power is not granted by the state or the law, but by the internal members through meetings or contract to complete. For example, the Bar Association can give its registered lawyers punishment or reward in the charter of its own regulations, so as to achieve the purpose of internal self-discipline. These two aspects have their advantages and disadvantages. Combining the two can better supply and complete government functions socialization.

At present, the government functions socializations are mainly in three aspects. First, the decision-making functions and executive functions of government began to separate; second, the government is no longer solely responsible for its public management functions, which forms the situation that government and social administration organizations take charge together; third, it gives more choices to society to help the masses to get more and better social public services. Through the three aspects above, the government will focus more on the decision making, to improve the people's sense of identity about the government.

## ***16.2.2 The Reasons of Government Functions Socialization***

### **16.2.2.1 The Objective Need of the Positive Interaction of Between Government and Society**

Government functions are relying on the community. When society is in a weak hour, it needs to do self-improvement and development under the guidance of the government functions. With society being more sophisticated, the decision-making functions of government functions become stronger, while executive function are weakened. At this time, the social management power of the government functions is necessary to gradually start to transfer to the community, through the power of social groups to complete the management and coordination of public affairs.

How to make a positive interaction between government and society has become the mainstream of social development. The government plays the functions of maintaining social order, political domination and improving the social security system in the whole society. It is the basis of normal, stable and

healthy development of society. Meanwhile, in social development, government is impossible to do all society matters exhaustively. It needs to fully mobilize the enthusiasm of the community, relying on the power of social groups to improve and repair its security system. That can improve the ability of social autonomy and can speed the government's efficiency either.

#### **16.2.2.2 The Inherent Requirements of Government's Increasing Administrative Efficiency**

At present, China's government functions are reforming from the basis of the original planned economic system. Since the reform and opening up, our government continues to streamline and improve its administrative units, but the phenomenon that the functions of the government and enterprises mixed up still exists. Premier Wen pointed out that the some government departments' functions are unclear, management falls behind, and efficiency is not high. Government functions socialization can effectively solve this problem. Government public affairs management is more democratic, and social forces that work with government departments would achieve a multiplier effect.

#### **16.2.2.3 Requirements of the Market Economy Development**

Currently, with the increasing economic level, China paid more attention to public service. In this process, government socializes the allocation of resources, social services and financial management aspects. The development process of market economy in fact is the process of national power gradually returned to society. In the market economy, the government no longer participates in market development and competition, but plays the role of middlemen and makers.

### **16.3 The Plight of Government Functions Socialization**

Although the current government functions socialization provides many other conveniences to the sound development of the people's living and social standards, it also produces a number of new conflicts at the same time. The difficulties faced by the government functions socialization is mainly reflected in the following aspects.

#### **16.3.1 *The Administrative Body Passive and Confused***

With the continuous improvement of the legal construction in China, people's rights awareness is rising. As in public schools, the school is an important component of

social public affairs. It undertakes teaching and is the cradle of social talent. In the school, there are also law contradictions between schools and teachers or students. In schools, when the students' legitimate rights and interests have been treated unfairly, how students safeguard their rights, and whether the school has the rights of chief subject and other issues. In the current society, legal experts and academics did not give a clear answer about how to deal with these issues.

### ***16.3.2 The Administrative Relief in Dilemma***

At present, the state pays part of the public affairs management authority to community groups to perform. But in the current society, people's service requirements are more detailed, and more and more rich in its content. Social public affairs service should be done by countries or social groups, which has become a new problem. The financial resource of the country is limited, but social groups cannot selflessly and heavily invest the construction of public affairs, thus creating a contradiction. The problem consists of the following three reasons: first, the relationship between government and community groups is indefinite. In many cases, social groups are directly ordered by the government and without autonomy. They need the government personally preside and invest in the construction and maintenance on the many affairs; second, the nature of the social groups itself is not clear. They have different results on whether they could enjoy the public administration implementation power, and our current laws did not give a clear statement; third, social administration groups' law enforcement powers and responsibilities are unclear. Some have seriously infringed upon the fundamental interests of the members or clients. The victim cannot find the relevant departments to have a lawsuit and struggle on the road to seek administrative relief. At present, the court only judges the legality of the case itself when hearing the case, and if it is reasonable, it can not be used as a standard of judgment. Social Administration groups and their members or clients are in an unequal position, which undoubtedly increases the difficulty of rights.

### ***16.3.3 Inducing Fair Problems***

To embody fair and equitable in the social public services, the most direct appearance is not letting the public property and services be the privilege of a handful of people and losing common sense. After China's implementation of the political function socialization, there are problems in fair and equitable issues. For example, in education, China's 9-year compulsory education is the rights and obligations that every citizen should enjoy, and all school-age children must receive compulsory education. The schools with better education quality and relatively

perfect running conditions are competed to select and eventually become schools of the privileged class, while the relatively poor schools become the school for common people's children.

#### ***16.3.4 Opaque Information***

Openness and participation, the important elements of the government functions socialization, play the key role in the development process of social democracy. Information is opaque, so the public cannot understand the content of government functions. The whole society functions socialization will not be able to properly implement, to cast a shadow over public services.

#### ***16.3.5 Rights and Responsibility is not Clear***

In the process of China's political reform, many local governments mainly consider the financial balance of payments and management functions, but do not consider the public liability of the socialization government functions. So, government is responsible for the public affairs through socialization of government function transfer to social administration groups. Social groups taking over, the first consideration is the source of funds and power, while the service is lagging behind, unable to safeguard fair competition and to provide basic services to form a vacuum in the service sector.

### **16.4 Measures of the Government Function Socialization under Political and Legal Governance**

After the government functions socialization, the role of government has changed. It becomes a supervisor from the service provider. The decreased QOS harm the public interest and monopoly which is caused by the existing non-identity information among social administration; the government should do a better job of oversight responsibilities.

#### ***16.4.1 Increasing Government Supervision***

At present, after the government functions socialization, the number of social administration is increasing. After the government freed from the heavy public affairs management, it is not unrelated, but to invest more effort in oversight

responsibilities. If the social administrative groups cannot satisfy the people, it should give a rigorous treatment. But in the process of supervision between what to do and how to do, there would be a clear provision. It should not involve too much about social administration affairs up to affect their normal office work.

#### ***16.4.2 Improving the External Oversight***

External oversight of government functions socialization is mainly researched in three aspects. They are entry supervision, price-quality supervision and exit supervision. Entry supervision means a strict qualification examination of social administration of a term of public service and management to ensure that the main body has the ability to provide normal help in public affairs during the process of government functions socialization. Price-quality supervision mainly means to ensure the quality of public services, to avoid the administration changing government's welfare in someones' way of getting social fortune. Exit supervision means some administrations find that the income cannot achieve the desired purpose after getting management of public programs or services, to cope with the supervision with a negative attitude, or directly throw the awful mess of the government, to result the public service quality greatly declining and bring the government image negative impact.

#### ***16.4.3 Improving the Internal Oversight***

Functions socialization of government agencies cannot be excessive. It can prevent the public property and social political functions from falling into the hands of some social administrations on improper means. Therefore, in the government, it should supervise layer by layer in same level departments and subordinate government agencies. To possible problems that may occur or has occurred, it should couple back timely, and order them to carry out rectification and recover its associated power.

### **16.5 Summary**

This paper presents the research on government functions socialization under political and legal governance, first of all, analyzed the government functions socialization theory. Secondly, describes the difficulties of socialization of political functions in the political and legal governance. Finally, the measures were analyzed in detail which should be taken by the government in socialization of government functions.

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# Chapter 17

## Medicine Research Based on Agility Project Management

Quan Yuan, Xiaohui Yu and Yao Zhang

**Abstract** This paper outlines the concept and significance of agility project management and discusses its applicability in medicine research and development. By analyzing the development and clinical practice of Xian Sheng Medicine, a new theory construction method is proposed based on the theory of applying agility project management in medicine research and development. Furthermore, a concept of “trading zone” is proposed. It helps to achieve the agility of the medicine research and development, as well as meet customer demands by utilizing stage delivery, modular decomposition of the system structure, iterative design and optimization.

**Keywords** Agility project management • Medicine research and development • Trading zone

### 17.1 Introduction

It is known that the ability of new drug research and development plays a vital role in the competition and sustainable development of the medicine enterprise[1, 2]. Medicine research and development shares some characteristics as that of system engineering, such as long cycle of research, high risk, expensive and obvious stage[3, 4]. The key to success is to adopt an appropriate management method[5]. This paper discusses the applicability of the agility project management in the nation’s medicine research and development and offers recommendations in the global optimization of medicine research and development on WBS technique and “trading zone” theory.

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## 17.2 The Concept and Significance of Agility Project Management

The concept of “Agility” is first defined in the manufacturing industry, which helps to adapt to the fierce competition and living environment. According to the definition given by the founder of agility Roger Nagel and Rock Dove, agility is the overall response to rapid change, constant subdivision, high performance and high quality of the global market, customized goods and services to generate profits to the business competition. Agility is dynamic, adapting to the specific situation of the change, catering for the change and self-perfecting. Therefore, agility is an ability of creating change, and response to the change is an attitude rather than a process, an atmosphere rather than a method, an ability that enterprises develop and expand in the continuous changes and unpredictable competitive environment, which can make the enterprise profit in the turbulent business environment.

Agility project management is originated in agility software development. It is a management method coping with the dubious software projects. The core values of which are as follows: (1) personal and interaction is better than process and tools; (2) working software is better than thorough document; (3) customer cooperation is better than the contract negotiations; and (4) to response change is better than to follow plan. The most important word in agility project management is innovation. The project managers who implement the agility project management process should pay attention to: adjusting the team to adapt to changes, focusing on products, coordinating with the customers, emphasizing on the communication. Agility project management regards the humanistic management and leadership cooperation as the main guiding ideology and the modular and iterative concept as the main guiding principle.

With the development of agility software development, the concept and method of agility project management have been widely used in software industry, which can be also used in the urban planning, the enterprise management, the production and supply chain management, and even to the society, economy, and education and in various fields of social development. Through the whole process of research and development to modular, agility project management focuses on improving the speed and adaptability of new products on the market and on solving series of problems of the enterprise in the new product envelopment process.

## 17.3 The Analysis of the Applicability of Agility Project Management in the Research and Development in Medicine

### 17.3.1 *The Present Situation of Pharmaceutical Industry Development*

As a high technology, high risk, high investment and high-return industry, the competition in medicine industry is becoming more and more fierce in recent years.

This industry in our country starts relatively late and has small, low concentration and low output value, whereas pharmaceutical research and development gives priority to generic drugs. Compared with the United States, the European Union and Japan's three big "high value" market, our country medicine market is a big "low value" market. The ability of drug research and development is very weak, while most of the pharmaceutical enterprises produce generics. According to the figures, in the country, 97.4 % western medicines are generics. The drugs that are under research and development and have intellectual property rights are rare, which result in the vicious cycle of "generic—fall behind—then more generic—far more behind." This kind of industrial organization structure seriously affected the medicine development of the enterprise in our country. Under the environment of weak basic management ability and low quality culture, this kind of pure market motivation will make enterprise cannot understand correctly and implement effectively. Each organization module has miscommunications, when the risk prediction and the result forecast could not be achieved ideally in advance. Seeking a method of speeding up China's medical research is imminent. So, the agility project management in medicine industry is an important topic.

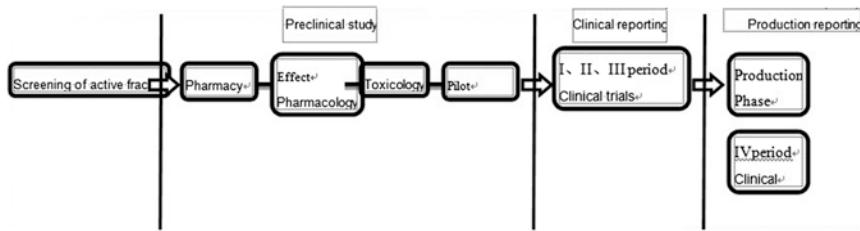
### ***17.3.2 Applicability Analysis***

Because of the linear thinking mode, the usual procedures, as well as the traditional method, cannot adapt to changing product development needs, the traditional development life cycle is long, thus hard to meet the market demand in terms of delivery time. So, medicine research project management must be improved appropriately, and it must be able to satisfy the flexible, rapid changing and prompt delivery needs. By studying and analyzing cooperation system in organizations and the members between organizations, we propose agility project management based on decomposition method WBS in micro level to deconstruct the formation process of joint different members of agencies. Therefore, adopting agility project management can help to promote enterprise continuous innovation, increase the adaptability of the products and shorten the delivery time, personnel and the flexibility of the process to help enterprise realize the ultimate goal of product research and development.

## **17.4 The Modularization of Pharmaceutical Research and Development**

### ***17.4.1 Breakdown of WBS Research and Development Process***

WBS stands for work breakdown structure. It is first used in the United States Defense Department large system procurement process in the 1970s. It has a detailed explanation that can show the whole project and a plan tool that can



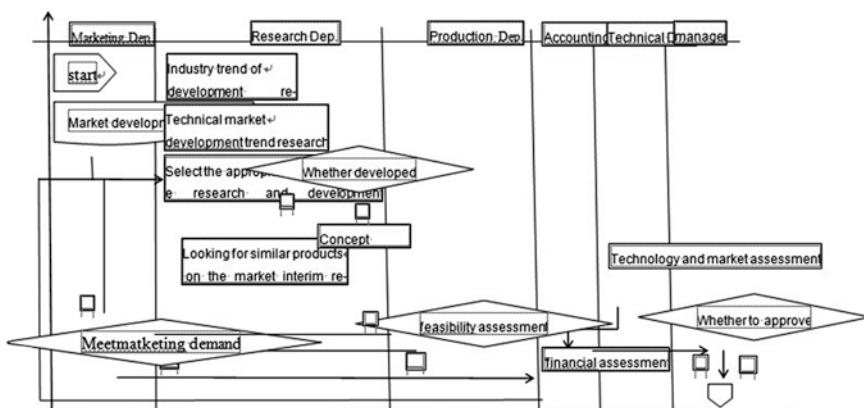
**Fig. 17.1** WBS breakdown structure

complete all of the work in the project. WBS faces the project deliverables, which are elements of project that rule and define the work range of project. The drop of each layer of WBS represents more detailed definition and description work of the project. The premise of realize WBS is that it must have a good knowledge of the research and development in medicine. This work concentrates on the study of medicine research and development of each stage on work scope, content, the responsibility, the time required to deliver results and the final medical research and development of the whole process of a series of clear and direct project work.

Thus, this article will decompose the new medicine process, active site, clinical research before the screening, clinical declare and production process and declare, see Fig. 17.1.

#### 17.4.2 The Modularization of Research and Development

WBS cannot exist alone, which needs to combine other elements of the research organization. The responsibility system should be combined with time of establishing WBS, the depth of the management, design specialized module in interior organization, as shown in Fig. 17.2.



**Fig. 17.2** WBS breakdown structure

Based on the modularization process, operation process is as follows:

1. Marketing department provides market trends report, including the industry trend research, technical market development trend of the study and then selects several research topics through the study.
2. Based on the selected issues of screening, we can judge whether to self-development or conceptual design in the market for the similar research report.
3. The design is completed, and a series of conclusion and material support will be reported including from external expert on the academic and market assessment, the production of the feasibility evaluation production, Marketing Department of market needs assessment, and the finance department of financial evaluation, etc.
4. After the evaluation, the enterprise's top decision makers decide whether the project gets approval. After the project is approved, the research and development department makes the project official. After that, research and development department first determines whether to fully develop independently. Research and development department then completes the product research and development and then passes it to the state food and drug administration (SFDA) for clinical examination and approval. Once it is approved, it can move on to the clinical trial stage. After it gets the final approval by the SFDA, the approval certificate is issued to the new drugs, and the whole process is completed.

## 17.5 The Establish of “Trading Zone”

The theory of “trading zone” is put forward by Professor Peter Galison of Harvard University in his work “The Division of Science.” He believes that “trading zone” is a kind of social and intellectual plaster port, which bonds the experiment, theory and instruments. It is this trade sector in them highly constrain the negotiation, which will be split up the different subculture adhesion. For example, scientists to experiment and theory predict the scientists of the experimental results are trading. About the deal, there are two points worth attention: first of all, the two may subculture in general, not the exchange of information and its significance in epistemology reached a consensus. Second, despite the existence of these sharp differences, there still is a significant point, that is background, in which both sides have a large number of consensuses.

In the process of new drug research and development, establishing “trading zone” means a zone that strictly follows the general flow of new drug research and law in different modules to establish internal organization structure. See Fig. 17.2. Each module of the work quickly realized “trade” of their results in the “trading zone” and then “activates” the next module of the work.

## 17.6 Anglicization Process on “Trading Zone”

Through WBS, we finished the medicine method development process and the research and development organization from the micro level of structure decomposition; in order to realize the agility of process, we should link each module as a matrix, networked way. This needs to “trading zone” theory as a foundation. Construction project management mechanism can establish medicine and trust contract, and coordination mechanism, to keep the whole organization of the good operation and further formation driving force for the development of the industrial activities. Among various modules full of information communication and exchange can not only eliminate mutual suspicions, misunderstanding, not understood, and to learn from each other, but also promote two-way transmission of information; thus, to shorten the members, the son of the many differences between organization enhances the confidence of the blend step each other and also common strategic objectives.

Now based on “trading zone” theory of pharmaceutical research and development process, we can analyze the problem from the following three aspects:

1. Information communication perspective: as far as the practical operation of drug development is concerned, its management mechanism and the coordination mechanism provide the safeguard for the existence and development of research and development; however, management mechanism that carries out the contract execution, building trust and the actual operation is facing many difficulties. Many of the research and development departments have complicated background, different agencies in culture, management mode, which is much different, and these factors led directly to the information miscommunication of departments. The traditional modular organization structure, such as the “production line” drug development process, can only communicate with the departments next to theirs. Hence the scope of information communication is narrow, and the efficiency is low. Many times just by playing games realizes efficient communication on the basis of the harmonious link.

However, the modular organization structure “trading zone” is dynamically adopted; departments can cross and mix the information communication; the efficiency of information communication is greatly improved. In the network organization structure form, internal organization of fusion and relevance is stronger, and adequate information communication and exchange can make product information in the two-way transmission. The conceptualization of “Trading zone” objectively the drug development to adapt to the characteristics of dynamic characteristics of the organization; this means that different departments of communication and exchange are not a fixed process, and its use stressed, communication and exchange the optimal model not, must consider all sorts of projects and organizational structure and the dynamic requirements adaptation. The higher the task uncertainty, the greater the need of “trade sector”. Because “trade sector” occurred

in objective of the exchange is trading parties through the information in a given exchange, under the premise of a meaningful way between the adjustment behavior.

2. Delivery perspective: form in the network structure, as it occurs with the market opportunities; once the market opportunity disappears, the organization relationship will relieve, and these characteristics which make their cooperation cannot be long term. The long bonds in solving realize cyclic and cooperation of the contradictions between short term, and “trade sector” in medicine research and development organization has a unique value. The traditional pattern of pharmaceutical research and development can deliver the final product and the products in the pipeline-in the process of research and development, do not use adapt to the changing market requirements, but also not use product development needs and be the fit of demand. The “trade sector” medicine research and development delivery products can be in trade zone delivery stage research achievements, which can adapt to the change of the effective demand of the market, and also have the use of product development in the utilization of the research results.
3. Research and development costs perspective: in the traditional mode, the product research and development cost is higher. Once a product development fails, the research and development of the input resources will be wasted. When adopting the “trading zone” medicine research and development, delivery cycle is short, cost is low, and the products can be in trade zone bouts of flexible delivery, reducing throughout the development process of capital in repeatedly put, so as to reduce the cost of the research and development. “Trading zone” is a kind of virtual trade mode. This virtual cost reduces the actual cost effectively and realizes the cost savings of the whole organization.

The pharmaceutical industry research and development organization is dynamic, and it occurs with the market opportunities. Once the market opportunity disappears, the organization relationship will relieve. These characteristics make their cooperation cannot be long term. The long bond in solving realize cyclic and cooperation of the contradictions between short term and “trading zone” in biologic pharmaceutical industry research and development organization has its unique value.

In addition, with participation of “trading zone,” we can construct “virtual” product project team according to the different products. In the gradually formed development process of parallel iteration, changes or risk is made to be appeared in advance and improved in the later iteration cycle, realizing agility management process.

## 17.7 Conclusions

This paper outlines the use of agility project management to scientifically and reasonably redesign the pharmacy development organization structure. It makes each stage of the medical research and development process modular and independent.

At the same time, by building “trading zone” in all the submodels, communication barriers between departments are eliminated, and the coordination between sub-module cooperation is strengthened. All these changes help to improve the ability of the enterprise medicine research and development.

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# Chapter 18

## Customer Segmentation Based on Dual Perspectives of Customer Value

Zhongqun Sun and Xi Sun

**Abstract** In the background of relationship marketing, customer segmentation and, in particular, customer segmentation based on the profitability of customer has received increasing attention among both academics and managers. However, there is an increasing awareness that the models presented have some obvious limitations: ignoring the unity of opposites of the value perceived by the customer and the value perceived by the company; failing to capture other potentially significant value sources that customers can provide to the company; and neglecting additional strategic analysis. Thus, the purpose of the paper is to explore a conceptual framework of customer segmentation based on dual perspectives of customer value. This is achieved through discussing on the unity of opposites of customer value and the systematic analysis of two-dimensional customer values in the context of customer segmentation.

**Keywords** Customer value • Dual perspectives of customer value • Customer segmentation

### 18.1 Introduction

It is commonly agreed upon that market segmentation is one of the most fundamental marketing concepts, in terms of matching supply with demand and constituting an important component of a company's marketing strategy. Most of the traditional approaches to market segmentation are based on non-economic customer characteristics [1]. In the background of relationship marketing,

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customer segmentation and, in particular, customer segmentation based on the profitability of customer has received increasing attention among both academics and managers. Customer profitability analysis (CPA) and customer lifetime value (CLV) are fast becoming accepted as new bases to customer segmentation.

The first model that came close to considering the profitability of customer was that of Shapiro et al. They developed a customer segmentation model that customers are classified according to the price they pay and the cost incurred by the company to acquire and serve them. Four classes of customers are identified: “carriage trade” (often newly acquired customers who are costly to serve but pay a relatively high price), “passive customers,” “aggressive customers,” and “bargain basement customers.” Later, Turnbull and Zolkiewski extended this model by including a third dimension, “relationship value.” The third dimension allows other strategic issues to be taken into account, and it is more judgmental than the other two dimensions proposed yet another approach for assessing companies’ customer base. They suggested a four-tier division of customer profitability, ranging from the highest to the lowest and dubbed “the platinum tier,” “the gold tier,” “the iron tier,” and “the lead tier.” Other customer segmentation procedures have been introduced, such as relative customer product margins and relative cost to serve, and classifications of customers based on loyalty and profitability [2].

However, although there are many types of customer segmentation models, there is an increasing awareness that the models presented segment customers only by single data mining technology from a specific view, rather than from systematic framework. Most of them have obvious limitations: ignoring the unity of opposites of the value perceived by the customer and the value perceived by the company; failing to capture other potentially significant value sources that customers can provide to the company; and neglecting additional strategic analysis. For many companies, the term “customer value” is used solely to refer to the value that the customer generates for them, rather than the value that they ought to offer their users. We believe that it is not sufficient to solely rely on customer profitability analysis or customer lifetime value as bases to customer segmentation, since it is likely to cause marketing strategy deviation from the basic principle of marketing. We hold that the customer segmentation as the core of enterprise’s marketing strategy must be combined with the dual perspectives of customer value. Meanwhile, the potentially significant impact of customers and additional strategic analysis cannot be neglected. Consequently, the paper seeks to offer a perfect conceptual framework of customer segmentation based on dual perspectives of customer value.

This paper is structured as follows. In the following section, the unity of opposites of dual perspectives of customer value is examined. Next, the systematic analysis of two-dimensional customer values in the context of customer segmentation is discussed. Then, an integrated customer segmentation model based on dual perspectives of customer values is given. A brief conclusion and suggestions for further research are provided at the end of the paper.

## 18.2 The Unity of Opposites of Two-Dimensional Customer Values

Most researchers agree that creating and delivering superior value to customers has long been recognized as a central concept in marketing and the fundamental basis for all marketing activity. Some marketing academics have even placed customer value on top of their research agendas and the purpose of organizations [3, 4].

Generally, there are two perspectives of customer value or two-dimensional customer values: the value for the customer (the buyer's perspective) and the value for the company (the seller's perspective). The most common perspective of customer value focuses on the value that a company can bring to the customers as the assessment of how the company creates value for its customers or how the customers perceive superior value in a supplier's offering compared with competition [5]. Another perspective of customer value focuses on the value that customers can bring to the company. This perspective is closely related to relationship marketing, which aims at developing and maintaining profitable business relationships with the customers who are more valuable to the company [6].

In fact, there is broad agreement in the literature on the unity of opposites between creating the value for the company and delivering the value for the customer. Based on the assumption that the value for the customer is an essential prerequisite of the value for the company, the link between them, in particular, CV's financial impact on the company, has been investigated and described by a number of authors [7]. For example, the customer centricity approach of Boulding et al. is concerned with the process of dual value creation, that is, value both for the customer and for the firm [8]. In the customer-based view, both service management and marketing literature proposed that customer satisfaction and loyalty are the result of a customer's perception of the value received in a transaction or relationship, where value equals perceived service quality relative to price and customer acquisition costs and relative to the value expected from transactions or relationships with competing vendors. Loyalty creates increased profit through enhanced revenues, reduced costs to acquire customers, lower price sensitivity, and decreased costs to serve customers familiar with a firm's service delivery system.

Below, we attempt to discuss the unity of opposites of two-dimensional customer values according to the characteristics of customer value. The key characteristics include four aspects: (1) customer value is a subjective concept; (2) customer value is based on a trade-off between benefits and sacrifices; (3) benefits and sacrifices can be multi-faceted; (4) customer value is relative and comparative.

Customer value is a subjectively perceived construct. From the customer's perspective, only the customer is able to define what is valuable and what is not. Different customer segments perceive different values within the same product or service. In addition, the various members in the customer organization involved in the purchasing process can have different perceptions of a supplier's value delivery. From the company's perspective, all people may be created equal, but the same cannot be said for customers (Epstein [9]). A company must choose the

customers who have higher value according to its “subjective perception.” One company, a Scandinavian process or of timer, considers 5 attributes in identifying their strategically significant customers: economic return, future business potential, learning value, and other strategic values by providing access to new markets, strengthening incumbent positions, and building barriers to new entrants [9].

Customer value can be regarded as a trade-off between “what you get” (benefits) and “what you give” (sacrifices). From the customer’s perspective, when customers perceive greater benefits or utility than sacrifices or costs, customer value is created. From the customer’s perspective, the perceived value occurs when the perceived benefits of purchasing the product exceed the perceived life cycle cost of product. From the company’s perspective, just as the customer will evaluate the supplier’s offering, the perceived value occurs when the perceived benefits of selling the product exceed the perceived life cycle cost of supplying the product.

Benefits and sacrifices can be multi-faceted. From the customer’s perspective, the benefits, or what a consumer derives from the offering, are conceived as a combination of economic, technical, service, and social benefits. The sacrifices component, what the consumer must contribute, is sometimes described as a combination of monetary costs and non-monetary sacrifices, that is, money and other resources such as time, energy, effort. From the company’s perspective, both the perceived benefits and the perceived sacrifices arise from what the customer offers and wants. These might include the following: the purchase price paid; production costs and delivery costs; access to markets; service and servicing costs; financing costs; and disposal costs, etc.

Customer value perception is relative and comparative. From the customer’s perspective, products and services are always assessed in relation to a competing offer and/or former experience. From the company’s perspective, in a well-regulated economy, most companies compete by trying to deliver consistently better value than competitors. This means that supplier firms will only succeed in the marketplace once they offer more value to their customers compared with their competitors.

### **18.3 A Conceptual Framework of Customer Segmentation Based on Dual Customer Values**

On the basis of the above analysis, the paper seeks to offer a conceptual framework of customer segmentation based on the unity of opposites of dual customer values. It is imperative for companies to focus on tackling three closely related key points: (1) to systematically identify customer value based on company perspective and recognize strategically significant customers; (2) to clearly analyze customer value based on customer perspective and describe the gaps of customer value; (3) to comprehensively categorize customers based on two-dimensional customer values and develop the relevant marketing programs.

### ***18.3.1 Identifying Customer Value Based on Company Perspective***

The starting point is to identify the customer value based on company perspective. From the company's perspective, customer value is generally based on the profitability of customer, the potentially significant impact of customers, additional strategic analysis, and identifying strategically significant customers.

First, it is essential to understand the profitability of customer. The profitability of customer is defined as "the difference between the revenues earned from and the costs associated with a customer relationship during a specified period". There are two main approaches in which companies can calculate the profitability of customer. These are CPA and CLV. Whereas CPA is defined as "the difference between the revenues earned from and the costs associated with a customer relationship during a specified period", CLV deploys "the present value of all future cash flows obtained from a customer over his or her life of relationship with the firm". As opposed to CPA's asset valuation approach focusing on accrual accounting profits earned in the past, CLV is based on future cash flows. Both approaches share a common purpose of measuring the financial value of customer relationships for resource allocation decision making. When calculating CPA, the most important issue to consider is activity-based costing. Some customers need more management effort or "hand-holding," but others are not. Therefore, this is what makes the difference between a profitable and an unprofitable customer. When forecasting CLV, this concerns the estimation of three key drivers of CLV: (1) the propensity for a customer to purchase from the company in the future; (2) the predicted product contribution margin from future purchases; and (3) the direct marketing resources allocated to the customer in future periods. In practice, where companies have hundreds or thousands of customers, a customer-by-customer calculation of CLV is not necessarily needed. In this situation, some companies use a customer equity approach. A few key questions are used to establish the likely future revenues from a customer and estimate their costs. The most valuable customers are those that combine high lifetime revenues with low costs to serve. The least valuable is those with low revenues but higher costs.

Second, it is imperative to know well the potentially significant impact of customers. Above CPA and CLV could provide excellent estimates of the value that each customer or segment provides to the company through normal purchasing and usage. But these approaches often fail to capture the potentially significant sources of value customer can provide to the company. There are dozens of statistics we could use to illustrate the potentially significant impact of the customers. When asked what sources "influence your decision to use or not use a particular company, brand or product," 71 % say reviews from family members or friends exert a "great deal" or "fair amount" of influence. 90 % of consumers online trust recommendations from people they know; 70 % trust opinions of unknown users. Actually, there are two critical sources of hidden customer value: customer influence and customer knowledge. Customer influence refers to the influence the

customer has, either through direct or indirect behavior, on other customers, on employees, or on other stakeholders of the firm. Customer knowledge refers to the actionable knowledge that can be gained by the company, either through analyzing customer behavior or through direct customer input. Both kinds of customer impact need to be included in the value equation.

Third, in addition to the specifically analyzing tools, some useful tools for additional strategic analysis are also necessary. These tools usually operate at company-specific levels. Among the tools are SWOT analysis, five forces analysis and Boston Consulting Group matrix analysis, etc. For instance, company could apply SWOT analysis when making a qualitative evaluation of customer's strategic value. These would be customers that (1) possess relevant strengths to exploit the opportunities open to them; (2) are overcoming weaknesses by partnering with other organizations to take advantage of opportunities; (3) are investing in turning around the company to exploit the opportunities; and (4) are responding to external threats in their current markets by exploiting their strengths for diversification.

Finally, the goal of the above analysis process is to identify the customers that will be strategically significant for the company's future. Generally, these are several classes of strategically significant customers, as follows.

High lifetime value customers who will contribute significantly to the company's profitability in the future.

High-volume customers who might not generate much profit, but they can generate the economies of scale.

Benchmark customers who are customers that other customers would like to follow.

Inspirators who could bring about improvements in the supplier's business.

Door openers who allow the suppliers to gain access to a new market.

### ***18.3.2 Identifying Customer Value Based on Customer Perspective***

From the customer's perspective, customer value is generally based on the understanding of the customer value sources and levels, the key value dimensions, the customer value gaps, and transforming of customer value data.

Identifying the customer value begins with understanding the customer value sources and levels. Based on the existing research, Smith and Mark captured five key sources of customer value: information, products, interactions, environment, and ownership/possession transfer. These sources of value are created by a variety of "value-chain" processes and activities within and between organizations. Information is created by value-chain activities associated with advertising, public relations, and brand management. Products are created by value-chain activities associated with new product development, market research, research and development, and production. Interactions between customers and companies' employees are created by value-chain activities relating to recruitment and training, service

quality, and operations. The purchase or consumption environment is created by value-chain activities such as facilities management, interior design, and merchandizing. Ownership/possession transfer is facilitated by value-chain activities concerned with accounting, delivery, and transfer of ownership. Related to this is the notion of customer value levels that was introduced by Noriaka Kano. The first level of customer value is the expected level or basic value that is related to attributes that customer routinely expects in the product. The second level of customer value is the desired level that is related to attributes that add value for the customer but simply are not expected. The third level of customer value is the unanticipated or unexpected level that is related to attributes that surprise, delight, and excite customers.

It is important to identify the key value dimensions that each customer segment is seeking to fulfill through their purchase of products and services. Some attempts have been made, and Kotler's perceived value model is particularly well suited as aids for identifying the key dimensions of customer value. The customer delivered value is defined as the difference between the total customer value and the total customer cost. The total customer value is the sum of all the benefits received by the customer from the products and services. The total customer cost is the sum of all the costs that the customer paid for the products and services, including the monetary cost, time cost, psychological cost, and physical cost. In short, company should creatively design and select appropriate customer value dimensions based on understanding the innermost feelings of their customers.

The third issue of identifying the customer value is to "listen to" the innermost feelings of the customers and describe the customer value gaps. A number of methods are used to measure the customer value gaps. These include

**SERVQUAL Scale:** the SERVQUAL model, developed by Parasuraman et al., is widely used for assessing the gaps between customer expectations and perceptions (gap 5). Gap 5 is the product of gaps 1, 2, 3, and 4. The SERVQUAL scale has the ability to achieve two goals: (1) to describe the gaps between the customer expectations and perceptions in different service attributes in order to locate the factors causing customer dissatisfaction and (2) to determine the average gap between the perception and the expectation of overall service quality and compare it with the main competitors in order to gauge the overall gap.

**Personal Experience of Top Managers:** company's top managers should try to come to the front line in person to directly establish interactive relationships with customers. This will allow them to learn about the problems of the company's service procedures that have resulted in customers' inconvenience and troubles through their personal experience. The managers will ask themselves, "How can the customers feel satisfied themselves when I am unsatisfied and feeling inconvenienced or perplexed?"

**Critical Incident Technique:** this technique allows customers (internal or external) to focus their attention on particular incidents through interviews or inquiries. They will give details on their unpleasant "stories," "experiences," and "incident descriptions" during service contact. Researchers will then comprehensively analyze these incidents in order to find common points that have caused customer value gaps or dissatisfaction.

Additionally, mystery shopping, experience mapping, analyzing customers' complaints, establishing 800 toll-free lines, and after-sale surveys are all effective ways to gather customers' potential dissatisfaction or customer value gaps.

Finally, an important component in identifying customer value is to transform customer value data into a mode that may easily be interpreted and understood by management. We could consider adopting the following ways to process the customer value data:

**Descriptive Graph for Performance Gap:** using the descriptive graph for performance gap displays a simple way to track the customer value gaps. The graph not only shows customers' expectations for the relevant service dimensions or attributes, but also reveals customers' awareness about the enterprises' performance. At the same time, gap description may also be used to compare the gap between the service performances of the enterprise and its competitors.

**Weighted Pareto Diagram:** it is a specialized form of a bar chart that classifies and sorts out the collected data and arranges them in order by the occurrence frequencies (or proportion) of the classified items together with a curve of cumulative percent. To analyze customer value gaps with the Pareto diagram, we shall consider the customers' opinion on the importance of the classified items of customer value and use the weighted frequency Pareto Diagram in order to decide the order of priority for service improvement actions.

**Importance/Performance Matrix:** the vertical axis of the matrix to show the importance of value dimensions and the horizontal axis to show customers' perceived value according to customers' scores on the importance and performance of value dimensions. The matrix may not only be used to compare the gap between importance and perceived performance, but also can be used to compare the gap seen with the competitors' performance. Through comparison and analysis, we are able to acquire the basic logic for improving customer satisfaction.

### ***18.3.3 Classifying Customers Based on Two-Dimensional Customer Values***

The goal of the entire process is to cluster customers into groups so that differentiated value propositions and marketing strategies can be applied. In this model, customers are classified according to the value for the customer and the value for the company. Four classes of customer are identified as detailed in Fig. 18.1.

**Harmonious Customers:** high value perceived by customer with high value perceived by the company. Company should treat them well with exceptional service for remaining in a relationship (since they are strategically significant and attractive to competitors).

**More Valuable Customers:** low value perceived by customer with high value perceived by the company. Companies should explore ways to add additional perceived value for the customers (since they are likely to take some or all of their business to other suppliers).

		Value for Company	
		High	Low
Value for Customers	High	Least valuable customers	Harmonious customers
	Low	Disharmonious customers	More valuable customers

**Fig. 18.1** Customer classification matrix based on two-dimensional customer values

**Least Valuable Customers:** high value perceived by customer with low value perceived by the company. Company generally can attempt to reduce cost-to-serve and/or up-sell and cross-sell other products or services in order to make them up the value ladder (since they are currently unprofitable or less profitable than desired).

**Disharmonious Customers:** low value perceived by customer with low value perceived by the company. Company could increase price or limit services in order to “sack” these customers. But sacking customers needs to be conducted with sensitivity (since they may be well connected and spread negative word-of-mouth about their treatment).

## 18.4 Summary

The research investigated in this paper proves that in view of limitations of the customer segmentation models presented, it is necessary for companies to apply a specialized customer segmentation based on dual perspectives of customer value. It is imperative for companies to focus on tackling three closely related key points: systematically identify customer value based on company perspective and recognize strategically significant customers; clearly analyze customer value based on customer perspective and describe the gaps of customer value; comprehensively categorize customers based on two-dimensional customer values and develop the relevant marketing programs. Future research should focus on the effectiveness and operability of the model and examine it in empirical analysis. We believe that there is a significant opportunity for future research on this topic, and we look forward to see continued advances in the field of customer segmentation based on dual perspectives of customer value.

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# Chapter 19

## Construct and Scale of Advertising Language Image

Shixiong Liu and Yanxiong Lu

**Abstract** The construct of advertising language image is proposed by literature analysis and depth interview. As a result of empirical study, the scale of advertising language image is developed, and five dimensions of advertising language image are discovered: elegant, intimate, benevolent, interesting and sincere. The internal consistency reliability, retest reliability, construct validity, content validity, criterion validity and predictive validity of the scale are tested and verified. The usefulness of the scale is also proved in the marketing practice of Skyworth India. The results could be workable for decision making during advertising in multi-language cultural environment.

**Keywords** Advertising language image • Advertising language • Language and culture scale

### 19.1 Introduction and Literature Review

More and more enterprisers find that they are facing a complex market with language diversity as economic globalization develops. Multi-language is a common phenomenon in international marketing environment, choosing proper advertising language to improve the communication effect has become an unavoidable question. The advertising is always trying to encourage the advertisement audience to form some attitude and behavior tendency [1]. Advertising language as a kind of important expression way has significant influence on the advertisement effect. Now, the academic research about the advertising language has two angles: mainly includes the advertising media, grammar, form and so on. Some scholars deeply studied the advertising language from the perspective of culture and psychology. But throughout the relative subjects, researches on consumer's overall perception about advertising language are rare, so

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this study investigates the consumer's overall perception image and basic dimensions of the advertising language using several representative advertising languages, which can help the enterprisers manage advertising campaigns. There are two different definitions about advertising language: the first narrow view point is regarding the language and characters used in the advertising language, including all the language information. The second generalized view is that advertising language is the means and methods used in the advertisements, including voice language, music language, graphic languages, color image, dance language, plane design language, words language and so on. This paper adopted the first view that the advertising language in this paper is the language used in the advertising language.

Some scholars analyze the effect of advertising based on advertising language content with psychology on consumers impact [2]. Another school of researchers investigates language image origin from the perspective of language of origin (LOO). Warden first puts forward the concept of LOO and argues that the mechanism of action between LOO and product origin is similar [3]. Hence, the mechanism can be explained by halo effect and stereotypes. The influence of customers' purchasing intention impacted on language image has verified [4]. The studies on language users and LOO show that consumers have specific perceptive image on the given advertising language. So, it is necessary to bring the independent concept of advertising language image. In addition, how to measure specific advertising audience impression under some languages (measurement of advertising language image) becomes a basic problem in advertising language research field, and that is what this paper will solve through the scale.

## 19.2 Research Design and Implementation

### 19.2.1 *Definition of Advertising Language Image*

“Image” is the comprehensive view of people to know something after description, memory, or others which can produce association. That is, “Image” is the overall evaluation and impression about others or other things in certain conditions, and people are the authenticator and rater. Language associative mechanism theory states that the consumers can produce different associations when facing different languages, and sometimes the association is produced in the subconscious mind [5, 6]. It is visible that consumer's psychological association mechanism generated the advertising language image.

### 19.2.2 *Does the Construct of Advertising Language Image Really Exist?*

This paper tries to use depth interview method to research the real existence of advertising language image. At first, a series of open descriptive question has been designed, and then, appropriate focus and process can make the problem

**Table 19.1** 64 Primary vocabulary

Kind	Happy	Cute	Comfortable	Moderate	Humorous
Sweet	Traditional	Heroic	Frank	Witty	Concrete
Connotation	Fashionable	Noble	High-end	Reliable	Authoritative
Enthusiastic	Dynamic	Rigorous	Exotic	Accurate	Melodious
Informal	Modest	Familiar	Authentic	Charming	Interesting
Rustic	Credible	Honest	Familial	Appetency	Elevated
Real	Easy-going	Belonging	Original	Beautiful	Graceful
Friendly	Gentle	Attractive	Amazing	Associate	Hometown
Sincere	Placid	Elegant	Sociable	Funny	Verisimilar
Vivid	Bright	Romantic	Harmonious	Infectious	Lively
Rural feelings	Proud	Practical	Groovy		

more meticulous and explore further. In order to enhance the explanatory power of the theory construction, the gender, age, occupation, education, consumption role, language recognition level and native of interviewees are taken into account. Interviewees aged above 50 are not sampled, considering the understanding ability, differences of the lifestyles and advertising contraction frequency. Besides 7 Chinese interviewees, an interviewee from the United States was also sampled.

The interview results show that the advertising language intimate effect, LOO effect, regional culture and related associations with language user's image can prove advertising language exist objectively. In other words, advertising language image does exist in consumer perception and association with different regional languages in real life.

### 19.2.3 Scale Design

This paper tries to detect dimensions of advertising language image by means of developing adjectives vocabulary. The related paper was referred, and the ways of vocabulary collection have been adopted [7]. Firstly, words were extracted when the respondents described the image characteristics of language through depth interview; secondly, inductive suitable words were summarized, which can describe advertising language image through analyzing the related paper about linguistics, marketing, psychology and so on; thirdly, the researchers consulted "Chinese big dictionary" and advertising research companies to gather words, preliminary reported 159 adjectives; fourthly, three marketing masters assessed the 159 words, respectively, and deleted the unsuitable words; finally 64 primary vocabularies have been obtained as shown in Table 19.1. The scale design adopted likert five-point scale.

### 19.2.4 Language Selection for Research

Because of the resources limitation and empirical maneuverability, this paper selected five high representative languages: English, French, Korean, Hindi and

Mandarin. Principles for selection include popularity of language, as well as cultural and economic features.

## 19.3 Data Collection, Analysis and Results

### 19.3.1 Data Collection

The research uses the investigation method, in all grants 700 questionnaires in the public place in Shenzhen, China, and acquires 650 effective questionnaires; the effective return ratio is 92.9 %. The sample demographics such as gender, age, education background conform to “China’s population and employment statistics yearbook in 2010” released by China’s National Bureau of Statistics. The respondents include staffs, civil servants, self-employed entrepreneur, business owners, teachers and students. The share of each language is not significantly different.

### 19.3.2 Data Analysis

The researchers analyzed the effective sample and found that factor loadings of 16 items are less than 0.4 and two-factor loadings of 9 items are greater than 0.4, so 25 items have been deleted. After that the rest of the 39 items for overall reliability analysis and the Cronbach’s  $\alpha$  value is 0.971, it shows that the data have good internal consistency and the rest of items can be used for the following factor analysis [8].

At first, adaptability test of the scale formed by the remaining items shows KMO value of  $0.975 > 0.9$ , and Bartlett coefficient test showed that its value is  $0.000 < 0.05$ . Comparing with the foreign psychology research, this resolution can accept. At the same time, the items should be deleted if their factor loading is less than 0.4 or in two-factor loading values are greater than 0.4 and finally retained five common factors.

The first common factor includes 13 vocabularies: noble, elegant, attractive, high-end, fashionable, romantic, connotation, beautiful, authoritative, reliable, groovy, gentle and graceful; this 13 vocabularies factor can best be summed up by “elegant” which reflect the characteristics related to language image; the second common factor includes 9 vocabularies: rural feelings, belonging, hometown, easy-going, real, proud, original, lifelike and familial; this factor can be named “intimate” which reflects the intimate characteristics of language image; the third common factor includes 8 vocabularies: cute, happy, vivid, comfortable, moderate, kind, sincere and friendly; this factor can be named “benevolence” which reflect the benevolence of language image; the fourth common factor includes 5 vocabularies: interesting, funny, infectious, associate and charming; this factor can best be summed up by “Interesting” which reflect the interesting of language image; the

fifth common factor includes 4 vocabularies: heroic, frank, concrete and traditional; this factor can be summed up by “genuine” which reflect sincere language image.

The scale has better convergent validity and discriminant validity because of the items-factor score is between 0.61 and 0.82 and the cross-factor loading is small. In order to further define the credibility and explanatory power of this scale, the reliability and validity of the above 5 dimensions will be test again.

### ***19.3.3 Reliability Test***

The statistical results show that Cronbach's  $\alpha$  of each dimension is between 0.85 and 0.95, suggesting the scale reliability is good. And the AVE values of each dimension are between 0.44 and 0.52. The CR values are greater than 0.7. Therefore, the reliability of the scale is acceptable.

### ***19.3.4 Validity Test***

The items are all extracted through grounded theory based on referring to the domestic and international research findings; five enterprise management graduate students and five marketing experts revised the items, so the scale has good content validity. In addition, 30 test objects were interviewed before the official investigation, and the interview results suggest that all objects can properly understand the scale and the question and show that the face validity of this scale can be accepted.

LISREL 8.70 is used for confirmatory factor analysis. The results are ideal ( $\chi^2/df = 3.48$ , RMSEA = 0.062 (<0.08), GFI = 0.84, AGFI = 0.83, NFI = 0.90, NNFI = 0.92 and CFI = 0.92). Criterion validity was tested by expert advice which has used in the research of brand experience dimension. Three Chinese marketing doctors judge the image belonging, respectively, and they have the same judgments on French, Hindi and Mandarin and suggest the language image is “elegant”, “interesting” and “intimate.” This conclusion meets the statistic results: French has the highest score in “elegant” ( $M = 3.86$ ), Hindi has higher score in “interesting” ( $M = 2.94$ ), and Mandarin has the highest score in “intimate” ( $M = 4.26$ ). It shows that the scale has good criterion validity.

In order to test predictive validity, the researcher designed some advertisement experiments to test the influence of advertising language image on brand personality. Three print advertisements have been made with Sichuan television advertising producers' assistance. The brand name of advertisements is “Brahman ancient emperor” which is only a fiction. “Special characters, special life,” the advertisements say. French advertising message was translated by a French professor in Sichuan University and Hindi advertising message by the local marketing manager of Skyworth Group India branch. French group, Hindi group and no advertising message group were gathering effective sample of 91, 100, 97, respectively. This

research prefers the sophisticated subscale to test predictive validity of advertising language image. The results shows that all the participants can not only understand the meaning of the Ads, but they also can give different judgments about products brand in Ads after they were told that the advertising languages are French, Hindi and no message separately. The scores for “sophisticated” of brand personality are as follows:  $M_{\text{French}} = 3.43$ ,  $M_{\text{Hindi}} = 2.80$ ,  $M_{\text{no}} = 3.15$  and,  $F(2, 285) = 13.87$ ,  $P = 0.000 < 0.001$ . It shows that advertising language image does affect brand personality. This conclusion is similar to some researches [9].

### **19.3.5 Reliability and Validity Retest**

To retest the reliability and validity of the scale, the researchers made the questionnaire with the rest 39 keywords, and 340 valid questionnaires were collected. The internal consistency analysis shows that the Cronbach's  $\alpha$  value of the five dimensions is still greater than 0.8. After the CFA results show that  $\chi^2/\text{df} = 2.86$ , RMSEA = 0.062 (<0.08), NFI = 0.96, NNFI = 0.97 and CFI = 0.98, which indicate the results are ideal. To further test the test-retest reliability, the researchers send the same electronic questionnaires through e-mail address left in the valid questionnaires one month after the investigation. These respondents are asked to refill and send back the questionnaires. Statistics show that the correlation coefficient of the total scales was 0.78 of two surveys, which indicates the scale has good test-retest reliability. In order to improve the external validity of the scale, the researchers questioned 300 students' perception image to German, Spanish, Arabic and Vietnamese, and 289 copies of valid questionnaires have been got. Statistical analysis found that the Cronbach's  $\alpha$  value of the total scale is 0.94. The CFA results also show that the scale is relatively stable: the  $\chi^2/\text{df} = 2.93$ , RMSEA = 0.07, NFI = 0.88, NNFI = 0.91, CFI = 0.92 and GFI = 0.90.

## **19.4 Conclusion, Discussion and Management Enlightenment**

### **19.4.1 Conclusion and Discussion**

This paper first reviewed the related theory about advertising language and image through literature study, and put forward construct of advertising language image. And after data collection through depth interview and data analysis with grounded theory, the results have demonstrated that language image existence and rationality as an independent construct. Finally the five dimensions of advertising language image are discovered: elegant (noble, elegant, attractive, high-end, fashionable,

romantic, connotation, beautiful, authoritative, reliable, groovy, gentle and graceful), intimate (rural feelings, belonging, hometown, easy-going, real, proud, original, lifelike and familial), benevolence (cute, happy, vivid, comfortable, moderate, kind, sincere and friendly), interesting (interesting, funny, infectious, associate and charming), genuine (heroic, frank, concrete and traditional). The reliability, content validity, criterion validity, predictive validity and external validity of advertising language image scale are proved.

Recently, there are abound of results in the academic circles of advertising language; however, it is still the tip of the iceberg. For example, the background of this paper is Chinese culture, and the cross-culture adaptability of the scale needs further study. It discussed the dimensionality of advertising language image, but excluded the relationship between each dimension, which is a worthwhile topic. The blank research area includes a number of topics, such as the source of the advertising language formation, the change of advertising language image and the source research, the relation research between advertising language image and other marketing variables.

#### ***19.4.2 Marketing Management Insight: Advertising Practice of Skyworth Company in India***

In 2011, Skyworth Group marked its first major overseas venture, firstly targeted the Indian market. India is a typical multi-lingual consumer market, and there are 33 kinds of languages. For the first time access to such a complex multi-language market, Skyworth (India) Electronics Co., Ltd feels the unprecedented challenges. The company managers boldly accepted the research proposals: to the 30 Indian employees and dealers using advertising language image scale to survey their perceived image to English, Chinese and Hindi. The research shows that the “Close” dimension of Indian is highest rated ( $M = 4.46$ ); and English gets the higher scores among the five dimensions of language image ( $M = 3.51\sim4.27$ ); while Chinese gets the relatively lower scores ( $M = 2.13\sim2.95$ ). The possible explanations for the above results are Indian long-term English education and ordinary Indians’ little known about Chinese culture. According to the research conclusions, Skyworth managers decided to use English and Hindi in the national marketing communication campaigns and appropriately use regional dialects of India in some regional advertising and promotional activities. After one year of the marketing operation, the advertising strategy has been proven to be effective: the Indian consumers of target markets have gradually accepted the Skyworth brand, and the company operations have basically made ends meet. Skyworth’s marketing strategy in Indian shows advertising language image scale can be used as assistant measurement tools for marketing decisions of multi-lingual culture.

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# **Chapter 20**

## **Undergraduate Employment Situation Analysis**

**Pan Yang**

**Abstract** Undergraduates are facing the severe employment situation, analyses the causes of the difficulty of college students' employment, from the students themselves and adjust to the reform of the government, university, department of job duties in graduate obtain employment, it puts forward the countermeasures to solve the college students' employment.

**Keywords** College students • Employment situation • The reform

### **20.1 Introduction**

In recent years, Chinese university graduates quantity increased year by year, college students are facing the severe employment situation, coupled with the current financial crisis, the obtain employment of graduates by unprecedented challenges, college students in employment after graduation can be successfully, the whole society has become the focus of concern [1, 2]. College students to solve the problem of employment is the immediate interests of the college students, the more related to social harmony and stability, needs the government, enterprises, universities and college students' common efforts. Once upon a time, is known as "favored" of college students looking for a job is "the emperor's daughter not sorrow to marry", but now this superiority a few do disappear, facing the employment but frowned. In 2006–2007 college students' employment situation, for example, in 2006 China university graduates 30 % didn't find work, is more than 120 college students leave school in not obtain employment, in 2007, 1 million or so graduates not achieve the employment, to China tens of thousands of migrant workers and laid-off again obtain employment personnel, even if the government provide 9 million jobs a year, still can't better solve the employment problem. Generally speaking, university student's employment prospects are not optimistic.

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## ***20.1.1 The Causes of the Difficulty of College Students' Employment***

### **20.1.1.1 Graduate Employment Unbalanced Structure, Supply and Demand Contradiction**

College graduates of the overall supply and social needs of the contradictions, essence is the rapid development of higher education and social development and economic development in transition are not supplied contradiction.

First, China is in peak population, there is a lot of new Labour need to obtain employment. “China has a population of nearly 1.3 billion, big population base, the rapid increase of new workers, far more than economic growth to create jobs, the speed of the national labor resources by 5 years before the 1990s the average new 12.5 million people expected to reach 1996–2010 new 14.5 million people on average, the future of the natural growth of labor resources every year can build two hainan province for university graduates employment, this has certain influence” appeared sharply increased the number of graduates, and employment growth and the economic growth and employment growth out of difficult situation.

Secondly, as China's higher education development, in a few short years, higher education entered the popular era. The higher education popularity has become a necessity, but some questions also from this bring, education popularization asked China to average college enrollment on a large scale, and enrollment expansion is one of the direct results of the rapid growth of college graduates. “2002 national ordinary high school graduates 1.45 million, 2003 2.12 million, 2004 2.8 million, 2005 will be more than 3 million in society, human resources needs no significant growth, under the premise of this amount of change on the influence of the graduates' employment is great, college students' employment from the elite to mass.”

Third, the social development area in balance, the more developed eastern region for graduates to provide a good living environment and a good return the development prospect, become talents input province. In these area talents competition is intense; many students failed to effective employment, even in unemployment also don't want to go to the western region employment. In the west, but there are a number of graduates find jobs.

### **20.1.1.2 College Students' Own Problems Brought About by the Difficult Employment**

First is a college student untimely professional value orientation and employment idea is causing the college students employment difficult important reasons. College students as a recognized elite, traditional Confucian thought of up “elite complex” deep tied their ideas. “Beijing social economic science research institute of contemporary university students' employment status study group” in the

China education newspaper published their investigation, college students present their ideas in the unit, the choice of choice: scientific research structure, party and government group, domestic and foreign enterprises accounted for 63 % of the total number of town enterprise and the choice, schools, the collective enterprise, only 7 % in the region, the choice of the big cities, the choice is 20.8 %, and the choice is small towns, and rural areas, and only 5 % in the three young and old [3]. Secondly, college graduates their comprehensive quality is not high, the ability to adapt to society is poor, difficult to meet the requirements of the employing unit. Some students in the school only satisfy the courses, lack of extensive knowledge accumulation and the ability of solving practical problems, and language ability is insufficient, apply for occasions tension, cowardly, cannot show yourself, thus missed many jobs. In addition, college students in employment, the lack of a clear orientation of their own, 'lack of purpose also resulted in success rate is not high.

#### **20.1.1.3 The Employing Unit Blind Set Conditions Brought Difficult Obtain Employment**

One of the main obstacles is experience, a lot of the employing unit especially enterprise frequently required job seekers 2–3 years of work experience, and many fresh graduates often because of lack of actual work experience to implement work. In addition, some choose to improve the employing unit blind standard, the pursuit of highly educated. Quite a few on the unit of choose and employ persons exist in contempt practice and the tendency.

#### **20.1.1.4 College in Their Own Development of Some Problems Existing in the Process also was Disadvantageous to the College Students' Employment**

Some of the school education methods and concepts backward, no market consciousness, professional setting and the market demand for the seasons, college students major in not with the market demand, the emergence of a structural contradiction of supply and demand. In addition, some universities graduate employment to the attention of not enough, employment work also the lack of systematic and scientific, employment the work often before graduation just undertakes, obtain employment guidance is simply a kind of professional introduction, and to some extent or from the actual generalized. The investigation shows, very need of career guidance for the college graduates employment guidance institutions understanding of how, which is very different degree of understanding and understand better only one third of the people, 10 % of the people don't know that school has such institutions [4]. This explains university vocational guidance work and very big play space.

### **20.1.1.5 Social Barriers, the Job Market Segmentation Reality Increased the Difficulty of the College Students' Employment**

In recent years, graduates self-dependent career choice already into the mainstream, however, some factors such as census register file is still stumbling block of college students' employment. Many college students looking for work are "not this city account no-go" painful experience, with no employing unit seat registered permanent residence, college students and many good job opportunity missed.

China's college student's employment is difficult situation of a variety of factors, to solve the social problems, must bring a variety of strength, made various efforts.

## **20.2 The Countermeasures of College Students' Employment Difficult to Solve**

### ***20.2.1 Adjust the Students Themselves and Hard Work***

First, changing employment idea, set up the new period is concerned. College students should abandon the reality "social elite" complex, sets up the popularization of concerned. At present there are many free position in society, small cities, in the countryside, etc. are in urgent need of talents, small businesses, private enterprise, also there are a lot of employing requirements; College students still should set up the consciousness, career consciousness and struggle consciousness, to a primary exercise myself, mining potential, still can look to the west, the western region to do exercise; Gradually set up "employment first, selection and entrepreneurial" career choice strategies, from reality to choose their own way of application. Second, improve their own quality, grasp the initiative employment. Faced with the severe employment situation, graduates of individual character, ability, expertise and team spirit will be leading the students' of important factor. Balance is the rule of market competition system, college students only by constantly improve their own quality, master of excellent skill, can obtain employment competition in seizing the initiative, for my ideal position. Third, start their own businesses, and rely on their own strength solving the employment problem. College students in certain conditions, find business opportunities, play good at something, go start their own businesses, and seek occupational to road, and in solve their employment, but also for society to provide the new employment channels, easing the employment pressure.

### ***20.2.2 University of Reform***

First, the college should according to the market demand, and rationally adjust the subject structure and professional setting, the society, and the market in

running schools. Adjust specialties, and to that of the recruit students, graduates employment trends of combination, increase of enrollment of professional society needs, and the teaching quality is not high, professional setting not reasonable schools and professional, reduce the number of recruit students, until the stop recruit students. Second, strengthen the employment of the graduates. The employment of college graduates department and the corresponding management personnel should be to strengthen college students employment guidance, and will obtain employment guidance work throughout the whole study of college students' career, but not limited to the rear of the graduates. Third, set up a high-quality, professional obtain employment guidance team. This requires engaged in college students' employment guidance to the full-time personnel specialized training, improve business level and comprehensive quality. At the same time, positive absorption has the psychology, sociology, education, information the expertise of the teacher added to obtain employment guidance team. Fourth, the employment as the guidance, quicken the pace of the education and teaching reform. Adjust its internal school teaching content and teaching methods, change the past heavy theory, light practice, heavy knowledge, light ability training mode, with professional characteristics open, strong practicality course, and make students with solid professional knowledge. At the same time pay attention to the social development of composite talents, to strengthen the cultivation of students' comprehensive quality.

### ***20.2.3 The Government Department in the Employment of the Graduates of the Duty***

First of all, policies and regulations, to perfect the employment market system. Governments at all levels should from the normative to the job market, establish and perfect the laws and regulations, and gradually put the graduate job into legal system and standardization of the track. Should also continue to improve the graduate employment policy, eliminate employment discrimination, deepen the personnel, household registration and related employment system supporting reform, break because the household registration system caused by market segmentation, regulating the employment market. Second, strengthen macro-control; promote the rational flow of talents. Countries should take the necessary measures for macro adjustment; try to be the necessary administrative, economic means to realize the talents rationally. Encourage college students in the west, in the western regions of China permanently. Still should see China's basic lack of talented, there is a lot of employing demand, the country is also should formulate the relevant policies and encourage the students to realize in the employment, do exercise. In addition, the government also shall establish college graduates unemployed security and training system. Graduates is China's precious human resources, graduate unemployment is a huge waste of talent. From the point of view of government, should

formulate the relevant laws and regulations and will not obtain employment of college students and unemployed college students into social unemployed personnel category, and give the corresponding relief. Such already can maintain social stability, and reflect the country “respect knowledge, respect the talent,” policy. At the same time, according to the actual timely graduates employment, targeted to organize all kinds of training class, the improvement of the employment guidance, a rise in unemployment the graduates’ competitiveness.

Believe that through the college students and the joint efforts of the whole society, college students the problem of employment must be able to properly solve, college graduates must realize full employment. College graduates as China’s large population and a large team of active in labor productivity, in their work, will be for the socialist modernization to make due contributions!

## 20.3 The Student’s Own Effort

### ***20.3.1 Improving the Planning and Learning Ability, Improve Employment Ability***

Planning learning ability namely college students should according to the career development tendency, and combined with the needs of the development of the individual, choose to study content, learning methods or way of ability. And, this is a long-term activity, college students must understand learn what, when, where they learn to learn, etc. Too often reflect on the knowledge structure of the now whether now or in the future can be qualified for the job soon. Only in this way can we know learning requirements, control the learning process, and adjust their learning method, flexible to him in the complex environment, finally make learning activities to achieve the desired objectives.

### ***20.3.2 Do Their Career Planning, Improve Employment Ability***

A university student once to define their own ideal career will be based on planning his career goal of the study and practice, and to obtain ideal career do positive preparation. Self analysis that is, through the methods and means of cognitive science, to his own interest, temperament, character and ability of comprehensive analysis, and the knowledge of the advantages and features, disadvantage and inadequate. Job analysis is to point to in the career planning, fully consider the career of the regional, industry and jobs such as sex characteristics, such as professional own industry’s status and prospect of professional post to apply for a job person their own quality and ability of the requirements, etc. The third, and build a reasonable knowledge structure. According to the professional and social

development of the specific requirements, the existing knowledge scientific restructuring, construct the rational knowledge structure, and maximize the overall efficiency of knowledge. Fourth, the cultivation of professional needs ability of practice. In addition to construct reasonable knowledge structure outside, they need to have basic skills in this post and professional ability. College students only will be reasonable knowledge structure and the application of the social needs of the various ability unifies, can be in an impregnable position.

### ***20.3.3 Improving his Social Adaptation Ability, Improve Employment Ability***

Though the university is a “small society”, the school and the society operation rules but very different. Many college students in the opinion of socialism tend to be simplistic, one-sided and idealized. Some enterprise in choosing and employment of university graduates, the same conditions, often preference will be given to those who have played in the social practice, has certain organization management ability and don’t choose the graduates the undergraduate of lack of work experience and life experience. This needs students in employment before it pays attention to the cultivation of their own adapt to society, the ability in the society.

### ***20.3.4 Cultivate Good Psychological Quality, and Improve the Employment Ability***

In recent years, college students’ suicide, murder incidents. This had to strike our warning: of psychological health of college students need to pay attention! And college students in the study, pay attention to the professional knowledge, ignore the psychological quality of the situation, make some people in face puzzled or in adversity, always at a loss and affect your choice of employment. Especially in the job search process, some students tumbled resistance ability difference; this is also one of the reasons the college students’ employment difficult. Therefore, in the process of college students’ studying attention should be paid to improve psychological quality, especially in daily life note exercise their indomitable character; In the process, fully understand the employment information, cool, calm to deal with the problems, with positive sense of optimism overcome all difficulties.

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**Part III**

**Control Engineering and Applications**

# **Chapter 21**

## **A Study on Flood Disaster Risk Vulnerability Assessment and Warning Monitoring System**

**YuRong Yu, Hua Xiao and Wei-Chen Hao**

**Abstract** Flood disaster assessment system and warning monitoring are of great complexity, including a variety of uncertainties, such as stochastic, fuzzy, gray. In this paper, the risk vulnerability assessment and warning monitoring analysis have been introduced systematically and have been studied for characteristics of flood danger, vulnerability and flood control program optimization in flood fields. Flood disaster system is a multi-level, multi-index and complicated system with a lot of uncertainty. Risk vulnerability assessment is used for calculating the index subject in the paper. On the basis of analysis of the current Chinese flood disaster mitigation efforts in flood prevention research background and current situation analysis of the status quo, the paper points out the existing problems of current China flood control and disaster mitigation and the importance of flood control program optimization.

**Keywords** Flood disaster • Risk vulnerability assessment • Warning monitoring system

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## 21.1 Flood Disaster Risk Vulnerability Assessment System Analysis

According to the theories of natural disasters risk analysis at home and abroad, and based on the system characteristics of flood disasters, we define the agricultural flood disasters vulnerability as: in a certain mode of agricultural production and socioeconomic background, specific regional agricultural system is sensitive to the properties of the flood threat, and it is effected jointly by natural environmental factors and agricultural socialemconomic factors. Agriculture flood disaster vulnerability analysis is divided into several steps: Step 1: qualitatively analyze the factors which affect the vulnerability of agricultural flood disasters; Step 2: establish the index system of quantitative evaluation of agricultural flood disasters vulnerability; Step 3: define the threshold and scoring criteria of the evaluation rating; Step 4: calculate the weight of the evaluation index; Step 5: use the weighted model to calculate the vulnerability of agricultural flood disasters in the relevant affected areas; Step 6: divide the vulnerability ranks of the agriculture floods in affected areas and use GIS technology to analyze the law of the geographic distribution of the vulnerability of China's agricultural floods and on this basis, GIS technology is used to zone the vulnerability of agriculture floods. Under the guidance of the above theory, we should further improve risk assessment and also study in detail the following aspects. First, the assessment model is established [1].

- (1) Data selection, this study selected the 1971–2006 daily rainfall data. The province's city and county crop planting area, crop flood-afflicted area, crop flood-inundated area and flood cut grain output data come from the Hunan Agricultural Statistics Yearbook (1990–2006).
- (2) Modeling indicators, which include the following.

### A. The afflicted rate

The afflicted rate is the ratio of the flood-afflicted area accounted for the planting area,  $P_s = S_s/S$ , where  $P_s$  is the afflicted rate,  $S_s$  is the afflicted area, and  $S$  is the planting area.

### B. Disaster rate

Disaster rate  $P_c$  is the ratio of drought and flood disaster area, and  $S_c$  is accounted for the planting area,  $P_c = S_c/S$ .

### C. Rainfall variability

The variability  $V$  of rainfall  $R$  from April to June over the calendar year is closely related to flood, so we take the rainfall and the average ratio as variability.  $V = R - \bar{R}$ , where  $R$  is the rainfall from April to June, and  $\bar{R}$  is the average rainfall during the same period of  $R$  over the years.

#### D. Disaster vulnerability

To define the disaster vulnerability, E is a very complex issue, and it involves not only the resilience of the crop itself but also the local water conservancy facilities, farming technologies, soil properties, topography and so on. To simplify the calculation procedure, we take the disaster area and the afflicted area ratio as the disaster vulnerability.  $E = Sc/Ss$ .

#### E. Calamity loss rate

Calamity loss rate F is the impact of droughts and floods on agricultural production, and now, it is mainly reflected in the level of yield loss. After studying, we find the floods mainly affect rice yield, so we can take disaster rate as the calamity loss rate.

- (3) Using evaluation model, to unify the dimensions, we normalize the afflicted rate, disaster rate, rainfall variability, disaster vulnerability and calamity loss rate of Hunan Province over the years and integrate them and attribute the weight coefficient according to the extent of the effects of disasters, thus to get at the disaster risk degree W and to assess the degree of risk of the droughts and floods over the years.

Secondly, the outcomes are obtained and analyzed. (1) The time distribution of the agriculture floods risk is obtained, through the calculation of the above model, and the flood risk changes of one area over the years are obtained.

Through the above theoretical analysis and examples, we can see, using agricultural risk vulnerability assessment subsystem can help us to very clearly understand the factors which affect the severity of floods, such as natural environmental factors including climatic factors, soil erosion degree, the condition of soil and vegetation, water type distribution and topography features, socioeconomic factors including the peasant per capita income, water conservancy facilities, population density and agricultural output. These different factors have some degree of impact on the formation of the flood disaster vulnerability; an area is often led by one or some factors; we can attribute the proper large weight to such factors when we analyze the disaster-caused vulnerability, so that our evaluation index system will have a high pertinence, and the disaster vulnerability divisions provide a sufficient basis for flood disasters analysis.

Agricultural risk vulnerability assessment subsystem is equivalent to an analysis model, when the flood is in the formation process, and the range of values of some factors must be different from that of quantized values in normal index system, but the system uses these different factors to do multi-faceted analysis; if the anomaly differs significantly, we transfer the data results to the early warning and monitoring system to carry out emergency flood prevention. Since the vulnerability of agricultural floods is affected by a number of factors, and the various factors are dynamically changing, the vulnerability of agricultural floods needs to be constantly explored to fix the index systems and reference systems and to improve subsystem operation.

## 21.2 The Analysis of Flood Warning Monitoring System

Taking advantage of the latest collection (integration) forecasting technology and area rainfall forecasting technology and combining with the hydrological flow and flood level forecasting model, we can develop the main river basin flood warning monitoring system; based on the qualitative and quantitative meta-syntheses principle, we study the comprehensive analysis method for flood flow and water level forecasts and provide accurate, objective, reliable flood warning information and hydrological, meteorological services information required by flood control decision making to the flood control decision-making system whenever necessary, and this is significant for improving weather forecasting decision-making efficiency and enhancing the river basin flood monitoring and warning capability [2].

The process of designing the subsystem functions is as follows. First, the main function of the system is cleared, and the functions of warning monitoring system include real-time monitoring automatic weather station data, radar-estimated precipitation products and timely warning, providing relevant flood parameters of main water system reservoirs. Second, the scientific warning theory is used. The decision theory is used in the modeling and evaluation of main river flood forecasting, and the response system is a very important sign in the process of flood control modernization; decision theory provides a great scientific support for the instantaneous flood warning system design. Therefore, in the flood warning and monitoring subsystem, focus on the use of decision theory and its appliance show the following three features:

- (1) Multi-objective decision-making techniques are used for planning and operating flood warning system. Bayesian theory has been widely used for the study of local flood warning system.
- (2) Bayesian theory provides a methodological framework and mathematical tool for the modeling of warning system of sudden flood areas. These models can be used to further improve the decision schemes of optimizing sending alerts and quantitatively evaluate the running of system and calculate the expected economic benefits of the system. The flood warning system can be divided into three parts of the monitoring, forecasting and decision making. The performance of monitoring part is determined by the diagnosis and the reliability parameters. Flood features are mainly determined by the peak height and the time that the peak reaches before forecasting; in the flood peak forecasting process, the characteristics of forecasting part are determined by a set of likelihood functions of actual peak. The characteristics of decision-making part are determined by the adverse function which is used to quantify the relatively unfavorable factors of flood results (such as property and loss of life) in order to provide an expected standard for the final decision.

Therefore, according to the above, the subsystem's design guidelines include the following: A. establish the historical rainfall of river basin meteorological stations database; B. establish the historical flood of rivers database; C. establish

the relational schema of rainfall and water level of river basins; D. establish the forecasting model of flood discharge of river basins; G. establishing the forecasting model of the water level of the reservoirs in river basins and the amount of water flew to reservoir; E. interdisciplinary, cross-industry, combine the hydrological prediction model and weather forecasting model to establish the basin flood monitoring warning system, and by developing the display software, the visualization of river basin rainfall and flood warning information products is realized, and it makes use of the geographic information developing function to realize the visualization of flood warning geographic information of the most dense tributaries which are observed by autostations along the main rivers. During the specific process of realization, the basic warning and monitoring analysis are made.

- (3) The analysis of designed flood and designed rainstorm amount analyzes the designed rainstorm amount and flood flow coefficient that is flood flow with different designed frequencies, and calculates the coefficients of flood amount with different designed frequencies.

### 21.3 Problems and Risks

The world is divided into two sides; floods bring us the inevitable loss, but they are not always presented to us in the form of destructive characteristics, and this is a gift which is excessively packaged by God.

If we can avoid the destruction that the floods bring to agriculture and even to all sectors of society to the greatest extent, and on this basis, we “inspire and guide” the floods and take advantage of the huge hydropower generated by the flood process and save and collect abundant water resources, thus to adjust the imbalances of the distribution in time and space of the water resources and to regulate the local climate and to achieve a true sense of changing the harm into benefit [3].

The ultimate goal of production and design of any system is to solve the problem, and changing the harm into benefit is the highest pursuit in the notion, but in the actual process, a variety of systems are needed to be used comprehensively for solving the fundamental problem. Here, we mainly take two aspects, engineering measures and non-engineering measures, into consideration; from the perspective of engineering measures, it involves the construction of the reservoir dam, 3S's information capture and the accurate operation of the decision-making system and so on; the cost of disaster control construction and media carriers is very large, and their technical requirements are very high; the maintenance and operation are difficult, and this requires that the subject of the facility not only has strong material and financial resources but also master the advanced science and technology to ensure the safe, scientific effective operation of the system. From the perspective of non-engineering measures, ecological harmony is a very important main line, and from the simple behavior of returning farmland to lakes, we can see, flood control is an integrative process of civilization; to overcome floods, we need to start from the detail behavior of ourselves and emphasize the harmony and unity of man and nature.

## 21.4 Conclusions

To solve the urban flood disaster problem has been the urgent matter of many cities, in which one of the basis is to evaluate the flood risk. To solve monitoring decision in flood disaster system evaluation, we propose risk evaluation methods and flood disaster system evaluation problems. The above risk assessment can apply into practical flood disaster emergency systemic evaluation, and the result presents that going deep into flood disaster risk vulnerability assessment and warning monitoring system research can reveal the complex feature of flood disaster system and contribute to develop and consummate the evaluation theory of flood disaster system. It is the new direction of system engineering development, which takes on wide application prospect.

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# Chapter 22

## Online Regenerative Braking Predictive Control for Hybrid Electric Bus

Hu Yanqing, Bin Yan, Zhang Shumei, Ting Yan and Lin Yang

**Abstract** Regenerative braking is an effective approach for electric vehicles to reduce fuel consumption and emission. In this paper, we propose a novel online regenerative braking predictive control strategy for hybrid electric bus. Together with the real-time model estimated vehicle mass and road load force, and model recognized distribution information of the bus stations and traffic lights, the strategy can predict the coming deceleration and control regenerative braking appropriately before the driver starts friction brake. The simulation results show that the approach is effective to improve the energy recovery and help to smooth the vehicle decelerating process.

**Keywords** Hybrid electric bus • Regenerative braking • Predictive control

### 22.1 Introduction

During these years, there is a huge attention for low emission and independence to the fossil fuel energy sources to decrease global warming. According to [1], 39.2 % of total emissions in 2007 raised from transportation. Electric vehicles are supposed to be realizable way to reduce carbon emission and the dependence to fossil fuel energy.

Regenerative braking is an effective approach for electric vehicles to reduce the fuel consumption and emission. GAO et al. proposed three strategies: ideal braking distribution curve, optimal energy regeneration and parallel distribution strategy to calculate regenerative braking force [2], and Jie Yao and Zhang lingming assumed fuzzy logic control strategies [3, 4]. H. Yeo et al. presented regenerative braking strategy to make maximum use of the braking energy [5].

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As for city buses, the distribution of bus stations and traffic lights of a certain bus line is fixed. When the bus arrives at the next station or traffic light, it can be expected that the bus will decelerate. If the electric motor can start the regenerative braking appropriately before the driver starts the friction brake, there would be more energy been recovered, and the vehicle deceleration process can be smoothed. Based on this idea, we design a novel regenerative braking controller to optimize the deceleration process of hybrid electric buses.

## 22.2 PHEV Powertrain Configuration and Model

In this paper, a medium-sized parallel hybrid electric bus is selected as an example. The engine and electric machine are situated in front of the gearbox and run with the same rotational speed, see Fig. 22.1.

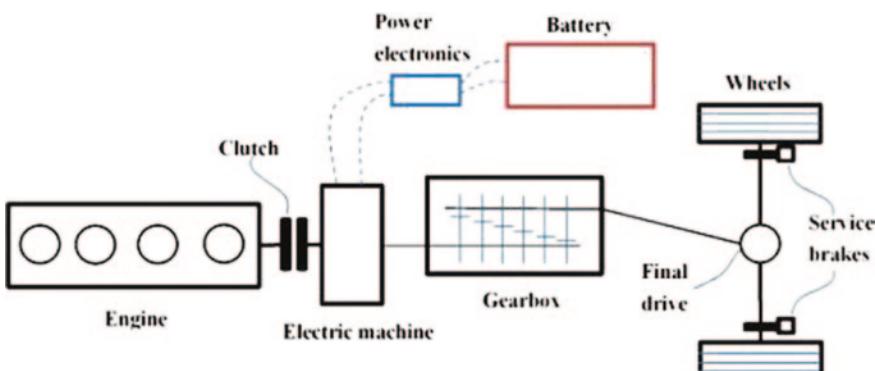
The mover of the bus is a diesel engine with a maximum power of 150 kW and an electric machine with a maximum power of 50 kW. The vehicle's road load force is described by:

$$F_{rl}(t) = f_r mg \cos \beta(t) + mg \sin \beta(t) + \frac{1}{2} \rho A_f c_d v^2 \quad (22.1)$$

in which  $m$  is the vehicle mass,  $v$  is the vehicle forward velocity,  $\beta$  is the road angle,  $g$  is the gravitational acceleration,  $f_r$  is the rolling resistance coefficient,  $A_f$  is the front area,  $\rho$  is the air density, and  $c_d$  is the drag coefficient.

The longitudinal vehicle dynamics are described by a force balance at the vehicle wheel:

$$m_e \frac{dv(t)}{dt} = F(t) - F_{rl}(t) \quad (22.2)$$



**Fig. 22.1** Schematic overview of the drivetrain components

Here,  $m_e$  is the effective vehicle inertia including the rotational inertia of the driveline, and  $F$  is the resultant drive force of the engine and electric machine.

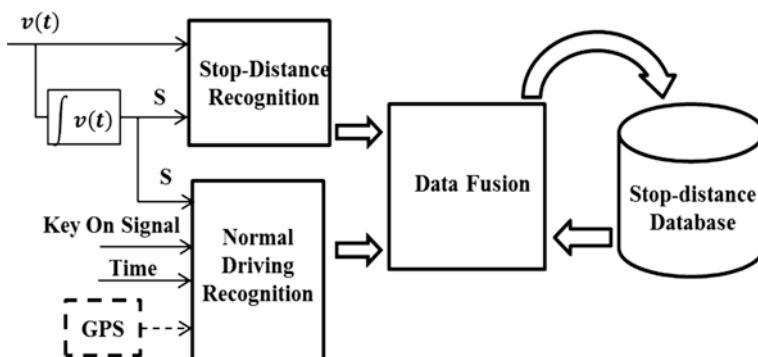
### 22.3 Bus Stations and Traffic Lights Distribution Recognition

When the bus is operating on the bus line, braking is usually caused by traffic congestion, traffic stoplight and bus stations. The distribution of the bus stations and the traffic lights is fixed. We build a distribution recognition model, see Fig. 22.2.

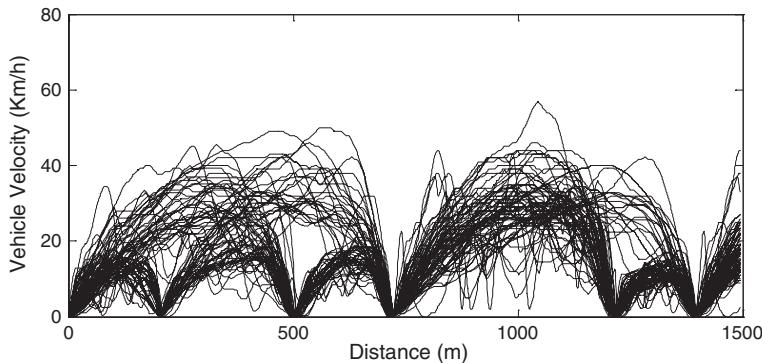
The “Stop-distance Recognition” module records the real-time velocity of the vehicle and transforms velocity versus driving time pattern into velocity versus driving distance pattern. The bus line 1 of Suzhou is taken as an example. Using the “Stop-Distance Recognition” module, we build the velocity–distance trajectories. Figure 22.3 shows the results of a driving distance about 1,500 m for many driving cycles.

The “Data Fusion” module recognizes the vehicle parking position and builds a “stop-distance” database by using data from the “Stop-Distance Recognition” module. We use a probability statistical analysis method to recognize the stop-distance record and save their information as a “Stop-Distance Database.” According to the velocity trajectories shown in Fig. 22.3, the model can build a distribution map, which is shown in Fig. 22.4.

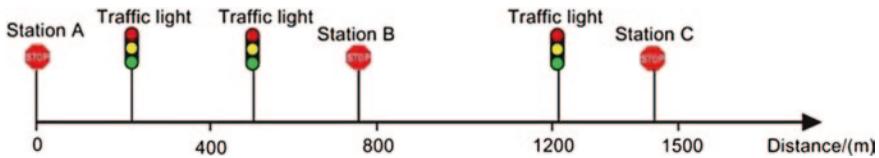
The “Normal Driving Recognition” module is designed to judge whether the bus is driving on the usual line by comparing the cycle characteristic with driving data that are collected before. The module will be more effective if there is GPS equipment on the bus (as shown in Fig. 22.2).



**Fig. 22.2** Overview of the bus stations and traffic lights distribution recognition model



**Fig. 22.3** Measured velocity trajectories



**Fig. 22.4** Model built distribution of the bus stations and traffic lights

## 22.4 Vehicle Mass and Road Load Estimation Model

We chose the longitudinal dynamics–event-seeking method for mass estimation. This approach has been proposed by Fathy et al. in [6]. The foundation of this approach for the mass estimation is discussed below. Assuming the rolling resistance is a constant fraction,  $f_r$ , linearizing Eqs. (22.1) and (22.2) for very a small deviation are as follows:

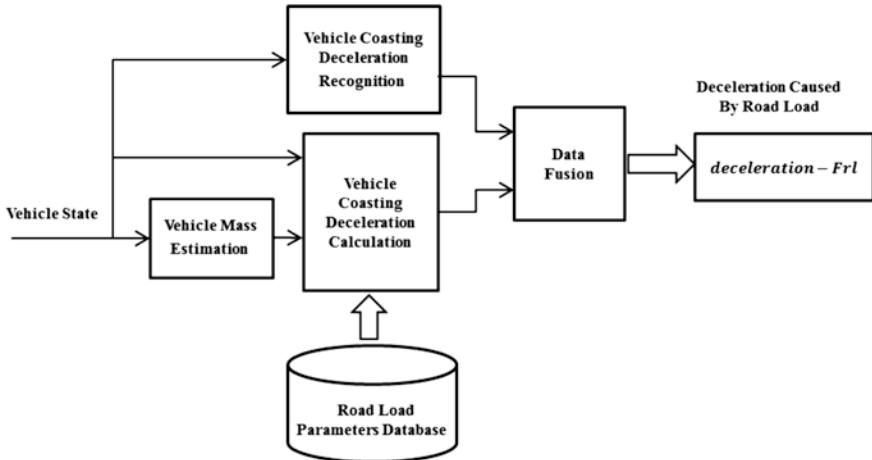
$$M_e \frac{d^2v(t)}{dt^2} = \delta F(t) - f_r mg \cos \beta(t) \delta \beta(t) - mg \sin \beta(t) \delta \beta(t) - \rho A_f c_d v \delta v \quad (22.3)$$

The symbol  $\delta$  denotes a small deviation. We can find that " $m_e \frac{d^2v(t)}{dt^2}$ " is larger than " $\rho A_f c_d v \delta v$ ." Furthermore, the road grade deviations  $\delta \beta$  diminish very slowly. So, when vehicle motion is predominantly longitudinal, the motion obeys

$$m_e \frac{d^2v(t)}{dt^2} = \delta F(t) \quad (22.4)$$

Here,  $F$  is the total drive force from the drivetrain. The proposed estimator searches for conditions under which Equation (22.4) is valid and then uses Eq. (22.4) as a basis for mass estimation.

Our road load–caused deceleration estimation model is shown in Fig. 22.5. We build a "Road Load Parameters Database," which stores the experience parameters



**Fig. 22.5** Road load–caused deceleration estimation model

like rolling resistance coefficient  $f_r$ , drag coefficient  $c_d$ . Then, Eqs. (22.1) and (22.2) together with the estimated vehicle mass are used to calculate the vehicle deceleration caused by the road load force. Another way uses a “Vehicle Coasting Deceleration Recognition” module to seek the moments when the vehicle is coasting and calculates the deceleration using the real-time velocity variation. Finally, the “Data Fusion” module generates the estimated deceleration by fusing the results of the two methods.

## 22.5 Regenerative Braking Predictive Control Model

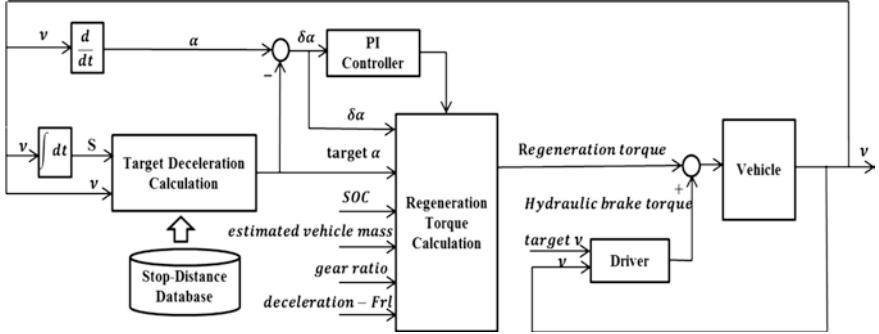
The regenerative braking predictive control model is designed to predict the coming deceleration process and act regenerative braking. See Fig. 22.6 for the model.

The model will be enabled when there is no drive torque demand from the driver. When the bus is on the line, the model calculates the driving distance from the initial station. Then, the distance (shown as  $\Delta S$ ) is calculated from the current position to the next stop (bus station or traffic light) by searching the “Stop-Distance Database.” Eq. (22.5) is used to calculate the target deceleration.

$$\alpha_{\text{target}} = \frac{v^2}{2\Delta S + S_{\text{externd\_cal}}} \quad (22.5)$$

The variable  $S_{\text{externd\_cal}}$  is added to cover the disadvantage of the driving time increase. The variable can be calculated by searching a calibration map according to the current  $v$  and  $\Delta S$ .

Then, the expressions (22.6) and (22.7) are used to decide whether or not to act the advance regenerative braking. Expression (22.6) is used to get rid of the



**Fig. 22.6** Overview of regenerative braking predictive control model

regenerative braking when the vehicle hardly get to the next stop with the current velocity and road load force by coasting. Meanwhile, expression (22.7) gets rid of the regenerative braking when the vehicle is too far from the next stop.

$$\alpha_{\text{target}} \geq k_1 * \alpha_{F_r} \quad (22.6)$$

$$\Delta S \leq k_2 * S_{\text{trip\_now}} \quad (22.7)$$

Here,  $\alpha_{F_r}$  is the deceleration caused by the road load,  $k_1$  and  $k_2$  are calibration variables, and  $S_{\text{trip\_now}}$  is the distance between the fore and the following stop.

If the expressions (22.6) and (22.7) are satisfied, Eq. (22.8) is used to calculate the target regenerative torque of the electric machine.

$$T_{\text{reg}} = \max \left( T_{\min}(w, SOC, BP_{\text{temp}}), \left( \frac{r_{\text{wheel}} m_{\text{esti}}}{i_g i_r \eta} (\alpha - \alpha_{\text{target}}) + T_{PI} \right) \right) \quad (22.8)$$

Here,  $T_{\min}(w, SOC, BP_{\text{temp}})$  is the minimum output regenerative braking torque, which is limited by the current rotational speed of the electric machine,  $w$ , and the battery state of charge,  $SOC$ , and the current battery temperature,  $BP_{\text{temp}}$ .  $\alpha$  is the current vehicle deceleration,  $r_{\text{wheel}}$  is the radius of the wheel,  $m_{\text{esti}}$  is the estimated vehicle mass,  $i_g$  is the current gear ratio,  $i_r$  is the rear axle gear reduction ratio, and  $\eta$  is the transmission efficiency.

We also design a “PI Controller” (shown in Fig. 22.6), which takes  $\alpha_{\text{target}}$  as the target, to correct the final output regenerative braking torque command.

## 22.6 Simulation Results

We take a microtrip between two adjacent parking positions for the test. First, we measured the usual driving velocity trajectory in the real world. The result is shown in Fig. 22.7 by the blue dash line. As shown in the figure, the vehicle was coasting from “point 3” to “point 4.” During this time, there was no regenerative

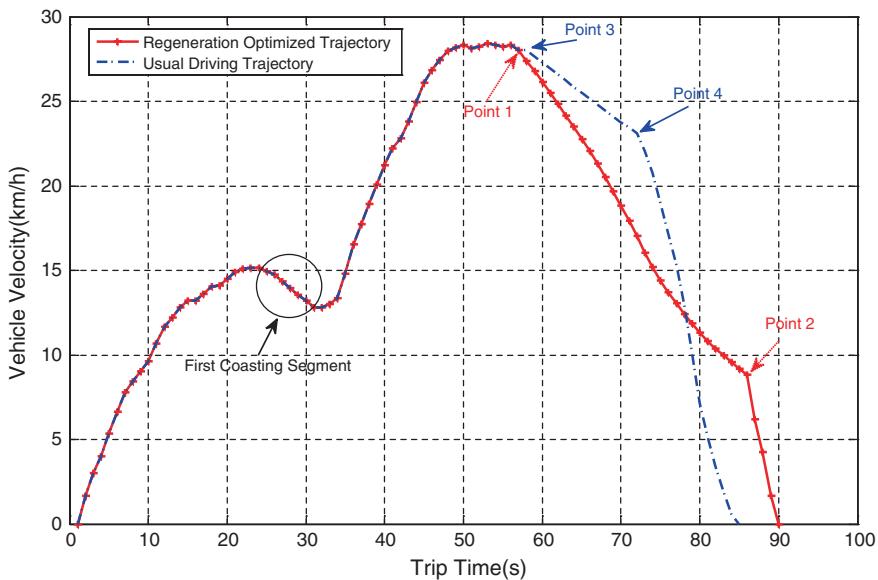


Fig. 22.7 Velocity–time trajectory comparison

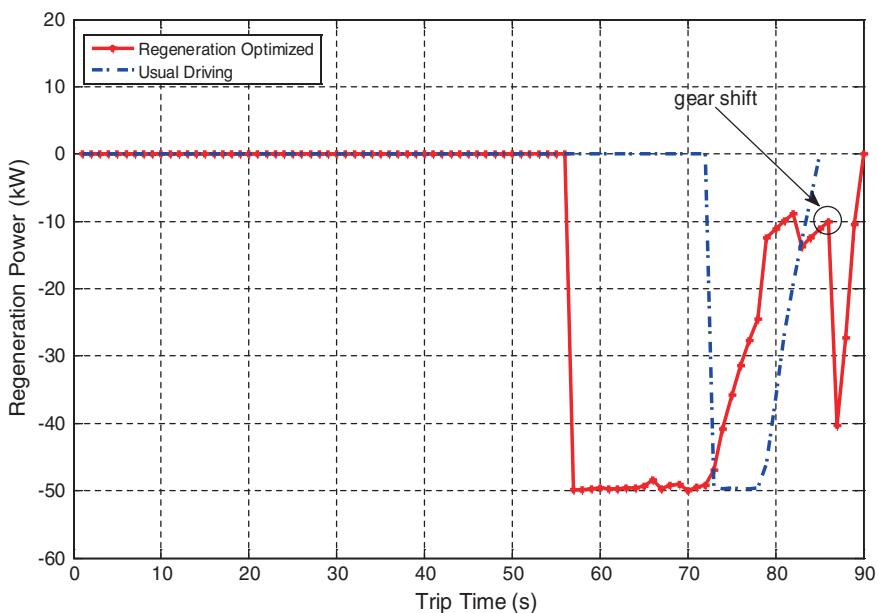
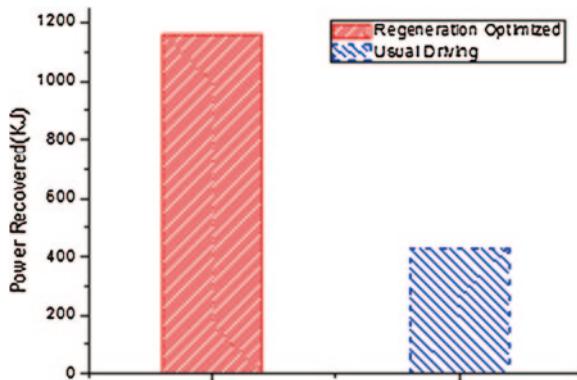


Fig. 22.8 Regenerative power comparison



**Fig. 22.9** Total energy recovered comparison

braking. And then, the driver started a hard braking from “point 4” to the end. The regenerative braking lasted for about 12s.

Then, we examined the regenerative braking predictive control strategy in a modeled vehicle built in MATLAB. The result is shown in Fig. 22.9 by the red dot-dash line. As is shown, “First Coasting Segment” represents a duration when the vehicle is coasting. Because the expressions (22.6) and (22.7) are not satisfied, there is no regenerative braking. When the vehicle approaches the “point 1,” the predictive control strategy enables the advanced regenerative braking. The modeled driver starts friction brake at “point 2” when the vehicle is near to the destination.

As shown in Fig. 22.8, the regenerative braking lasts till the end of the trip for about 33s. And the decelerating process has been smoothed compared with that of the usual driving. As shown in Fig. 22.9, there is a great increase in energy recovery, from 431.5 to 1161.4 kJ, by using the proposed strategy. Meanwhile, the trip time increases only 5s. It is acceptable.

## 22.7 Conclusion

Regenerative braking is an effective way to improve energy efficiency of EV. In this paper, we proposed a novel online regenerative braking predictive control strategy. The simulation results show that the approach is effective to improve the energy recovery and help to smooth the vehicle decelerating process.

**Acknowledgments** Supported by National 863 Project No. 2010AA044401.

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# Chapter 23

## An Extrapolation Method of Crank-Nicolson Finite Difference Scheme for Distributed Control Equation

Jun Zhou and Min Xiong

**Abstract** This paper studies a finite difference scheme for the distributed control equation, which is based on Crank-Nicolson finite difference scheme and is constructed by applying an extrapolation technique to the nonlinear term. We proved the existence, uniqueness and convergence of the numerical solution. In literature review, there is no report of theoretical studies about the extrapolation. Meanwhile, these theoretical studies are confirmed by numerical experiments in the end. These show that the scheme is a practical numerical method for some computations or numerical simulations which require less accuracy and less computational time.

**Keywords** Extrapolation method • Finite difference scheme • Distributed control equation • Existence • Uniqueness • Convergence

### 23.1 Introduction

In this paper, the following initial boundary value problem for distributed control equation is considered:

$$u_t - du_{xx} = \lambda u + f(u), \quad (x, t) \in (0, 1) \times (0, T) \quad (23.1)$$

$$u(0, t) = \alpha(t), u(1, t) = \beta(t), t \in (0, T) \quad (23.2)$$

$$u(x, 0) = \varphi(x), x \in (0, 1) \quad (23.3)$$

Here  $d > 0, \lambda > 0$ , they are constants. Notation  $\bar{\Omega}_T = [0, 1] \times [0, T]$  is given.

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This kind of Semi-linear Parabolic Equations has wide applications such as in chemical reaction, neural conduction, biological competition and other application fields [1, 2]. Numerical methods based on these equations have been a popular topic in the past decade. There are some finite difference methods based on these equations such as alternating direction iterative scheme, predictor-correctors methods and the linearized two- or three-level difference schemes [3–6], all of which are second-order convergence. The first two methods need a lot of time to solve two linear systems for every time level. The later linearization methods are efficient methods, but the theoretical analysis needs to assume that the non-linear reaction function  $f(u)$  has second- or higher-order derivatives. To overcome the above drawbacks, Qianshun Chang etc., presented some finite difference schemes by applying extrapolation technique on the nonlinear term of the generalized nonlinear Schrödinger equation's  $iu_t - u_{xx} + q(|u|^2)u = f(x, t)u$  nonlinear term [7], and Zhou and Hu presented a finite difference scheme on non-uniform meshes by applying the same extrapolation technique on nonlinear term  $f(u)$  of the distributed control equation nonlinear term  $f(u)$  [8]. Based on these studies, we do an extrapolation for the nonlinear term of the second-order convergence for Crank-Nicolson finite difference scheme. The scheme is a three-level extrapolation method on uniform meshes, and the scheme's existence, uniqueness and convergence have not been studied according to literature review. It is shown that the scheme can preserve second-order convergence of CN schemes. The more important point is that the presented scheme will save computing time because the coefficients of the systems are the same for every time level except the nonlinear term.

The outline of this paper is as follows: Sect. 23.2 some notations will be first introduced and the extrapolation scheme is given. The existence and uniqueness will be proved in Sect. 23.3. The convergence will be given in Sect. 23.4. In Sect. 23.5, some numerical experiment results in support of theoretical analysis are shown accordingly, and the conclusion is drawn afterwards.

According to nonlinear parabolic equations theory [2], when the reaction function  $f(u)$ , the initial function  $\varphi(x)$  and the boundary function satisfy appropriate conditions, the Eqs. (23.1)–(23.3) have a unique classical solution. In this paper, we will always assume that.

1. Problems (23.1)–(23.3) have a unique smooth solution  $u \in C^{4,2}(\Omega_T)$ , there exists a constant  $C_0 > 0$ , which satisfies

$$\max \{|u_{xxxx}|, |u_{xxtt}|, |u_{ttt}|, |u_{tt}| |u_x|, |u_t|, |u|\} \leq C_0, (x, t) \in \Omega_T \quad (23.4)$$

2.  $f(u)$  is a monotone but not increasing, second-order differentiable function with constants  $C_1 > 0$  and  $K > 0$ . When  $|s| < C_0 + K$ , it satisfies

$$\max \{|f(s)|, |f'(s)|\} \leq C_1 \quad (23.5)$$

## 23.2 Notations and Finite Difference Scheme

Let  $m$  and  $n$  be positive integers. Notations

$$h = \frac{1}{m}, \tau = \frac{T}{n}, x_i = ih, 0 \leq i \leq m, t_k = \tau k, 0 \leq k \leq n, t_{k+\frac{1}{2}} = t_k + \frac{\tau}{2}.$$

$\Omega_h = \{x_i | 0 \leq i \leq m\}$ ,  $\Omega_{ht} = \{(x_i, t_k) | 0 \leq i \leq m, 0 \leq k \leq n\}$  are given and  $\{v_i^k | 0 \leq i \leq m, 0 \leq k \leq n\}$  are defined as the grid functions on  $\Omega_h$ . The following notations are introduced also:

$$v_i^{k+\frac{1}{2}} = \frac{1}{2}(v_i^k + v_i^{k+1}), \delta_t v_i^{k+\frac{1}{2}} = \frac{1}{\tau}(v_i^{k+1} - v_i^k), \quad (23.6)$$

$$\delta_x v_{i+\frac{1}{2}}^k = \frac{1}{h}(v_{i+1}^k - v_i^k), \delta_x^2 v_i^k = \frac{1}{h^2}(v_{i-1}^k - 2v_i^k + v_{i+1}^k). \quad (23.7)$$

Here  $V_h = \{\omega | \omega = \{\omega_i, 0 \leq i \leq m\}$  is the grid function of  $\Omega_h$ , and  $\omega_0 = \omega_m = 0\}$ .

Suppose

$$\omega \in V_h, \|\omega\|_\infty = \max_{0 \leq i \leq m} |\omega_i|, \|\omega\| = \sqrt{h \sum_{i=1}^{m-1} (\omega_i)^2}, |\omega|_1 = \sqrt{h \sum_{i=0}^{m-1} (\delta_x \omega_{i+\frac{1}{2}})^2}$$

are denoted.

Therefore, the difference scheme for the initial boundary value problem Eqs. (23.1)–(23.3) can be constructed as

$$\delta_t u_i^{k+\frac{1}{2}} = d\delta_x^2 u_i^{k+\frac{1}{2}} + \lambda u_i^{k+\frac{1}{2}} + f\left(\frac{3u_i^k - u_i^{k-1}}{2}\right), \quad 1 \leq i \leq m-1, 1 \leq k \leq n-1 \quad (23.8)$$

$$u_i^0 = \varphi(x_i), \quad 0 \leq i \leq m \quad (23.9)$$

$$u_0^k = \alpha(t_k), u_m^k = \beta(t_k), \quad 0 \leq k \leq n \quad (23.10)$$

In order to get the numerical solution of every time level, we construct an explicit scheme when  $k=1$ :

$$u_i^1 = \varphi(x_i) + \tau[d\varphi''(x_i) + \lambda\varphi(x_i) + f(\varphi(x_i))] \quad 0 \leq i \leq m \quad (23.11)$$

## 23.3 Existence and Uniqueness of the Finite Difference Method

**Theorem 1** When  $\tau < \frac{2}{\lambda}$ , the difference scheme of Eqs. (23.8)–(23.11) has a unique solution.

*Proof:* Suppose  $r = d \frac{\tau}{h^2}$ , the difference scheme Eqs. (23.8)–(23.11) can be written as

$$\begin{aligned} & -\frac{r}{2}u_{i-1}^{k+1} + (1+r - \frac{\lambda}{2}\tau)u_i^{k+1} - \frac{r}{2}u_{i+1}^{k+1} \\ &= \tau f(\frac{3u_i^k - u_i^{k-1}}{2}) + \frac{r}{2}u_{i-1}^k + (1-r + \frac{\lambda}{2}\tau)u_i^k \\ &+ \frac{r}{2}u_{i+1}^k \quad 1 \leq i \leq m-1, 1 \leq k \leq n-1 \end{aligned} \quad (23.12)$$

$$u_i^0 = \varphi(x_i), \quad 0 \leq i \leq m \quad (23.13)$$

$$u_0^k = \alpha(t_k), u_m^k = \beta(t_k), \quad 0 \leq k \leq n \quad (23.14)$$

$$u_i^1 = \varphi(x_i) + \tau[\varphi''(x_i) + \lambda\varphi(x_i) + f(\varphi(x_i))], \quad 0 \leq i \leq m \quad (23.15)$$

For any  $k \geq 2$ , when  $\tau < \frac{2}{\lambda}$ ,  $1 + r - \frac{\tau}{2} > r$  can be deduced, therefore, the coefficient matrix is the strict row diagonally dominant and tri-diagonal. Consequently, the solution of the systems is existent and unique [9].

*Remark 1:* From the expanded equations, it is derived that the coefficient matrixes of the non-homogeneous linear systems which the numerical solution of difference scheme meets are the same for each time level, which can help to save the computing time.

## 23.4 Convergence

**Theorem 2** Suppose  $u(x_i, t_k)$  as the solution of problems (23.1)–(23.3) and  $u_i^k$  as the solution of differential Eqs. (23.8)–(23.11). Suppose  $e_i^k = u(x_i, t_k) - u_i^k$ , if  $\varphi(x) \in C[0, 1]$  and there exists a constant  $C_0 > 0$  to satisfy  $\max_{0 \leq x \leq 1} |\varphi(x)| \leq C_0$ , when  $h, \tau$  are sufficiently small, it satisfies

$$\max_{0 \leq k \leq n} \|e^k\|_\infty \leq C(\tau^2 + h^2), \quad \max_{0 \leq k \leq n} \|e^k\| \leq C(\tau^2 + h^2) \quad (23.16)$$

$$\max_{0 \leq k \leq n} \|u^k\|_\infty \leq C_0 + K, \quad 0 \leq k \leq n \quad (23.17)$$

Here  $C > 0, K > 0$  are constants and they are independent on  $h, \tau$ .

$$\max_{0 \leq k \leq n} \|e^k\| \leq C(\tau^2 + h^2) \dots \quad (23.18)$$

*Remark 2:* The proof method of theorem 2 is by use of general discrete energy normal method, inequality scaling method and some important inequalities such as Gronwall inequality and Young inequality [9, 10]. Here, the remainders are briefly proved as follows: Without the reaction term of the formulation (23.8),

the remainder  $O(\tau^2 + h^2)$  can be gotten obviously by General Taylor expansion method, and remainder  $O(\tau^2)$  for the first term of reaction  $\lambda u_i^{k+\frac{1}{2}}$  is also gotten by the same method. For the second term of the reaction, the extrapolation term  $f\left(\frac{3u_i^k - u_i^{k-1}}{2}\right)$ , the remainders can be proved as follows. Suppose  $U_i^k = u(x_i, t_k)$ , then at  $(x_i, t_k)$  by Taylor expansion, we have:

$$U_i^{k+1} = U_i^k + \tau \frac{\partial u_i^k}{\partial t} + \frac{\tau^2}{2} \frac{\partial^2 u_i^k}{\partial t^2} \quad (23.19)$$

$$U_i^{k-1} = U_i^k - \tau \frac{\partial u_i^k}{\partial t} + \frac{\tau^2}{2} \frac{\partial^2 u_i^k}{\partial t^2} \quad (23.20)$$

And adding (23.19)–(23.20), we can derive

$$U_i^{k+1} + U_i^{k-1} = 2U_i^k + \tau^2 \frac{\partial^2 u_i^k}{\partial t^2} \quad (23.21)$$

From (23.19)–(23.21), we can derive

$$f(U_i^{k+\frac{1}{2}}) = f\left(\frac{3U_i^k - U_i^{k-1}}{2}\right) + \rho_{ik}^{(2)} \quad (23.22)$$

Here  $\rho_{ik}^{(2)} = f'\left(\frac{3U_i^k - U_i^{k-1}}{2}\right) \tau^2 \frac{\partial^2 u_i^k}{\partial t^2}$ . So the remainder of the second part of reaction  $f\left(\frac{3u_i^k - u_i^{k-1}}{2}\right)$  is  $O(\tau^2)$ . Then, it can be proved that the extrapolation scheme has a second-order convergence which the general CN schemes have.

*Remark 3:* Although the results of Theorem 2 are the same as Wu's conclusion, the methods to get the estimators are different. In Wu's study, the estimator was obtained by direct methods [5], while in this paper, the result is gotten by using the mathematical induction method as that in Zhou and Hu's study [8]. Firstly, the estimator  $\|e^0\|_\infty \|e^1\|_\infty \|e^0\|_2 \|e^1\|_2 \leq O(\tau^2 + h^2)$  was obtained, secondly when  $l \leq k - 1$  it satisfies  $\|e^l\|_2 \|e^l\|_\infty \leq O(\tau^2 + h^2)$  is supposed. By induction methods, the results for  $l = k$  are gotten. That is to say the theorem's results can be derived.

## 23.5 Numerical Experiments and Conclusion

Numerical example: we apply the constructed difference scheme in solving the initial boundary problem:

$$\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial t^2} = -e^u - e^{2u} \quad (23.23)$$

**Table 23.1** Numerical results

N	$\tau$	Linearization method			Extrapolation method		
		Computing time	$\ E\ _\infty$	$\frac{\ E(h,\tau)\ _\infty}{\ E(h/2,\tau/2)\ _\infty}$	Computing time	$\ E\ _\infty$	$\frac{\ E(h,\tau)\ _\infty}{\ E(h/2,\tau/2)\ _\infty}$
20	1/2	0.008469	6.84E-03		0.006549	8.67E-02	
40	1/4	0.009412	1.75E-03	3.90777464	0.007831	2.56E-02	3.38126784
80	1/8	0.022488	3.70E-04	4.73474986	0.015522	7.11E-03	3.60917381
160	1/16	0.082562	7.97E-05	4.63979797	0.042141	1.90E-03	3.74928898
320	1/32	0.539973	1.94E-05	4.11293931	0.397851	4.93E-04	3.84741178
640	1/64	3.351015	4.80E-06	4.03453266	3.048141	1.26E-04	3.90570102
1280	1/128	23.61073	1.20E-06	4.00965026	20.309287	3.20E-05	3.94058804
2560	1/256	169.7419	2.99E-07	4.00472865	152.89259	8.08E-06	3.96180312

$$u(x, 0) = -\ln(1 + x), x \in [0, 1] \quad (23.24)$$

$$u(0, t) = -\ln(1 + t), u(1, t) = -\ln(2 + t), t \in [0, 10] \quad (23.25)$$

The exact solution is  $u(x, t) = -\ln(1 + x + t)$ . The maximal errors and error ratios for different time steps are listed in Table 23.1, where  $\|E\|_\infty$  denotes  $\max_{0 \leq k \leq n} \|u(x_i, t_k) - u_i^k\|_\infty$ .

From the above table, we can see that numerical results conform to our theoretical analysis, in which the solution of the difference scheme's convergence order is  $O(\tau^2 + h^2)$  on  $L^\infty$ . Although the extrapolation scheme is more inaccurate than that of the linearization schemes in Wu's study [5], but the computing time is spent less than that with Wu's method [5]. Meanwhile from the previous assumptions and analyses, it is known that in this paper, the reaction functions need less smoothness condition than that by using the linearization schemes. Therefore, the extrapolation scheme is practical in some practical computations or numerical simulations which require less accuracy and less computational time.

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# Chapter 24

## Multi-Channel Video Monitoring System Based on ARM11 and FPGA

**Qian Zhang and Le Dang**

**Abstract** Aimed at the problem of multi-channel video acquisition and transmission, a new scheme based on ARM11 and FPGA is put forward. The configuration and key technology of system are analyzed. Firstly, the acquisition of the multi-channel video signal with synchronization is realized by FPGA; secondly, the problem of storage conflicts between reading and writing frame cache and the clock synchronization is resolved when operating the video cache; finally, the video data stream of BT.656 is generated to be processed next. The video data is encoded by the MFC of ARM11 processor and transferred through net. The monitor decodes the receiving data. And it shows strong practical and broad application prospects.

**Keywords** Multi-channel video • Acquisition and transmission • ARM11 • FPGA

### 24.1 Introduction

The real-time dynamic video acquisition and transmission have also become a hot spot research on information and computer area. There are four ordinary design schemes: (1) the scheme based on special video acquisition card. With this scheme, only application software on the top layer can be developed, and the hardware's circuit cannot be changed. It is also too large in bulk and too high in cost to suit the embed application area [1]; (2) the scheme based on special media embedded processor. However, each channel video acquisition needs a separate video encoding and decoding chip and processor in this scheme, so it also has limits when acquiring multi-channel video [2]; (3) a scheme based on FPGA. FPGA is logic control and time sequence oriented,

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so it can be easily used to acquire multi-channel video signal. However, it is hard to implement video signal coding [3, 4]; (4) a scheme based on DSP. Though this scheme is designed flexible, it is not suited to top layer application program development. This scheme also has the limits of complicate, long development period and high cost [5, 6].

## 24.2 System Construct

The system is composed of four parts, as shown in Fig. 24.1. Multi-channel simulation video input unit consists of four simulation video cameras; multi-channel video acquisition unit is composed of FPGA, four SAA7111, two SRAM, and crystal and configuration circuit. This part is used to acquire, store and combine four channel simulation video signals and transform the video data of BT.656 for next unit; Video signal compressing, encoding and transport unit is composed of ARM11 (S3C6410), memory circuit, Ethernet module. This part is used to compress video signal that had been acquired and combined to data of H.264 in MFC and finally send the signal to remote monitor term through IP network; remote monitor term unit. This part can not only shows the signals acquiring from remote, but also is used to control remote video acquiring system, such as video matrix switching and cradle head controlling.

## 24.3 Preliminary Works

### 24.3.1 Multi-Channel Video Signal Clock Synchronization

For the convenience of data transport and the compression encoding of video data in the follow units, the CCIR-656 (8 BIT) is used as the output data format of SAA7111. The interface used 8 bit compound YUV data, 27 MHz clock and

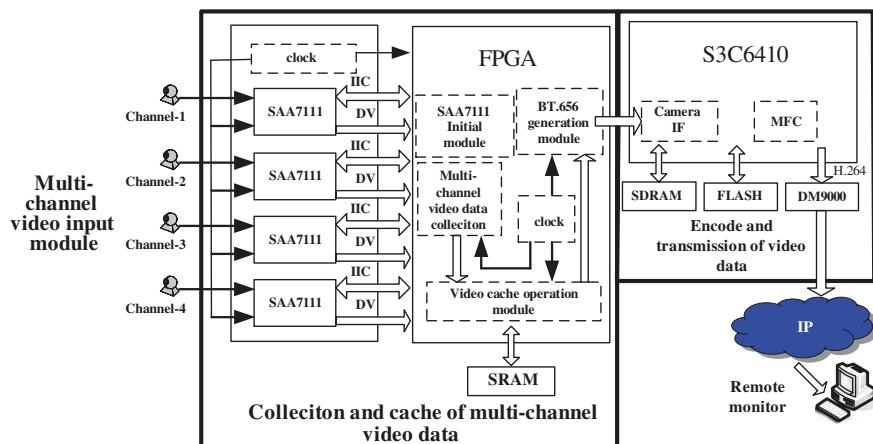


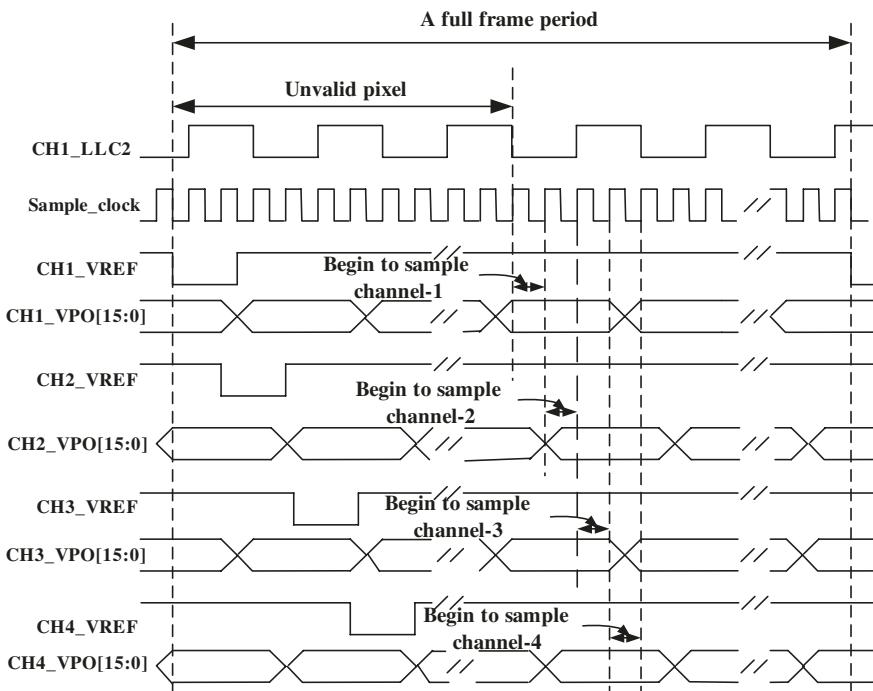
Fig. 24.1 The system configuration

720 \* 576 resolution, which is embedded timing code into video stream without using traditional video timing signal (HSYNC, VSYNC and BLANK), and could reduce the pins of chip interface [7].

Because the four SAA7111 are asynchronous when they are on work, while the final four collected video data were stored in the same display cache, we must synchronize the output video signal of the four SAA7111. The signal (LLC2) of any channel SAA7111, whose frequency is 27 MHz, is multiplied by 4, using the PLL circuit in FPGA, and then the sample clock (108 MHz) is generated. In that case, each channel video data collection was completed in the four sample clock cycle; taking the frame synchronic signal of channel 1 (VREF1) as reference, when the first valid pixel data outputs, the acquisition starts. Since the resolutions of the four channel video are same, that is to say the amount of data sampled is also same. In a period of frame, the acquisition of all valid pixel data of four channels will be accomplished, as shown in Fig. 24.2.

### 24.3.2 Caching Multi-Channel Video Data

First, FPGA in the system should cache the valid data collected by four SAA7111, then send the data with format of BY.656 to ARM11 and finally encode. The above



**Fig. 24.2** Synchronized timing of multi-channel video

procedure should solve three problems: (1) The display cache is SRAM with capacity of 16 BIT, while BT.656 is 8 BIT, the video data cannot be neither stored into SRAM directly nor sent to ARM11 from SRAM directly; (2) In order to assure the efficiency of video data transmission, data in SRAM should be read by FPGA in time and sent to ARM11. So, there is conflict between reading and writing in SRAM; (3) The frequency of, four channels video data collected by FPGA, sample clock is 108 M, but the clock frequency of BT.656 video format is 27 M. However, there is strict timing demand on reading and writing by FPGA in SRAM, the synchronous among the clock read and written by FPGA, the clock collected by FPGA and the clock of BT.656 should be solved properly. In this paper, FIFO circuit and SRAM reading and writing time-division multiplexing mechanism are applied to solve above three issues.

In the module of video cache, the input ports are connected with multi-channel, and four input FIFO groups are used, which cached four collected video data, respectively; each group had three queues, which store Y, U, V component data, respectively. A right FIFO was chosen by a choose controller of 1/4. During each writing operating on SRAM, data in queue U (or queue V) and queue Y are read once, so video data of 16 bits is stored in a memory unit of SRAM. As for the output ports connected with video generating module of BT.656, another output FIFO groups should be set, which composed of queues that cached Y, U, V, as well. For the data read from SRAM, the higher 8 bits were stored in queue U (or V) and the lower 8 bits were stored in queue Y. It should be noted that because the U, Y and V components are synchronous, the status of three FIFO queues, “full” or “empty,” is also synchronous. So, status signal of any queue could be used when designed program. Figure 24.3 shows the process of caching video data.

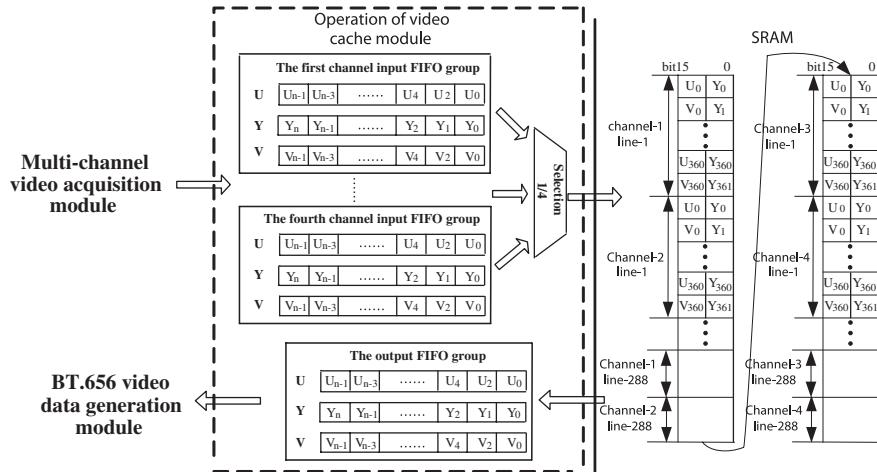


Fig. 24.3 The principle of multi-channel video signal cache

The “SRAM reading and writing time-division multiplexing mechanism” is put forward here. On the basis of master clock (master\_clk) in FPGA, the timing requirements for multi-video signal collection, BT.656 video format, and SRAM reading and writing are satisfied. According to certain time interval, reading and writing SRAM during time-division can not only solve the conflict between reading and writing SRAM when using one video data cache, but also solve the problem above, which is the synchronization of three signals timing (Fig. 24.4).

The output signal of the first SAA7111 (LLC2), whose frequency is 27 MHz, is multiplied by eight times, then the master clock of FPGA (mater\_clk) is generated, whose frequency is 216 MHz. The master\_clk is falling edge trigger, used as reference clock. Based on the status of “empty” mark signal of the input FIFO group and “full” mark signal of the output FIFO, the status of SRAM read or written is determined. Taking SRAM reading, for example, the principle is that when the first falling edge of master\_clk came, FPGA begins to judge the SRAM state whether can be read (r0). If the output FIFO group is not full, it showed that data should be read from SRAM. During the next three cycle of master\_clk, the status turned to r1, r2 and r3 in sequence, to accomplish SRAM reading operation one time; if the FIFO of data output module is full, then SRAM should not be read. During the next three cycles of master\_clk, the status turned to r4, r5 and r6 in sequence, SRAM should not be processed by any operation. The four statuses only play the role of time-lapse. When judging whether SRAM can be written, it came to refer to the “empty” signal of the input FIFO. The above eight statuses switched over  $r0 \rightarrow r1 \rightarrow r2 \rightarrow r3$  (or  $r0 \rightarrow r4 \rightarrow r5 \rightarrow r6$ )  $\rightarrow w0 \rightarrow w1 \rightarrow w2 \rightarrow w3$  (or  $w0 \rightarrow w4 \rightarrow w5 \rightarrow w6$ )  $\rightarrow r0$  are just a LLC signal or BT.656 video clock signal cycle that accomplished SRAM read and write each time.

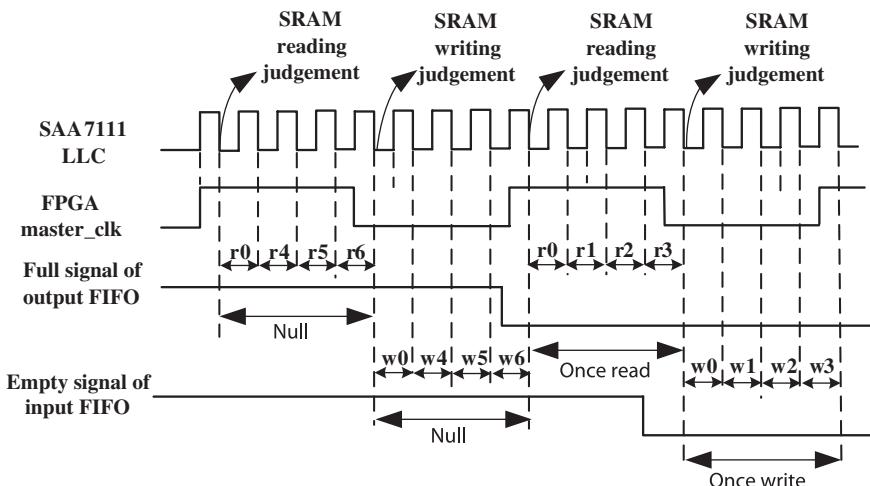
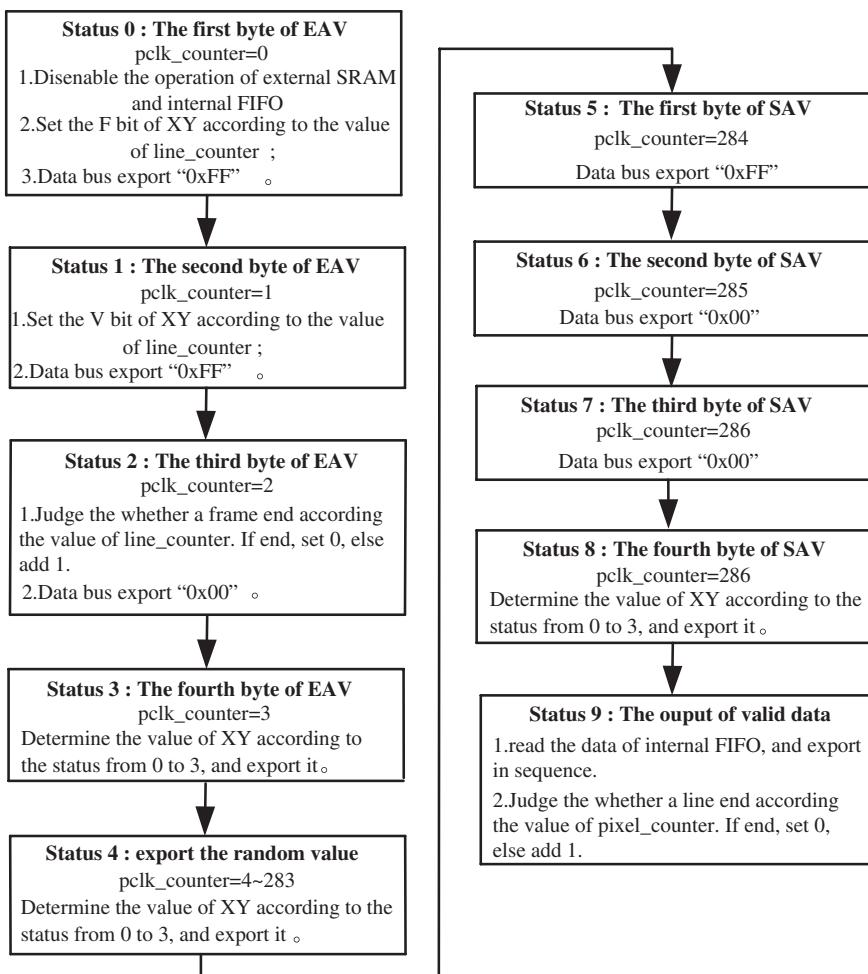


Fig. 24.4 Time-division multiplex technology principle of reading and writing SRAM

### 24.3.3 Implements of FPGA and ARM11 Data Interface

In order to compress and encode the collected multi-channel video signal, FPGA should export the video data stored in display cache (SRAM) with the format of BT.656. Because the output data format of SAA7111 had configured to YUV 656–8 bits, we just need to generate BT.656 video timing signal again and read the data from output FIFO of video cache operating module.

Using external crystal source 20 MHz, a clock whose frequency is 27 MHz is generated by PLL inside FPGA, which is just the frequency of BT.656 video standard pixel clock. Using a 20 bits pixel clock counter (pclk\_counter) to count the pixel clock signal (pclk), and using a 4 bits status switch to record variable status,



**Fig. 24.5** The status transfer course of timing control code production

the variable switched over 10 statuses according to the value of pclk\_counter; and 10 bits line counter (line\_counter) was used to count the line of output video. The procedure of each status kept and executed is shown in Fig. 24.5.

#### 24.3.4 Compression Coding of Video Data

The ARM processor of system is S3C6410, which has a multimedia encoder and decoder (MFC) supporting encode and decode in the format of MPEG4/H.263/H.264 and VC1. The camera interface inside S3C6410 supports video data with ITU R BT-601/656 YUV 8 bit standard and 90 rotate [8].

S3C6410 received multi-channel video data collected by FPGA in terms of Camera IF, and the FPGA is mapped as a device file. It bypassed core cache block, so the progress could access a file like a normal RAM. At the same time, two caches are used to accelerate the speed of video data reading and writing. After loading MFC driver, MFC function is invoked like dealing with normal file to encode video data in H.264. Finally, the video data after encoded is transported through net interface of the system, and then the remote monitor host machine just decoded it using normal video decode soft.

### 24.4 Conclusions

The system proposed implemented function of multi-channel video monitor based on ARM11 and FPGA, which can collect, encode and transport multi-channel video data. Experiment indicated the speed of collecting and transported VGA could reach 25 fps. After decoded by H.264 only, a frame of video is only 12 k in average, with low net broadband seizure rate. What's more, it has more practicability and broad application prospects.

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# Chapter 25

## A Tower Crane Weight Detection and Control System Based on 51 Serial MCU

Jin Shang

**Abstract** More and more tower crane accidents happened these years. It's necessary to development a system to ensure the operation safety of tower crane. Such a system was designed based on 51 serial MCU. Its functions include lifting weight detection, processing and output controlling. Additional functions such as password setting, standard weight setting, and power down detection and USB data reading are included also. Through the definitions of effective weight and normal/abnormal weight wave, a lifting weight calculation model was proposed clearly. Such a system is cheaper and functional.

**Keywords** Tower crane • MCU • Control system

### 25.1 Introduction

More and more crane accidents occurred in China with the rapid development of building industry. According to statistics of Chinese Ministry of Construction and State Administration of Quality Supervision, comparing with the year of 2005, in 2006, construction-crane accidents in China increased by 76.5 %, major accidents up 66 %, the number of deaths increased by 61 %, direct economic losses ascended 8.6 %. Compared with the same period in 2006, fatal crane accidents increased by 20 % in 2007 [1, 2]. However, according to tracking and surveying more than 1,000 cranes, it showed that 80 % of the accidents were due to peccancy and overloading. It illustrates that avoiding peccancy and overloading completely is a formidable project.

Some national standards or industry rules were released frequently these years in China, face on the serious safety situation of construction industry. These standards or rules illustrate the government steady determination to control the accidents. Such standards include: tower crane (GB/T 5031-2008), overloading

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protection device of crane (GB 12602-2009), and the design standards of crane (GB/T 3811-2008). Such industry rules include: concrete basic engineering technology standards of tower crane (JGJ/T187-2009), and safety technology standards of construction tower crane installation/operating/disassembling (JGJ196-2010). Furthermore, we could find that the safety monitoring and management system is so important, from the book of “10 new techniques of construction industry (2010)”.

Some products of tower crane safety monitoring and controlling system were appeared these years. A tower crane safety protection system has been designed based on the single chip processor of dsPIC30F6012 [3]. TJL-1S pulling force sensor was used in the system. The system could monitor the moment of lifting force dynamically. An intelligent tower crane controlling system has been designed also [4]. This system used two AT89C51 MCUs. The sensor output signal was isolated by photo-electricity devices to resist noise. The detected weight was processed by a method called delay protection to decrease the influence of crane shaking, such as tower crane start to lift. Furthermore, some theoretical crane models were appeared. Tower crane foundation slope model based on inclination feature (TFSM) was built by Shijun [5]. This model is obtained based on the analysis of tower crane mechanical model during normal work. Three features of tower crane inclination were pointed out in the model.

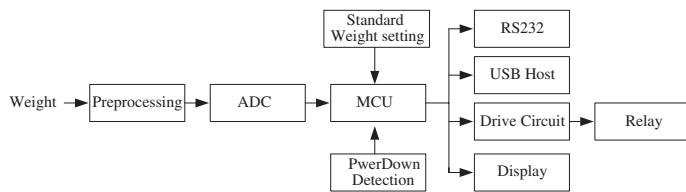
Some works we can do from the analysis of the products appeared. One is that a cheap product is necessary. The main accidents occurred of tower crane were caused by overloading. Thus, the limitation of weight to lift is the main task of the similar system. Therefore, only weight detection, but not multiple parameters detection is necessary for those simple applications. The next is that most of weight detection is achieved by strain gauge. This weight sensor is cost much. And its difficulty to paste the strain slices. The final work we can do is that the influence of workers operation convenience should be considered in the production design. Some products appeared in the market cut off the crane power frequently when “overloading” is appeared. This “overloading” may be caused by crane shaking and the time of “overloading” is very small. This case should be considered as normal, but not true overloading.

A weight detection and control system has been designed based on the analysis above. 51 MCU was employed as the core monitoring and controlling unit. The input of the system is the weight only. The outputs of the system include four controlling signals of electric relay which used to control lifting speed and alarm. Functions such as standard weight setting, USB data reading and power down detection are all achieved by one MCU. This design idea make the product become cheaper. Through the building of weight data processing model, the weight data displayed becomes more real. The pseudo overloading caused by crane shaking is eliminated in the model.

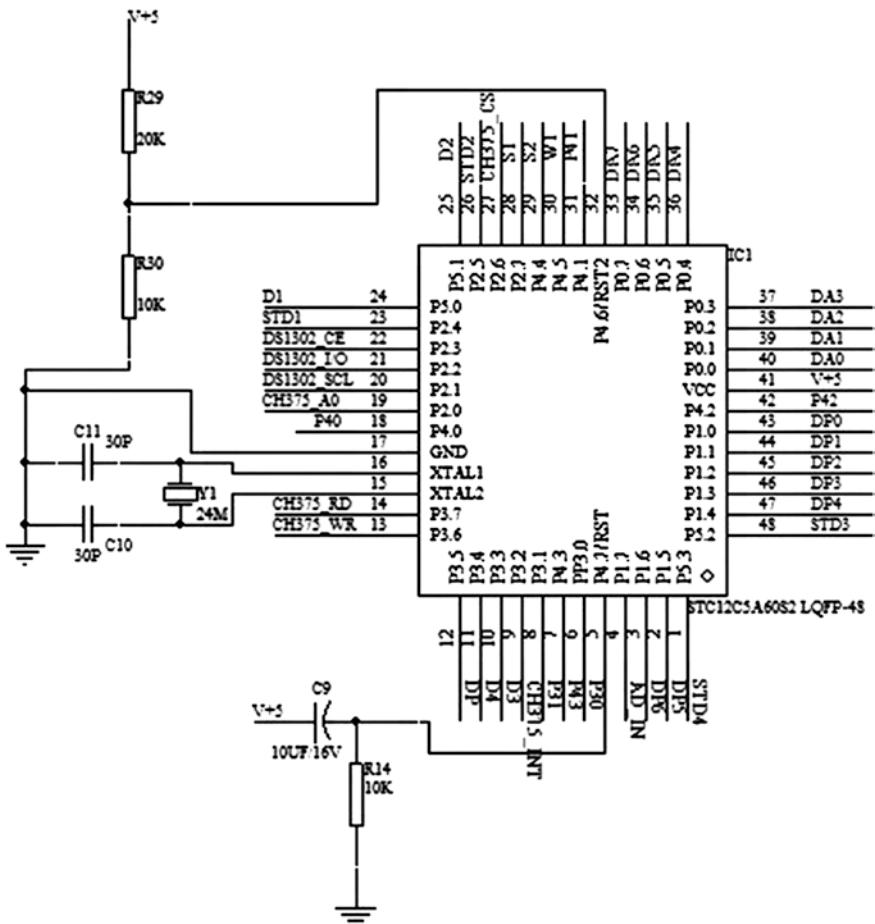
## 25.2 Hardware Design

The proposed system is illustrated in Fig. 25.1. The weight is detected by a force detection ring. There are two steel flat in the ring. When the tower crane is working, the shape of steel flat will be changed so that a position shift produced.

This shift is corresponding to the weight and detected by a sensor. After the output of the sensor is amplified by the preprocessing circuit, ADC then convert the analog signals to digital signal which MCU processing need. Standard weight



**Fig. 25.1** Principle block diagram of the proposed system



**Fig. 25.2** Application design of MCU

setting and power down detection are the two important functions system needed. The responsibility could be determined by power down detection circuit when accident happened. The outputs of MCU include display, communication and controlling. RS232 is used to connect the host PC. USB host is used to read the system operation data such as weight, date, time, etc. Drive circuit and relay are used to control the lifting speed or alarm.

MCU is the system core. All the I/O ports are used. In the system, total 41 ports needed. They are 4 ports for Flash, 13 ports for USB host, 3 ports for clock producing circuit, 12 ports for display, 2 ports for keys, 4 ports for relay, 2 ports for ADC, and 1 port for alarm circuit. To solve the problem that less ports 51 MCU has, some ports are multiplexing. For example, one port used in ADC is multiplexed with display port. All the ports of MCU were labelled in Fig. 25.2. It's clear that all the necessary requirements are satisfied and all the functions are achieved by only one MCU. This design method makes the system much cheaper than others.

## 25.3 Software Design

The software design should consider how to calculate the lifting weight firstly. Then according to the calculated result, system controls display and other outputs. ADC takes the weight sample in a certain time. But noise and pseudo weight may contain in the samples. So a reasonable flow to process the sample is necessary. The proposed flow bellow illustrates the principle of data filtering and data processing to solve these problems.

### 25.3.1 *The Modified Middle Filter*

The modified middle filter is employed to filter the noise from the shifter sensor. Let  $W_i$  be the every lifting weight that sensor detected. In a certain time interval,  $M$  lifting weights were detected. The proposed filter is defined as:

$$W_e = \text{mid} \{W_i | i = 1, 2, \dots, M\} \quad (25.1)$$

where  $W_e$  is an effective weight we called?  $\text{mid}()$  is the function that the middle value is obtained from the sorted sequence of  $W_i, i = 1, 2, \dots, M$ .

### 25.3.2 *The Mean Filter*

Based on every effective weight obtained, the mean filter is employed to calculate the weight which used to display and control. In a certain time interval which

is several times of middle filter used,  $N$  effective weights are obtained. Then the mean filter is described as:

$$W_x = \frac{1}{N} \sum_{j=1}^N W_{ej} \quad (25.2)$$

where  $W_x$  is the output of the mean filter, which means the actual weight system processed.

### 25.3.3 Pseudo Weight Processing

Pseudo weight we called is caused by the tower crane shaking. In fact, it's the overloading weight caused by shaking. For example, in the situation of that the lifting weight is reached nearly the full weight that tower crane has, overloading will happen when crane shaking. Generally, once the overloading happened, the crane operation power will be cut off. Actually, when the lifting is steady, overloading will disappear. Therefore, this pseudo weight could be eliminated to provide convenience to crane workers.

But in other situation, this overloading may the true. For example, when the lifting begins to start, overloading will happen if the actual goods is heavier than the tower crane's full weight. Therefore, we define some rules to process this pseudo weight. If the pseudo weight could be exist a time which is longer then a time threshold, we regard it as overloading really. Otherwise, we regard it as noise which could be eliminated.

### 25.3.4 Program Flow

The program flow could be divided into two parts. One is the normal weight processing flow. Another is pseudo weight processing flow. Which flow the program should execute is determined by the effective weight in the time? If the detected effective weight is much different from the weight before, pseudo flow will execute. Otherwise, the normal flow will execute.

Suppose that: the goods weight is  $W_x$ , the effective weight in time  $t$  is  $W_t$ , the effective weights before  $t$  are  $\{W_{t1}, W_{t2}, \dots, W_{tN}\}$ . Then the normal weight processing flow is described bellow.

1. To update  $W_x$ . Which means  $W_{t1}$  is replaced by  $W_t$  firstly, and then  $W_x$  is calculate again according to the Eq. (25.2).
2. To display  $W_x$ .
3. To output controlling signal according  $W_x$ .

If pseudo flow executed, the bellow steps will be followed.

1. Let  $W_x = W_t$ , and the flow label is set.
2. To determine whether  $W_t$  could exist in a certain time interval  $T1$ .
3. If  $W_t$  could, then  $W_x$  is calculated from the effective weights in  $T1$ , and  $W_x$  is used to display and control. Next is going to step 5.
4. If  $W_t$  could not, all the weights detected in  $T1$  will be deleted.
5. To reset the flow label, and go to the normal weight processing flow.

## 25.4 Conclusion

The proposed weight detection and control system's design include hardware design and software design. Focus on the tower crane accidents caused by overloading, 51 MCU is employed to detect weight and process weight. It makes the proposed system could satisfy all the requirements user needed exactly right. Focus on the noise and lifting shaking, two level filters are employed to process the weight data. The processed result is more reasonable to put into the use of display and controlling.

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# Chapter 26

## Moving Object Tracking in Intelligent Video Surveillance System

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**Abstract** Through the in-depth study of the current motion detection and tracking technologies, combined with the practical application of intelligent video surveillance, this paper improves the existing motion detection and tracking algorithm. The improved algorithm continues the characteristics of original algorithm such as simple to implement and lower computational complexity, increases its range of application and improves the anti-jamming capability and robustness of video tracking.

**Keywords** Intelligent surveillance • Motion detection • Object tracking • Camshift • Frame difference

### 26.1 Introduction

Intelligent video surveillance is an emerging application direction and leading topic in the field of computer vision. With the rapid development in network technology and digital video technology, intelligent surveillance technology continues to move forward in the direction of intelligence and networking [1]. Intelligent video surveillance system not only meets the future development of information industry, but also represents the future direction of the surveillance industry, containing tremendous business opportunities and economic benefits, concerned by academia and industry. The typical video surveillance system components are shown in Fig. 26.1.

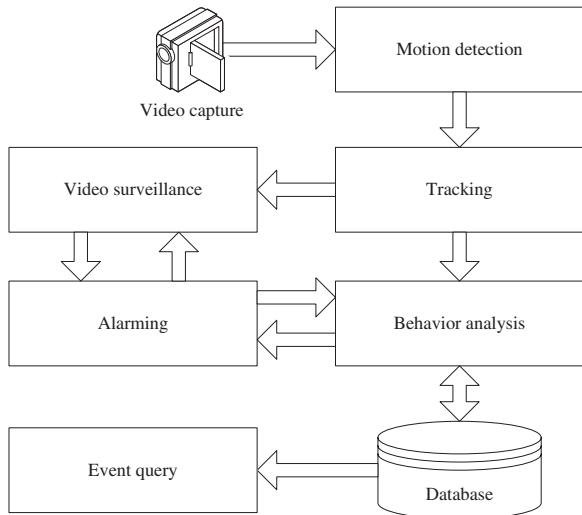
Intelligent video surveillance is to capture the images in the monitored area by cameras and then through the corresponding transmission network that sends the video signal to the designated monitoring center, for storage, display and analysis.

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**Fig. 26.1** Typical video surveillance system components



Without human intervention, it is to use computer vision and video analysis to automatically analyze the image sequence recorded by the camera, thus achieving the positioning, identifying and tracking of the moving objects in dynamic scene and on this basis analyzing and judging the behavior of them, thereby both completing the daily management and timely responding when abnormal situation occurs. Moving object detection and tracking is an important part of video surveillance system, so how to achieve real-time, stable and effective detection and tracking of moving objects is an important issue that needs to focus on and study.

## 26.2 Moving Object Detection

Moving object detection is use digital signal processing and other technologies to deal with the image sequence which contains the motion information, which can detect and extract the moving foreground of the image sequence. And then based on the image gray scale, edge and other features it can segment the moving object [2, 3]. Moving object detection algorithm can be divided into static moving object detection algorithm and dynamic moving object detection algorithm. Static background refers to that the camera in the whole monitoring process is stationary; dynamic background refers to that the camera in the monitoring process has movement, such as translation, rotation or motion with more degrees of freedom. In static background, the commonly used motion detection methods are as follows: frame difference, background difference and optical flow. In dynamic background, there are complex relative motions between the object and camera, so the detection algorithm is more complex than the static background. This paper will use frame difference to achieve the detection of moving objects.

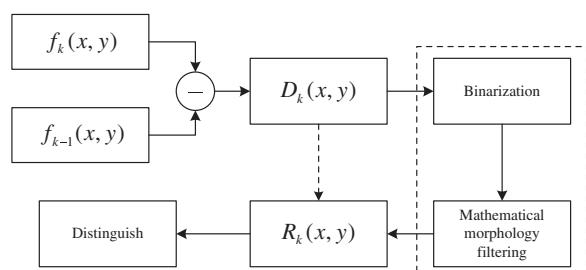
### 26.2.1 Principle of Frame Difference

Frame difference method is a pixel-based motion detection method, to obtain the contours of moving objects through difference operations for the adjacent two or three images in the video image sequence. In the image sequence, by pixel comparison, the difference between a few frames of adjacent images can be directly obtained. Assuming that the light in a multi-frame image basically does not change, it is not zero in the image after difference indicates that the pixel of it moves. Frame difference method is to use the difference between two successive frames or a few different frames in the image sequence for moving object detection, that is, seeking absolute time difference of the two images in the image sequence and then using a threshold to determine changed region. In this paper, we assume that the image of the first  $k$  frame and  $k-1$  frame is, respectively,  $f_k(x, y)$  and  $f_{k-1}(x, y)$ , and their difference is  $D_k(x, y) = |f_k(x, y) - f_{k-1}(x, y)|$ , and then, the obtained difference image through a closed value  $T$  to determine that each pixel point in the image is a moving object or background pixel point, thereby extracting the image  $R_k(x, y)$  in the moving region. In the difference map, if the differential value is greater than the given threshold, then the corresponding pixel value takes 1, or takes 0, resulting in non-zero area, using which moving objects can be detected [4]. In actual process to facilitate processing, there often is the difference image  $D_k(x, y)$  binarization, and mathematical morphology filtering, connectivity analysis for the binary image. When the area of a connected region is more than a given closed value, the object is detected, and this region is regarded as the object occupied. The specific implementation principle of frame difference method is shown in Fig. 26.2.

### 26.2.2 Improvement of Frame Difference Method

Frame difference method is to check the changes in the pixel intensity between adjacent frames within a shorter time, and the pixel with more changes is considered to be caused by moving objects. The commonly used frame difference method is adjacent frame difference, which uses two adjacent video images for subtraction, and in the obtained frame difference image, there is a significant

**Fig. 26.2** Implementation principle of frame difference



difference between the noise and motion regions, generally a fixed threshold can be used to separate them [5]. There is also a cumulative frame difference, which uses several adjacent frame difference images for accumulation, and the accumulated value will make the difference between the noise and motion regions, thus facilitating the extraction of threshold and noise cancelation of the frame difference image, but this method also will blur the boundaries of the motion region, thus making the area of the detection results larger.

Taking into account the fixed camera, the gray value change in the background pixel is slow, but the gray value change in the pixel gray value corresponding to the moving object is relatively faster. Virtually, every image can be divided into two regions: one consists of the pixels with little changes in gray value, that is, the background region; the other consists of the pixels with more changes in gray value, including the region of the current frame where the moving object is in and the region of it is in the last frame; the changes in the pixel gray value in such region are larger, that is, the motion region. A frame image every other time is captured, the image  $[f_0, f_t]$  obtained in this time is collected  $[0, t]$ , and then, the frame difference method is used for pair difference, to distinguish the background image and motion region for each frame image, to average the gray value of background pixels in each frame and to get clean background frame. The specific implementation process is shown in Fig. 26.3.

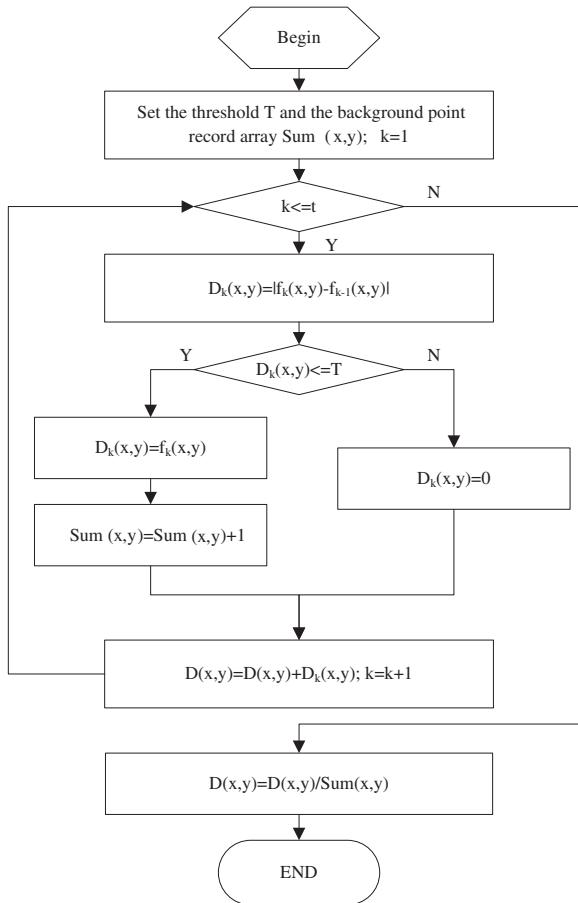
## 26.3 Tracking of Moving Object

### 26.3.1 Camshift Algorithm Principle

In recent years, Kalman filter, Camshift and particle filtering algorithms have become the main object tracking algorithms, in which the Camshift algorithm is the most widely used tracking algorithm. Camshift algorithm is a nonparametric method with dynamic distribution and gradient estimate by using probability density function and is used for quick and efficient tracking based on the color probability distribution of the object [6]. It extends the mean shift algorithm to a continuous image sequence, making mean shift operation for all frames of the video image and taking the results of the previous frame as the initial track window value of the next frame mean shift algorithm, and if such iteration continues, the object tracking will be achieved [7], and the specific implementation process of Camshift algorithm is shown in Fig. 26.4.

Through analysis, it is easy to find that the traditional Camshift algorithm is an object tracking algorithm based on color histogram, when the target and background color are similar or the target occlusion and scale changes, the tracking robustness will be greatly affected; at the same time, it cannot be used in a dynamic context; moreover, the traditional Camshift algorithm in tracking efficiency also has potential improvement and enhancement. When the background is relatively simple and the objects are few, the traditional Camshift can achieve accurate and effective

**Fig. 26.3** Implementation process of frame difference improvement

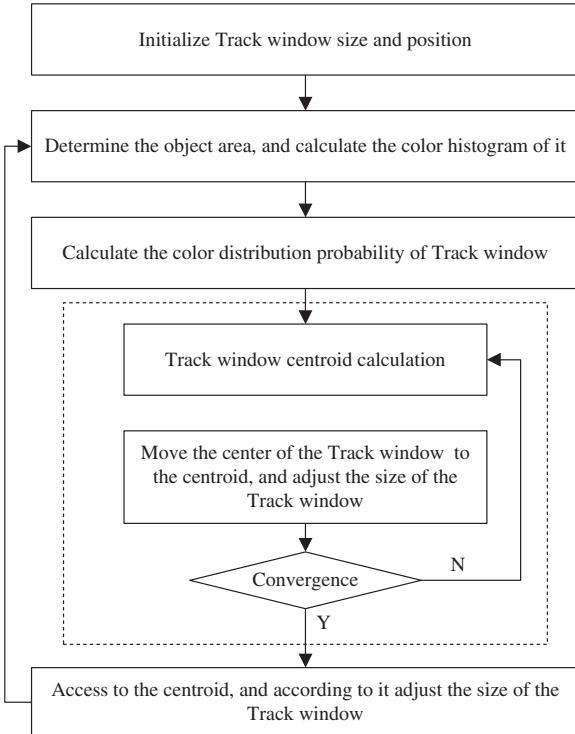


object tracking, but when the background is complex and the objects are increased, Camshift tracking results will be greatly affected. Meanwhile, the traditional Camshift tracking window size is fixed, tracking window cannot adaptively adjust its size according to the size of the target, which leads to low tracking accuracy when the object shape and size are frequently changed.

### 26.3.2 Improvement of Camshift Algorithm

The traditional Camshift algorithm uses color histogram as description of the target template for matching and only contains the frequency of a certain color value occurred in the image and loses the space location information of the pixel, when the background color is similar to the object and the emergence of occlusion and the background and occlusion will generate interference, resulting in the tracking

**Fig. 26.4** Camshift algorithm process

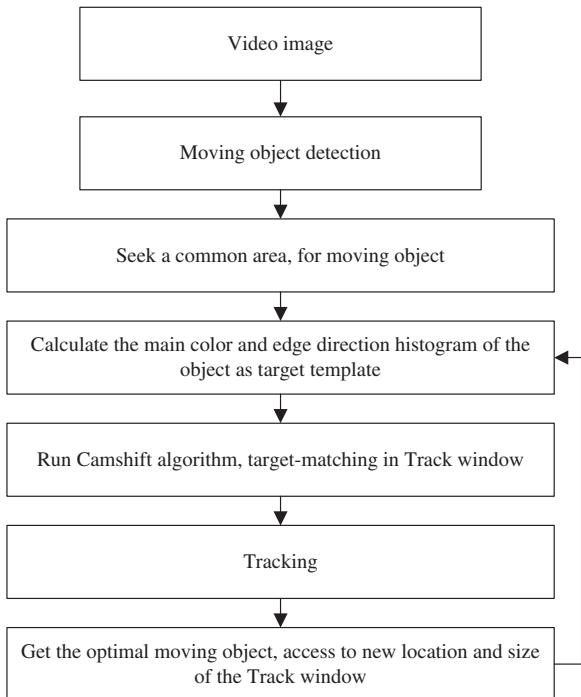


method based on color histogram losing the target; meanwhile, the traditional color histogram is a global color histogram, computation is larger, is not conducive to real-time tracking [4]. Therefore, the improved algorithm will continue the good characteristics of the color histogram and use a simplified main color histogram and an edge direction histogram which has robustness for the situation that the occlusion and background object color are similar, together to describe the moving object, thus achieving the accurate and robust moving object tracking in complex environments.

For the above deficiencies for Camshift algorithm, this paper will improve it, and the specific improvement measures are as follows: first, the quadratic difference method based on background motion estimation for object extraction is used, and the tracking process integrates the simplified main color histogram and the above-concerned edge direction histogram as the target characteristics; second, the obtained center is the initial search point, for similarity detection of the target template and the candidate target, and we can search the optimal matching position and then to get the exact location of the target object in the current frame. The specific implementation process of the improved Camshift algorithm is shown in Fig. 26.5.

The improved algorithm introduces the object detection algorithm based on background motion parameter estimate, to achieve the effective tracking of the traditional Camshift algorithm in the dynamic context, thus expanding its range of applications. Meanwhile, in order to improve its tracking robustness in dynamic

**Fig. 26.5** Implementation process of improved Camshift algorithm



context, the improved algorithm continues the good characteristics of the color histogram and uses a simplified main color histogram and an edge direction histogram which has robustness for the situation that the occlusion and background object color are similar, together to describe the moving object, which greatly improves the anti-jamming capability and robustness of tracking [8].

## 26.4 Conclusion

With the development in science and technology, intelligent computer technology has been continuously applied. In the surveillance field, intelligent video surveillance has unparalleled huge advantages and in the future will be certainly applied to all aspects of social life. Moving object detection and tracking is the key technology to achieve intelligent video surveillance and also one of the hotspot issues in the current computer vision research. In this paper, through the in-depth study of the current motion detection and tracking technologies, combined with the practical application of intelligent video surveillance, the existing motion detection and tracking algorithm is improved. The improved algorithm not only has the characteristics of original algorithm such as simple to implement and lower computational complexity, while increasing its range of application, but also improves the anti-jamming capability and robustness of video tracking.

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# Chapter 27

## Boiler Temperature Remote Monitoring System Based on Wi-Fi Network

Zhenghua Ma, Shunxian Wang, Jiongru Zhou, Teng Wang and Baiyang Gu

**Abstract** In order to realize the remote monitoring of temperature, the paper proposes the use of Linux OS and ARM (S3C6410) processor to build the hardware and software platform for the system. So as to complete the temperature measurement of controlled object, we employ thermocouple and thermal resistor to collection temperature signal and use the A/D converter integrated by microprocessor to carry out A/D conversion. The system makes use of temperature control algorithm based on fuzzy PID to reach an ideal temperature control purpose, combines with Wi-Fi and TCP/IP protocol embedded in Linux OS to realize the network connection, and employs the Wi-Fi function of Android mobile phone to monitor temperature of the boiler at the remote terminal. After the key module testing and analysis, the system is proved to be stable and reliable, and can realize the remote monitoring of boiler's temperature.

**Keywords** Remote monitoring • Linux OS • Wi-Fi technology

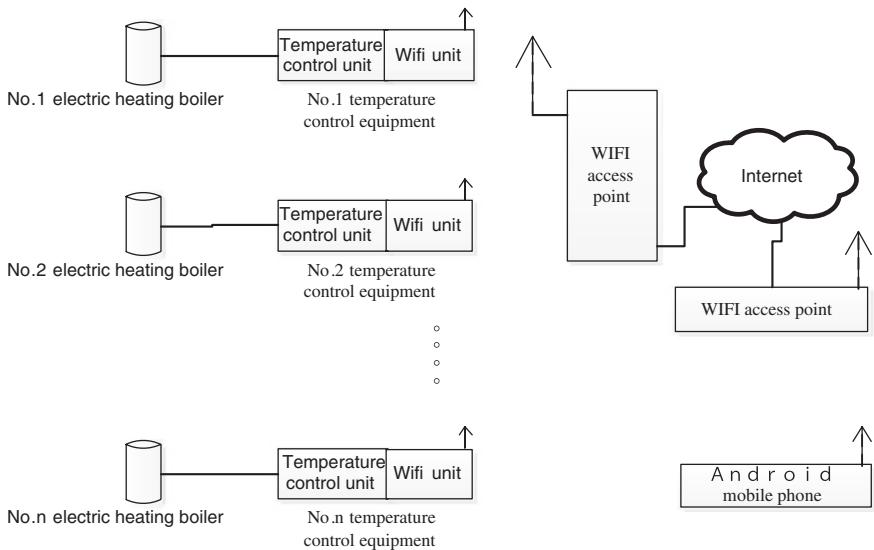
### 27.1 Introduction

The temperature is one of the main objects of industrial control, the mathematical model of temperature control commonly employ is the first order inertia with pure time-delay link, but as the heating object and environment changes, the control effect can appear larger difference. The characteristics of pure time-delay link of temperature controlled object can easily cause the system level oscillation and overshoot. So the traditional PID control approach is difficult to achieve the ideal effect, but the fuzzy PID control can achieve very good control effect without accurate mathematical model of the controlled object.

Wi-Fi (wireless fidelity) is widely used for short-range wireless communication [1]. The project the paper proposed adopting Wi-Fi wireless access technology based on ARM CPU and Linux OS can realize the purposes of remote monitoring.

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**Fig. 27.1** System mode

## 27.2 System Overall Scheme

Figure 27.1 is the system mode of the remote boiler temperature control system. The system is composed of two parts: the first is the temperature control equipment including the temperature control unit and Wi-Fi communication module, and the second is the distant Android mobile phone. The system employs the client/server model, assigning an IP address for each temperature-control-equipment. Temperature control equipment acting as server is responsible for electric heating control, and communicates with outside world through its Wi-Fi unit. Users can use Android mobile phone to send instructions to and query for the temperature control equipment on the remote client.

## 27.3 Control Strategy Select

Electric heating boiler is a complex temperature control object, which has much interference, pure lag, time varying, nonlinear, many parameters and so on Characteristics. It is difficult to model for the system accurately, and the fuzzy control can introduce expert experience to solve the problem of temperature without accurate mathematical model of controlled object [2]. It is not easy to eliminate the steady-state error by using fuzzy control alone, but PID algorithm can better eliminate steady-state error. It shows that combining fuzzy control and PID algorithm can make a more satisfactory effect in industrial production through the theoretical analysis and practical operation effect [3].

PID controller give the controller output  $u(k)$  via an weighted calculation of the results, which are obtained by means of carrying out proportional, integral, differential operation on error signal  $e(k)$ . This value of output  $u(k)$  is used for temperature control. The Eq. (27.1) is mathematical description for PID controller.

$$u(k) = K_p e(k) + K_i \sum_{j=0}^k e(j) + K_d [e(k) - e(k-1)] \quad (27.1)$$

The  $u(k)$  in the mathematical expression is for control input,  $e(k) = r(k) - c(k)$  is error signal,  $r(k)$  is the target temperature,  $c(k)$  is the current temperature of boiler.

In order to improve the control accuracy and robustness of temperature control system, the system combines the fuzzy control and PID control, according to the practical experience and fuzzy theory, using fuzzy control to correct parameters of PID control [4].

## 27.4 Design of the Temperature Control Equipment Hardware

The hardware diagram of temperature control equipment including the following several modules: the power modules, the ARM processor, Wi-Fi module, LCD touch screen, Nandflash, thyristor and its driving module, thermocouple and its regulate op-amp module, thermal resistance.

The ARM processor is running Linux operating system. Power supply module provides all kinds of dc voltage for the processor and its peripherals, and 220 V AC for the thyristor and its driving module.

The system employs the ARM processor own PWM generator to produce PWM signal, whose duty factor is controllable, for the thyristor driver module. The TCA785 chip serves as the core of the thyristor driver module. The circuit diagram of thyristor driver module is as shown in Fig. 27.2. In order to realize the purpose of temperature control, the module outputs the pulse signal, whose phase is controllable, to control the turn-on angle thyristor.

The circuit diagram of temperature measurement is as shown in Fig. 27.3. This module choose K type of thermocouple to measure boiler's temperature. As shown in Fig. 27.3, E1 and E2 are input ends of the module for introducing temperature signal sensed by thermocouple. The theoretical magnification of the amplifier module is designed for 49 times. The temperature of indoor is measured by thermal resistance, as shown X\_R16 in Fig. 27.3, for the purpose of temperature compensation for the cold end of thermocouple. The two kinds of analog signal are introduced into the CPU, Using the ARM processor (S3C6410) own A/D converter to carry out A/D conversion, to calculate the actual temperature of boiler.

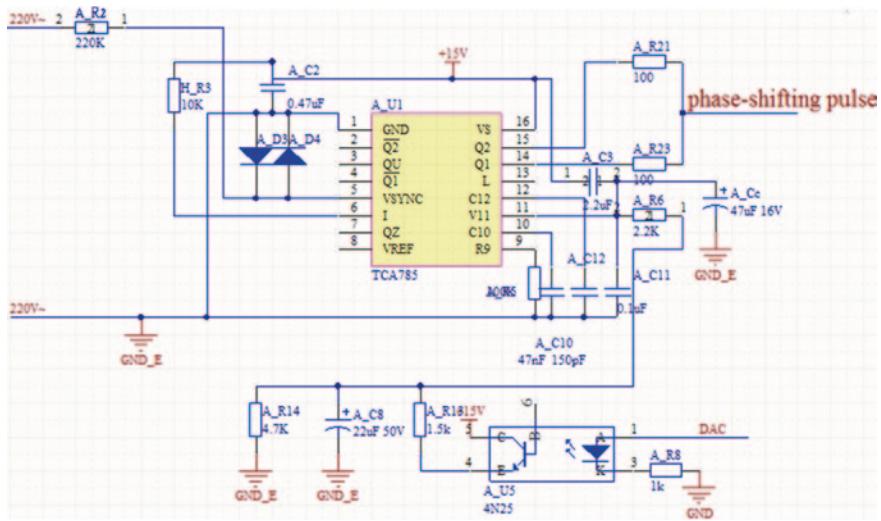


Fig. 27.2 The circuit diagram of thyristor driver module

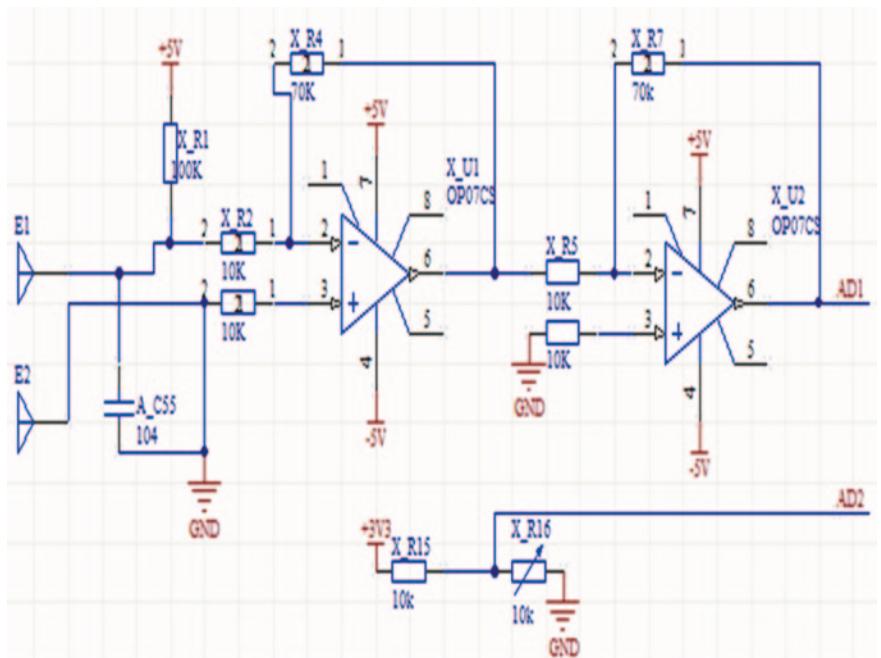


Fig. 27.3 The circuit diagram of temperature measurement

In order to realize seamless connection with the Internet, the system employs the Wi-Fi module of Realtek RTL8187L. In order to let workers operate equipment in the field, we use the resistive touch screen and LCD. The system adopts Nandflash to store the program code.

## 27.5 Design of System Software

The system uses the client/server design patterns, temperature control devices server as the servers, the distant Android mobile phone acts as a client. The design of the system software contains the transplantation of Linux operating system, the development of driver for Wi-Fi wireless card, touch screen and LCD, and the development of application at the server-side; at the mobile client, the software should complete data receiving, inquiring information about the working state of the boiler, displaying messages, and sending instructions.

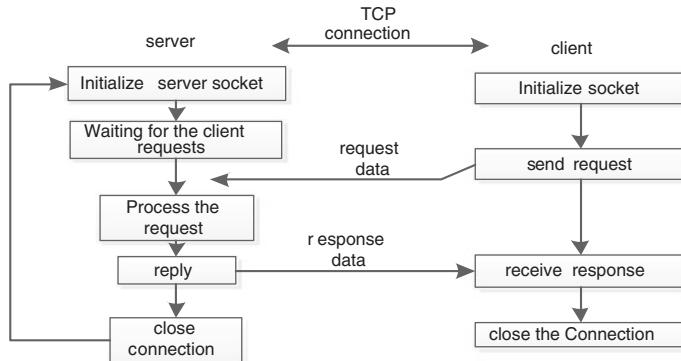
### 27.5.1 *Design of Server Software*

Linux kernel can be cut very small, and its source code is open to all users. According to their different needs, users can make modification and cut out upon the Linux kernel. Linux system has perfect network communication protocols and document management mechanism, can support almost all the Internet network protocols and a lot kinds of the file system [5].

The temperature control unit of temperature control equipment chooses Linux2.6 as the operating system, compared with Linux2.4, Linux2.6 supports the kernel preemption, which makes its real-time performance more ideal, can completely meet the system requirements. The kernel transplant steps are as follows: At first download and unpack the kernel code, modify the document of makefile in the kernel directory so as to adapt to the ARM cross-compiling environment, modify the clock and flash division information, according to the hardware platform, and then compile configured the kernel, and make root file system. To this step the previous work of transplant is ready. The order of transplant is: transplant bootloader first, and then the kernel, last for the file system. The file system can also be compiled into the kernel [6].

Wireless card Wi-Fi driver belongs to Linux network drivers. The project employs RTL8187L module of Realtek Company as Wi-Fi module. Realtek web site provides the wireless module to support the Linux OS, The source code of driver for RTL8187L provided by Realtek official has very good function support. So this system chooses the driver provided by Realtek official, and we do some appropriate modification on the driver to meet the needs of the system.

The design procedure of the drive is as follows: download RTL8187L source code of the driver, copy the files of RT18187 and IEEE802.11 to the path:driver/net/wireless. Modify the files: Makefile and Kconfig, so the driver can be added to the kernel and compiled, use the order “make modules” to compile and generate



**Fig. 27.4** TCP network communication model

kernel module file, download the kernel module file to hardware platform and install the kernel module. So the system can well support Wi-Fi module, and have the function of network communication. Use similar methods to design the drivers of resistive touch screen and LCD.

The application program at the server side should realize: fuzzy PID temperature control and the network communication. Temperature sensors, thermocouple and thermistor, collects the temperature information, and let the CPU carry out A/D conversion and calculate the current temperature of the boiler. Combined with target value of temperature user set and the current temperature of boiler, Fuzzy PID controller employed by our system can give a best controlling quantity.

Linux has provided the network function of TCP/IP. The system uses the client/server model (C/S), employs TCP/IP communication protocol, can transmit data after the connection between the client and server been established [7, 8]. At the server side, the system uses the socket technique of Linux to complete network communication, and finish some work designated by the client. The system adopt the technology of thread-pool, which means that the OS should create several threads previously, so that the system can deal with the received business more conveniently and fast. The design of server based on TCP has the following steps: create a socket, bind IP address and port to the socket, set allowed maximum number of connections, wait for the client connection, send and receive data, close network connection finally. According to the different request of clients, the OS use different threads in the thread pool to hand business. The network communication model based on TCP is as shown in Fig. 27.4.

### 27.5.2 The Design of Client Software

Now public places being covered by Wi-Fi signal has become more popular. The managements of this company can view the state of boiler equipment operation; send some instructions according to different client permissions on a business trip,

as long as being covered by Wi-Fi signal. The client is mobile phones running Android system. The client is to complete the function of the right part of Fig. 27.6. Specific steps is: call the function `Socket()` to create a flow socket, and connect to the server, call the functions belong to the class of `Socket`: `getOutputStream()` and `getInputStream()` to get the output and input stream, the system can send and receive network data at this step, close the socket at the end of communication [9].

## 27.6 System Test

### 27.6.1 Temperature Measurement Module Testing

The theoretical value of voltage magnification of thermocouple regulate module shown in Fig. 27.5 is 49 times, the actual magnification is 46.2 figured out from practical measurement data shown in Table 27.1

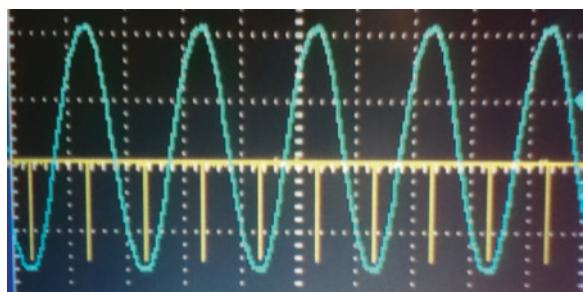
### 27.6.2 The Thyristor Driver Module Testing

The principle diagram of the thyristor module driver is as shown in Fig. 27.2. Figure 27.5 shows the test result observed via an oscilloscope. The sine wave signal, whose frequency is 50 Hz, is synchronous input signal. The other signal is pulse output signal. The phase angle of pulse output signal is controlled at 90° when the duty factor of PWM signal is set 50 %. The testing shows that the phase angle of pulse output signal can accurately shift from 0 to 180° controlled by PWM signal, whose duty factor is controllable.

### 27.6.3 Temperature Control Effect Testing

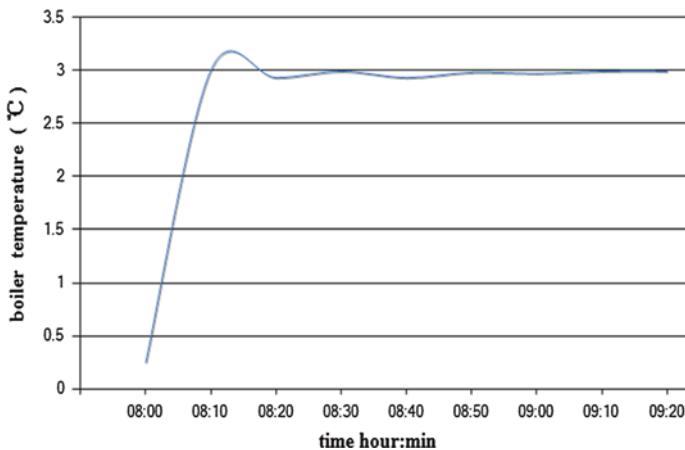
The actual temperature control effect of temperature control unit is shown in Fig. 27.6. The target temperature we set is 300 °C. We started heating at eight a.m.

**Fig. 27.5** Result observed via oscilloscope



**Table 27.1** Measurement data of magnification module

Input voltage(mv)	Output voltage(mv)	Magnification
29.2	1348	46.16
33.3	1539	46.22
35.3	1633	46.26
37.4	1725	46.12
39.3	1817	46.23
41.3	1908	46.20
45.2	2087	46.17
48.5	2242	46.23
52.1	2409	46.24

**Fig. 27.6** Temperature control effect

The temperature was stable at 300 °C after about 63 min. The steady-state error is in two negative degrees Celsius.

#### 27.6.4 System Overall Testing

Two temperature control equipment were selected at system overall testing. The remote client can log on to different temperature control equipment, send command to temperature control equipment, and inquire the data. The equipment initialization can be carried out at the temperature control equipment. The real-time control boiler heating is started after PID parameters setting being finished. When the temperature control equipment is working, the remote client can view the information of equipment, such as, the current temperature, PID parameters. Remote client can send stop heating instruction to the temperature control

equipment to inform equipment stop working. At the whole experimental process, the fuzzy PID control algorithm is running well, can accurately control temperature of boiler. The real-time communication can be well realized between the client and the server. The work of temperature control equipment can be monitored by remote client.

## 27.7 Conclusion

This system employs a high-performance ARM processor S3C6410 produced by Samsung, uses embedded operating system Linux, combined with the Wi-Fi technology, and has realized the purpose of remote monitoring temperature of boiler. The system has a good application effect. Remote monitoring technology is a new kind of control technology, the model of our remote monitoring system can also be used in other areas such as, remote monitoring home, remote agricultural production, etc.

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# Chapter 28

## Remote Temperature Monitoring System Based on Embedded Web Technology

Zong Ming, Zhou Yinfeng, Shi Jie and Dai Zhaohui

**Abstract** The Embedded Web Server system in remote temperature monitoring system based on the PIC8 bit microcontroller was discussed. A remote temperature monitoring system based on embedded and Web technology was proposed. Managers can completely access the remote device via the Internet using a Web browser and can monitor and maintenance other operations without having to install specific software. This solution has the cross-platform ability to effectively solve the use of the limited resources to achieve the network access to the equipment.

**Keywords** Embedded system • Web • TCP/IP • Monitoring • CGI

### 28.1 Introduction

In the field of people's daily life, industrial manufacturing, refrigeration, and temperature are important factors in the current environment, which are widely used as reference factors. In order to ensure the normal operation of the various tasks, such as real-time monitoring of temperature in the fire alarm, greenhouse, or granary, cold storage temperature adjustment, temperature control system based on temperature parameters was widely development and use [1]. Use the traditional sense of the thermometer collection temperature information, not only acquisition low accuracy, bad real-time, and operation of the personnel of high labor intensity, go against the extensive expansion. Moreover due to environmental factors

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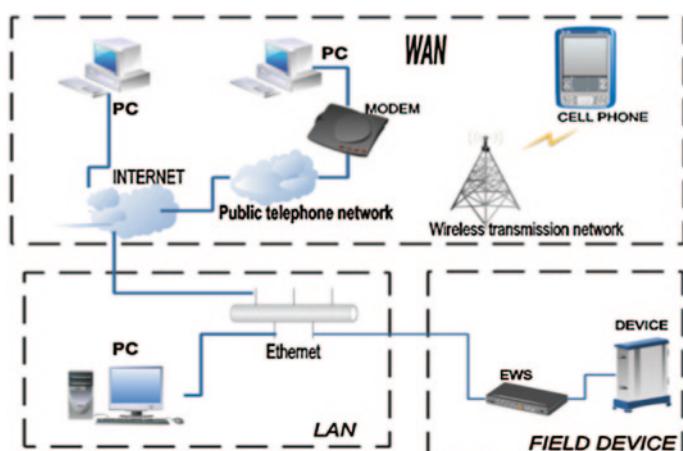
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to the problem of data acquisition, especially in the factory, the staff can no longer stay in the field observation and collection temperature, Need to implement data acquisition and transfer it to a local centralized processing, in order to save manpower and improve efficiency, But this appears the problem of data transmission, due to large plant, you need to transfer data using traditional methods likely to cause waste of resources and the operability is poor, accuracy is not high, which in varying degrees, limit the work carried out and unfold. Therefore, this paper presents an embedded remote temperature monitoring system based on Internet, tcp/ip protocol, and a web server integrated in embedded systems, so that managers can be at anytime, anywhere access remote to the system, to view system status. Implement a cross-platform visit between heterogeneous devices.

## 28.2 Overall System Architecture

The design is based on pic18f46k22 chip, implement http service in the embedded device, convert it into the web server embedded in the device being controlled, So for the remote user or administrator provides a no client cross-platform management interface. The administrator can through the wan (Internet, public telephone network, wireless transmission network) at any time and any place monitoring equipment state. The system architecture consists of three parts of the wide area network, local network, embedded web server [2], shown in Fig. 28.1.

1. Field devices: field devices consist of embedded web server (EWS) and equipment, EWS and equipment connected to in the form of relay. Through the network interface, EWS upload information to the network.



**Fig. 28.1** Overall system architecture

2. The local network: local network using the Ethernet network, LAN PC directly through web browser to view the status of the EMS. And send commands to the EWS. The use of local network in order to make the EWS can connect to the Internet.
3. Wide area network: including the Internet, public switched telephone network and wireless transmission network administrator via a PC or cell phone to monitor the EWS.

### 28.3 System's Hardware Design

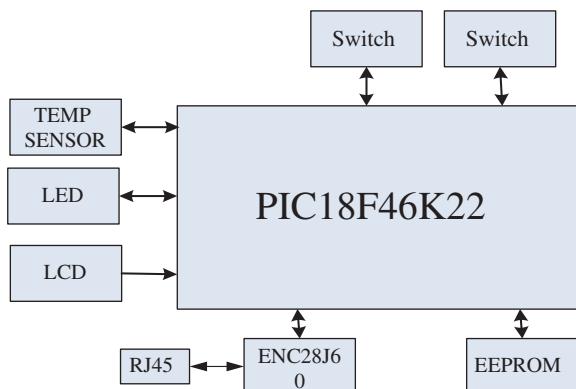
In order to ensure the practicality and scalability of the system, we use the microchip PIC18F46K22 chip; the pic18f46k22 is rich with peripheral interfaces, which is a high-performance chip. The system hardware structure is shown in Fig. 28.2.

The pic18f46k22 chip is specific with 64 K of flash memory and 1 K of the EEPROM. The pic18f46k22 chip has 30 A/D converter channels, two SPI ports, and two comparators. Built-in EEPROM is too small. Not conducive to the page file storage, and does not conducive to expansion. Added a 25LC256 EEPROM capacity is 256 KB. Chip external 16 \* 2 LCD screen used to display some basic status information, and debugging purposes. Obtain the surrounding temperature information by the temperature sensor. Through the enc28j60 and RJ45 jack connected to Ethernet.

### 28.4 System Software Design

Web-embedded monitoring models based on web management use B/S model, the client Web browser, and EWS. So we need to implement two functions in the embedded device. (1) TCP/IP protocol implementation and (2) establish a web server, which change the field status information to another format using WEB technology.

**Fig. 28.2** The hardware structure



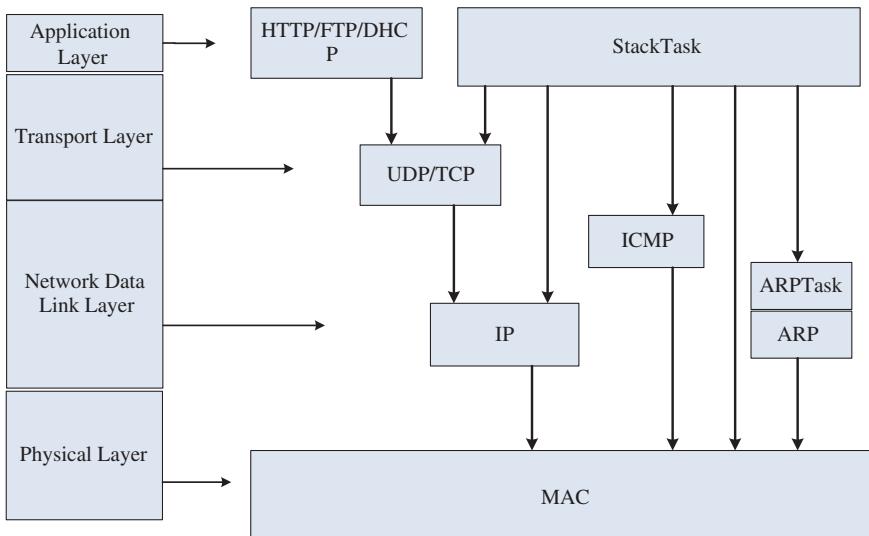
The URL from the client Web browser requests sent through the Internet to Local area network, To reach the Ethernet interface of the embedded Web server; The embedded Web server respond to this URL, Bring up device monitoring page stored in the embedded file system; When the client web browser get response, can send command to the field device b the monitoring page. EWS response and explanation of this command and forwards the command to the field devices.

#### **28.4.1 The TCP/IP Protocol Stack Downsizing**

TCP/IP protocol is the most basic protocol of the Internet, the basis of the World Wide Web by the network layer of the IP protocol and the transport layer of the TCP protocol. TCP/IP defines how electronic equipment connected to the Internet, and data transfer standard between them. The protocol uses a four-layer hierarchy, each layer is provided to call the next layer of the network to complete their own needs [3].

Traditional TCP/IP implementation is too complex occupy a lot of system resources, Must consider the cost-effective when used for its own limited resources of embedded systems, Reasonable choose the relevant protocol implement and the processing method. According to system need, making a module cutting design for network protocol stack and implement a subset of the TCP/IP protocol stack.

Like the TCP/IP reference model, the Stack divides the TCP/IP Stack into multiple layers (Fig. 28.3). The code implementing each layer resides in a separate



**Fig. 28.3** Subset of tcp/ip protocol stack

source file, while the services and application programming interfaces (APIs) are defined through header/include files. Unlike the TCP/IP reference model, many of the layers in the stack directly access one or more layers which are not directly below it. A decision, as to when a layer would bypass its adjacent module for the services it needs, was made primarily on the amount of overhead and whether a given service needs intelligent processing before it can be passed to the next layer or not [4].

An additional major departure from traditional TCP/IP Stack implementation is the addition of two new modules: “StackTask” and “ARPTask”. StackTask manages the operations of the stack and all of its modules, while ARPTask manages the services of the Address Resolution Protocol (ARP) layer [5].

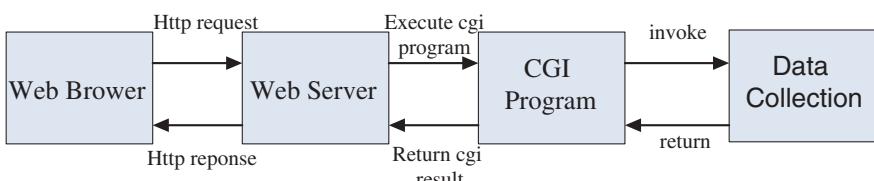
#### 28.4.2 The Design of the CGI Program

CGI defines the Web server and users' access and implementation of the standard interface of the program. It makes the interaction between the browser and Web server. Figure 28.4 shows the relationship between the browser, Web server, and CGI program.

When customers access the Web server through a browser, Browser and Web server establish a TCP connection and send HTTP requests. The Web server receives an HTTP request. Analysis requested content, if the requests for static documents. Directly return the result of the request. If the CGI request, The Web server to the request through environment variables, command line arguments or standard input passed to the specified CGI program, and Take over this CGI program standard output. CGI program process the corresponding information. The results to an HTML form file to standard output. Web server added additional header information and the status line to the output of the CGI program. Then, the results sent back to the browser.

### 28.5 Summary

In this paper, Design and implementation a Remote temperature monitoring system based on embedded Web technology. Resolve the problem of using the limited resources to implement network access to the embedded device. Managers can be



**Fig. 28.4** Workflow chain of CGI

exempted from the restrictions of time and space through a Web browser on the device for real-time monitoring. Without having to install specific software, with a cross-platform property, more suitable for distributed network management, the accused device has the intelligence and remote management features.

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**Part IV**  
**Bioinformatics and Applications**

# Chapter 29

## Analysis of Protean Genomics to Increase Genome Annotation Accuracy

Lina Zhao, Baoling He, Weiwei Li and Candong Wei

**Abstract** Advances in sequencing strategies facilitate complete genomic sequence of a variety of organisms. However, conventional computational predictions for genome annotation remain imperfect. Here, we applied a protean genomics approach to complement genome annotation by combining bioinformatics analysis and proteomic data. By using Shebelle Flexner 2a as a model, a total of 1041 proteins were unambiguously assigned, including 240 hypothetical proteins. Through comprehensive analysis against in-house N-terminal extension database, three annotated open reading frames (Offs) were respectively extended upstream. Above all, eight new ORFs were discovered by searching our MS/MS data against all six possible reading frames of S. Flexner 2a str. 301 genome, which were not predicted by any other annotation approaches. Our findings indicate that protean genomic analysis is quite qualified for comprehensive and accurate genome-wide annotation. This strategy could be taken as a routine work.

**Keywords** Genome annotation • Protean genomics • Shebelle flexner

### 29.1 Introduction

With recent improvements in sequencing technology, the number of sequenced organism genomes has been rising sharply. Nevertheless, accurate annotation of the resulting sequenced genomes continues to be a challenging task. Conventionally,

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most genome sequences are annotated with multiple gene prediction algorithms such as glimmer, critical, and gene mark, or by manual assignment based on blast search results [1]. Gene density is sufficiently high in prokaryotes, such that coding sequences (cuss) frequently overlap. Moreover, exon–intron structures presented in eukaryotic genomes also make annotation difficult to predict computationally. These annotations are rarely experimentally validated, though in silicon annotation methods could be executed with both high speed and coverage. The predicted genes exhibit frequent errors, particularly in false recognition of alternative start cordon, underestimate of short cuss and powerlessness in the face of overlapping genes. The previous studies have demonstrated that error rates in the definition of translation start sites (toss) varied from 10 to 40 % in some bacterial and archival genomes, according to different computational methods [2]. Likewise, after analysis of overlaps larger than 60 BP among 338 prokaryotic genomes, it was found that most previously annotated genes were done so incorrectly [3]. As such, there is a great need for complementary annotation approaches for conventional genome annotation.

Currently, proteomic methods have been used to address difficulties in gene annotation. Unambiguous identification of proteins by mass spectrometry is more explicit and confident than that from genomic sequence data alone. Integrating proteomic information into the genome annotation process, called protean genomics, directly maps ms/ms spectra data against all six possible reading frames from raw genomic dank sequences, that is, experimental proteomic data can be fed back to genome to aid in the validation of predicted protein-coding genes [4, 5] potentially avoiding any biases of the computer algorithm. As a complementary annotation approach, proteomic methods are important for improving the quality of genome annotation, especially for correction of start cordon errors [6] and discovery of novel genes [7, 8].

Shebelle Flexner is the primary causative agent of endemic shigellosis in developing countries. Its genome shares a large proportion of chromosomal genes with the model organism *E. coli*. It is such an attractive target for protean genomic annotation. In this article, we constructed in-house databases and applied high-throughput proteomic technology to explore comprehensive profiling of *S. Flexner* 2a str. 301. We validated 1030 protein products encoded by previously annotated genes, including hundreds of hypothetical proteins. We also corrected several TSSs with the help of the original N-terminal extension database. Furthermore, some novel ORFs were discovered. Our findings suggest that current genome annotation is not yet complete, and that protean genomic tools have the potential to validate and complement the genome-wide annotation.

## 29.2 Construction of In-House Database

### 29.2.1 Six Reading Frames Database

Translation of six reading frames is the translation of a dank sequence taking into account the three possible reading frames in each direction of the strand,

giving rise to three forward and three reverse translations. We translated nucleotide sequences of s. Flexner 2a str. 301 genome (downloaded from incubi) into all six possible reading frames, generating a set of all possible peptides (more than 15 amino acids) that could be encoded. The final database fast file had a total number of 90330 entries. The Perl program of translation is as follows:

```
use strict; use Bio::Sequa
my $castile = $ARGV[0]; # input file
my $pep file = $ARGV [1]; # output file
if($castile Esq. $pep file)
{print "input fast file should not be overlapped\n";
print "please input a new output file name\n\n";
exit(-1);}
my $ins = Bio::Sequa -> new(-file => $castile, -format => "fast");
my $outs = Bio::Sequa -> new(-file => ">".$pep file, -format => "fast");
while(my $sew = $ins -> next sew
{ if($sew-> length()%3 eel 0) my $pep = $sew -> translate; $outs -> write
sew($pep); } else {print $sew-> display id."sew length wrong\n";}
```

### 29.2.2 N-Terminal Extension Database

To detect potential extended toss of the predicted coding sequences, we constructed a specialized n-terminal extension database, using a similar strategy as previously described with some changes. The database took into account all currently annotated cuss from s Flexner 2a star 301 genome the region upstream of each cads was scanned until an in-frame stop cordon was identified. Then, the in-frame cordons downstream of this stop cordon were scanned for the first location of a start cordon (ate, gag or tag). The peptide from the new start cordon to the 33th amino acid residue downstream of original start site was collected into the extension database except one whose start cordon was the same as the previous annotation. As a result, total 1311 peptides were collected in the customized extension database.

## 29.3 Data Evaluation

MS/MS data were searched using Boito's 3.1 software (Broker Atonics, Germany) with MASCOT 2.2 plug-in (<http://www.matrixscience.com>) against the six reading frame translation of S. Flexner 2a str. 301 genome. The following search parameters were applied: max missed cleavage: 1; fixed modification: Carob amidogen halation (C); variable modification: Oxidation (M); Precursor ion mass tolerance:  $\pm 50$  pap; fragment mass tolerance:  $\pm 0.6$  Da. The false-positive rate (FPR) was estimated by searching against decoy database containing randomized sequences

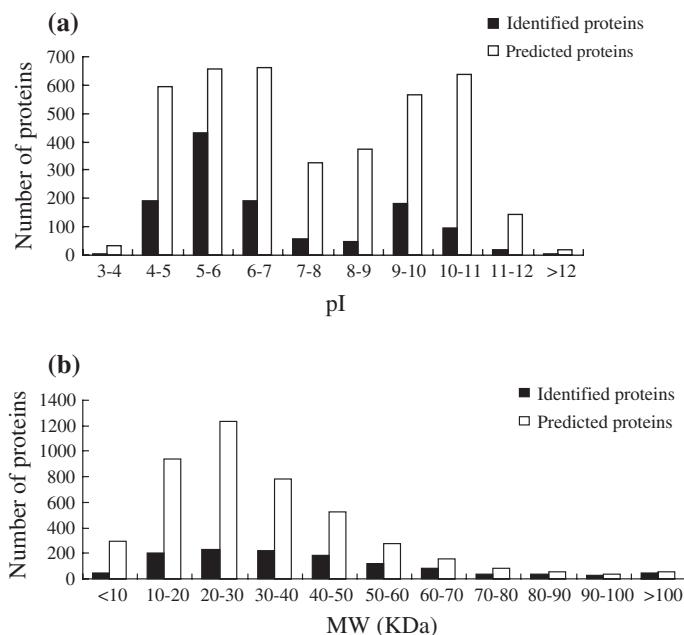
of above six reading frame database. The FDR were controlled less than 1 %. Under these criteria, all the proteins with at least one unique peptide identification at  $p < 0.01$  were considered likely to be present in the sample.

$$\text{FPR} = \text{FP}/(\text{FP} + \text{TP}) \quad (29.1)$$

## 29.4 Results of Genome Annotation Improvement

### 29.4.1 Validation of Annotated Offs

Raw MS/MS data were used to search the database containing all six possible reading frames of the entire *S. Flexner* 2a str. 301 genome using Mascot version 2.2. In total, 1041 ORFs were unambiguously assigned, of which 1030 (23 % of the 4443 annotated ORFs) were previously annotated in the *S. Flexner* 2a str. 301 genome database from NCBI, which provided a relatively complete proteome profile. On average, 3 peptides were used to identify each ORF, and amino acid sequence coverage for detected ORFs averaged 13.6 %. The distribution patterns of is electric point (pI) and molecular weight (MW) of the identified proteins were similar to those of all *S. Flexner* 2a str. 301 predicted proteins (Fig. 29.1). For



**Fig. 29.1** Patterns of pI and MW of identified/predicted proteins **a** comparison of pI between identified proteins and predicted proteins; **b** comparison of MW between identified proteins and predicted proteins

example, the pI patterns of the identified proteins had the characteristic bimodality distribution, which was previously observed for bacterial and archaic genomes [9]. Due to the lack of experimental evidence, hypothetical genes were likely annotated incorrectly and required further experimental validation. In our study, 240 hypothetical or putative ORFs were validated at the protein level, reaching 12 % of the 1944 predicted hypothetical proteins of *S. Flexner* 2a str. 301.

#### 29.4.2 Correction of Start Codon Errors

It was traditionally difficult to correctly identify the TSS within a given sequence. For example, a previous study of 143 annotated prokaryotic genomes showed that approximately 60 % of the genes might have incorrectly assigned TSSs [1]. TSSs were usually verified by N-terminal sequencing analysis. This method was often technically demanding and was not amenable to the majority of proteins with ‘blocked’, and therefore inaccessible, N-termini. To amend the approximate location of TSSs in these sequences, we developed a proteomic strategy that was likely more simple than N-terminal sequencing, and also capable of high-throughput analysis, as it was possible that incorrectly assigned start sites could be validated and corrected in a single experiment using this method.

All ms-derived peptides were screened among both the *s. Flexner* 2a str. 301 protein database (downloaded from nub) and the customized n-terminal extension database. Peptide hits using the latter indicate that the 5' end of the corresponding gene should be expanded. As a result, three genes (hype, yap, and sampan), which were identified with their current start cordon, should be relocated upstream (Table 29.1). In addition, by performing a blast search against greenback, we found the n-terminus extended proteins shared higher similarities with their counterpart homologs in other bacteria than with the original proteins (data not shown). A previous study showed that accurate prediction of toss could be critical for defining protein sequences, as well as interagency regions that might contain transcriptional regulatory elements. However, the three extension segments identified here seemed to have no effect on the function of their corresponding proteins. Nonetheless, our original strategy of n-terminal proteomic analysis represents an effective and promising means for experimental identification of toss. We expect that this strategy can be applied to other organisms.

#### 29.4.3 Discovery of Novel ORFs

The most striking result of our study was the identification of novel orbs. All ms/ms spectra were searched with mascot against the six possible reading frames of the entire genome of *s. Flexner* 2a str. 301. All assigned orbs were aligned with the current annotated orbs of *s. Flexner* 2a str. 301 using blast, and those

**Table 29.1** The result of three genes' N-terminal extension

Gene	Predicted start site	Updated start site	Old start	New start	Peptide matching N-terminal extension database
Hype	3382990	3383830	GTG	GTG	DLTFWQLR
Yap	1434566	1433987	GTG	ATG	IGIFQDLVDR VDLDGN- PCGELDE- QHVEHAR
SMPA	2752334	2752145	ATG	ATG	VVYRPDINQQ- NYL-TAND- VSK

that aligned with known proteins were discarded. As a result, we detected eight novel orbs that were not predicted in *s. Flexner 2a str. 301* by any other annotation pipelines (Table 29.2). Further analysis showed that four orbs had homology with annotated orbs from other closely related organisms, while the other four orbs were completely novel genes that showed no significant similarity to other known proteins from any species.

The novel orbs that we identified were relatively short, and most consisted of less than 50 amino acid residues. To the best of our knowledge, short cuss (especially less than 150 nucleotides) are among the most difficult genomic features to predict and are often missed during the annotation process due to conservative calls [10]. On the other hand, many novel orbs overlapped with known genes. As shown in Table 29.2, two orbs (bio50043 and bio07235) partially overlapped with known genes. In addition, the translated regions of the four novel orbs (bio68373, bio42245, bio73653 and bio48527) were completely nested within the translated regions of longer known genes. Generally, genes contained within another gene were referred to as nested genes. Of the four nested genes, three overlapped with their host genes on the complementary strand, while the remaining one overlapped with their host genes in different frames of the same strand. Previous studies suggested the presence of overlapping genes in microbial genomes, whose overlapping sequences were usually short [3]. Other studies showed that nested genes were quite rare, and most of them were often on the opposite strand of host genes. For example, in the *s. Flexner 2a* genome, set1a and set1b genes were completely embedded within the pica gene [11], and in the *E. coli* genome, the ins5b and ins5c genes were wholly contained within the ins5a gene [12]. As has been established, there is greater ineffectiveness in identifying nested genes using in silicon approaches than with experimental methods. As such, protean genomic methods offer a promising avenue toward the experimental identification of nested genes at the protein level.

Partial(s), orbs partially overlapping known genes on the same strand; nested(c), orbs completely overlapping known genes on the complementary strand; nested(s), orbs completely overlapping known genes on the same strand.

**Table 29.2** The characteristics of eight novel orbs

Gene tag	Stand	Length (as)	Overlaps	Annotation in other organisms
BIO01188	—	99	No	Hypothetical protein
BIO01608	+	80	No	Hypothetical protein
BIO50043	—	370	Partial (S)	Sulfate/this'll fate transporter subunit
BIO68373	—	59	Nested (C)	Conserved hypothetical protein
BIO07235	+	25	Partial (S)	None
BIO42245	+	49	Nested (C)	None
BIO73653	—	40	Nested (C)	None
BIO48527	—	36	Nested (S)	None

Short cuss remain largely unknown, even though small peptides encoded by short genes are involved in such diverse functions as secretion, stress response, metabolism, and gene regulation in bacteria [13]. In our study, there were no certain functional domains in eight novel orbs except for bio01608 and bio50043 (Table 29.2). Bio01608 contained the conserved domain of the yoga super family involved in bio film development and stability. Bio50043 contained the conserved domain of the abs cyst sulfate importer involved in sulfate import, whose analog in *E. coli* was annotated as a sulfate/this'll fate transporter subunit. As for nested genes, it was generally assumed that their expression correlated with host genes, either positively or negatively, similar to coordinated regulation of functionally related gene pairs [14]. But more and more studies acknowledge that most nested genes negatively influence the host gene, possibly through antisense-mediated inhibition [15]. Defining the biological functions of novel nested genes, and their coordination with host genes, requires further investigation.

## 29.5 Conclusions and Suggestions

Protean genomic strategies could provide an efficient approach to re-annotate prokaryotic genomes. Apart from the validation of predicted genes at the protein level, the greater features of protean genomic tools included revision of TSSs and discovery of novel ORFs. With the rapid development of bioinformatics, it is expected that proteomic data, in combination with bioinformatics analysis, are qualified for comprehensive and accurate genome-wide annotation. This strategy could be extended to every traditional sequence-based genome annotation endeavor.

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# **Chapter 30**

## **Statistical Analysis of Risk Factors of Major Occupational Diseases Based on Information Management System**

**Feng Mei Xing, Pan Zhang, Feng Lan Wang and Xiao Li Zhang**

**Abstract** *Objective* To investigate monitoring of occupational risks factors and preventing occupational diseases. *Methods* A computer-based occupational disease network management system was established, namely an occupational diseases declaration and management system at work place, and collected data were analyzed by the system. *Results* The total number of victims contacting the occupational hazards was 13.8 million in our city, accounting for 28 % of the total number of current workers. The cumulative number of patients with occupational diseases has reached to 1,529 in the recent 5 years. *Conclusion* The network information management contributes to monitoring and prevention of occupational diseases, standardizing and improving the quality and efficiency of occupational diseases prevention.

**Keywords** Computer-based network management • Occupational diseases • Monitor

### **30.1 Introduction**

With the development of society and economy, the incidence of occupational diseases, however, wanders in a high level and shows a rising trend [1]. To control the risk factors and prevent occupational diseases, our city carries out information management in urban areas and their counties by establishing occupational disease declare and record management system at work place to monitor and report the risk factors of occupational diseases which will help the authorities to find out the occupational health status of various sectors in our city timely and prevent the occurrence of occupational diseases [2]. The results of statistical analysis toward the collected date by this system are as follows:

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## 30.2 Subjects and Methods

### 30.2.1 Subjects

Enterprises in urban areas and subordinate counties (9 areas and 10 counties) were chosen as subjects, including the following industry categories: (1) manufacturing; (2) transportation, warehousing and postal services; (3) wholesale and retail trades; (4) health, social security and social welfare; (5) agriculture, forestry, animal husbandry and fishery; (6) mining industry; (7) electricity and gas industry; (8) building industry; (9) leasing and commercial services; (10) resident and other services. The enterprises with registration were rejected.

### 30.2.2 General Information about the Enterprises

Name, subordinate areas and counties, industry category and nature of the enterprises, etc. are included.

### 30.2.3 Incidence of Occupational Diseases

The number of people exposed to occupational hazards, cumulative number of case with occupational diseases, the number of new case and suspected case are counted.

### 30.2.4 Major Occupational Risk Factors

Dust, toxic chemical, high temperature, noise and radiation are covered.

### 30.2.5 Methods

Cooperated with the city occupational disease supervision department in December, 2011, we analyzed the data of 3,448 enterprises in 11 industries collected by the occupational disease declare and record management system. First, the reported results were classified into five categories by the system, such as industry, risk factors, registered type, administrative area and enterprise list. Then, statistical analysis forms were generated according to categories and screening conditions. Based on the results, four industries with higher prevalence rate were chosen for further study, including mining, manufacturing, wholesale and retail, electricity and gas industries.

### ***30.2.6 Statistical Analysis***

The analysis was performed using SPSS13.0 software package.

## **30.3 Results**

The data of 3,448 enterprises in 11 industry categories were collected among which the total staff number came up to 490,515 with 138,000 contacted risk factors, accounting for 28 % of the total staff, and cumulative number with occupational diseases reached 1,529 in 3,259 enterprises among 5 industries in recent 5 years.

### ***30.3.1 Analysis on Incidence and Risk Factors of Occupational Diseases in Different Industries***

#### **30.3.1.1 Incidence of Occupational Diseases**

The result shows that manufacturing, mining, wholesale and retail, electricity and gas industries ranked the top four in 3,448 enterprises among 11 industries when case contacted occupational risk factors and case with occupational diseases were considered.

#### **30.3.1.2 Risk Factors of Occupational Diseases**

Table 30.1 shows the first 10 risk factors and the diseases they caused. When ranked by case number contacted occupational risk factors, the top 5 factors were as follows: noise, high temperature, other dust, silicon dust and CO. Instead, when ranked risk factors according to which one could cause the most case number with occupational diseases, the top 5 were as follows: silicon dust, coal dust (with free SiO<sub>2</sub> content < 10 %), other dust, electric welding soot, noise and gasoline.

### ***30.3.2 Incidence and Risk Factors of Occupational Diseases in Manufacturing Industry***

In manufacturing enterprises, staff in ferrous metal smelting and rolling processing industry is most likely to contact risk factors and the second is the non-metallic mineral products industry.

The most case with occupational diseases located in chemical raw materials and chemical products manufacturing followed by electrical machinery and equipment manufacturing industry and special equipment manufacturing industry (Table 30.2).

**Table 30.1** Top 10 risk factors and case number with occupational diseases caused by risk factors among 11 industries

Risk factors	Case number contacted occupational risk factors	Rank	Case number with occupational diseases	Rank	Enterprises number
Silicon dust	19695	4	351	1	564
Coal dust (with free SiO <sub>2</sub> content < 10 %)	6826	7	139	2	266
Other dust	25194	3	82	3	881
Electric welding soot	8689	6	79	4	649
Noise	33098	1	66	5	1484
Gasoline	3773	8	66	5	717
Cast dust	3282	9	49	7	218
Diesel	2884		41	8	527
Xylem	1112		26	9	91
Grease paint	88		23	10	16
Cement dust (with free SiO <sub>2</sub> content < 10 %)	2985	10	3		156
CO	15520	5	2		266
High temperature	27344	2	0		451

**Table 30.2** Incidence of occupational diseases in manufacturing industry

Industry categories	Case number contacted occupational risk factors	Case number with occupational diseases			Enterprises number
		Cumulative	New	Suspected	
Chemical raw materials and chemical products manufacturing	2553	194	2	0	87
Electrical machinery and equipment manufacturing industry	1273	139	2	132	27
Special equipment manufacturing industry	2345	122	4	0	65
Non-metallic mineral products industry	10764	55	9	8	321
Metal product industry	6925	21	2	10	340
Ferrous metal smelting and rolling processing industry	44286	19	2	35	230
Transportation equipment manufacturing industry	3149	13	0	0	23
Non-ferrous metal smelting and rolling processing industry	4662	9	0	0	26
Handicrafts and other manufacturing industries	7963	8	0	0	59
General machinery manufacturing	2501	4	0	0	159
Food industry	140	2	0	0	22
Printing and record media copying	375	2	0	0	43
Total	86482	590	21	190	1401

### **30.3.2.2 Risk Factors of Occupational Diseases in Manufacturing Industry**

The result indicates that the main risk factors which may lead to occupational diseases were silicon dust, cast dust and electric welding soot.

The top 5 risk factors that were contacted by most people with occupational diseases were as follows: noise, high temperature, other dust, silicon dust, electric welding soot and cast dust.

### **30.3.3 Incidence and Risk Factors of Occupational Diseases in Mining Industry**

#### **30.3.3.1 Incidence of Occupational Diseases in Mining Industry**

Case number contacted occupational risk factors was higher in ferrous metals mining, non-metallic mining, other mining and non-ferrous metals mining while case number with occupational diseases was higher in non-ferrous metals mining, ferrous metals mining and non-metallic mining among which both the case number with occupational diseases and suspected occupational diseases ranked first in non-ferrous metals mining listed in Table 30.3.

#### **30.3.3.2 Risk Factors of Occupational Diseases in Mining Industry**

The result shows that the main risk factor causing occupational diseases was silicon dust and risk factors that were contacted by most people were silicon dust, noise, other dust and electric welding soot.

**Table 30.3** Incidence of occupational diseases in mining industry

Industry categories	Case number contacted occupational risk factors	Case number with occupational diseases			Enterprises number
		Cumulative	New	Suspected	
Ferrous metals mining	7788	187	4	10	432
Non-ferrous metals mining	1163	212	3	609	39
Non-metallic mining	1973	67	1	0	221
Other mining	1541	2	0	0	65
Total	12465	468	8	619	757

### ***30.3.4 Incidence and Risk Factors of Occupational Diseases in Wholesale and Retail Trades***

#### ***30.3.4.1 Incidence of Occupational Diseases in Wholesale and Retail Trades***

We can observe from Table 30.4 that case number contacted occupational risk factors and with occupational diseases is high in retail trades.

#### ***30.3.4.2 Risk Factors of Occupational Diseases in Wholesale and Retail Trades***

The result illustrates that gasoline and diesel were the major occupational risk factors and risk factors that were contacted by most people were also gasoline and diesel.

### ***30.3.5 Incidence and Risk Factors of Occupational Diseases in Electricity and Gas Industry***

Incidence of Occupational Diseases in Electricity and Gas Industry. The result indicates that case number contacted occupational risk factors and with occupational diseases is high in electricity and gas industry.

Risk Factors of Occupational Diseases in Electricity and gas Industry The result indicates that coal dust was the major occupational risk factor, and risk factors that were contacted by most people were noise and coal dust.

## **30.4 Discussions**

### ***30.4.1 Computer-Based Network Management is Helpful to Monitor and Prevent Occupational Diseases***

With the rapid development of economy, the task of occupational disease prevention in the city is getting heavier with various occupational diseases being

**Table 30.4 Incidence of occupational diseases in wholesale and retail trades**

Industry categories	Case number contacted occupational risk factors	Case number with occupational diseases			Enterprises number
		Cumulative	New	Suspected	
Wholesale trades	229	2	0	0	25
Retail trades	3470	231	0	7	682
Total	3699	233	0	7	707

increasingly serious and incidence of occupational diseases rising. The system helps the authorities to take control of the situation so as to focus their management on the most needed industries. On the basis of database established by the system, enterprises and the supervision departments can monitor the risk factors of occupational diseases in work place which improve the occupational disease prevention services through its different operating permissions, such as reporting, modifying, deleting, reviewing, browsing, querying, statistics and information analysis [3, 4].

### ***30.4.2 Computer-Based Network Management Standardizes and Improves the Quality and Efficiency of the Prevention and Control of Occupational Diseases***

Enhancing the prevention of occupational diseases by computer-based method is a very important and effective way [5]. Previous prevention reports which need to be presented manually show a low work quality and efficiency. The computer-based system involves the enterprises inputting related data and supervision department analyzing the data, which speeds up the information input, processing and feedback speed, reduces the workload of enterprises and supervision department, saves time and labor, and improves the scientific and technological prevention level of occupational diseases.

### ***30.4.3 Computer-Based Network Management is a New Comprehensive Management Model for Occupational Diseases Prevention***

Computer-based platform or information is a need and development tendency in contemporary social management and becomes an important symbol of modern management. The computer-based system contributes to a comprehensive understanding of authorities toward the general and changing information of occupational health, provides a new, standard, routine management mechanism, improves the area's overall level of occupational disease prevention which ensures the workers' lawful rights and promotes the establishment of the new service model of occupational disease prevention and management.

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# Chapter 31

## Cana Cloning and Plant Expression Vector Construction of Soybean 11s Glycerin Gy3

Hongyun Huang and Ning Du

**Abstract** The RNA was extracted from immature seeds of soybean and it is directly used in single-stranded dank synthetic reaction. According to soybean 11s glycerin Gy3 coda sequences in gene bank, a pair of primers was designed. Double-stranded coda was amplified by PCR. The amplified Gy3 coda was cloned into plasmid pMD19-T and sequenced. Fragment of the Gy3 coda in the recombinant plasmid was cut with Xbox I/bah I and ligated with plasmid pbi121, and then a plant expression vector was constructed. It includes camv35 proctor, nose terminator and no-II gene.

**Keywords** Soybean • Gy3 • Coda • Clone • Plant expression vector

### 31.1 Introduction

Soybean seed is rich in protein, whose protein content is much higher than any other crops, accounting for about 20 % of seed dry weight. According to the settling velocity in the buffer of pH 7.6, 0.5 m soybean globulins include four components: 2s, 7s, 11s and 15s, of which 11s globulin is the major storage protein of soybean, accounting for about 43.6 % of the total protein content. Soybean globulins express only in the period of seed endosperm formation and accumulate in cotyledon cells of protein [1]. Studies show that soybean 11s globulin has five a-b subunit (a representative of acidic peptide, b represents a basic peptide), which is composed of five different genes encoding the gill ( $a_1b_2$ ), gy2 ( $a_2b_1a$ ), Gy3 ( $a_1ab_1b$ ), Gy4 ( $a_5a_4b_3$ ) and Gy5 ( $a_3b_4$ ), and each subunit consists of three intones and four axons. According to the coda nucleotide sequence homology, the family is divided into two groups 1 and 2: group 1 includes Gyl–Gy3 and group 2 includes Gy4 and Gy5, and the homology of the same group is 85–90 % and of different groups is only about 50 %. We often see the research and the application about

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each subunit, and Gy3 coda is the most widely used. Kats be [2] first reported Gy3 coda and rice glutel gene GluB-1 promoter composition fusion gene into rice, and they found soybean globulin in the endosperm of rice, forming six dimmer senior structure and rice glutamine co-localization in protein body 2, whose properties are convenient for the use in the experiment. Zhang Xian in, Xue Qing Zhong [3, 4] and so on constructed globulin subunit ( $a_{1a}b_{1b}$ ) gene expression vector and then transferred into agro bacterium respectively for rice and mulberry genetic transformation and obtained transgenic plants. This study used RT-PCR method of rapid amplification and cloning of Gy3 coda sequence. The construction of the plant expression vectors is convenient for transformation and utilization research. It can be used not only for our current research topics to improve sand plant protein content, but also in other economic crops, grain crops or grass transgenic research.

## 31.2 Material and Method

### 31.2.1 The Material

#### 31.2.1.1 Plant Material

Soybean material “Henning no37” was used for the extraction of total RNA.

#### 31.2.1.2 Strains and Plasmids

Mongolia University gene engineering laboratory preserves clones of *Escherichia coli* strain dh5  $\alpha$ ; pMD19-T plasmid vector was purchased from Tamara Company; construction of carrier pbi121 plasmid vector was done by Shandong University, Jing.

### 31.2.2 The Method

#### 31.2.2.1 Extraction of Total RNA

Eighty micrograms of immature seeds of soybean, after pollination for 45 days, was taken, precooked, ground using mortar and pestle. While grinding, liquid nitrogen was added continuously and ground into powder, and then 6 ml RNA reagent (reagent kit in the lysine) was added. It was ground further with lysine.

#### 31.2.2.2 Reverse Transcription Coda Synthesis

Total RNA is used as template, and olio (dot) is used as a primer. According to the following requirements of the preparation of reverse transcription reaction

liquid, we implement reverse transcription reaction according to the following conditions:

42 °C	30 min (1 cycle)
99 °C	5 min
5 °C	5 min

### 31.2.2.3 PCR Amplification Reaction

On the basis of the [5]gene bank registration number m36686 reported in the literature, a pair of specific primers for soybean mRNA31–1539 base ends sequence was designed. :

Up primers: 5`-tctaga aacactcatcagtcatcacc-3'

Down primers: 5'-ggatcc ctaagccacagctcttc-3'

PCR amplification was carried out under the following conditions:

94 °C	5 min (1 cycle)
94 °C	1 min
56 °C	45 s
72 °C	2 min (30 cycle)
72 °C	10 min

### 31.2.2.4 PCR Cloning and Identification

The PCR product and pMD19-T plasmid vector were leased by t4 dank in, 14°C–16°C reaction (12 h). Using CaCl<sub>2</sub> prepare of *E. coli* dh5a competent cells; will be connected by thermal shock method transformed into *E. coli* competent cells, the bacteria liquid onto a amp, X-gal, pit lb culture medium, 37°C cultured overnight. Pick floccosoids, using alkaline lyses method of extracting plasmid, using restriction end nuclese Xbox, Bahia enzyme identification and PCR detection.

### 31.2.2.5 Sequence Analysis

Dan sequence determination was carried out by Dalian boa Biotechnology Company, nucleic acid sequence analysis was done using nubby online analysis, and sequence analysis was done using software cols free workbench 2.5 by amino acid coding analysis [6].

### 31.2.2.6 Plant Expression Vector Construction

Plasmid pbi121 was extracted by alkaline lyses method and it contains a target gene pMD19-T; meanwhile, Xbox and Bahia double-digest the plasmid, with

0.7 % agarose gel electrophoresis digestion products, using dank fragment recovery kit for recycling purpose fragment, and t4 dank lipase gene fragment and the carrier recovery. Alkaline lyses method was used for extraction of plasmid dank, and Xbox and Bahia double-digest the recombinant expression vector pbi121/Gy3. Connection system includes the following components (10 ml):

Water	2 $\mu$ l
Pbi121	2 $\mu$ l
Gy3	4 $\mu$ l
Buffer	1 $\mu$ l
T4 dank ligers	1 $\mu$ l

## 31.3 Results

### 31.3.1 RNA Extraction

Soybean immature seeds contain large amounts of protein, carbohydrate and other secondary metabolites after 40 days of blossoming, so we added double the quantity of lysine , which contains two times quantity of proteins, sugars and phenol substances. Isopropyl alcohol and chloroform extraction was used to obtain highly purified RNA samples. RNA concentration was found to be 1.65 ug/ $\mu$ l using spectrophotometer,  $1.8 < \text{od}_{260/280} < 2.0$ , and through the denaturing electrophoresis detection, we obtained two clear bands of 28s and 18s(Fig. 31.1); therefore, we obtained the RNA of high purity.

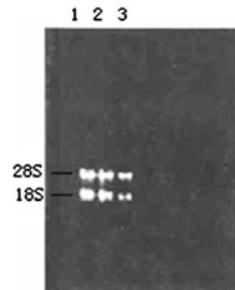
### 31.3.2 PCR Amplification Reaction

The RNA is used as template by reversing transcriptase to get coda the first strand, which includes using synthetic primers for amplification of a treaty 1520 bp belt (as shown in Fig. 31.2).

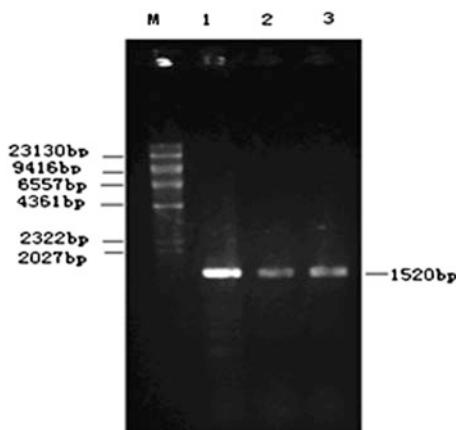
### 31.3.3 Objective to Clone and Identification of Genes

The target gene and cloning vector were connected in order to get recombinant plasmid pMD19-T/Gy3, transformed into Ecolab dh5  $\alpha$ , amps, X-gal, pit

**Fig. 31.1** Electrophoresis of soybean



**Fig. 31.2** Electrophoresis of PCR



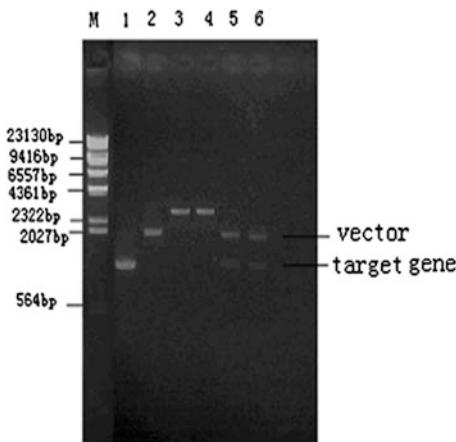
screening out of 32 white and 3 blue plaques. By enzyme digestion and PCR detection, positive clone strains were obtained (as shown in Fig. 31.3).

### 31.3.4 The Sequence Analysis

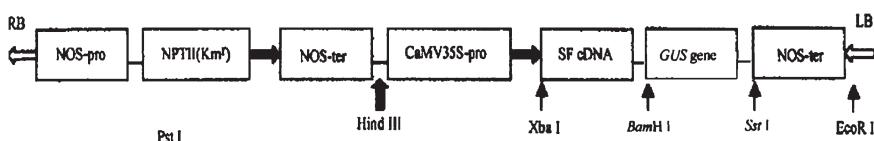
Sequencing primer is m13 (-47) and rave (-m) universal primers. Sequencing was done through the nubby server, and blast software was used for sequence homology comparison; nucleotide and encoded amino acids are shown as follows:

AACACTCATCAGTCATCACC	ATG GCC AAG CTA GTT TTT TCC CTT TGT TTT CTG CTT TTC AGT M A K L N F S L C F S L F S
GGC TGC TGC TTC GCT TTC AGT TCC AGA GAG CAG CCT CAG CAA AAC GAG TGC CAG ATC CAA AAA G C C F A F S S R E Q P Q Q N E C Q I Q K	
CTC AAT GCC CTC AAA CCG GAT AAC CGT ATA GAG TCA GAA GGT GGG TTC ATT GAG ACA TGG AAC L B A L K P D N R I E S E G G F I E T W N	
CCT AAC AAC AAG CCA TTC CAG TGT GCC GGT GTT GCC CTC TCT CGC TGC ACC CTC AAC CGC AAC N K P F Q C A G N A L S R C T L P N N R N	
GCC CTT CGT AGA CCT TCC TAC ACC AAC GGT CCC CAG GAA ATC TAC ATC CAA CAA GGT AAG GGT A L R R P S Y T N G P Q E I Y I Q Q G K G	
ATT TTT GGC ATG ATA TAC CCG GGT TGT CCT AGC ACA TTT GAA GAG CCT CAA CAA CCT CAA CAA I F G M I Y P G C P S T F E E P Q Q P Q Q	
AGA GGA CAA AGC AGC AGA CCA CAA GAC CGT CAC CAG AAG ATC TAT AAC TTC AGA GAG GGT GAT R G Q S S R P Q B R H Z K I Y N F R E G D	
TTG ATC GCA GTG CCT ACT GGT GTT GCA TGG TGG ATG TAC AAC AAT GAA GAC ACT GGC GTT TCT L I A V P T G N A W W M Y N B E D T A N S	
GGG AAC CAA GAG CAA GAG TTT CTA AAA TAT CAG CAA GAG CAA GGA GGT TCC CAA AGC CAG G N E E Z Z F L K Y Z Z Z E G G S Z S Z	
AAA GGA AAG CAT CAG CAA GAA GAA AAC GAA GGA GGC AGC ATA TTG AGT GGC TTC ACC K H Q Q E E E N E G G S I L S G K G F T	
CTG GAA TTC TTG GAA CAT GCA TTC AGC GTG GAC AAG CAG ATA GGG AAA AAC CTA CAA GGA L E F L E H A F S V D K Z I A K N H Z G	
GAG AAC GAA GGG GAA GAC AAG GGA GGC ATT GTG ACA GTG AAA GGA GGT CTG AGC GTG ATA E B E G E D K G A I V T V K G G L S V I	
AAA CCA CCC ACG GAC GAG CAG CAA CAA AGA CCC CAG GAA GAG GAA GAA GAA GAG GAT K P P T D E Z Q O R P Z E E E E E E B	
GAG AAG CCA CAG TGC AAG GGT AAA GAC AAA AAC TGC CAA CGC CCC CGA GGA AGC CAA AGC E K P Z C K G K D K Z C Q R P R G S Q S	
AAA AGC AGA AGA AAT GGC ATT GAC GAG ACC ATA TGC ACC ATG AGA CTT CGC CAC AAC ATT R R B G I D E T I C T M R L R H K S N I	
GGC CAG ACT TCA TCA CCT GAC ATC TAC AAC CCT CAA GCC GGT AGC GTC ACA ACC GCC ACC G Q T S S P D I Y N P Q A G S V T T A T	
AGC CTT GAC TTC CCA GCC CTC TCG TGG CTC AGA CTC AGT GCT GAG TTT GGA TCT CTC CGC S L D F P A L S W L R L S A E F G S L R	
AAG AAT GCA ATG TTC GTG CCA CAC TAC AAC CTG AAC GCG AAC AGC ATA ATA TAC GCA TTG K N A M F V P H Y B L N A B S I I Y A L	
AAT GGA CGG GCA TTG ATA CAA GTG GTG AAT TGC AAC GGT GAG AGA GTG TTT GAT GGA GAG N G R A L I Q V V B C B G E R V F B G E	
CTG CAA GAG GGA CGG GTG CTG ATC GTG CCA CAA AAC TTT GTG GTG GCT GCA AGA TCA CAG E G R V L I V P Q B F V V A A R L Q S Z	
AGT GAC AAC TTC GAG TAT GTG TCA TTC AAG ACC AAT GAT ACA CCC ATG ATC GGC ACT CTT S D B F E Y V S F K T B B T P M I G T L	
GCA GGG GCA AAC TCA TTG TTG AAC GCA TTA CCA GAG GAA GTG ATT CAG CAC ACT TTC AAC A G A B S L L B A L P Z E V I Z H T F B	
CTA AAA AGC CAG CAG GCC AGG CAG ATA AAG AAC AAC AAC CCT TTC AAG TTC CTG GTT CCA L K S Z Z A R Z I K B B B P F K F L V P	
CCT CAG GAG TCT CAG AAGAGAGCTGTGGCTTAG P Z E S Z	

The Sequences in the shadow are the upstream, downstream primers and the difference of nucleotide. The coined sequence is compared with the gene bank, which is different in five nucleotides. Using cols software free workbench 2.5 amino acid coding analysis, there are two amino acid differences, which is 51



**Fig. 31.3** Digestion and PCR analysis of recombinant plasmid pMD19-T/Gy3 M: 1, marker; 2, PCR results of pMD19-T/Gy3; 3, recombinant plasmid pMD19-T/Gy3; 4, restriction digestion results of pMD19-T/Gy3;



**Fig. 31.4** A schematic diagram of the recombinant pB1121 vector with soybean coda

(phenylalanine) and 200 (serine) with embank m36,686 Gy3 coding protein, and in m36,686 Gy3, in two positions—leonine and histamine. Amino acid sequence homology is 99.9 %. The causes of these differences may be attributed to differences in the slightly different structure of soybean 11s globulin.

### 31.3.5 Construction of the Plant Expression Vector

The fragments and vector were recovered and then connected by t4 danks enzymes, which is as shown in Figure 5 of plant expression vector of pbi121/Gy3. It was transformed into competent dh5  $\alpha$ , using alkaline lyses method of extraction.

Plasmid of the constructed expression vectors was double enzyme through digestion and PCR verification. The results are shown in Fig. 31.4. Based on plant expression vector pbi121/Gy3, we can transform it into agricultural coli competent cells.

Figure 31.4 shows restriction digestion and PCR analysis of plant expression vector of pBI121/Gy3 M: 1, marker; 2, PCR results of pBI121/Gy3; 3, expression vector pBI121/Gy3; 4, restriction digestion results of pBI121/Gy3.

### 31.4 Discussion

We successfully obtained the soybean 11s globulin Gy3 coda sequence by this experiment using RT-PCR method. The soybean 11s subunit globulin is the most widely used product currently in our country and other countries. The soybean Gy3 gene was used to produce soybean globulin in genetically modified rice. In other crops, improving the protein content and quality has great application value [7]. Soybean globulin is expressed only in the period of seed endosperm formation. This specificity and developmental stages will determine the RNA receptors that should be immature soybean seed. Because in the fruit needle buried 45–85 [8], it is the most active period of soybean mina protein synthesis. At the same time, Nielsen [9] proposed that first and second groups of soybean glycerin gene is the transcript after blossoming 25 days, and it will reach the maximum after 55 days. Nielsen [10] also confirmed that Myrna is an abundant protein synthesis period and is the most active period, so gene expression regulation mainly occurs at the transcriptional level. Because the soybean is rich in protein, carbohydrates and phenol substances, those experiments improve the extraction rate and purity of RNA through the increase in paralysis liquid dosage and repeated extraction method. RNA concentration was found to be 1.65  $\mu\text{g}/\mu\text{l}$  using spectrophotometer,  $1.8 < \text{od}_{260/280} < 2.0$ , and through the agarose gel electrophoresis detection, we obtained two clear bands of 28s and 18s. From the experimental study, we can see that we can amplify Gy3 coda sequence based on the method of RT-PCR, which can screen out Gy3 chromosome gene.

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# Chapter 32

## Research on Interpersonal Relations and Mental Health in Teenagers

Ruifang Liu, Jie Yuan and Jun Li

**Abstract** The objective of this study was to explore the relationship between interpersonal relations and mental health of teenagers and provide theoretical basis for understanding mental health of teenagers. We administered a questionnaire to 256 junior high school students in Baoding and found that junior high school students suffer the following psychological problems: learning anxiety, allergic tendencies, physical symptoms, self-blame tendencies, human anxiety, terrorist tendencies, impulsive tendencies, and lonely tendencies. We analyzed the obtained results using SPSS 16.0 software, interpersonal relations scale, and Mental Health Test (MHT). The interpersonal relations of junior high school students depend on gender ( $t = -3.76$ ,  $p < 0.01$ ) and grades ( $F = 24.22$ ,  $p < 0.01$ ), but regardless of whether they are singleton or not, interpersonal relations were negatively correlated with their mental health ( $r = -0.45$ ,  $p < 0.01$ ).

**Keywords** Junior high school students • Interpersonal relations • Mental health • Correlation

### 32.1 Introduction

With the development of human society, interpersonal relations have become more and more important in social life. Research shows that [1] the mental health situation of teenagers in China is not optimistic, and there has been an increase in psychological problems year after year. Mental diseases are caused mainly by the disorders of the interpersonal relations.

Interpersonal relations as psychological and social factors nurtured by human communication affect people's physiological and psychological states and mental health. Interpersonal relations are always associated with certain emotional experiences: if

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there exists a harmonious relationship, people will feel happy, and it is easy for people to keep a healthy mental state; on the contrary, if there is a disordered relationship, people will feel depressed, isolated, and dreary. In this situation, the mental health will be affected and the mental diseases will occur. Normal interpersonal communication and relations are necessary for the normal individual mental development, healthy personality and happiness in life. It is an important index to measure whether the mental state of a person is healthy or not. So, conducting research on interpersonal relations on teenagers has significance in theory and educational practice.

Middle school students are in the rapid development period of physiology and psychology, and their physiological and psychological characters are bound to reflect in their interpersonal relations. Research conducted in China and in other countries shows that the interpersonal relations of teenagers have changed dramatically when they enter the middle school [2]. Their mental and emotional relying on their parents and teachers is decreasing, and they depend more on their interpersonal relations established with their companions.

## 32.2 Research Methods and Test Tools

### 32.2.1 *Research Objects*

The research was conducted on 280 students of three grades of junior high school in the city of Baoding. we sent out 280 questionnaires and got 256 responses (response rate is 91.4 %). Among them, 81 were of first grade 87 second grade and 88 third grade; there were 108 boys and 148 girls; 43 people were singleton and 213 non-singleton; their age ranged from 12 to 17 years, and the average was  $14 \pm 0.06$  years.

### 32.2.2 *Research Methods*

We selected 280 junior high school students randomly at different levels and then administered the questionnaires in closed form. Analysis was carried out using SPSS 16.0 software, and the following statistical methods were used: independent sample *t* test, single-factor analysis of variance, product-moment correlation analysis, multiple independent sample of parametric test [3].

### 32.2.3 *Test Tools*

#### 32.2.3.1 **Interpersonal Relations Scale**

Interpersonal relations scale as a tool to measure the interpersonal relations of junior high school was designed by Qingxiang Wu et al [4]. This questionnaire

consists of 36 questions, and each question have only “yes” or “no” answers. The total scores were obtained by adding up all the scores of each question.

If the score is higher, it means that the tested people have a better relationship, and the highest score obtained was 36.

### 32.2.3.2 Junior School Students' Mental Health Test

Middle school students' Mental Health Test used in our study was the edition revised by Professor Bucheng Zhou. The scale is suitable for grade 4 in primary school to grade 3 in high school, and it has the more responsibility and validity. The test has 100 projects; except the total score, there are 8 content scales (learning anxiety, human anxiety, lonely tendencies, self-blame tendencies, allergic tendencies, psychological problems, physical symptoms, terrorist tendencies, impulsive tendencies) and a validity scale. Each individual scale score  $\geq 8$  is abnormal, and if the total score is  $\geq 65$ , then it is thought that there are certain psychological barriers.

## 32.3 Results Analysis

### 32.3.1 *The Analysis of the Psychological Health Problems of Junior High School Students*

From Table 32.1, we can see that the junior high school students suffer the following problems: learning anxiety, allergic tendencies, physical symptoms, self-blame tendencies, human anxiety, terrorist tendencies, impulsive tendencies, and lonely tendencies.

This research shows that the incidence rate of students who have obvious mental problem is 5.1 %. Eight content scales above show the rate of mental problems from high to low among students ( $\geq 8$ ) are learning anxiety, physical symptoms,

**Table 32.1** The comparison about the difference of the mental health and interpersonal relationship among different genders' students

Project	Boy (n = 108)	Girl (n = 148)	t
Impulsive tendencies	$3.25 \pm 0.23$	$3.80 \pm 0.20$	-1.82
Terrorist tendencies	$3.19 \pm 0.26$	$4.72 \pm 0.22$	-4.57**
Physical symptoms	$5.97 \pm 0.28$	$6.08 \pm 0.23$	-0.30
Allergic tendencies	$5.89 \pm 0.17$	$6.16 \pm 0.14$	-1.19
Self-blame tendencies	$5.69 \pm 0.21$	$5.99 \pm 0.16$	-1.14
Lonely tendencies	$2.95 \pm 0.20$	$2.01 \pm 0.14$	3.92**
Human anxiety	$4.37 \pm 0.22$	$5.20 \pm 0.17$	-3.04*
Learning anxiety	$8.57 \pm 0.27$	$9.40 \pm 0.22$	-2.36
Interpersonal relations	$24.55 \pm 0.48$	$26.66 \pm 0.32$	-3.76**

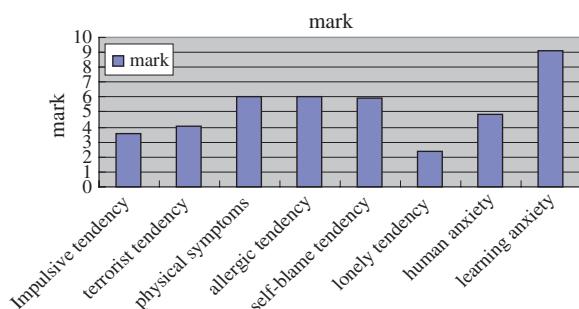
\*  $p < 0.05$ ; \*\*  $p < 0.01$

lonely tendencies, allergic tendencies, human anxiety, terrorist tendencies, impulsive tendencies and self-blame tendencies. Huilan Liu conducted a Mental Health Test on 1919 junior high school students in Baoding, and the result indicates the incidence rate of obvious mental problems among those students is 1.8 %. The main eight mental problems with high to low score are learning anxiety, allergic tendencies, physical symptoms, self-blame tendencies, terrorist tendencies, impulsive tendencies, human anxiety and lonely tendencies. Among those eight problems, the highest score was given to learning anxiety. The reason why it has highest score is that students have huge pressure on learning. Many schools emphasize on the proportion of students entering schools and make it as the only criteria to measure the educational quality. Parents also put all their hopes on their children and expect them to enter the best high school and university. Schools and parents pay more attention to talents training, but they neglect the developments of other aspects, like mental and body health. Teacher works overtime in class, let their students fall into the sea of questions, and their time in sports and entertainment is exploited entirely. Parents have great expectation on their children; they focus only on children's scores, but fail to concentrate on their mental condition. Being so for a long time in a humdrum life full of anxiety, junior students will become overloaded both physically and mentally, which easily leads to the mental problems. It shows that we must pay more attention to learning anxiety problems and research on mental health education needs to be carried out (Fig. 32.1).

### **32.3.2 The Comparison About the Difference of the Mental Health and Interpersonal Relationship Among Different Genders' Student**

Table 32.1 shows that boys and girls have differences in human anxiety and learning anxiety ( $p < 0.05$ ). On these two aspects, girls' scores are higher than boys'. With respect to terrorist tendencies and lonely tendencies, there exist obvious differences between boys and girls ( $p < 0.01$ ); there is no difference between boys

**Fig. 32.1** The score of junior high school students' mental health in each scale



and girls in the other four aspects. On the aspect of interpersonal relations, boys and girls have obvious difference ( $p < 0.01$ ). Girls have higher scores than boys.

Girls' interpersonal relation is better than boys'. The reason may be that girls mature earlier than boys, and they are good at building companion relationships. The results on this test are different from Chunhua Rong's test. Their result is that in junior school stage, the gender difference has no influence on the interpersonal relations. The reason for the difference in the results is that they used different research objects. Their study included junior students in city as the sample, but this test included students from town as sample. The difference between city and town makes their growth environment, education, cultural background has obvious difference. So the difference is normal.

### ***32.3.3 The Comparison About the Difference of the Singleton and Non-Singleton Students' Mental Health and Interpersonal Relationship***

Table 32.2 shows that junior students whether singleton or not have obvious difference on the aspect of human anxiety ( $p < 0.05$ ), but it does not have statistical meaning on other aspects of mental health and interpersonal relations ( $p > 0.05$ ).

From the result above, we can find that junior students whether singleton or not have obvious difference on the aspect of human anxiety, but it does not have obvious difference on other aspects of mental health and interpersonal relations [5].

Huilan Liu's study results shows that in student's mental health condition, students from families that have only one child are better than non-singleton [6]. Their research included primary and junior high school students from city and town. But this research included teenagers from town. With the increase in the number of singletons in town and the development of society, parents begin to treat their children equally. So, there is no obvious difference in mental health between singleton or non-singleton.

**Table 32.2** The comparison about the difference of the singleton and non-singleton students' mental health and interpersonal relations ( $\bar{x} \pm s$ )

Project	Singleton (n = 43)	Non-singleton (n = 213)	t
Impulsive tendency	$3.00 \pm 0.38$	$3.69 \pm 0.16$	-1.70
Terrorist tendency	$3.53 \pm 0.42$	$4.18 \pm 0.19$	-1.41
Physical symptoms	$5.81 \pm 0.48$	$6.08 \pm 0.19$	-0.56
Allergic tendency	$5.58 \pm 0.27$	$6.14 \pm 0.12$	-1.88
Self-blame tendency	$5.40 \pm 0.32$	$5.95 \pm 0.14$	-1.61
Lonely tendency	$2.79 \pm 0.32$	$2.33 \pm 0.13$	1.41
Human anxiety	$4.21 \pm 0.35$	$4.98 \pm 0.15$	-2.11*
Learning anxiety	$8.51 \pm 0.43$	$9.16 \pm 0.19$	-1.38
Interpersonal relationship	$25.23 \pm 0.77$	$25.87 \pm 0.30$	-0.84

\*  $p < 0.05$ ; \*\*  $p < 0.01$

### **32.3.4 The Comparison About the Difference of the Mental Health and Interpersonal Relations in Different Grades**

Table 32.3 shows that junior students in different grades have obvious difference on the aspects of self-blame tendency, lonely tendency, and human anxiety ( $p < 0.05$ ). The higher the grade is, the lower the scores of self-blame tendency and human anxiety are. There is obvious difference in interpersonal relations ( $p < 0.01$ ), and the grades with high to low are third grade, first grade, and second grade.

There are obvious differences in interpersonal relations between different grades, the scores of interpersonal relations from high to low is the third grade, the first grade and the second grade. The reason maybe that high grade students are more mature than the students of other two grades. They are emotionally more attached, and their relationships with each other are harmonious.

### **32.3.5 The Correlation Between Interpersonal Relations and 8 Aspects of Mental Health in Junior High School Students**

Table 32.4 shows that the junior high school students' interpersonal relations were negatively correlated with impulsive tendencies, terrorist tendencies, physical symptoms, allergic tendencies, self-blame tendencies, lonely tendencies, human anxiety. There is no statistical meaning when correlating the interpersonal relations with the learning anxiety in mental health [7].

This shows that the better the interpersonal relations are, the better the mental state is and the lesser the possibility of psychological barriers. This is consistent

**Table 32.3** The comparison about the difference of the mental health and interpersonal relations in different grades ( $\bar{x} \pm s$ )

Project	The first grade (n = 81)	The second grade (n = 87)	The third grade (n = 88)	F
Impulsive tendency	$2.99 \pm 0.25$	$3.91 \pm 0.26$	$3.57 \pm 0.15$	3.58*
Terrorist tendency	$4.16 \pm 0.31$	$4.28 \pm 0.31$	$3.80 \pm 0.28$	0.72
Physical symptoms	$5.93 \pm 0.31$	$6.48 \pm 0.29$	$5.69 \pm 0.31$	1.79
Allergic tendency	$6.02 \pm 0.18$	$6.16 \pm 0.21$	$5.94 \pm 0.19$	0.33
Self-blame tendency	$6.32 \pm 0.22$	$5.83 \pm 0.24$	$5.47 \pm 0.21$	3.65*
Lonely tendency	$2.48 \pm 0.19$	$2.78 \pm 0.24$	$1.98 \pm 0.18$	3.89*
Human anxiety	$5.23 \pm 0.22$	$5.02 \pm 0.25$	$4.33 \pm 0.24$	4.06*
Learning anxiety	$9.35 \pm 0.30$	$9.26 \pm 0.28$	$8.57 \pm 0.31$	2.05
Interpersonal relationship	$26.06 \pm 0.40$	$23.82 \pm 0.56$	$27.42 \pm 0.42$	24.22**

\*  $p < 0.05$ ; \*\*  $p < 0.01$

**Table 32.4** Correlation between interpersonal relations and 8 aspects of mental health in junior high school students

Relationship	Mental	Impulsive	Terrorist	Allergic
	-0.42**	-0.27**	-0.35**	-0.27**
	Self-blame	Lonely	Human anxiety	Learning anxiety
	-0.16**	-0.53**	-0.34**	-0.11

\*  $p < 0.05$ ; \*\*  $p < 0.01$

with studies conducted in China and in other countries [1] Normal interpersonal communication and relations are necessary for the normal individual mental development, healthy personality, and happiness in life. It is an important index to measure whether the mental state of a person is healthy or not [8].

## 32.4 Conclusion

The junior high school students are in a transitional period from naive to mature, and they are in a stage where they would witness changes both in body and mind. The pressures they face in life are different from those in other age groups, and their interpersonal relations and mental health may also be different from other groups. With the social reformation and development, as well as the occurrence of a series of new problems and illnesses, the junior high school students who are in adolescence will face different kinds of changes in physiology, psychology, living environment, and other aspects. They need to undertake more pressures in study, interpersonal relations and other aspects, so it is easier to lead to different sorts of psychological problems.

The junior high school stage is a transitional period for people from childhood to teenagers, and the individual's mental is experiencing the mixing and alternating from naive to mature. Some scholars point out the adolescence is the "second birth" period, and in this period, the maturity in physiology leads to the imbalanced characteristics in mental health. The junior high school students are easier to appear emotional distress, bad adaption and other problems in mental health [9]. The psychologists think that the excitement and depression, tension and strong impulsiveness, and volatility of junior high school students lead to their personality in turmoil. The confusions in students' interpersonal relations are caused by their interpersonal environment, academic success, and other factors [10]. For the student's mental health, the building of interpersonal relations is a two-way street, that is to say, the building is not only affected by the students' internal factors but also the external factors of interpersonal environment [11]. For the students' problems, we should "suit the remedy to the case," find out the roots, and undertake psychological counseling to improve their cognitive and judgment ability on purpose. To evaluate the students' mental state, our education workers and research workers should focus on their mental development.

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# Chapter 33

## Information Analysis on Depression in Patients with Parkinson's Disease

**Qingwen Wu, Haoqi Wang, Shenglian Dong, Yichun Luo and Benshu Zhang**

**Abstract** *Objective* To investigate the relationship between depression and clinical aspects of Parkinson's disease (PD). *Methods* 318 patients diagnosed by the London Brain Bank criteria took part in the investigation. 318 PD patients were evaluated using United Parkinson's Disease Rating Scale (UPDRS), Hoehn & Yahr staging (H&Y). Depression was evaluated with Zung's Self-Rating Depression Scale (SDS). The analysis of quantitative data was performed using descriptive statistics, ANOVA and  $\chi^2$  test. *Results* 208 (65.4 %) patients were depressed. There was a significant difference between men and women PD patients respect to the depression degree ( $\chi^2 = 16.981, P < 0.05$ ); depression degree among duration groups were statistically significant different ( $\chi^2 = 18.0, P < 0.05$ ); when compared to the non-depressed ones, presented the following results: H&Y:  $2.34 \pm 0.851$  versus  $1.83 \pm 0.725$ ; UPDRS total:  $50.486 \pm 23.787$  versus  $38.191 \pm 16.081$ . *Conclusion* Depression is a frequently neuropsychiatric phenomenon in Parkinson's disease. Female and long duration PD patients has higher incidence of moderate and severe depression. PD patients with depressive disorder presented more advanced H&Y staging, greater UPDRS score than non-depressed ones.

**Keywords** Parkinson's disease • Depression • Incidence • Zung's self-rating depression scale

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### 33.1 Introduction

Parkinson's disease (PD) is a chronic, progressive neurodegenerative disorder, characterized by cardinal motor symptoms, such as bradykinesia, resting tremor, rigidity, and postural instability. Depression is one of the most common psychiatric symptoms in Parkinson's disease. Symptoms of depression are reported in 40–50 % of PD patients according to different study [1, 2]. Unfortunately, only 20 % of all depressed PD patients receive treatment for their psychological status [3, 4]. If depression is left untreated, there is an increased risk for greater disability and reduced quality of life [5]. However, the mechanisms of depression in PD are poorly understood. The present study was undertaken in the hope of exploring the association, such as the incidence of depressive symptoms occurring in male and female PD patients, the relationship between the depressive symptoms and certain variable factors, namely, the duration of the illness; UPDRS; Hoehn & Yahr stage; and SDS score compared to Chinese norm.

#### 33.1.1 Patients

318 PD patients who went to extrapyramidal outpatient service of Tianjin Medical University General Hospital were investigated by the questionnaire from December 2010 to January 2012. Among these patients there were 162 men (50.9 %,  $63.07 \pm 9.47$ ) and 156 women (49.1 %,  $63.95 \pm 9.647$ ), total average age is  $63.51 \pm 9.55$  years old.

#### 33.1.2 Methods

These patients was diagnosed idiopathic PD according to the United Kingdom Parkinson's disease Society Brain Bank clinical criteria for idiopathic Parkinson's disease [6]. The questionnaire were designed by ourselves and the content includes general information such as age, sex, duration of disease, the time of appearing depression and so on, mini-mental state examination (MMSE), the Zung's Self-Rating Depression Scale (SDS), the Unified Parkinson's Disease Rating Scale (UPDRS). Unified Parkinson's Disease Rating Scale (UPDRS) sub-scale I, mental condition; sub-scale II, functional activity; sub-scale III, motor condition; and IV, Motor Complications [7]. The UPDRS is a tool used to evaluate all those aspects and higher scores indicate the severity of the symptoms. Hoehn & Yahr Clinical Staging Scale that ranges from 1 (mild) to 5 (severe, incapacitating) [8]. Because cognitive impairment makes it difficult to complete the questionnaire by himself, patients with a Mini-Mental State Examination Scale (MMSE)10 score < 21 were excluded.

### 33.1.3 Statistical Analysis

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) with version 17.0. Chi square test was used to compare the sex, duration of disease, the time of appearing depression among different depression groups. One-way ANOVA was used to compare SDS score between PD patients and Chinese norm.  $P < 0.05$  was considered statistically significant.

## 33.2 Results

### 33.2.1 General Information

According to the Hoehn and Yahr scale, forty-eight PD patients classified as stage 1–1.5, 120 as stage 2–2.5, 130 as stage 3, 17 as stage 4, and 3 as stage 5. PD patients with dementia who cannot complete the questionnaire by himself were excluded. Incidence of depression in this study is 65.4 %. The results from our Chi squared analyses produced significant differences between men and women PD patients respect to the depression degree ( $\chi^2 = 16.981, P < 0.05$ ). Moderate and severe cases in female group were more than in male group. It implied that female PD patients were liable to depression (Table 33.1).

### 33.2.2 The Relationship Between Duration of Disease and Depression

A Chi square test showed that the difference of depression degree among duration groups in PD patients were statistically significant different ( $\chi^2 = 18.0, P < 0.05$ ). Serious cases have a rising tendency along with the duration extend (Table 33.2).

**Table 33.1** The relationship between sex and depression

Sex	Depression degree				$\chi^2$	P
	No	Mild	Moderate	Severe		
Male	61	50	19	32	16.981	0.001
Female	49	25	34	48		

**Table 33.2** The relationship between duration of disease and depression

Duration of disease (year)	Depression degree				$\chi^2$	P
	No	Mild	Moderate	Severe		
<1	40	14	11	18	18.00	0.006
1–5	55	43	28	34		
>5	15	18	14	28		

### 33.2.3 The Relationship Between First-Onset Depressive PD Patients and Others

In Table 33.3, it is showed that depression incidence is 11.32 % as the first symptom before the motor symptom of PD. These patients were all moderate and severe cases, and the difference were statistically significant ( $\chi^2 = 49.84, P < 0.05$ ).

### 33.2.4 The Relationship Between Different Depression Groups and Disease Severity

The outcome about comparing UPDRS score and Hoehn & Yahr stage between non-depression and depression is showed in Table 33.4. Depressive patients presented higher UPDRS and Hoehn & Yahr. UPDRS I mental condition ( $F = 47.199, P < 0.05$ ); UPDRS II functional activity ( $F = 15.876, P < 0.05$ ); UPDRS III, motor condition ( $F = 14.987, P = 0.002$ ); and IV, Motor Complications ( $F = 10.057, P < 0.05$ ). Hoehn & Yahr ( $F = 28.464, P < 0.05$ ). The difference was statistically significant.

### 33.2.5 Mean Scores of Each SDS Item for PD Patients Compared to Norm

The scores of each SDS item for PD patients compared to norm were showed in Table 33.5. PD patients scored higher on all items compared to Chinese norm

**Table 33.3** Depression before first-onset depressive PD patients and others

First-onset depressive PD patients	Depression degree				$\chi^2$	P
	No	Mild	Moderate	Severe		
Yes	0	0	11	25	49.84	0.000
No	78	47	26	46		

**Table 33.4** The relationship between different depression groups and disease severity

	Non-depression	Depression	F	P
	Mean $\pm$ SD	Mean $\pm$ SD		
UPDRS I	1.86 $\pm$ 1.511	3.47 $\pm$ 2.193	47.199	0.000
UPDRS II	11.12 $\pm$ 4.595	13.98 $\pm$ 6.751	15.876	0.000
UPDRS III	25.0 $\pm$ 12.603	32.38 $\pm$ 17.777	14.987	0.000
UPDRS IV	0.209 $\pm$ 0.526	0.649 $\pm$ 1.403	10.057	0.002
UPDRS total	38.191 $\pm$ 16.081	50.486 $\pm$ 23.787	23.651	0.000
Hoehn & Yahr	1.83 $\pm$ 0.725	2.34 $\pm$ 0.851	28.464	0.000

**Table 33.5** Mean scores of each SDS item for PD patients compared to norm

Item	PD	Norm	T	P
	Mean ± SD	Mean ± SD		
Depressed affect	2.32 ± 1.270	1.5 ± 0.73	10.8008	0.0000
Diurnal variation	2.48 ± 1.269	2.31 ± 1.19	10.6139	0.0000
Crying spells	1.99 ± 1.23	1.16 ± 0.48	11.5121	0.0000
Sleep disturbance	2.36 ± 1.292	1.6 ± 0.85	9.2549	0.0000
Decreased appetite	2.19 ± 1.367	1.74 ± 1.07	5.3909	0.0000
Decreased libido	2.49 ± 1.352	2.33 ± 1.21	1.9166	0.0559
Weight loss	2.09 ± 1.331	1.26 ± 0.63	10.5438	0.0000
Constipation	3.08 ± 1.313	1.23 ± 0.56	23.8846	0.0000
Tachycardia	2.08 ± 1.177	1.24 ± 0.58	12.0421	0.0000
Fatigue	2.73 ± 1.347	1.48 ± 0.78	15.5166	0.0000
Confusion	2.20 ± 1.180	1.72 ± 1.03	6.6023	0.0000
Psychomotor retardation	3.04 ± 1.090	1.81 ± 1.09	18.0906	0.0000
Agitation	2.06 ± 1.178	1.50 ± 1.24	7.3085	0.0000
Hopelessness	2.29 ± 1.248	1.99 ± 1.05	3.9137	0.0000
Irritability	2.44 ± 1.365	1.56 ± 0.81	10.7635	0.0000
Indecisiveness	2.63 ± 1.241	2.24 ± 1.04	5.1182	0.0000
Personal devaluation	2.23 ± 1.194	2.0 ± 1.05	3.1245	0.0000
Emptiness	2.31 ± 1.258	1.96 ± 0.96	4.5652	0.0000
Suicidal ideation	1.92 ± 1.152	1.18 ± 0.58	10.8264	0.0000
Dissatisfaction	2.26 ± 1.198	1.69 ± 0.98	7.7644	0.0000

except decreased libido, and these differences were statistically significant (Table 33.5).

### 33.3 Discussion

#### 33.3.1 Parkinson's Disease has a much Higher Incidence in Older People

Depressive illness among patients with PD has been estimated to range between 20 % and 70 %, the wide range mainly depending on criteria used for defining depression [9, 10]. Such as difficulty of recognizing depressive symptoms in PD, use of different diagnostic tools, diagnostic procedures adopted, methodological design choices, and particularities of each investigated sample. In this study incidence was 65.4 %, so there is higher incidence of depression in PD patients. Moderate and severe cases in female group were more than in male group. The result is quite like the previously study that showed PD patients, especially women, are more likely to develop depression. PD patients' quality of life will be reduced by depression. Therefore, physicians should pay attention to depression when treating PD patients, especially treating female PD patients.

### ***33.3.2 Serious Cases have an Increase Tendency Along with the Duration Extend***

It is reported that the high incidence of depression in patients with PD is a result of decreased activity in dopaminergic pathways. The fact that the antihypertensive drug methyldopa frequently causes depression as a side-effect supports this, as does the fact that reserpine which depletes dopamine in the brain is a powerful inducer of depression. However, levodopa therapy rarely alleviated the symptoms of depression. The explanation maybe that the central neurotransmitters about PD patients is getting disorder along with the duration extend. It reminds us to keep our eyes open for the drug use in PD patients with long duration and the patients with hypertension.

### ***33.3.3 Our Study Showed that Depressive Patients had Higher UPDRS and H&Y Score than the Non-depressive Ones***

In the study, ANOVA elicit significant correlation between depression and PD scales (as measured by UPDRS, Hoehn & Yahr). It concurs with some of previous studies. However, in our study there was some cases occurrence of depression before early PD typical motor signs. Our data presented that PD patients scored higher on all items of SDS compared to Chinese norm. It is reported that though many PD patients were in a state of depression but only fewer of the patients themselves and their caregivers were aware of depression. It was a more important factor than the severity of motor disability. Therefore, depression could be a early manifestation of the neurodegenerative process of PD and that it is part of PD. These result implied that the mechanism of PD depression is complex, and this psychiatric condition could be considered not only a reactive manifestation, but a symptom of PD in itself. This could be related to the underlying pathology of PD itself.

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# Chapter 34

## Study of Cancer Diagnosis Based on Families Attitudes' Analysis

Yuqian Sun, Bingfu Sun, Xiaomei Li, Ruihua Liu, Jia Zhao, Yingna Wen and Jing Hao

**Abstract** *Objective* To investigate the proportion of Chinese families' preference for cancer disclosure and explore the variables associated with their preference. *Methods* Family members who had a relative with recently diagnosed cancer were interviewed. Among 220 eligible family members, 194 answered a questionnaire and stated whether or not they preferred the diagnosis to be disclosed. *Results* It was estimated that 57.7 % of family members preferred no-disclosure and 42.3 % favored informing. Families' perceptions of telling the truth to patient were the most critical factors contributing to their preferences ( $OR = 0.160, P < 0.01$ ). Important involved others' opinions and practices also were associated with families' preferences ( $OR = 0.338, P < 0.05$ ). *Conclusions* Family members' preferences for nondisclosure of cancer diagnosis were relatively strong in mainland China. Family members' perceived values and meanings of cancer disclosure were major determinants of their preferences. Physicians' increased communications with families about reasons for telling the cancer patient would change families' opposing minds.

**Keywords** Cancer care • Diagnosis disclosure • Family

### 34.1 Introduction

In China, as in many other developing countries around the world, disclosing the diagnosis to cancer patients can be a serious challenge to the physicians and cancer patients are often not told the truth about their illness [1]. However, evidence

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suggests that honest disclosure of cancer diagnosis could lead to improved outcomes in cancer patients and lighten the burden of secrecy [2]. So, how to tell the cancer patients the diagnosis in a way that maintain their right to information and yet perform the duty of beneficence poses a difficult task for physicians in clinical oncology practices.

Despite the fact that there is a recent call for increased attention to cancer patients' autonomy rights in mainland China, Chinese oncologists still prefer adopting a more passive mode letting family members decide whether or not the patient was to be informed [3]. In China, few studies have been found specifically concerned how family members make decisions on whether or not to tell a cancer patient the diagnosis. In the present study, we attempt to look into what governs family members' judgment on whether or not to disclose a diagnosis to cancer patients, possibly as an example of the issue in developing countries.

## 34.2 Methods

### 34.2.1 Study Population

We consecutively identified 220 cancer family members whose relatives were diagnosed cancer approximately 3 months after initial diagnosis in 4 hospitals' medical oncology department in Beijing and Tangshan city. A family was defined as one who made decisions on behalf of the patient, age 18 or older, well enough to fill out a questionnaire and well enough to provide informed consent. We explained the objectives of the study and asked the families if the physicians told them the diagnosis ahead of the patient (if "No", then excluded). Finally, 194 family members who said "yes" filled out the questionnaire. The study was approved by research ethics committee in Beijing.

### 34.2.2 Questionnaire

The questionnaire was developed on the basis of thorough review of the relevant literature and 13 successive in-depth interviews with families. The questionnaire composed of three dimensions with a total of 17 items concerning families' perceptions of telling the truth, families' perceptions of doctor's or others' opinions and practices and families' resources for decision-making. The questionnaire first asked the families' one general question: "Do you prefer to disclose diagnosis of cancer to patient at any time?" The response categories were no and yes. The questionnaire's content validity tested by five experts was 0.95 and internal consistency demonstrated with a Cronbach coefficient pretested in a pilot study of 20 family members was 0.85.

### 34.2.3 Statistical Analysis

For each outcome (e.g., prefer to disclose the truth to the patient), the percentage of families in each category of the independent variable was calculated. Factors considered to be potentially associated with family members' preferences were first evaluated by chi-square tests, and  $P$  value of less than 0.10 was considered significant. Multivariate logistic regression analysis with forward stepwise selection was performed to assess which of the independent variables best predicted families' preferences about the disclosure. For this analysis, we set the significance level at  $P$  value less than 0.05. The SPSS software (version 11.3) was used for the statistical analysis.

### 34.2.4 Results

Of a total of 220 family members approached, 194 (86 %) individuals who considered that doctors discussed the diagnosis first with them completed the questionnaire. Among the 194 participating subjects, 89 (45.9 %) were men, and 105 (54.1 %) were women; more families (46 %) were patients' child and others were patients' spouse or other families (38, 16 %). The patients' and families' characteristics and demographics are presented in Table 34.1. Of the 194

**Table 34.1** Characteristics of family members and patients

Characteristic	Family members n = 194 n (%)	Cancer patients n = 194 n (%)
<i>Sex</i>		
Male	89 (46)	118 (61)
Female	105 (54)	76 (39)
<i>Age</i>		
≤39	67 (35)	18 (9)
40–59	108 (56)	70 (36)
≥60	19 (9)	106 (55)
<i>Relationship to patient</i>		
Spouse	75 (38)	–
Child	90 (46)	–
Other families	29 (16)	–
<i>Primary cancer</i>		
Lung cancer	–	47 (24)
Stomach cancer	–	59 (30)
Colorectal cancer	–	37 (19)
Kidney, bladder cancer	–	13 (7)
Breast cancer	–	12 (6)
Leukemia	–	26 (14)
<i>Type of treatment</i>		
Operation	–	135 (70)
Chemotherapy	–	36 (18)
Palliative treatment	–	23 (12)

**Table 34.2** Distribution of participants in the dimension of families' perceptions of telling the truth and chi-square values

Variable	Disclosure group (n = 82)	No -disclosure group (n = 112)	Total n (%)	P
<i>The degree of anxiety and distress the patient would experience after disclosure</i>				
Mild level	46	8	54(27.8)	0.000
Moderate level	28	27	55(28.4)	
High level	8	77	85(43.8)	
<i>Patient would not lose hope and confidence after disclosure</i>				
Disagree	1	60	61(41.1)	0.000
Neutral	11	24	35(28.1)	
Agree	70	28	98(31.4)	
<i>Patient would cooperate with health professionals actively after disclosure</i>				
Disagree	3	31	34(17.5)	0.000
Neutral	11	52	63(32.5)	
Agree	68	29	97(50.0)	
<i>Patient could decide how best to spend the time they have remaining after disclosure</i>				
Disagree	15	98	113(58)	0.000
Neutral	21	12	33(16.9)	
Agree	46	2	48(24.7)	
<i>I think the patient wants to be informed</i>				
Disagree	3	55	58(29.9)	0.000
Neutral	6	7	13(6.7)	
Agree	73	50	123(63)	
<i>I want to be informed if I had cancer</i>				
Disagree	10	30	40(20.6)	0.006
Neutral	2	9	11(5.7)	
Agree	70	73	143(73)	

participating family members, 82 (42.3 %) preferred to disclose the cancer diagnosis to the patient, and 112 (57.7 %) did not prefer the diagnosis to be disclosed.

The distribution of participants in the dimension of families' perceptions of telling the truth and chi-square analysis of data between disclosure group and no-disclosure group according to categorical variables are shown in Table 34.2. Majority (72.2 %) of the family members reported that they thought the patients would experience moderate to high level of anxiety and distress after being given diagnosis. A small proportion (24.7 %) believed that disclosure is useful for patients deciding how best to spend the time they have remaining (Table 34.2).

As regarding to the dimension of families' perceptions of doctor's or others' opinions and practices, nearly half of the families (45.9 %) reported

**Table 34.3** Distribution of participants in the dimension of families' perceptions of doctor's or others' opinions and practices and chi-square values

Variable	Disclosure group(n = 82)	No-disclosure group(n = 112)	Total n (%)	P
<i>Oncologist discuss with me about whether the patient had known the diagnose</i>				
Disagree	29	60	89(45.9)	0.012
Agree	53	52	105(54.1)	
<i>Oncologist told me that patient has a right to be informed</i>				
Disagree	67	95	162(83.5)	0.564
Agree	15	17	32(16.5)	
<i>Oncologist explained to me the patient's possible emotional responses and handling methods</i>				
Disagree	78	108	186(95.9)	0.931
Agree	4	4	8(4.1)	
<i>Patient requested disclosure from me</i>				
Never happened	9	24	33(17)	0.017
Happened, occasionally	37	59	96(49.5)	
Happened, eagerly	36	29	65(33.5)	
<i>Other people surrounding me tell the truth to patient as far as I know</i>				
Very little or not at all	32	76	108(55.7)	0.000
Less than half or half of	14	23	37(19.1)	
Most or all of	36	13	49(25.3)	

that oncologist did not discuss with them whether the patient had known the diagnosis. The majority (83.5 %) and vast majority (95.9 %) of families recalled that oncologist never told them that patient has a right to be informed (Table 34.3).

According to what was reported by family members about the items in the dimension of families' resources for decision-making, approximately half of the families felt that both themselves and patient had very little knowledge on cancer (49, 52.1 %, respectively). Statistically significant difference ( $P$  value below 0.10) was found in 3 items of this dimension (Table 34.4).

To reduce the number of variables for the stepwise multiple logistic regression analysis, variables that were not associated with families' preferences in chi-square tests were excluded. Respondents who agreed with the statement, "Patient could decide how best to spend the time they have remaining after disclosure," were less likely to want no-disclosure than were those who were neutral to the same statement ( $OR = 0.160$ ,  $P < 0.01$ ), etc. (Table 34.5).

**Table 34.4** Distribution of participants in the dimension of families' resources for decision-making and chi-square values

Variable	Disclosure group (n = 82)	No-disclosure group (n = 112)	Total n(%)	P
<i>I prefer to make the choice after considering doctor's opinions</i>				
Disagree	10	20	30(15.5)	0.65
Neutral	22	39	61(31.4)	
Agree	50	53	103(53.1)	
<i>The amount of knowledge I have on cancer</i>				
Very little or not at all	33	63	95(49)	0.097
Less than half or half of	44	43	87(44.8)	
Most or all of	5	7	12(6.2)	
<i>The amount of knowledge the patient has on cancer</i>				
Very little or not at all	32	69	101(52.1)	0.000
Less than half or half of	39	43	82(42.3)	
Most or all of	11	0	11(5.7)	
<i>I obtained additional cancer information from television, internet and newspaper</i>				
Very little or not at all	15	18	33(17)	0.864
Less than half or half of	21	27	48(24.7)	
Most or all of	46	67	113(60.3)	
<i>My family is good in economic conditions</i>				
Disagree	7	21	28(14.4)	0.003
Neutral	45	72	117(60.3)	
Agree	30	19	49(25.3)	

**Table 34.5** Stepwise multiple logistic regression analyses of factors predictive of families' disclosure preferences

Variable	Bj	SE	P	OR	95%CI(OR)
Constant	14.186	2.36	0.000		0.800–0.463
Patient could decide how best to spend the time they have remaining after disclosure	-1.834	0.40	0.000	0.160	0.073–0.351
Patient would not lose confidence and hope after disclosure	-1.649	0.45	0.000	0.192	0.800–0.463
Oncologist told me that patient has a right to be formed	-1.084	0.55	0.050	0.338	0.114–1.006
Patient would cooperate with health professionals actively after disclosure	-1.043	0.45	0.019	0.352	0.147–0.845
Patient request disclosure from me	-0.928	0.39	0.019	0.395	0.183–0.856
I think the patient wants to be informed	-0.677	0.34	0.044	0.508	0.263–0.981

### 34.3 Discussion

Our findings that 57.7 % of families objected to telling the patient cancer diagnosis revealed that preference for concealment appears to be the prevalent attitude among the public today in mainland China [4]. Cultural aspects of values and behaviors, along with life experiences, and socioeconomic status affect the meaning of cancer for both patients and their families, as well as how they cope with the disease [5]. In Chinese Confucian society, where family is regarded as the basic social unit and paternalism, nonmaleficence are dominant philosophies, cancer remains seen as a punishment or the result of a curse, and disclosure of a cancer diagnosis was seen as more ominous and stigmatized than in wealthier countries. Therefore, reluctance to disclose a cancer diagnosis was widely accepted by the public.

In our study, majority (72.2 %) of families thought that the patient would experience moderate to high level of anxiety and distress after being given cancer disclosure [6]. This finding is higher than the actual prevalence of anxiety and depression in cancer patients that reportedly range from a low of 15–25 % in America and 27 % in Africa to a high of 39.5 % in Korean cervical cancer survivors [7, 8]. Overestimate the patient's emotional reactions can easily lead family members to want a nondisclosure of diagnosis. Therefore, in clinical practice, when faced with nondisclosure families who cited the anecdotal reasons that cancer information would psychologically damage patients, healthcare professionals should cooperate fully with families to assess whether the personality type of the cancer patient was appropriate for disclosure and identify whether families had overestimated the patient's psychological shock before decide whether, how and when to inform the cancer patient.

The item "Patient could decide how best to spend the time they have remaining after disclosure" means that the patient not only successfully adjusts the cancer diagnosis but also deals well with issues concerning the meaning of life, death and an uncertain future, which had a great impact on families' preferences in this study. Some argue that patients may want to make peace with enemies, go on trips to memorable places or make decisions about the distribution of their assets before dying. Similarly, Chinese family members also specially concern the quality and changes in life among patients after being given the diagnosis. Nevertheless, our results show a low proportion (24.7 %) of agreement with this statement. In mainland China not like in America, the relatively poor economic condition limits most patients' dreams and not all people has needs for complicated decisions about the disposing of property. The cultural and economic situations in mainland China reduce the significance of the consequences of nondisclosure in this context.

The striking findings in our study were that most of the oncologists did not explore further about disclosure issues after telling the cancer to families. This kind of leaving complex decision-making entirely in the hands of the family is an abdication of the doctors' responsibilities. In the stepwise multiple logistic regression analyses, oncologist assertion that patient has a right to be informed

significantly influenced the families' disclosure preferences, which suggested that oncologist can overcome a family's opposition to disclosure by describing their reasons for wanting to tell. In practice, oncologist should take as much time as necessary to repeatedly encourage nondisclosure families to change their minds. Health care providers should indeed take the responsibility to convey the proper and timely information to their patients [9].

It is recommended that truth telling should depend on what the patient wants to know and is prepared to know, and not on what the family wants to disclose [10]. In our study, family members who thought that the patient wants to be informed or who were requested for disclosure by patient tended to prefer disclosure. Nevertheless, compared with other considerations, these two aspects were slightly associated with family members' preferences. These results are a reflection of Chinese families' not respecting patient's wishes, needs and right to know.

In summary, the data presented here provide a comprehensive portrait of Chinese families' experiences of decision-making on cancer disclosure. It is clear that family members' no-disclosure preferences are slightly strong and oncologists' performances on cancer disclosure are suboptimum in mainland China. We are hopeful that regular focus on physicians' insensitive approach on cancer disclosure will catalyze improvements in cancer patient care.

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# Chapter 35

## Research on Medical Image Processing Method Based on the MATLAB

Shirui Gao

**Abstract** This paper emphasizes the MATLAB-based medical image processing tools. It includes the theoretical background and examples. Through MATLAB, this paper makes the introduction of the post-imaging quality in medical technology and medical imaging. It also introduces the medical image processing technology and describes the image processing and processing technologies, including the organ contours, interpolation, filtering, and segmentation techniques. In medicine, the DICOM image data processing using MATLAB is also widely used in this type of image processing.

**Keywords** Matlab • Medical imaging • Data processing

### 35.1 Introduction

Advanced image processing and analysis technology are increasingly used in medicine. In medical applications, image data are used to collect the details of the imaging process of the patients, whether it is a disease process or physiological process [1]. The information provided in medical imaging has become an important part in today's patient care. The applications of medical images are complex and changes from one form to another. The medical images display information on the characteristics of the structure, organs, and physiological characteristics. In order to have high-quality medical diagnostic imaging, image processing is necessary. The range of image processing and analysis of medical applications is to improve the quality of acquired images and extract quantitative information from an efficient medical imaging data in accurate manner.

Matrix Laboratory (MATLAB) is a high-performance interactive software package developed by Math Works Inc. (2009) scientific and engineering

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computing [2]. MATLAB allows matrix operations, algorithm implementation, simulation, drawing functions and data, signal and image processing, and image processing toolbox. It allows several ways of medical imaging, quantitative analysis and visualization of single-photon emission computed tomography (SPECT), positron emission tomography (PET), or hybrid systems (SPECT/CT examination), and computed tomography system (CT) scan is included in the SPECT system [3]. The image processing toolbox is a comprehensive reference standard algorithm and has graphical image processing, analysis, visualization, and algorithm development tools. It offers the possibility of noisy or degraded image restoration, improves image clarity, feature extraction, and analysis of shapes and textures, and registers the two images. Therefore, with all the features, we can use MATLAB to perform any sophisticated analysis of the image. Most toolbox functions are written in MATLAB's open language, and this provides users with the opportunity to check whether the algorithms modify the source code and create a custom function.

## 35.2 Principles and Methods of Medical Imaging

Medicine is the human physiology and biochemistry about science section of the nature of radiopharmaceuticals and clinical data. According to the emphasis on pharmaceuticals (tracer) and the entire complex for each patient examination, radionuclide, and then we sent them to the patient intravenously. Radioactivity follows the physiological pathways; And we focuses on specific organs and tissues of the short period [4]. Then, the patient is positioned in the medical device, and the image can detect biologic distribution of the radiation emitted by radioactive drugs.

There are two main approaches in medical image processing: SPECT and PET. In the past decade, the hybrid system has been developed to integrate the SPECT or PET and CT technology lead in of SPECT/CT and PET/CT. This chapter will focus on the  $\gamma$ -camera planar imaging, SPECT, and SPECT/CT in the implementation of MATLAB code.

The medical examination of the range is quite extensive. It includes, inter alia, the patients in the study. Basic image analysis methods includes lots of partds,such as cardiac muscle, brain, kidney, thyroid,lung tumor. And medical research includeds regional property, boundary analysis, curvature analysis and so on. Image processing services as image reconstruction technology, such as viewing the improvement of image quality and image preparation,the quantitative analysis of the results referred the examination of the data.In order to get the research effect, we use Matlab to realize algorithms.

Our goal is a reliable image quality that plays an important role in images of organs in medical imaging and is expected to provide an accurate diagnosis or treatment. The physical characteristics used to describe the image quality are as

follows [5]: (1) contrast, (2) spatial resolution, and (3) noise. The image contrast corresponds to intensity difference in the patient's activities. High diagnostic accuracy of medical imaging must be high contrast.

### 35.3 The Analysis and Processing of Medical Image

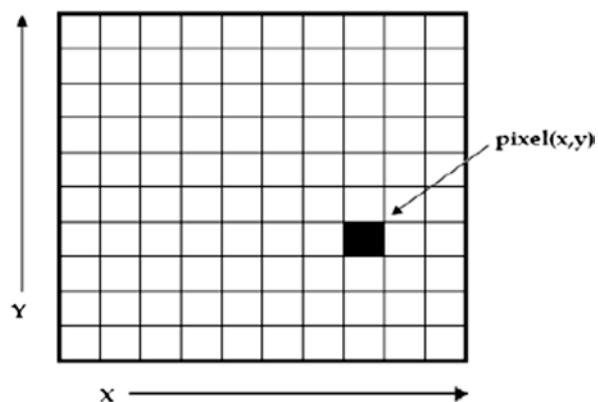
The image processing is a set of technologies, image data analysis and processing algorithms and tools to improve the interpretation of some image information more useful. Image processing allows the extraction of useful parameters and increases the likelihood of detection of small lesions more accurately. Medical image processing has three main objectives [6]: (1) reconstruction tomography (SPECT) imaging technology; (2) quality to improve the image contrast, uniformity, and spatial resolution view; (3) in order to extract useful diagnostic qualitative and quantitative image ready message.

#### 35.3.1 Digital Imaging

In all modern medical imaging systems, image display is an array of discrete picture elements (pixels) in two dimensional (2D) and is known as a digital image. In the digital image, each pixel has an intensity value and the address of the location (Fig. 35.1). Medical image pixel values are used to display the record counts in it. Compared to the simulation of a digital image, we can get benefit from the digital image data for further computer processing.

The matrix size was determined by the number of columns (m) and the image of the number of lines (N) matrix ( $M \times N$ ). The size of the matrix is selected by

**Fig. 35.1** Digital image is a two-dimensional array of pixels



the operator. In general, getting better as a matrix resolution, the size increases. Medical imaging is matrix now ranging from  $64 \times 64$ ,  $1,024 \times 1,024$  pixels. Each pixel in each pixel digital has color level image. Each pixel can take 2 K different values, where k is the bit depth image. This means that an 8-bit image, and each pixel can have from the different layers of color (gray level) of 1–28 (=256). Medical imaging is often expressed as 8–16 images.

The long-term image resolution refers to the number of pixels per unit length of the image. The spatial resolution of digital images depends on the pixel size. The pixel size calculation of view can be divided by the entire matrix of pixels field. For a standard FOV, matrix size is increased to reduce the pixel size to be able to see the details to improve.

### ***35.3.2 MATLAB Type of Digital Imaging***

MATLAB provides a simple function, among variety of image file formats, and supports a number of color maps. Based on file type and color space, the returned matrix is two-dimensional matrix of intensity values (gray-scale images) or 3D matrix of RGB values. Medical imaging is gray-scale or true-color image (RGB or red, green, blue).

### ***35.3.3 Image Processing Techniques Based on MATLAB***

Image processing technology includes all of the tools used to change or analysis of an image based on individual needs. This section describes the most extensive implementation of image processing in medical imaging technology. Mostly from the graphic images of medical kidney, radiographs is a simple object, which display the image processing application by Matlab.

### ***35.3.4 Contrast Enhancement***

The problem is one of the first image processing and contrast enhancements. Acquired image usually does not propose the necessary objects contrary. The contrast improvement is absolutely necessary for organ shape; boundary and internal functions can be better portrayed. In addition, institution division, can be achieved in many cases, does not eliminate the background activity.

Contrast processing command is imadjust. Using this, if necessary, the image contrast can be enhanced or degraded. In addition, a very useful result of the object of interest may be color, especially in the gray-scale image inversion, it can be outlined. The general features of contrast enhancement are as follows:

```
J = imadjust (I, [low_in_high_in], [low_out_high_out], gamma);
```

Assume that J is the relationship between the new image, I is the first image, and the shape of the curve is described by the gamma values, I and J. If gamma is omitted, it is considered to be 1.

### 35.3.5 The Organ Contours

In many medical imaging, organ boundary is not clear, due to low resolution or the existence of a high percentage of noise. To command to draw the organ contours, imcontour can be used in medical imaging. In addition, the variable n defined equidistant contours required. This variable count is closely related to strength. For the higher value of n, the line drawn between the smaller spaces depicts the stripes of different intensity. And contour type can be specified. For example, when the outline of a five contour drawn with a solid line is the desired result, the overall function is as following:

Figure, imshow (I)

```
J = imcontour (I, 5, '—');
```

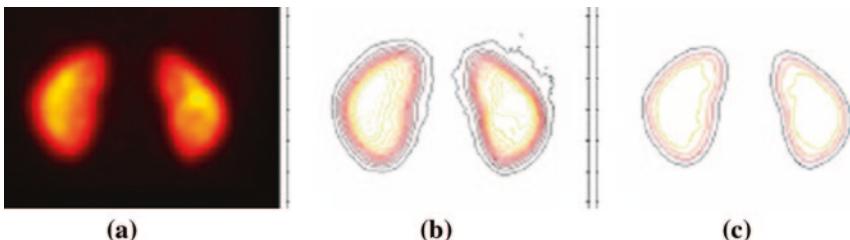
Figure, imshow (J)

Among them, the J and I represent the final and initial images and symbol ('-') represents the solid line drawing. For example, the initial image contour with N = 15 and N = 5 is, respectively, as follows (Fig. 35.2).

### 35.3.6 Gaussian Filter

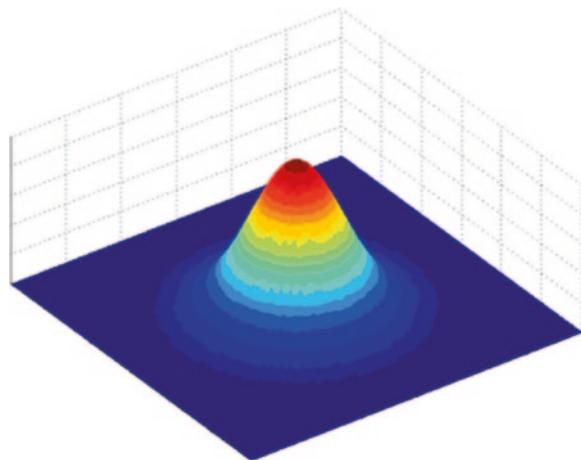
Gaussian filter is a linear low-pass filter. On the curve side of the tapered part of the Gaussian filter mask forms the high point in the center and symmetric (Fig. 35.3). The application of the Gaussian filter can produce the weighted average in each pixel in the image. Such a central pixel can get more effective results in the edge of the pixel mask. According to the weight of the Gaussian function (Eq. 35.1) [7]:

$$f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-(x-\mu)^2 / (2\sigma^2)} \quad (35.1)$$



**Fig. 35.2** **a** original image depicts the kidney; **b** N = 15 organ contours; **c** N = 5 organ contours

**Fig. 35.3** The 2D gauss function



Among them,  $\mu$  is for the average value and  $\sigma$  for standard deviation sigma.

Smoothness depends on the standard deviation. The larger the standard deviation, the smoother is the image portrayed. The Gaussian filter is very effective at reducing impulsive and Gaussian noise. Gaussian noise due to random variations in intensity and distribution follows the Gaussian curve.

### 35.3.7 MATLAB Filter

In MATLAB, using image processing toolbox, we can design and implement the filter image data. For linear filter, MATLAB provides `fspecial` command to produce a common 2D filter.

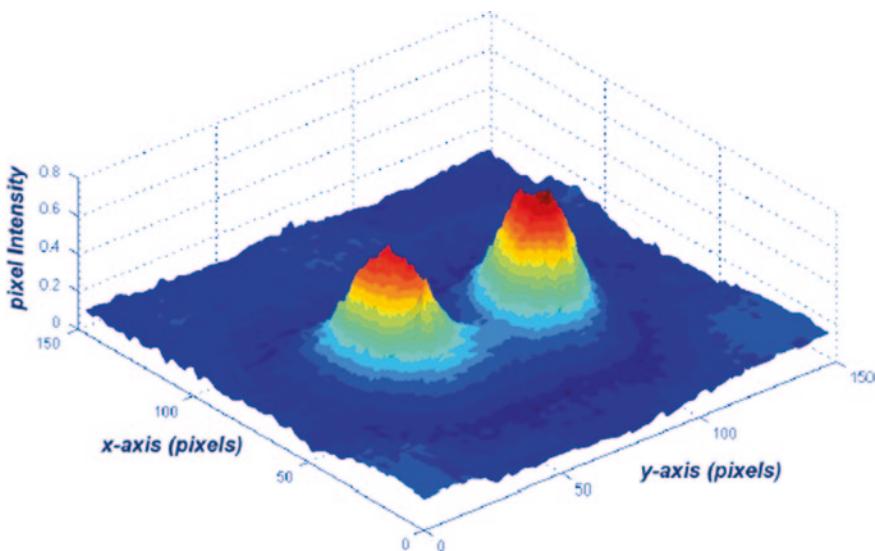
```
h = fspecial ('average', parameters)
```

The following example describes the command packet, the mean (average) radiographs of the convolution kernel of the application size of the filter can be used ( $3 \times 3$ ,  $9 \times 9$ ,  $25 \times 25$  average filter) (Fig. 35.4).

```

h = fspecial ('average', [3 3]);
b = imfilter (a, h);
Figure, imshow (b);
i = fspecial ('average', [9 9]);
c = imfilter (b, h);
Figure, imshow (c);
j = fspecial ('average', [25 25]);
d = imfilter (c, h);
Figure, imshow (d);

```



**Fig. 35.4** Pixel intensity surface plot represents the identity in X-axis and Y-axis, and pixel represents the intensity of the pixel in the Z-axis

## 35.4 Dicom Image Processing

MATLAB digital medical image processing, the development of a standard is the same in order to enable users to retrieve the image transfer digital images and the related use of a standardized way all the information from different imaging way. The geometry of three-dimensional image data in accordance with the header contains the information. DICOM files there. The DCM expansion. In medicine, the most common and supported formats for the three-dimensional data are stored using the DICOM volume split into pieces (such as heart or kidney), and each of them is saved as a simple DICOM image slice. Encoded digital slides can be distinguished in the file name or by specific DICOM tags. MATLAB supports DICOM files, and DICOM image processing is a very useful tool. DICOM images are gray-scale images. We can use the following function to read DICOM images of the command dicomread in the name of the hypothesis “kidney”. I = dicomread ('kidneys.dcm');

To read DICOM file meta-data, command dicominfo is used. The latter returns a MATLAB structure, where each field contains a specific DICOM meta-data. Such as the same DICOM images,

```
Info = dicominfo ('kidneys.dcm')
```

Loaded images can now modify and process in any desirable way. To modify or write image data or meta-data in the DICOM format files, dicomwrite functions are used. The following command is used to write the image I or K DICOM file kidneys\_file.dcm of thyroid\_file.dcm and DICOM files.

### 35.5 Conclusion

The application of medical diagnostic imaging, image processing, and analysis to improve the quality of images was acquired as well as to provide quantitative data useful for patient treatment and care. Advanced image processing and analysis techniques are found to be widely used in medicine. Matlab and Image Processing Toolbox also enabled the quantitative analysis of medical imaging and visualization plane possible, which can reconstruct tomography (SPECT, PET) slices and 3D volume image in surface rendering.

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# Chapter 36

## Electronic Medical Record Retrieval Platform

Pengfei Hu and Jianbiao Chen

**Abstract** The electronic medical record, electronically created, saved, and used by the medical institution, is a data integration system focusing on clinical diagnosis and guiding intervention information for the outpatient and inpatient (or care). In this paper, based on the Oracle Text tool, the data retrieval, filtering, segmentation, morphological analysis, and indexing method, an electronic medical record retrieval platform is constructed, providing technical support for clinical research inquiry and the realization of information sharing.

**Keywords** Electronic medical records • Oracle Text • Full-text retrieval

### 36.1 Introduction

Electronic medical record, created, saved, and used by medical institutions in an electronic way, is an data integrated system mainly targeted at clinical diagnosis and guiding intervention information of outpatients and inpatients (or health care objects). It is the resident individuals' complete and detailed clinical information resources produced and recorded in all their previous treatment processes in medical institutions [1]. Electronic medical record system has provided the functionality surpassing the paper medical record with the advantages of large information, easy circulation, access to medical information, and a wide range of application; it is a real “data pool” of patient-centered diagnosis and other check data. Based on the modern information management system, the possible secondary use of medical records will make many benefits and will be the core of the medical informationization. Now “bingli No 1” project, without an independent electronic medical record system, inquires about patients' medical records through

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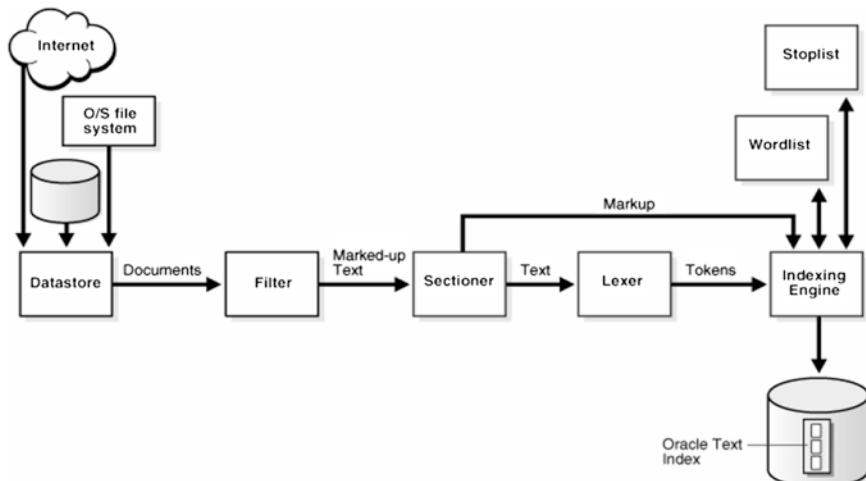
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their ID number to find the structured information, such as diagnostic information and basic condition. As for the unstructured information, such as hospitalization records and treatment process notes, it cannot conduct the full-text retrieval and serve the clinical research, which greatly affects the secondary use of the electronic medical record. The Oracle Text technology provided by Oracle in this article can use the standard SQL tools conveniently and effectively to establish a full-text retrieval system of the electronic medical record with manifold document format and complex search standard [2].

## 36.2 Oracle Text System Structure

Oracle Text, a pack unit starting with Oracle 9i, offers a powerful full-text retrieval function and intelligent text management ability. Its index and search function is not limited to the stored data in the database; it can retrieve and find documents stored in the file system and look up more than 150 kinds of document types including Microsoft Word, PDF, and XML. Oracle Text search functions include fuzzy search, stem search (search for mice and find mouse), wildcards, proximity, some other search methods, and the results classification and keywords to highlight, etc. The system structure is shown in Fig. 36.1.

Oracle Text needs to create index for the retrievable data so that users can find the contents by searching. Indexing process is modeled according to the pipe, and in the pipe, the data after a series of conversion will add the keywords in the index.



**Fig. 36.1** Oracle Text system structure

1. Data Retrieval: Taking data from the data storage and then the data transferred to the next stage.
2. Filter: Choosing proper documents to filter will transfer various data files to the form of texts, because the index can only deal with texts.
3. Sectioner: Altering the original data of structure.
4. Lexer: According to the language of data item, it divides the stream of characters into few words.
5. Index: It is the last period to add the primary key into the actual indexes.

### **36.3 The System of Building EMR Retrieval**

In the “bingli No 1” project, the unstructured EMR owned the early word editor to form the system of medical record [3]. Oracle Text can search these forms of texts, taking word for an example to explain the method and steps of using the Oracle Text.

#### ***36.3.1 The Configuration of Oracle Text***

Before Oracle 9i, Oracle Text must be installed manually. If the DB did not contain the CTXSYS user and CTXAPP, then it means that the DB has no function of Oracle Text when it was created. So you have to install it at first. Only owner of the CTXAPP can carry out the task of creating index and managing the data library of Oracle Text, which includes searching the Oracle Text and using the bag program.

#### ***36.3.2 Download the Information of Texts***

Oracle insists on putting the texts into the text field or some other forms, such as the system of document, URL, and so on. Besides, you can also accord to the medical record road of MR\_WORK\_PATH of HIS and the MR\_WORK\_PATH, copy the document of EMR to d:\MR\_path; the progress of creating a DBF in the DBS as below:

```
create table Mr_doc (
id varchar2 (20) primary key—the only sign of one document
title varchar2 (255)—the title
text varchar2 (255)—the road without the name of one document
)
```

In this case, Word was put to the system of document (d:\docs) rather than put immediately to the DBS.

### ***36.3.3 Form the Preferences***

You should set the forms of the indexed document, the unit of character, classification of languages, the style of document storing, and some other information. The preferences are completed by the progress of CTX\_DDL, create\_preference, and CTX\_DLL. Set\_attribute in the bag of CTX\_DLLB. The main steps are setting the parameter as following:

1. Datastore Objects: The parameter tells the storing method. The word EMR of “bingli No 1” project was set to the limited content, thus made the using of FILE-ATASTORE to search on the set road. If there is some change in the document, you can only do by altering the indexes to inform the Oracle that the indexed data have been changed.
2. Filter Objects: The filter is made to change all kinds of data in file formats into plain text, and the other components in the index track only deal with the plain text data, instead of Microsoft Word or Excel. The filter has several kinds, such as charset\_filter, auto\_filter, null\_filter, user\_filter, and procedure\_filter. The following example is chosen in the case of auto\_filter; this is a common one, and it is applied to most kinds of documents, including PDF and Ms Word, and it can also identify plain text, HTML, and XHTML automatically.
3. Lexer Objects: Lexer is used to deal with all kinds of languages: the primitive English will use basic\_lexer and Chinese will use chinese\_vgram\_lexer or Chinese\_lexer.

BASIC-LEXER: it is applied to English and the majority European language, which uses the single-byte character set.

MULTI-LEXER: there are different kinds of languages in the index texts

CHINEXE-VGRAM-LEXER: the index text is in Chinese.

In the following case, we chose MULTI-LEXER, and we set the index in many languages. In detail, we set a basic searching language and some branches of it.

The preference also includes some other parameters. However, if it is the common index, three data are enough. Next we are going to set an example in an anonymous memory procedure, and we build a preference named mr\_datastore.

```
begin
ctx_dll.create_preference('mr_datastore', 'File_DataStore');
ctx_dll.set_attribute('mr_datastore', 'path', 'd:\ mr_path');
end
```

If there is any mistake during it, a drop preference () would solve the problem.

### ***36.3.4 The Building and Renew of Index***

When we are setting an index, we need a special kind of filter, the one that could get texts from the binary system pattern such as Word, Excel, Pdf.

```

CREATE INDEX mr_text_index ON Mr_doc (path) INDEX TYPE
IS ctxsys. context
PARAMETERS(
datastore file_datastore
Filter auto_filter
Lexer muli_Lexer
');

```

When performed the former sentence successfully, the user will get four charts: they are DR\$mydocs\_text\_index\$I, DR\$mydocs\_text\_index\$K, DR\$mydocs\_text\_index\$R, and DR\$mydocs\_text\_index\$N, and among them the DR\$mydocs\_text\_index\$I remains in the Word format of the document, including the position, times, and hash of the words, and it is the center researching of the whole document. The recording of the DR\$mydocs\_text\_index\$I originated from the index word collection, and when it is changed, the researching should also be changed. The change is made by performing the following sentence regularly: alter index mr\_text\_index rebuild.

### ***36.3.5 Searching for Use***

When the searching is set, we can search the whole document, for example:

Eg1: Select \* From Mr\_docs where contains (text, ‘appendicitis’) > 0; we can get all the records about appendicitis included in the text of appendicitis in the Mr\_docs.

Eg2: Select \* From Mr\_docs where contains (text, ‘coronary heart disease hypertension’) > 0; we can get all the records of heart disease or hypertension included in the text of appendicitis in the Mr\_docs.

### ***36.3.6 The Tackling of Researching Result***

With the above procedures, we can only get the information when the words exist in the document. In fact, the Oracle Text also provides many data that are able to deal with the text. For example, with the ABOUT, we can gain the quantity of the related text returned. In the English character set, ABOUT searching could use the index of the theme subassembly, and this subassembly is set in acquiescence. Thus, the operator will return the document according to the researched notion, instead of the certain accurate word or phrase. The CTX-DOC includes the functions that are able to select [5].

## ***36.4 Examples in Application***

With the Oracle Text of whole-text searching technology, the proscenium developing facilities use power builder 9.0, operating system, managed to apply in the searching of the whole document of the electronic case history named “bingli

No 1". Its functions include document introduction, index management, and text searching interface. When searching the information of the electronic case history half-structured or structured, it is possible to make it with slandered SQL sentence, instead of too much prophase disposing, thus reducing the complexity of the system.

## 36.5 The Summary

Oracle Text provides a powerful document searching function. As a subassembly of oracle, it does not need any added fee, and it is suitable for the document researching in huge literature data. Of course, the Oracle Text do exist some shortages, for instance, the functional problems, the huge expending of setting an index searching, and so on. What's more, this system only makes it possible in the matched searching of keywords, and the information returned to users is limited. If we classify the keywords beforehand, then the information returned to the users may increase.

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# Chapter 37

## Study of Health Examination Information System

Yun Wang

**Abstract** The healthy physical examination work will produce large amounts of medical information. The completion of the information management must have a set of relatively complete information management system. The development pattern of the combination of test drive technology (TDD) and V-model structure is adopted, and a combination of physical examination information is designed, which can quickly give the physical health of report management system. The system improves the work efficiency of medical staff, has a better usability.

**Keywords** Medical information system • V-model • TDD

### 37.1 Introduction

The healthy examination is the behavior of diagnosing to test the people's body by the medical way so as to know their healthy condition well, and find out the clue of physical examination department, which face more and more work. But its way of management is still behind the time [1]. The physical examination will result in so much information, so there must be a perfect information management system to manage the information. The original physical examination information system of our physical examination central could not adapt to the medical scale and efficiency requirements of physical examination for it is too old [2]. So, our hospital develops a new physical examination information system in October 2010. During the process of development, we adopt the way of test-driven development (TDD), which could identify the demand of development further, accelerate the process of development, and improve the quality of software, comparing to the traditional development way of V-model.

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## 37.2 Module and Function of the System

System divides into six modules as follows:

### 37.2.1 *The Module of Physical Examination Appointment*

It divides into personal appointment and group appointment. Multi-choice input-output improves the availability of system. The group appointment would lead-in the fined form sheet to improve its efficiency. We allot the unique ID to the people who accept the physical examination, giving the magnetic card for examination. If they have the ID of patient, or the file is in the hospital information system (HIS), the system would connect the ID of patient with the ID of physical examination correspondingly and offer the condition to share information between the PETS and HIS. After the success of appointment, the system could set the item or package of physical examination and print the guidance document of physical examination and the bar code label of test sample, sending their information to the online test system.

### 37.2.2 *Module of Tapping the Results Input Module*

After the physical examination for the patients, doctors in each department could tap the information in, such as the information, conclusion, picture of physical examination, the diagnosing of disease and so on. They could do it by hand, or from the module according to the authority. Software also could design module on the spot based on the information tapped in by hand, and then, next time is easy.

### 37.2.3 *Summary and Suggestion*

After the examination of projects, the general doctor summarizes the result of old people who accept the test, giving the conclusion and suggestion of examination. The project of summarize and suggestion is also adopted the flexible module to tap information in, it could be auto-designed, too.

### 37.2.4 *Report of Physical Examination*

The module could generate the testing and printing report of patients. There is the examination result, reference standard and the descriptive information of results on

the report, which could be batch printed. The system would lead out the results of people who finished the test, publishing the results on the Internet for being looked up.

### ***37.2.5 Counting and Analyzing***

The system user could count and analyze the test results according to the rules of system settings or themselves ones; generating kinds of form.

### ***37.2.6 System Maintenance***

The system could achieve the function of maintaining the system dictionary, connecting and managing the test system, sharing the date with test device and so on.

## **37.3 Traditional Structure of V-Model and the Way of TOD**

Now, V-model is widely applied among the models of testing software. There are five stages in the process of developing software on the left; and correspondingly, there are five ones in the process of testing on the right. The advantage is that the model indicates the different stages in the process of testing definitely and describing the relevant relationship of these testing stages and development process ones clearly [3].

The shortcoming of V-model are also obvious: (1) The testing action starts after the end of code; and then, it may miss the chance of finding out the analysis of demand and the mistakes hidden in the design on the early stage. The most serious mistakes are those that lead to program cannot satisfy demand. According to the relevant research, the mistakes hidden on the stage of demand design are always the biggest part of software mistakes. (2) After the end of code, the development personal will not amend the program until the testing groups submit the report of software imperfection to them. The availability of human resources is low. (3) The model rigid differentiates between the testing process and developing process on the time. There is the disadvantage to store the files such as the test plan, test design, error statistics, the last analysis report and so on.

### ***37.3.1 Test-Driven Development***

Test-driven development is a project of core practice and technology in the process of acutely developing, which is the process of checking and derivation the design

form the angel of testing, pushing form art the whole developing through the way of testing, writing the sample code for using before writing the code of production function, real-time testing the accuracy of functional code writing, quantifying the demand analysis, design and the control of quality [4].

The ways of TOD as follows: (1) Add up a testing sample for using quickly. (2) Compile all the codes, if there is a mistake, the code could not get through, then it will modify the mistake as less or possible to make the compiler perfect. (3) Run all the tests, modifying the newly found test which could not get through as less as possible to get it through. (4) The reconstitution of code to eliminate the repeated design.

TOD is the unit test, which is the developing process by the way of definition the interface needed to be developed, and then, it achieves its function. The test is aimed at the unit, which is the smallest software element to be tested. Kent Beck put forward two simple rules of TOD: There is the need to write the new functional code when some auto-test failed, and no need to write new function code without testing; and achievement of applying the TOD to physical examination information system.

The system adopted Power Builder 9.0 as its language of development. There is no unit test device in the environment of developing, which adopts the ways as follows: (1) Self-build up the agreement and start the test by hand [5]. (2) Make an agreement that every testing function without the real function to input, nor the return. If the test gets through, it returns normally; if the test could not get through, then it will lead some abnormal phenomenon. (3) Design a group of testing function according to the demand, and write a start testing function (4) Run the main when the renewal of vocational code is finished.

In the testing and developing process of traditional V-model, it is easy to misunderstand the demand because the software developing personal is unfamiliar with the medical knowledge and the process of physical examination. The user may add up the new demand on the later stage of developing. These problems are serious. But the TOD will release the pressure created by the change of demand. First, it writes the testing sample before developing, the developing personal will understand the demand from the angel of user, and then, they will master the demand well. Second, testing sample progressively develops according to the pace, achieving the demand from the slightness. When the demand changes, the personnel could modify the physical examination information system safely only if the testing sample could get through effectively. Then, the influence of change will be the minimum. It also avoid the useless maintenance because of the endless adding code resulted by the change of personnel and the lack of file. Using the testing sample could test the function code effectively.

## 37.4 Conclusion

This text points out the strong advantages of TDD's quick software development system with the comparison of traditional V-model structure. The basic idea is that the testing sample code should be compiled before the functional code, because the

development of the testing-driving technology can adapt to the change in demand rapidly, improve the developing process, and upgrade the quality of software project.

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# Chapter 38

## Biology Modeling Teaching Method Based on Information Technology

Lin Guodong and Qian Xiaowei

**Abstract** In theory, this paper sums up the concept of modeling method and the classification of biology modeling method and also emphasizes the important roles of the integration of biology modeling method with information technology in the biology teaching process. In practice, this paper applies information technology to make biology models and meanwhile designs the teaching plan to cultivate students' biology modeling methods with special focus and aims, implementing it into the teaching practical process specifically. More importantly, good results are achieved.

**Keywords** Information technology • Modeling method • Biology teaching • Biology model

### 38.1 Modeling Method

"American National Science Education Standards list models and scientific facts, concepts, principles and theories as the focal points of scientific subjects, and also regards the construction, modification, analysis, and evaluation of model as the basic science exploration abilities of high-school students."

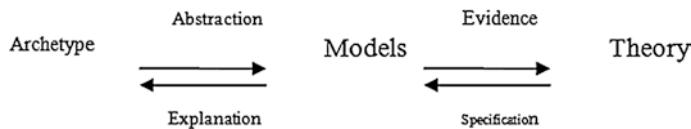
Modeling method is an approach to reveal the archetype's shape, characteristics and nature through the researches on the model [1, 2], which is a special form of logical method, a cognitive means and thinking way as well as a bridge to connect theory and application. Abstraction and specification are two important characteristics of modeling method (See Fig. 38.1).

Biology model can be generally classified into physical model and mathematical model based on the ways represented and reflected by itself [3, 4]. Specific classification can be as shown in the following Fig. 38.2:

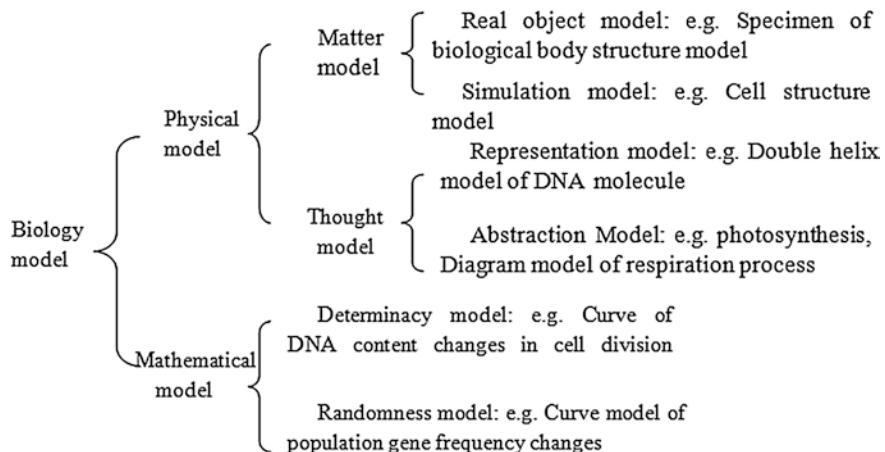
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**Fig. 38.1** Characteristics of Model



**Fig. 38.2** Biology model can be classified into physical model and mathematical model

## 38.2 Necessities of Information Technology Integrating with Biology Modeling Method

1. From the model establishment, computer provides powerful simulated functions. As teaching resources, powerful computer simulation functions cannot only bring teachers convenience to make and apply model, but also possess obvious advantages on media's expressive force, reappearing force, contacting horizon, participation and controlling, etc.
2. From the development of thinking way, high school students are experiencing a developing process shifting from imagery thinking to abstract thinking, while modeling methods and information technology are just an integration of imagery thinking with abstract thinking. Currently, the application of information technology in biology is mainly represented in the comprehensive processing ability of computer multimedia, forming a multimedia teaching system integrating fig., text, voice and videos, having rich techniques of expression and strong expressive forces, and it is able to make biological shapes, structures, movement changes specifically and visually and imitating the dynamic process of biological genetic variation, ecological evolution and

- biological evolution illusorily. Hence, life's phenomenon and essence can be disclosed, and a bridge from imagery thinking to abstract thinking is set up.
3. From the perspective of teaching process elements, information technology and modeling method not only carry and transmit information as teaching media in the process of teaching, becoming the important elements of teaching system, but also can instruct the teaching elements such as teachers, students and learning contents. Moreover, all kinds of learning contexts can be established to help the implementation of the constructed theories, connecting direct and indirect experiences.
  4. From the teaching evaluation, the integration of information technology with modeling method can supplement and perfect each other in the formative evaluation. In the teaching evaluation, modeling is mainly embodied in the evaluation on students' thinking way and thinking process. Information technology provides a powerful interaction and feedback function for teaching evaluation, facilitating teachers to timely know the teaching effects at each stage and the study progress and hence timely adjusting and improving their teaching.

### **38.3 Practices of Applying Information Technology to the Teaching of Biology Modeling Method**

#### ***38.3.1 Applying Information Technology to Make Biology Model***

Using computer simulations and simulation technology to show biological shapes and structures and make biology simulation model can provide students with an environment for experience and observation, simultaneously arousing their imaginations effectively through lively and intuitive images [5], awaking relevant knowledge, experience and representation in the long-time memory, and hence making use of relevant knowledge and experience from their previously formed cognitive structures to assimilate the new currently learnt knowledge, and forming more stable and firm cognitive structure.

#### ***38.3.2 Implementation of Biology Modeling Method at Classroom Teaching***

The teaching of model should guide students to know why to set up a model, how to establish a model, what conditions of a model to be used, as well as how to inspect and perfect a model. By combining the classroom teaching of “plant's water absorption and utilization,” the teaching process by modeling method is discussed as the following.

### 38.3.2.1 The Modeling Method Teaching of the “Plant’s Water Absorption and Utilization”

External Performances of the Observed Object, and Putting Forward Questions and Research Subjects

The following can be shown in the computer: Two pieces of green vegetable with similar growing status are put into the same amount of clean water and strong brine, respectively, and then the vegetable in strong brine will gradually wilt. Through observation, ask students to put forward questions according to the observed phenomena: Why do the vegetable in strong brine wilt? And an assumption can be made that the wilting of the vegetable in strong brine comes from its dehydration. Besides, new question can be proposed based on the assumption: What part does the vegetable suffer from dehydration? How does it happen? Thus, the research subject can be confirmed: How does plant’s cell absorb and dehydrate water, namely a model of plant’s cell osmosis, can be established. The process from individual dehydration phenomenon to cell dehydration analysis is a sort of simplification to research object, which is a reflection of the basic idea of modeling.

Design Experimental Model to Find the Main Characteristics of the Experimental Phenomena and Their Generating Conditions

Analysis on the cell structure model through computer simulation is as shown in the following: The protoplasm layer can be regarded as a semipermeable membrane, and its water molecules can freely go through the semipermeable membrane but inorganic salt ion needs a selection to go through it. If the plant’s cells are put into strong brine, more water molecules will spread outside, and this is why the dehydration will happen, hence represented by the phenomenon of the separation of the protoplasm layer and the cell wall. Based on such an analysis, students can design the experiment to verify the cell’s osmosis, water absorption and dehydration; and can they conduct operations according to the designed experiment, observing the phenomenon and analyzing the experimental reasons. Except the necessary equipments offered in the experiment, many kinds of solutions are also prepared such as strong brine, sucrose solutions with different concentrations, alcohol and potassium nitrate solution, which are necessarily conducive to the formation of abstract and generalized model thoughts, though these all may not be used.

Analyze the Experiment Facts and Establish Relative Models

As the experimental process is only a kind of judgment or verification on a thinking way, the formation of the osmosis model still needs to rely on computer to demonstrate the model of deplasmolysis microcosmic process, establishing a model of “there is a concentration difference between the two sides of semipermeable membranes able to have osmosis.” Due to the influence of the complicated

cell structure on the process of cell's plasmolysis, the established model is needed to pass the examination. Thus, the osmosis demonstration experiment is designed to examine whether the difference between the two sides of semipermeable membrane will have osmosis, and meanwhile, the variant questions are put forward as well. For example, what will be the results if the mouth of the long neck funnel used completely permeable or non-transparent membrane but not the semipermeable membrane? And what will be the results if the solutions of membrane's two sides exchanged?

### Apply the Established Model to Explain the Phenomena

This is a process to use model to explain the prototype. There are many examples in production and life, such as plant's burnt seeding and wilting phenomena, cold cucumber, reasonable fertilization and irrigation, even including the maintenance of plant cell's osmotic pressure and the steady state of internal environment, etc. All these osmotic models can be used to explain these phenomena. Besides, these can let students experience the roles of the theoretical knowledge and also generate students' stable needs for the happy and proud feelings obtained after successful explorations, helping to form stable leaning interests.

### Modify and Perfect Model

Do all plant cells have water absorption and dehydration through osmosis? The computer model absorbing water through dry seeds proves that some cells absorb water through imbibition. By such a way, students can supplement or expand their former models, allowing students to recognize the establishment of the model is a constantly developing and improving process.

## 38.4 The Evaluation on Teaching Practices | and the Problems

Evaluation is a process to judge value which is polybasic. Due to the important roles of the evaluation on students' studies and teachers' development, it is necessary to carry on special discussions.

### 38.4.1 Quantitative Evaluation

I select the Cangnan County Qianku Advanced High School as the experiment school, a second-class key high school in Zhejiang province. The school has eight parallel grade-two classes. The freshmen stepping into sophomore are based on the order of their science courses' total scores, which are conducted by the classing software according to the average score out of the total scores and the average score out of all courses' scores. Now, class two from grade two is

selected as the teaching practice class, and the integration of information technology with modeling method is applied to the teaching practices, while other classes are selected as the reference classes, and the regular teaching methods are utilized in this experiment. To make a summative evaluation for teaching practice, an evaluation test on the results from biology modeling method was carried on September 2, 2008, with the form of comprehensive evaluation paper, in which eight science parallel classes participated from grade two and the actual number of participants was 402. All papers were sealed and graded with assembly line form. Besides, the statistical results are as shown in Table 38.1:

Z examination is adopted to carry on the significance of difference on the scores of the two classes, and the examination value is gained as the following:

$$|Z| = \left| \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S_1^2/n_1 + S_2^2/n_2}} \right| = 3.19 \quad (38.1)$$

The level of significance ( $\alpha$ ) can be at 0.01 by using two-sided test;  $Z_{0.01} = 2.58$  can be gained by checking Z distribution table; due to  $Z > Z_{0.01}$ , the students' scores of the class two of grade two are obviously different from other parallel classes.

Seen from the above analysis, there is an obvious improvement on students' biology academic results and most of students achieve a great improvement on their results, which indicate that it is generally successful for the application of information technology to cultivate students' biology modeling method.

### 38.4.2 Qualitative Evaluation

#### 38.4.2.1 Promoting the Development of Students' Thinking Ability

In the biology teaching, through osmosis biology modeling method, the thinking process of analyzing biological modeling, seeking for the relationship and difference among models, actual matters and phenomena, the specification and visualization of actual problems making researches' biological problems, life phenomena and process form dynamic biology model and biological representation all promote the developments of students' visualization thinking ability, abstract thinking ability, divergent thinking ability, difference thinking ability, intuition thinking ability, etc.

**Table 38.1** Analysis on the effect of grade-two biology comprehensive test

	Student number (n)	Average score ( $\bar{x}$ )	Standard deviation (s)
Grade two (class two)	50	78.52	11.07
Grade two (except class two)	352	69.31	12.34

### **38.4.2.2 Optimizing Students' Cognitive Structure**

In the biology teaching, guiding students to conduct the training of modeling method fully develops students' subjective initiative, their subject consciousness are reflected, and their learning methods change as well from the previously traditional method of accepting studies alone to accepting studies by initiative discovering studies, paying more attention on the initiative analysis and exploration on problems, starting to construct their own knowledge structure through the interaction between new and old knowledge, becoming good at discovering problems and creatively solving problems, and timely controlling, examining and evaluating themselves' cognitive progress.

### **38.4.2.3 Methods and Consciousness are Enhanced**

In the biology teaching, after the modeling teaching practice is implemented, a majority of students were benefited from the method, knowing "methods are more important than knowledge" and realizing the importance of methods, tending to looking for methods to solve problems, but not only relying on memory ever.

### **38.4.2.4 The Concepts of Teachers' Teaching and Students' Learning Change**

Modern education theories require dealing with the relationship between knowledge imparting and ability cultivation well, guiding students to propose questions and exploration, letting students construct knowledge, commanding the methods to solve the problems and attaining the development of intelligence and ability as well as in-depth feeling experience in the process of exploration. In the teaching practices of modeling method, we deeply appreciate that the modeling process is a scientific exploration process in some ways. Teachers should be both the instructors and promoters for the construction significance of students, not only imparting knowledge but more importantly conveying learning methods and abilities. However, students should become the hosts of their studies, the constructor of the significance, which is a "torch light needs to be ignited."

### **38.4.3 Main Problems**

Due to the time limitation, the subject research was conducted at exceptional classes only in one-year teaching practice activities, so it is difficult to be improved greatly in a short term.

Due to the complexity of the teaching problems, the measurement on students' biology modeling ability and scientific exploration ability is also quite difficult;

and the quantitative evaluation is hard to be presented, so the teaching evaluation mainly focuses the qualitative evaluation.

Due to the practices conducted only in one class, whether the achieved results have universal meaning still needs to be explored further.

Due to the constraint by traditional teaching method and the limitation by school's teaching requirements, students' main body roles are not fully shown in the subject research, impacting the effect of the subject research to some extent.

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## Chapter 39

# Clustering Algorithm for Extracting Chinese Herbal Medicine's Chemical Composition

Wei Guang Li

**Abstract** Traditional Chinese medicine is a shining pearl in China's scientific developmental history. To cure illness with it has its unique effect and contribution. But the illnesses database, the prescription database and herbal medicine database are very large and complex, so we have to treat these databases' data through database technology. The article analyzes the chemical composition of some traditional Chinese medicine to cure some illness by means of data mining. First, we build three databases: the illnesses database, the prescription database and herbal medicine database. Second, we search the prescription database to some illness to find all traditional Chinese medicine. Third, we cluster these traditional Chinese medicines to find the common composition. And it may be useful in the treatment for illness. And this way gives doctors a way to treat some illness.

**Keywords** Traditional chinese medicine • Database • Data mining • Clustering algorithm

### 39.1 Introduction

Traditional Chinese medicine originated in China. It is a traditional science with ancient Chinese medical practice and has thousands of years' history [1, 2]. Chinese herbal medicine is the aggregation of drugs under the guidance of traditional Chinese medicine theory [3, 4]. Each drug has its own features such as four natures of drugs and five flavors, and each drug has its own unique effect. Different diseases can be treated using the same kind of Chinese herbal medicine, and different herbs can be used to cure the same disease [5]. Then, this study analyzes what kinds of ingredients are useful in healing.

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There is a wide range of Chinese herbal medicine, which also has different chemical composition; therefore, chemical composition of herbs is huge and has complex database [6]. So, such database can only be researched and explored using database theory. Therefore, we use data mining to study the chemical constituents of traditional Chinese medicine and research which composition can cure which disease. Then, we may use the method to cure some known disease or unknown disease with some kind of drug.

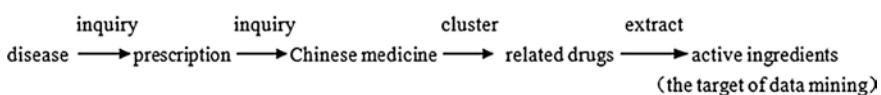
There are many methods of data mining, such as classification or prediction models, data summary, data clustering, association rules, sequential pattern discovery, dependencies, trends found. In this paper, we use the method of clustering analysis to extract the same treatment ingredient of different herbal and study which Chinese medicine components work on some specific disease, and then, these components are increased in the drugs to achieve treatment or mitigation to the disease.

## 39.2 The Analysis to the Algorithm Model

As shown in Fig. 39.1, to a particular disease, we search the prescription database to query the Chinese herbal medicine which can cure the disease. Then, we cluster these Chinese herbal medicines to get a collection of related drugs. To analyze the chemical composition of these drugs, we get the public portion of them, and this part will have a certain role in curing the disease. Finally, we use some medical methods to detect whether the clustering results are correct. If correct, we can put the result to use in clinical medicine.

## 39.3 Database Construction

In our system, we build three large databases: a disease database, a prescription database and a Chinese medicine database. Each database includes a number of related tables, but in this article, we only use four tables of them. The first is the disease table (the number of the disease, the name, pathogenesis, symptoms and common prescription). The second is the prescription table (the number, the name, prescription source, drugs, usage and cautions). The third is the Chinese medicine table (the number, the name, aliases, four natures of drugs, five flavors, lift ups and downs, treatment site, and efficacy). The fourth is the Chinese chemical composition table



**Fig. 39.1** Treatment medicines clustering algorithm flowchart

(the number, the name and chemical composition). The number of the prescription table is the foreign key of the disease table associated with a common prescription. The Chinese medicine table and the Chinese chemical composition table have the same number and the same name, and these two tables could have been used as a table, but taking into account the different uses of the two tables, these two tables were created. The number field of the two tables in the Chinese medicine library is foreign key to the prescription table. Database can use the Web database through a search engine; a local database can also be created by using DBMS. This issue establishes relevant database with the SQL Server 2008 (free evaluation version), related data tables are created, the databases' relationship with these tables are studied and then treatment components are gained from the treatment for disease. We use SQL Server 2008 Management Studio to establish three databases and four related tables. We input 20 records as the training data to the disease table, 100 records as the training data to the prescription records, and 400 records as the training data to the Chinese chemical composition table. Then, we will see whether we can get our required goals. If we get our goal, we can expand the database contents. With more input training data, we can get more objective results.

## 39.4 Clustering Extraction Process

After the databases are created, we use the SQL Server Business Intelligence Development tool to create an Analysis Services Project, and then data sources are created to mine data source views, multidimensional dataset and mining structures, as shown in Fig. 39.2.

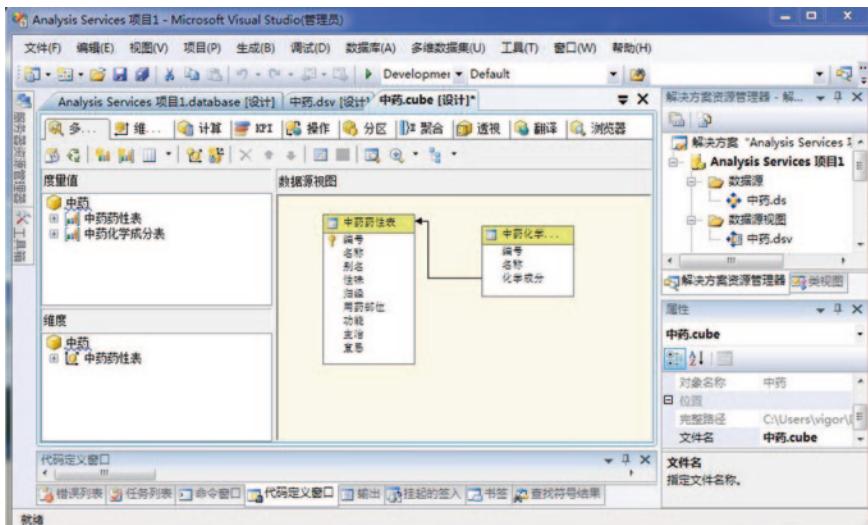


Fig. 39.2 Data mining project graph

Here, we take high blood pressure for example. For hypertension, we search the prescription in the disease database and then search out chrysanthemum, Apocynum, Eucommia, cassia and other Chinese medicines in the Chinese medicines database. By using cluster analysis mining algorithm, we clustered these drugs together. Then, SQL statements are created in the Chinese Medicines database, the chemical composition of these medicines is searched and made as a temporary table to find the intersection of these components. It is proved that there is some falconoid content in those medicines. After verification, Falconoid are anti-hypertensive obviously. So, this method has some auxiliary medical treatment, and it gives a reference method to traditional Chinese medicine use.

## 39.5 Limitations

Even after data mining and database processing, we got some conclusion of our expectations, but because of the limitation of disease database, prescription databases and data sources in the Chinese medicine database, the data may contain noise, and the chemical composition of traditional Chinese medicine table is different, so there are some limits to the Chinese medicine's mining by this way, which is needed to resolve in future studies.

## 39.6 Conclusion

Traditional Chinese medicine is a profound science, but the disease database, prescription database and drugs database are very large, so doctors prescribe according to prescription alone is not a good solution. With the continuous development in database technology, for such large and complex database, we use the database theory, particularly data mining method, to mine this useful information in these vast databases. The article first searches prescription in the disease database, then looks for commonly used Chinese medicine in the prescription database and clusters these Chinese medicines and at last finds useful chemical composition to some disease in the analyzed data, which is an useful attempt in Chinese medicine treatment with data mining technology. Of course, limited by the source data and the complex chemical composition of traditional Chinese medicine, the results of this method are also subject to certain restrictions, but it can still be used as a reference tool to choose traditional Chinese medicine herbs.

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**Part V**

**Computer Simulation and Modeling**

# Chapter 40

## Mobile Device Data Information Processing Research on Based on Queue Algorithm

Feng Pan and GuoRong Chen

**Abstract** Queuing theory is widely used in a variety of operations branch, and it exists for situations in the environment to have the very successful application. Although it is sometimes possible to not pay too much attention to the length of the waiting time, in many business activities the service provider must be given to the mobile device data information processing waiting time to full attention. Most of the large retail store design is actually balance mobile device data information processing convenience and efficiency of the enterprise product; this gave a good explanation of why a supermarket there may be more than a dozen cashier lanes, although in most of the time may be only two or three in operation. Retailers cannot let mobile device data information processing in the line to wait for too long, because the time for mobile device data information processing may be very valuable; if you wait too long, they may turn to the other competitors.

**Keywords** Queue algorithm • Information processing • Model design

### 40.1 Queuing Theory

In management science and operations research, waiting for the team known as the queue, queuing theory is an important branch of operations research in the past decades, which has considerable development, represents a specific environment model, and has a steady increase in the number. The origin of the quantitative optimization, and queuing theory can be traced back to 1909 in A. K. Erlang's(a Danish telephone engineer) paper, since then the Eland's name connected with the

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probability of queuing model closely together, the paper's publication and later for the queuing theory development and laid a solid foundation.

### ***40.1.1 Model Design***

Queuing model plans for a mobile device data information processing way of providing services to achieve certain operation efficiency; it is not to have encountered some models (such as linear programming and inventory model) that chase a minimum cost or maximum profit goals. Specifically [1], queuing model queuing system is to determine the various features, such as the average waiting time and average queue length, or to construct a service system to meet the specific mobile device data information processing service level. These average values are a system for mobile device data information processing service level symbol, which in the follow-up of cost analysis will play an important role.

In daily life and production, people will often encounter all sorts of queuing system, such as road traffic light system, the supermarket cash register system, and telephone communication system. Some queuing system structures are very clear, and other queuing system structures may be very fuzzy. To call from Guangzhou to Beijing, the same time the call number is limited due to the channel capacity constraints; therefore [2], when asked to call the number that exceeds this limit, the caller would have to wait, while the caller is dispersed in the city every corner, each other of not seeing each other, but they and the long-distance station together constitute a service system; they are long-distance stage that forms an invisible force; actually, this kind of invisible force with the supermarket cash register system in the tangible team can constitute the queuing system of queue.

### ***40.1.2 Algorithm Design***

In queuing system there is always a set of service facilities (service facility), and there are many mobile device data information processing (customer) randomized to the system requirements of service, automatically. If the mobile device data information processing arrived with idle service facilities, It services-immediate [3], otherwise the mobile device data information processing will be waiting in line or leave. Usually, we will naturally think that mobile device data information processing is to service the system that is ready to accept the service; however, the queuing system of mobile equipment data information processing should not be subject to any restrictions, can be a person, can also be a matter. Auto repair shop to repair car and airport waiting for a landing aircraft can constitute the queuing system of mobile equipment data information processing. In queuing system, service facilities can also be people, objects or people and material collection.

If the mobile device data processing information is according to a fixed time interval to reach the service system, service facilities in each mobile device data information processing on the business hours are fixed, as the factory assembly line production that has a fixed rhythm [4], so this kind of service system design is very simple. But in most of the service system, the mobile device data information processing to be random, mobile device data information processing business hours is random; this means that the queuing theory has wide application prospect.

#### ***40.1.3 Queuing System Architecture Design***

A queuing system is composed to four parts, They are input, output queue, service station and composed

1. The reliability principle (Reliable). Queue management system of enterprises and institutions as always need to use a software system, must have the reliability characteristics. Not because of the large amount of data and other external causes that are likely to collapse, the design of the system should be considered in reliability design.
2. The principle of safety (Security). Health care for individuals with queuing system of interest, in order to prevent the illegal operation, the security of the system is self-evident. From our data security, system security, and security management, the focus is on the specific considerations. Data security data operation has to be backed up by designing the system rollback principles for data recovery. Safety management is the queuing system bureau to set queue management system, through laws and regulations to restrict people's behavior, from the source to eliminate unsafe sex. System security from application software, hardware and other aspects into consideration, design research, and design software should also consider a number of attacks, such as SQL injection attacks.
3. Expansibility principle (Extensible). Queuing system management is always developing, if the need for new business taken from the original system was expanded and does not influence the function before.
4. Can be customized principle (Customizable). For such a set of software, if the need is function expansion, preferably through page configuration code generation, as the computer technology without understanding the users to provide their own design the required functional convenience.
5. Scalable principles (Scalable). With the development of computer hardware and software, it needs to import new technology, according to different needs and system parameters set to add.
6. Maintenance of the principle (Maintainable). When the queuing system management system problems can be convenient for the vulnerabilities to modify. The demand for change, after the revision of the code, must also consider the convenience principle, in short to reduce the consumption of technical problems.
7. The principle of customer experience (Customer experience). As a result of queuing system management, personnel of computer technology does not

understand, through customer experience will allow users to have a general understanding of the system, through communication can make the system on the basis of the original more convenient.

At the same time the annotation of concepts and query very relevant behoove, it should be more to meet the needs of users. The formula for this is as follows:

$$B_{d_j} = F_{d_j} + (1 - \alpha) \times T_{d_j}, \quad \alpha \in [0,1] \quad (149.1)$$

Put forward, a user model mathematical expression, namely the user model, has a structure:

$$\Theta = (C, R, \sigma, \theta, \vec{c}_u, w_u) \quad (149.2)$$

On ontology model initialization, the structure and members are assigned.

The member is the initial value. This means the user in the beginning on the domain ontology is no special preference. Only after a period of use, we can understand the user's preference.

For the members, its initial value is

$$w_{ij,u} = \frac{1}{\sum_j r_{ij}} \quad (149.2)$$

## 40.2 Queuing Mobile Device Information Data Model Design

Queuing system data warehouse is a series of key sets of information, decision support system, and online analysis processing of the data in the data source object environment, compared with the traditional database system in which in the aspects of the design, there is an essential difference [5]. Design of the database is transaction oriented, and the design of the data warehouse is subject oriented; the database design is to avoid redundancy, generally with paradigm rules to design; the design of the data warehouse is the intentional introduction of redundancy, adopting the paradigm of ways to design. The father of the data warehouse Inman W H in 1991 published "construction of data warehouse in the book writes:" a data warehouse is a subject-oriented, integrated, data variable, non-volatile collection of data used for decision support. According to the data warehouse conceptual meaning, we can see that the data warehouse has the following four basic characteristics:

### 40.2.1 The Theme

In traditional operational databases, data organization form is usually oriented transaction processing, business systems are separated from each other, and the

data warehouse is subject to organize data. Subject-oriented organization data refer to a higher level of analysis of the data, which is a complete and consistent description, which depicts the analysis object-related data linkage; the higher level is compared with traditional database. For example [6], a system for supermarket data warehouse subject can be the “shopping basket” and “orders,” while the traditional database design may be based on the system further divisions, such as sales management system, financial system, warehouse inventory system, and human system for data organization.

#### ***40.2.2 The Integration***

Data warehouse integration refers to the data from the business processing system to obtain some source data on possible units that are not unified, and word length is skimble-skamble wait for a problem; according to the need for data extraction, screening, cleaning, and a series of switching operation, this work called the data preprocessing. The purpose of preprocessing is to let the data warehouse finally presented to the user data is a unified view.

#### ***40.2.3 The Data***

The data in the data warehouse are changes with time. Although the business database is compared to reflect the actual situation, business processing requirements are much lower, but the data must be in a certain period of time for replacement; on the basis of more than 10 years ago sales records to analyze existing users purchase ability and make decision [7], one can imagine that the decision results brought about by the reliability are bad. Therefore, the data warehouse need to continue to be with the theme of change-related data is appended to the data warehouse, thereby creating a new snapshot theme, in order to meet the requirements of decision making.

#### ***40.2.4 Data in the Non-Volatile***

The data in the data warehouse are according to a certain time interval to new old replaces, generally at intervals of 3–5 years. But do not update processing. Once the data are loaded into a data warehouse, it will be retained for a longer period of time; unless the data in the data warehouse are clearly wrong, these data are mainly used for inquiry and decision-making analysis; relational databases often need to modify and add other operations.

Based on relational database storage form that is referred to in the construction of data warehouse is used directly to the analysis of data storage in

relational database. A table in a relational database is divided into two categories: One category is the fact table, and another kind is the dimension table. The fact table stores subject description and keywords, dimension table dimension description, or dimension hierarchical information. Dimension table and the fact table connected together through the foreign key relationship. As a result of the fact that model shape is like a snowflake or star, this model is also called the star schema and snowflake pattern. Multidimensional database data stored in the form of the data are stored in an n-dimensional array [8], to multidimensional manner, rather than as a relational database that records stored in the form of.

### 40.3 Queue Algorithm for Mobile Device Data Information Storage

Dimension is the analysis object of different observation angles, for example, companies with time perspective on sales volume, so the time is one dimensional; if sold the company to geographical perspective on sales, then the region is a dimension.

Using multidimensional data stored as a data warehouse, physical storage format is the biggest advantage: reduce the basic framework of the physical memory space, the multidimensional data operation algorithms implementation process, greatly improving the operation efficiency of algorithm analysis.

Virtual storage form refers to the use of the source of the data in the database multidimensional view to construct a virtual data warehouse. It does not require the use of specialized data warehouse to store data, real data in the source database, but the data pointer is stored in a central location; it is according to the user's multidimensional data operation request to form a multidimensional view, temporary in the database to find the needed data for multidimensional data analysis. It is characterized by a user who can view in real-time history data and can see the real-time data.

Multidimensional database stores have a concept clearly; the storage space occupied is small, multidimensional transaction query has the advantages of higher speed. But it also has two important drawbacks: A multidimensional database management system is the lack of a unified standard; second a multidimensional database in large-scale database management ability is not strong enough.

Virtual storage form have the advantages of simple construction of data warehouse, small occupied space, and flexible, but it is a database entity table view mapping, so they need too dependent on the original data of the data model, if the source data in the presence of noise, redundancy, or missing data, the form of data warehouse is not suitable for the use of. Based on relational database storage form in the processing of large data capacity can meet the requirements of data warehouse, but the point is a database storing large volumes of the details of the data and less comprehensive data, at the cost of efficiency. Because the virtual

data warehouse and a number of the data warehouse technology are relatively mature, the mainstream of the current data storage mode is based on the relationship between system storage.

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# Chapter 41

## Hash Encryption Algorithm Structure Based on the Three-Dimensional Cat Mapping

Xiang Yu

**Abstract** In order to effectively defense against plaintext, selective plaintext, and all kinds of attacks, this paper explored three-dimensional cat map and the chaotic system as a pseudo-random tool to generate the initial value. And after a number of iterations, we can remove part of the code into a 128-bit hash value, which can construct a hash encryption algorithm based on three-dimensional cat map. The proposed algorithm can increase the intensity of confidentiality, improve the resistance of the hash encryption algorithm on the types of attacks plaintext and selectively plaintext.

**Keywords** Chaotic system • Cat mapping • Hash encryption

### 41.1 Introduction

Nowadays, the computer network has been widely used and computer technology has moved from a single field to all aspects of people's lives, so the secure communications come into being. Among the numerous being designed encryption algorithm for the confidentiality, using the chaotic systems for encryption has become a common encryption method [1]. At the same time, taking into account the specific circumstances and ensuring information security, we only need one-way operation. Therefore, using hash algorithm to encrypt the one-way function has become the preferred solution and combining with chaotic system to construct one-way hash of the confidentiality, the strength of the encryption algorithm is more reliable. In this paper, we use three-dimensional cat mapping of the chaotic system to construct hash function.

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## 41.2 Cat Mapping

### 41.2.1 Two-Dimensional Cat Mapping

The cat mapping is a two-dimensional chaotic system, also known as the Arnold mapping, and its specific matrix is expressed as  $\begin{pmatrix} x_{n+1} \\ y_{n+1} \end{pmatrix} = C \begin{pmatrix} x_n \\ y_n \end{pmatrix} \bmod 1$ , where  $C = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix}$ , that is,

$$\begin{pmatrix} x_{n+1} \\ y_{n+1} \end{pmatrix} = C \begin{pmatrix} x_n \\ y_n \end{pmatrix} \bmod 1 = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x_n \\ y_n \end{pmatrix} \bmod 1 \quad (41.1)$$

where,  $\bmod 1$  expresses only take the fractional part, that is,  $x \bmod 1 = x - [x]$ , ( $[ ]$  expresses rounding) [2, 3], and therefore, the phase space of  $(x_n, y_n)$  is limited within the unit square  $[0, 1] \times [0, 1]$  [4].

### 41.2.2 Three-Dimensional Cat Map

Three-dimensional cat map is created based on two-dimensional cat mapping and extend to the three-dimensional thinking. It firstly introduces two parameters  $a$  and  $b$  to the two-dimensional cat mapping, and the two-dimensional cat mapping can be represented as [5]

$$\begin{pmatrix} x_{n+1} \\ y_{n+1} \end{pmatrix} = \begin{pmatrix} 1 & a \\ b & ab + 1 \end{pmatrix} \begin{pmatrix} x_n \\ y_n \end{pmatrix} \bmod 1 \quad (41.2)$$

The steps of extending mapping to three-dimensional plane are as follows:

First, fix  $z_n$ , do cat mapping in plane of  $x - y$ , and then, fix  $x_n$ , do cat mapping in plane of  $y - z$ . Finally, fix  $y_n$ , do cat mapping in plane of  $x - z$ .

Connecting the three matrixes gets three-dimensional cat mapping matrix expression:

$$\begin{pmatrix} x_{n+1} \\ y_{n+1} \\ z_{n+1} \end{pmatrix} = A \begin{pmatrix} x_n \\ y_n \\ z_n \end{pmatrix} \bmod 1 \quad (41.3)$$

where

$$A = \begin{pmatrix} 1 & a_z & 0 \\ b_z & a_z b_z + 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & a_x \\ 0 & b_x & a_x b_x + 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & a_y \\ 0 & 1 & 0 \\ b_y & 0 & a_y b_y + 1 \end{pmatrix} \quad (41.4)$$

to make  $a_x = a_y = a_z = b_x = b_y = b_z = 1$ ,  $A = \begin{pmatrix} 2 & 1 & 3 \\ 3 & 2 & 5 \\ 2 & 1 & 4 \end{pmatrix}$ , three-dimensional cat mapping matrix is expressed as

$$\begin{pmatrix} x_{n+1} \\ y_{n+1} \\ z_{n+1} \end{pmatrix} = \begin{pmatrix} 2 & 1 & 3 \\ 3 & 2 & 5 \\ 2 & 1 & 4 \end{pmatrix} \begin{pmatrix} x_n \\ y_n \\ z_n \end{pmatrix} \bmod 1 \quad (41.5)$$

### 41.3 Hash Function Structure Based on the Three-Dimensional Cat Mapping

#### 41.3.1 Ideas of Design

Constructing a hash function based on three-dimensional cat mapping can consider the following aspects:

Use bit as the units of the original plaintext, after the linear transformation, ensuring each bit of the plaintext content can be applied in order to obtain three values in [0,1]. Put these three values as the initial values (initial conditions) of three-dimensional cat mapping to have an iterative calculation. Finally,  $x_R$ ,  $y_R$ ,  $z_R$ ,  $x_{2R}$ ,  $y_{2R}$ ,  $z_{2R}$  ( $R$  is a set value, this is the first key) six iteration results are mapped into binary number of  $a_1$ bit,  $a_2$ bit,  $a_3$ bit,  $a_4$ bit,  $a_5$ bit,  $a_6$ bit bit, and then select  $b_1$ bit,  $b_2$ bit,  $b_3$ bit,  $b_4$ bit,  $b_5$ bit,  $b_6$ bit bit from these binary numbers (the medians are selected as the second key), together to form a hash value of 128 bit.

The above design constructs two encryption keys for hash encryption algorithm based on three-dimensional cat mapping, thus reinforcing the confidentiality of the algorithm.

#### 41.3.2 Description of Algorithm

According to the design ideas of 2.1, hash encryption algorithm based on three-dimensional cat mapping is described as follows:

Set the to-be-encrypted plaintext H has N bytes. Put the to-be-encrypted plaintext H converts to its corresponding ASCII code according to bytes, denoted by  $h_1, h_2, \dots, h_N$ , and then  $h_1, h_2, \dots, h_N$  linear transformation [0,1] range, the entire message into a large array, denoted by M, the number of the number means plaintext number, N.

Set the initial values of three-dimensional cat map  $x_1, y_1$  and  $z_1$ . Order:

$$x_1 = \frac{m_1}{A} - \left[ \frac{m_1}{A} \right] \quad (41.6)$$

$$y_1 = \frac{m_2}{B} - \left[ \frac{m_2}{B} \right] \quad (41.7)$$

$$z_1 = \frac{m_3}{C} - \left[ \frac{m_3}{C} \right] \quad (41.8)$$

where, take large numbers in the A, B, C, [] indicates rounding operator.

Iterative computation:

Set iterative rounds  $r$ :

$$r = R \times \left( \left[ \frac{N}{R} \right] \right) + K \quad (41.9)$$

where, [] expresses the integer operation, and R value is a positive integer, K can take an integer greater than 0.

Put  $x_1$ ,  $y_1$  and  $z_1$  as the iterative initial value of three-dimensional cat mapping to make r round iteration, the three-dimensional cat mapping equation is as follows:

$$\begin{cases} x_{n+1} = 2x_n + y_n + 3z_n & \text{mod } 1 \\ y_{n+1} = 3x_n + 2y_n + 5z_n & \text{mod } 1 \\ z_{n+1} = 2x_n + y_n + 4z_n & \text{mod } 1 \end{cases} \quad (41.10)$$

Set results of six iterations  $x_R, y_R, z_R, x_{2R}, y_{2R}, z_{2R}$  map to binary numbers of  $a_1$ bit,  $a_2$ bit,  $a_3$ bit,  $a_4$ bit,  $a_5$ bit,  $a_6$ bit, respectively, by linear transformation, and then ,respectively, remove  $b_1$ bit,  $b_2$ bit,  $b_3$ bit,  $b_4$ bit,  $b_5$ bit,  $b_6$ bit

$b_6$ bit from them, merging together to form 128-bit hash value.

Description: in step (4), take out  $b_i$  ( $i = 1, 2, 3 \dots 6$ ) from  $a_i$  ( $i = 1, 2, 3 \dots 6$ ), which can be of any position from  $a_i$  ( $i = 1, 2, 3 \dots 6$ ), and this position will serve as a part of the key.  $a_i$  ( $i = 1, 2, 3 \dots 6$ )  $>$   $b_i$  ( $i = 1, 2, 3 \dots 6$ ), and  $a_i$  ( $i = 1, 2, 3 \dots 6$ )  $\in$  {positive integer},  $b_i$  ( $i = 1, 2, 3 \dots 6$ )  $\in$  {positive integer}.

## 41.4 Computer Simulation

Use the one-way hash function based on three-dimensional cat mapping encryption algorithms for computer simulation experiments in 2.2. The computer equipment configuration in the experiment is shown in Table 41.1.

The hardware equipment shown in Table 41.1 uses MATLAB 6.1 in Win7 to have a system simulation test. The five simple steps are described as follows:

Take the to-be-encrypted plaintext as an original plaintext encryption to get the ciphertext 1, and as a contrast standard of encryption effect.

Change the first character “9” of the plaintext into “8,” obtain plaintext 2, do the second encryption, and compare ciphertext 1 and ciphertext 2.

Change the last character of the plaintext 1 “Z” to “z,” obtain plaintext 3, do third encryption, and compare ciphertext 3 and 1

Add “.” to the end of plaintext 1, obtain plaintext 4, do fourth encryption, and compare ciphertext 4 and 1

**Table 41.1** Computer simulation experimental device configuration table

CPU	Intel Core i5-2430 M @ 2.40 GHz Dual-core
Memory	2 GB (Elpida DDR3 1333 MHz)
Hard Disk	Hitachi HTS545050B9A300 (500 GB/5400 switch/min)
Monitor	LG LGD02E9 (14 In.)

Exchange of the place of “M” and “N” in plaintext 1, obtain plaintext 5, do fifth encryption, and compare ciphertext 5 and 1

Computer simulation with experimental data of one-way hash function algorithm based on three-dimensional cat map is shown in Tables 41.2, 41.3.

We can see from the above data, changing each 1 bit of the initial value will result in a high probability of change, which shows that the algorithm has a good one-way hash performance and a high degree of initial value sensitivity.

## 41.5 Analysis of Chaos and Distribute Statistical Properties

According to Shannon’s definition of chaos and distribution, the statistics to chaos and distribution of hash function based on three-dimensional cat mapping are as follows [6, 7]:

**Table 41.2** Plaintext lists of simulation experiments

Plaintext number	Plaintext sequence
Plaintext 1	9876543210abcdefgHIJKLMNOPqRSTuvwxyzXYZ
Plaintext 2	8876543210abcdefgHIJKLMNOPqRSTuvwxyzXYZ
Plaintext 3	9876543210abcdefgHIJKLMNOPqRSTuvwxyzXYZ
Plaintext 4	9876543210abcdefgHIJKLMNOPqRSTuvwxyzXYZ
Plaintext 5	9876543210abcdefgHIJKLMNOPqRSTuvwxyzXYZ

**Table 41.3** Ciphertext hash value of simulation experiments

Ciphertext number	128-bit hash value of ciphertext
Ciphertext 1	110101101010011100011110011010011000010100110100001010010100101 1101010110001101100111101100011011001110111100101000000011
Ciphertext 2	10111010110011011010001011101110011000110000100011011111010011 001010111100010100100000110011100110111001101101000011100100010
Ciphertext 3	10010011010001000111110000101111011001110111010011011001000000 00101010101101101100010100010000010111011010001011111010000001
Ciphertext 4	010100110100010110101010011001000111100100000011010111011001000111 10111101001001011010010001110010000000110101110110010001000111
Ciphertext 5	101100101000011001000111000101000010000100010010100100110000010011110 0110010110111001000011101000000111011101101111000100111001100

The average change in the number of bit:

$$\bar{B} = \frac{1}{N} \sum_{i=1}^N B_i \quad (41.11)$$

The average change in probability:

$$P = \frac{\bar{B}}{128} \times 100 \% \quad (41.12)$$

Average variance of  $B$ :

$$\Delta B = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (B_i - \bar{B})^2} \quad (41.13)$$

Average variance of  $P$ :

$$\Delta P = \sqrt{\frac{1}{N-1} \sum_{i=1}^N \left( \frac{B_i}{128} - P \right)^2} \times 100 \% \quad (41.14)$$

where  $N$  is the total number of statistics and  $B_i$  is the change in bit number of  $i$  test results.

Based on the 128 tests, we can get the statistics change bit from the plaintext 1 bit change:

$$\bar{B} = 63.433, P = 49.62 \%, \Delta B = 5.123, \Delta P = 4.258 \% \quad (41.15)$$

From the expression (41.15), we can see the chaotic and distributive nature are very stable.

## 41.6 Analysis of Speediness and Collision of the Algorithm

The speed of three-dimensional cat mapping hash algorithm and the original packet length is proportional to the top, so it can greatly shorten the time to encrypt in very long original text.

The measure of the range space and domain space ratio is very close to 1, based on hash function algorithm of three-dimensional cat map, so the collision of the algorithm is still lower

## 41.7 Conclusion

The hash function algorithm based on the three-dimensional cat mapping in this paper possesses high-degree sensitivity to the initial value and one-way hash function property. The nature of chaos and distribution is more even, and the ability

to resist attacks is stronger. Simultaneously, the encryption time is shorter and the encryption efficiency is higher, which is a more rapid and efficient encryption algorithm.

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# Chapter 42

## Modeling of Complex Production Process Based on Artificial Neural Networks and Genetic Algorithm

Jike Ge and Taifu Li

**Abstract** Owing to the complex nature of many systems, such as precision machinery design and manufacturing, advanced chemical process, the underlying physicochemical phenomenon is seldom fully understood. As the empirical methods, artificial neural networks and genetic algorithms are used to model and optimize a complex nonlinear system for increasing productivity and saving costs. In this paper, we propose an adaptive modeling and optimization method based on artificial neural network and genetic algorithm for the complex production process. The trained artificial neural network can be objective function, and then, a system model is set up. Genetic algorithm is used to optimize the input space of the neural network model to find the optimum settings for maximum products production. Using this procedure, experimental data reported in the literature were used to build a neural network model that has been effectively integrated to create a powerful tool for process modeling and optimization.

**Keywords** Artificial neural network • Genetic algorithm • Complex system optimization • HCN

### 42.1 Introduction

Availability of a system model is a prerequisite to system optimization. Conventionally, two approaches, namely phenomenological (first principles) and empirical, are employed for system modeling. In conventional empirical modeling,

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appropriate linear or nonlinear models are constructed exclusively from the input-output data [1]. Once an ANN-based system model is developed, it can be used for optimization to obtain the optimal values of the input variables that maximize or minimize a specified objective function. Conventionally, various deterministic gradient-based methods [2] are used for optimizing a process model. Most of these methods, however, require that the objective function should be smooth, continuous, and differentiable. The ANN models cannot be guaranteed to be smooth especially in regions wherein the input-output data (training set) used in model building are located sparsely. Hence, gradient-based methods cannot be used efficiently for optimizing the input space of an ANN model. In such situations, an efficient optimization formalism known as genetic algorithms (GA) can be used, which is lenient toward the form of the objective function. The GAs is stochastic optimization formalisms originally developed as the genetic engineering models mimicking population evolution in natural systems [3, 4].

Optimization techniques have been applied to versatile engineering problems for reducing manufacturing cost and for automatic design. The deterministic approaches of optimization neglect the effects from uncertainties of decision variables. The uncertainties include variation or perturbation such as tolerance band. At optimum, the constraints must be satisfied within the tolerance ranges of the decision variables. The variation of decision variables can also give rise to drastic change in performances [5].

## 42.2 Problem Definition

The process optimization objective under consideration is stated as: given catalytic process data comprising values of process operating (input) variables and the corresponding values of process output (response) variables, find the optimal values of input variables such that the pre-specified measures of process performance are simultaneously maximized.

Conventionally, an optimization problem can be formulated as

$$\begin{aligned} \min_x F(X) &= \{f_1(X), f_2(X), \dots, f_m(X)\} \\ \text{s. t. } &\left\{ \begin{array}{ll} g_j(X) \geq 0 & j = 1, \dots, p \\ h_l(X) = 0 & l = 1, \dots, q \\ x_k^l \leq x_k \leq x_k^u & k = 1, \dots, n \end{array} \right. \end{aligned} \quad (42.1)$$

where  $F(\bullet)$  is the objective function,  $f(\bullet)$  is the feasible solution,  $g_j(\bullet)$  is inequality constraint,  $h_l(\bullet)$  is equality constraint,  $X$  is  $N$ -dimensional decision variable, and  $x_k^l, x_k^u$  are lower and upper boundaries, respectively.

In practice, for many complex optimization problems, there do not exist the objective function and constraint conditions in mathematical expression. In addition, classical optimization methods mainly maximize (or minimize) performance and do not account for variations of decision variables. Then, considering

variations of decision variables from the disturbances and other uncertainties, it is necessary to carry out the robust optimization. Robust optimization methods account for the effects of variations of decision variables by simultaneously optimizing the objective function and minimizing its sensitivity to decision variation [6].

For the optimization problem of complex system, a typical solution is as follows: firstly, constructing the mathematical model of the objective function; then, considering the robustness criterions that is low sensitivity to decision variations; finally, searching the optimal decision solution which could not only maximize (or minimize) performance but also decrease the sensitivity to all kinds of uncertainties.

## 42.3 Methodology

### 42.3.1 ANN-Based Modeling for Complex System Optimization

Artificial neural networks are considered as artificial intelligence modeling techniques. They have highly interconnected structure similar to brain cells of human neural networks and consist of large number of simple processing elements called neurons, which are arranged in different layers in the network. Each network consists of an input layer, an output layer, and one or more hidden layers [6]. Artificial neural networks are adaptive statistical devices. This means that they can change the values of their parameters as a function of their performance. These changes are made according to learning rules which can be characterized as supervised or unsupervised [7].

ANN has been capable of expressing a variety of nonlinear response surfaces using a number of input–output training data that are selected from the entire design space in a global manner. The advantages of an ANN-based modeling are as follows: (1) it can be constructed solely from the historic process input–output data (example set), (2) detailed knowledge of the process phenomenology is unnecessary for the model development, (3) a properly trained model possesses excellent generalization ability owing to which it can accurately predict outputs for a new input data set, and (4) even multiple input–multiple output (MIMO) nonlinear relationships can be approximated simultaneously and easily.

For complex system modeling, the commonly used feed-forward ANN architecture, namely MLP, may be employed. The MLP network approximates the nonlinear input–output relationships. This optimization problem can be formulated as

$$\text{Maximize } y_k = f_k(x, w_k), \quad k = 1, 2, \dots, K \quad (42.2)$$

where  $y_k$  denotes the  $k$ th output variable,  $x = [x_1, x_2, \dots, x_n]^T$  is an  $N$ -dimensional vector of process operating variables,  $f_k$  is the function correlating  $k$ th output variable with the inputs, and  $w_k$  is the parameter vector of function  $f_k$ .

Equation 42.2 describes a multi-objective (MO) optimization problem since it involves simultaneous maximization of  $K$  outputs,  $\{y_k\}$ ,  $k = 1, \dots, 2, \dots, K$ . Using aggregation principle (also known as “weighting objective method”), the MO optimization task can be converted into a single-objective (SO) optimization by defining.

$$\text{Maximize } \hat{f} = \sum_{k=1}^K \hat{\omega}_k y_k = \sum_{k=1}^K \hat{\omega}_k f_k(x, w_k) \quad (42.3)$$

where  $\hat{f}$  denotes the single aggregated objective function and  $\hat{\omega}_k$  the weighting coefficient ( $0 \leq \hat{\omega}_k \leq 1, \sum_k \hat{\omega}_k = 1$ ). The weighting coefficient,  $\hat{\omega}_k$ , signifies the relative importance of  $k$ th function in the MO optimization (Eq. 42.2). The hybrid strategies fulfill the SO optimization task in two steps. In the first step, an ANN-based complex system model,  $y_k = f_k(x, w_k)$ , is developed, and in the second step, the input space ( $x$ ) of the complex system model is optimized using GAs with a view of maximizing the single aggregated objective function defined in Eq. 42.3.

### 42.3.2 GA-based Optimization of ANN Models

The optimization objective  $\hat{\omega}_k$  underlying the GA-based optimization of an ANN model is as follows: find the  $N$ -dimensional optimal decision variable vector,  $x^* = [x_1^*, x_2^*, \dots, x_N^*]^T$ , representing optimal decision variables such that it simultaneously maximizes process outputs,  $\{y_k\}$ ,  $k = 1, 2, \dots, K$ . The corresponding SO function  $\hat{f}$  to be maximized by the GA is defined in Eq. 42.3. In the GA procedure, the search for an optimal solution (decision) vector  $x^*$  begins from a randomly initialized population of probable (candidate) solutions. The solutions, usually coded in the form of binary strings (chromosomes), are then tested to measure their fitness in fulfilling the optimization objective. Subsequently, a main loop comprising the following operations is performed: (1) selection of better (fitter) parent chromosomes, (2) production of an offspring solution population by crossing over the genetic material between pairs of the fitter parent chromosomes, and (3) mutation (bit-flipping) of the offspring strings. Implementation of this loop generates a new population of candidate solutions, which as compared to the previous population, usually fares better at fulfilling the optimization objective. The best string that evolves after repeating the above-described loop till convergence forms the solution to the optimization problem [7].

## 42.4 Experiments and Evaluation

### 42.4.1 Experimental Data

Hydrogen cyanide is a chemical compound with chemical formula HCN. HCN is a colorless, extremely poisonous liquid that boils slightly above room temperature

at 26 °C (79 °F). Because of its high toxicity, HCN is important in designing the evacuation routes from fires.

HCN forms in at least limited amounts from many combinations of hydrogen, carbon, and ammonia. HCN is currently produced in great quantities by several processes, as well as being a recovered waste product from the manufacture of acrylonitrile. The most important process is the Andrussow oxidation invented by Leonid Andrussow at IG Farben in which methane and ammonia react in the presence of oxygen at about 1,200 °C over a platinum catalyst:  $2\text{CH}_4 + 2\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{HCN} + 6\text{H}_2\text{O}$ . Experimental data sets collect from HCN production process of one chemical plant, in which, HCN production process includes 10 parameters: the volume ratio of natural gas and ammonia (CN), the volume ratio of air and ammonia (AN), the compensation pressure of ammonia ( $P_N$ ), the compensation pressure of natural gas ( $P_C$ ), the compensation pressure of air ( $P_A$ ), the compensation temperature of ammonia ( $T_N$ ), the air pocket pressure ( $P_p$ ), the reactor export temperature ( $T_f$ ), the mixer export temperature ( $T_d$ ), the compensation flow of ammonia ( $F_N$ ), and a performance indicator of ammonia's conversion ratio ( $\alpha$ ). But, the current conversion ratio of HCN using Andrussow oxidation technique is about 60–70 %. For increasing production ratio and decreasing production costs, we apply the proposed GA and ANN-based optimization method to the processing of HCN production.

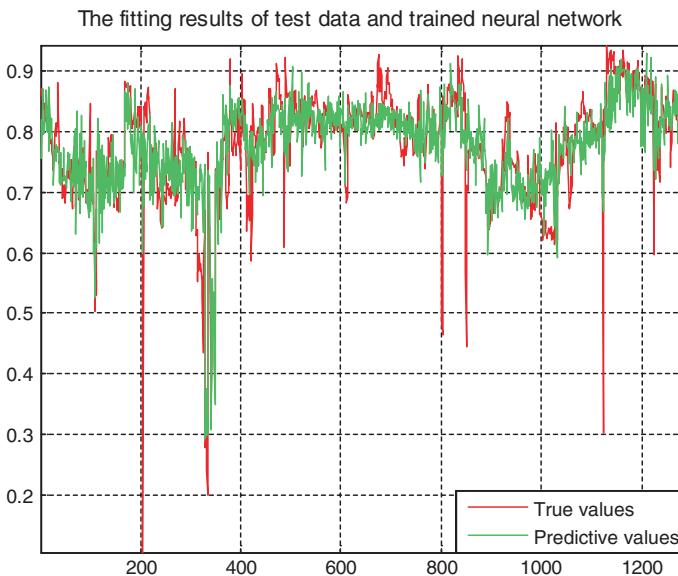
#### **42.4.2 ANN-Based Modeling of HCN Process**

Process data used for development of ANN-based models include 3,000 groups, as shown in Table 42.1.

In this experiment, the multi-layer perception neural network trained with back-propagation (BP) algorithm, the input layer include 10 nodes, the hidden layer include 7 nodes, and output layer include one node.

**Table 42.1** The normalized experimental test data (partly)

1	2	3000	
CN	0.35103	0.36794	0.382
AN	0.11343	0.13791	0.11784
PN	0.43382	0.43382	0.43382
PC	0.43313	0.43675	0.42345
PA	0.45057	0.45299	0.44954
TN	0.69558	0.73128	0.59588
PP	0.67976	0.67012	0.67596
Pf	0.46797	0.52332	0.48157
Pd	0.48796	0.056037	0.34739
FN	0.63317	0.70116	0.71041
$\alpha$	0.67499	0.68927	0.66623



**Fig. 42.1** The fitting results of test data and trained network

#### 42.4.3 Training ANN Model

For the experimental data, we choose 50 % as training data, and the rest as test data. The fitting results of test data and trained network are shown in Fig. 42.1.

It shows in Fig. 42.1, the finally trained BP neural network has more ideal features, and it can be used to modeling of the HCN production process.

#### 42.4.4 GA-Based Optimization

The GA-based technique was to optimize the input space of ANN model with objective of maximization of conversion ratio of ammonia. The values of GA-specific parameters used in the optimization simulations were chromosome length = 15, population size = 60, crossover probability = 0.7, mutation probability = 0.05, and number of generations over which GA evolved = 200. The evolving strategy is random traversing.

The objective function can be defined as follows:

$$\text{Maximize } y = f(x, w), \quad x_i^L \leq x_i \leq x_i^U, \quad i = 1, 2, \dots, P \quad (42.5)$$

where  $f$  represents the objective function (ANN model),  $x$  denotes the input vector,  $w$  denotes corresponding weight vectors,  $y$  refers to the conversion ratio of ammonia, the input vector  $x$  denotes the HCN process parameters,  $P$  denotes the number of input variables, and  $x_i^L$  and  $x_i^U$  represent the lower and upper bounds on  $x_i$ ,

respectively. The fitness of each chromosome (candidate solution) was evaluated based on following fitness function:

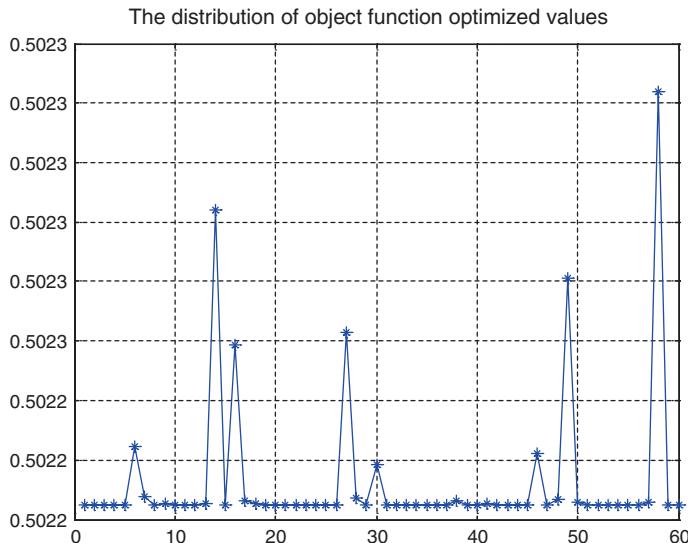
$$\text{error}_j = 1 - \frac{1}{\hat{y}_{\text{pred}}^j}; \quad j = 1, 2, \dots, N \quad (42.6)$$

where  $\text{error}_j$  denotes the fitness value of the candidate solution, and  $\hat{y}_{\text{pred}}^j$  denotes the ANN model predicted conversion ratio of ammonia for given candidate solution. The optimized values after GA implementation are shown in Fig. 42.2. The final optimal parameters are shown in Table 42.2.

We take the optimal parameters in Table 2 into BP neural network model and obtain the conversion ratio of ammonia 73.667 %. This partly proved our proposed method can be applied on the modeling and optimization of complex system.

## 42.5 Conclusion and Future Work

In this paper, an adaptive modeling and optimization strategy integrating ANN with GA has been proposed. To evaluate the performance of the proposed approach, the conversion ratio of ammonia in the production processing of HCN is selected as case study. Experimental results manifest that the conversion ratio of ammonia will be improved by employing the suggested optimization parameters in the present study.



**Fig. 42.2** The optimized output values

**Table 42.2** The optimal parameters of HCN process

CN	AN	P <sub>N</sub>	P <sub>C</sub>	P <sub>A</sub>	T <sub>N</sub>	P <sub>P</sub>	T <sub>f</sub>	P <sub>d</sub>	F <sub>N</sub>
1.5	6.149	2.04	2.1	2.27	12.52	3.16	210	78.7	605

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# Chapter 43

## The Extended Multi-Level Fuzzy Comprehensive Evaluation Model Based on Fuzzy Set

Liu Yunjie and Hui Xiaolu

**Abstract** Comprehensive evaluation model is a useful model in practical application. To extend the fuzzy comprehensive evaluation model is a very meaningful thing which can promote the perfection of a comprehensive evaluation of the theory and application areas. In this paper, according to the theory of fuzzy comprehensive evaluation, we extend the max-min model to a new multi-level max-min fuzzy comprehensive evaluation model. With introducing the extended max-min model, we improved the max-min model of the fuzzy comprehensive evaluation, and get the combination of subjective and objective weights effectively. Then we build the multi-level max-min fuzzy comprehensive evaluation model based on comprehensive weights. In the end, it had drawn the evaluation of scores and the sorting, according to the improved max-min fuzzy comprehensive evaluation model which can further promote the application areas and rough set theory.

**Keywords** Fuzzy set • Max-min model • Multi-level fuzzy comprehensive evaluation model

### 43.1 Introduction

In daily life, we often encounter a variety of competitions, such as selecting the outstanding student leaders, party members, activists and so on [1, 2]. In various competitions, each evaluator has unique insights into different candidate. However, in actual work, the evaluation of a thing generally used various indicators, which requires combined multiple indicators to give a comprehensive evaluation called the comprehensive evaluation method [3, 4]. Fuzzy comprehensive

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evaluation method is applied to the theory of fuzzy information processing to the actual evaluation, which can consider the relevant indicators of the object, given a reasonable value to the evaluated objects that contain a variety of quantitative and non-quantitative fuzzy targets and fuzzy relationship [5, 6]. It is versatile and can be used in the evaluation of subjective and objective indicators. Because there is a lot of obscure boundary phenomenon in the real world, fuzzy comprehensive evaluation is widely used, particularly in multi-index comprehensive evaluation of subjective weights; fuzzy comprehensive evaluation has played a very important role.

The remainder of this paper is organized as follows: [Section 2](#) defines basic theory about the extended max–min model of fuzzy comprehensive evaluation. [Section 3](#) improved max–min fuzzy comprehensive evaluation model to build multi-level fuzzy comprehensive evaluation model. The last section summaries the contribution of this paper and points out future research work.

## 43.2 The Extended Max–min Model of Fuzzy Comprehensive Evaluation

In fuzzy comprehensive evaluation, we generally use the method max–min algorithm. It mainly depends on the model  $M(\wedge, \vee)$  to expand the operator. Generally, simply using the evaluation made by the evaluators for each indicator, part of the information cannot be taken into account, so the results of the evaluation are not able to identify and distinguish. Only establishing the new model of the information cannot be ignored more.

Extending method: modify the model of  $M(\wedge, \vee)$  to  $M(\wedge^*, \vee^*)$ , the establishment of the method can refer to the papers of [1, 2], and combine with multi-indicators to solve the practical problems. Let the fuzzy comprehensive decision-making model as  $(U, V, R)$ , so the weight is  $A \in M(U)$ , corresponding to the comprehensive evaluation:

$$\begin{aligned} B &= A * R, \text{ where } A = (a_1, a_2, \dots, a_n), B = (b_1, b_2, \dots, b_m), R = (r_{ij})_{n \times m}; \\ b_j &\stackrel{\text{def}}{=} \underset{i=1}{\overset{n}{\vee^*}}(a_i \wedge *r_{ij}) \quad (j = 1, 2, \dots, m) \text{ is called } M(\wedge^*, \vee^*). \end{aligned}$$

Model 1 weighted average model  $b_j = \sum_{i=1}^n a_i r_{ij}$ , ( $j = 1, 2, \dots, m$ ). According to weights, all the indicators in the model have been taken into account; it is suitable for multi-indicators to evaluate the case.

Model 2 weighted average model  $b_j = \oplus \sum_{i=1}^n a_i r_{ij}$ ,  $\oplus$  present the sum is 1 in the upper bound:  $b_j = \min\{1, \sum_{i=1}^n a_i r_{ij}\}$  ( $j = 1, 2, \dots, n$ ).

In  $u_i$  of membership  $b_j$  of each indicator, taking into account of all indicators which has the greatest impact to  $b_j$ . In addition, each coefficient of  $a_i$  must be met

$$\sum_{i=1}^n a_i = 1 \tag{43.1}$$

In practical application, when the biggest indicator of sovereignty weight plays a major role, we usually use the Model 1. When the model is failure, we can use the model 2. But simply applying these models to solve practical problems, which have some limitations, thus need to expand and improve the model.

### 43.3 Improved Multi-level Fuzzy Comprehensive Evaluation Model

To improve the fuzzy comprehensive evaluation model, first, the variety of subjective with objective weight extended to the first level and then the second level integrated into multi-level and created to the multi-level fuzzy comprehensive evaluation model, which is easy to broaden the application of fuzzy comprehensive evaluation.

#### 43.3.1 To Establish the Assessment of Indicators

First of all, to establish a multi-level fuzzy comprehensive evaluation model, we must establish the indicator system. First, we divide the indicators sets  $U = \{u_1, u_2, \dots, u_n\}$  into several groups  $U = \{U_1, U_2, \dots, U_k\}$ , and that must satisfy the expression

$$U = \sum_{i=1}^k U_i^{(1)} \quad (43.2)$$

$U_i^{(1)} \cap U_j^{(1)} = \varnothing$  ( $i \neq j$ ).  $U = \{U_1, U_2, \dots, U_k\}$  is the first level of the indicators sets.

Accordingly, the second level of the indicators set is:  $U_i = \{U_1^{(1)}, U_2^{(1)}, \dots, U_k^{(1)}\}$ , ( $i = 1, 2, \dots, k$ ); the second level of set is:  $U_{in}^{(1)} = \{U_{i1}^{(2)}, U_{i2}^{(2)}, \dots, U_{in}^{(2)}\}$ . So the  $n$ -level of the indicators set is  $U_{in}^{(n-2)} = \{U_{i1}^{(n-1)}, U_{i2}^{(n-1)}, \dots, U_{in}^{(n-1)}\}$ .

#### 43.3.2 To Establish the Evaluation Set

The evaluation set is a direct description of the various experts on the evaluation results, denoted by  $V = (v_1, v_2, \dots, v_m)$  which is a single indicator evaluation on indicator set. If the scores are denoted by  $E = (E_1, E_2, \dots, E_n)$ , for example, student performance evaluation results can generally be divided into five levels:  $V = (v_1, v_2, v_3, v_4, v_5) = \{\text{excellent}, \text{good}, \text{medium}, \text{pass}, \text{poor}\}$ .

### 43.3.3 To Determine the Weights that Combine the Objective Weight with Subjective Weight

First of all, introduce the subjective weights method: the weighted statistical method. When the number of experts is less than 30 individuals, we can use weighted statistical method to calculate the weights

$$a_k = \sum_{i=1}^s \omega_i x_i \quad (s \text{ is the serial number}) \quad (43.3)$$

After using the weighted average statistical method, the Model 2 can be changed to

$$b_j = \bigoplus_{i=1}^n a_i \cdot r_{ij} = \min\{1, \sum_{i=1}^n \sum_{j=1}^s \varpi_i x_i \cdot r_{ij}\}, \text{ so the Model 1 can be as}$$

$$b_j = \sum_{j=1}^s \varpi_i x_i \sum_{i=1}^n r_{ij}$$

Secondly, discuss the objective weight determination methods. The criteria importance through inter-criteria correlation (CRITIC) is more popular objective weight method. The method was first proposed by Diakoulaki [1] in 1995. The method is an objective weight method. The basic idea is that according to contrast intensity of each indicator and the confliction of each characteristic property to measure the objective weight determination. The contrast intensity represents the gap in the same characteristic property of each indicator value, by the form of the standard deviation to reflect; the greater the standard deviation is the greater the weight is. The conflict between the indicators is based on the correlation between the indicators as a basis. Assuming that there is a strong positive correlation between the two indicators, it means less conflict between them. So, the quantitative indicators of conflict between the  $j$  indicator and other indicators are  $\sum (1 - R_{ki}) R_{ki}$ . It represents the  $i$  characteristic between  $k$  indicator and  $i$  indicator amount of information contained the information of  $G_i$ . We called  $G_i = S_i \sum_{k=1}^m (1 - R_{ki})$ .  $S_i$  presents the standard deviation of  $i$ th indicator, by the CRITIC can refer to the  $i$ th indicator of the normalized weights:

$$v_i = G_i / \sum_{i=1}^m G_i \quad (43.4)$$

When the standard deviation is certain, the greater the conflict of the indicator the greater the weight, the greater the negative correlation coefficient of two indicators, then the conflict will be greater, which is indicating that the two indicators reflect slightly different information on evaluation method; otherwise, indicates that the greater the similarity, the smaller the conflict, and the smaller the weight is.

### 43.3.4 Determine the Comprehensive Weight of the Model

The judgement of the evaluation model cannot be separated from determining the weights; the subjective weight is often decided by evaluators according to an objective weight. In this paper, it is to establish the subjective weight model based on the weighted multi-expert evaluation and then, combined the known objective weights with the opinions of experts to determine and refine the weight.

There are many ways of the weight determining method, which are mainly divided into two categories: subjective weight and the objective weight. Subjective weighting method and the objective weighting method, both of them are a variety of defects. So, we define the comprehensive weights which are normalized by expert's weight and CRITIC weight as

$$\omega_i = \frac{2a_i \cdot v_i}{a_i + v_i} \quad (43.5)$$

$\omega_i$  is the comprehensive weight of  $i$ th indicator on the objects,  $a_i$  and  $v_i$  are the weights which are getting from the experts weight and CRITIC weight.

- Model 1  $M(\bullet, \oplus)$ :  $b_j = \min\{1, \sum_{i=1}^n a_i r_{ij}\} = \min\{1, \sum_{i=1}^n \omega_i r_{ij}\}$  ( $j = 1, 2, \dots, m$ ),
- Model 2  $M(\bullet, +)$ :  $b_j = \sum_{j=1}^s \varpi_i r_{ij}$  ( $j = 1, 2, \dots, m$ ).

### 43.3.5 Determine the Degree of Membership

So,  $R_f$  can describe by the fuzzy matrix:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}, R \in \mu_{n \times m} \quad (43.6)$$

Besides,  $r_{ij} = \frac{c_{ij}}{\sum_{j=1}^n c_{ij}}$ ,  $c_{ij}$  represent the number of  $j$ th evaluation of  $i$  indicators, and  $r_{ij}$  is the probability of evaluation. According to the values of weight, the improved  $\max-\min$  model can be as follows  $b_j = \sum_{j=1}^s \varpi_i r_{ij}$ ,  $b_j = \min\{1, \sum_{i=1}^n \omega_i r_{ij}\}$ .

For the convenience, the improved formula of the model can be simplified as  $B = A * R$ .

Considering comprehensive evaluation to the first-level set of indicators  $U = \{U_1, U_2, \dots, U_k\}$ , we suppose the weight  $A_i^1 = (a_1, a_2, \dots, a_n)$ . According to

model  $M(\bullet, +)$ , we get  $B_i^1 = A_i^1 * R_i^1$ , so  $A_i^1$  is the first-level weights of set, and  $R_i^1$  is the first-level fuzzy matrix. According to model  $M(\bullet, \oplus)$ , we get  $\tilde{B}_i^1 = \min(1, A * R)$ .

$$\text{For the second-level model: } U_i = \{U_1^{(1)}, U_2^{(1)}, \dots, U_k^{(1)}\}, \tilde{B}_i^2 = \begin{pmatrix} B_1^1 \\ \sim \\ B_2^1 \\ \sim \\ \vdots \\ B_n^1 \end{pmatrix},$$

$$M(\bullet, +) : \tilde{B}_i^2 = \sum_{i=1}^n A_i^1 * R_i^1, M(\bullet, \oplus) : \tilde{B}_i^2 = \min(1, \sum_{i=1}^n A_i^1 * R_i^1).$$

For the  $n$ -level, we can get from the previous method:

$$M(\bullet, +) : \tilde{B}_i^n = \sum_{i=1}^n A_i^{n-1} * R_i^{n-1}, M(\bullet, \oplus) : \tilde{B}_i^n = \min(1, \sum_{i=1}^n A_i^{n-1} * R_i^{n-1})$$

#### 43.3.6 To Determine the Final Assessment of Score

$$I = E \cdot B^T \quad (43.7)$$

where  $E$  is the set of scores,  $B$  represents the  $j$ -level evaluation set, and  $I$  is the scores. Accordingly, we can accurately distinguish the category of the evaluation.

### 43.4 Conclusion

In this paper, we introduce the general method of fuzzy comprehensive evaluation and the mathematical model of the commonly used fuzzy comprehensive evaluation. With the multi-storey fuzzy comprehensive evaluation method, we extend the first level and the second level to multi-level model, and combine the weighted statistical method with the CRITIC method to determine the integrated expression. In addition, to further refine the model of max–min model, we combine with the score expressions to consider the level of results for making a reasonable judgment to ensure the rationality and accuracy of the evaluation. In the next works, determination of weights more based on the objective method and interval numbers analysis should be considered furthermore.

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# Chapter 44

## A Revision Approach Based on Decomposition

Dong Chen Jiang and Yi Hua Lou

**Abstract** This paper proposes a revision algorithm based on decomposition. A set of decomposing rules are presented to analyze the satisfiability of propositions. It is proved that the satisfiability of a given set is equivalent to whether there exists a consistent leaf on its decomposition tree. Based on these rules, a deductive decomposing function  $Div$  is given, and it can calculate all consistent leaves of a decomposition tree. A revision algorithm based on the decomposing function is proposed, which can calculate maximal contractions for given sets. The algorithm has a complexity of  $O(2^n m)$ , and the decomposition-based tactic improves the efficiency of the algorithm.

**Keywords** Revision algorithm • Decomposing rule • Decomposition tree

### 44.1 Introduction

Belief revision is one basic problem in database and artificial intelligence. It was first proposed by Alchourron, Gardenfors and Makinson in 1985 [1]. They provided eight postulates to formalize the process of belief revision. After that, many researchers analyzed this problem and proposed their theorems or methods. In 1989, Katsunoo and Mendelzon proposed KM theory to formalize revision problem in finite knowledge database [2]. Dalal first proposed a model-based “minimal changed” revision operator, which satisfies all AGM postulates [3]. Nebel proposed several syntax-based revision approaches for finite revision problem [4]. In 1994, Wei Li proposed a logical inference framework (R-calculus) to describe revision problem [5]. Based on this framework, Jie Luo and Wei Li presented an interactive algorithm to solve revision problem with Horn clause [6].

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In our earlier research work, we proposed a syntax-based approach to formalize the revision process and proved that the framework is correct [7]. We introduced assignment equivalence classes and delegate models to improve the performance of the algorithm. After analysis the previous work, we find that there are still some computational redundancies during the process of calculating delegate models. It does not matter how many delegate models satisfying a proposition, the algorithm will always check every possible assignment equivalence class. Furthermore, as the algorithm need to store all satisfying delegate models, there is a requirement on storage.

In order to improve the above problems, we propose a logical decomposition system to analyze the satisfiability of propositions and sets. More specifically, we propose a set of decomposing rules to decompose propositions into sets which only contain atomic propositions or negations of atomic propositions. Furthermore, we find that there is a relation between the satisfiability of the original set and the satisfiability of these sets. It is easier to analyze the satisfiability of the sets with atomic propositions or negations of atomic propositions, which makes the consistency checking easier too.

## 44.2 Problem Description and Basic Framework

The propositional logical language  $Lp$  is the object language of our algorithm. It consists of atomic propositions, logical connective symbols and parenthesis symbols. For a formal theory  $\Gamma$  and a fact set  $\Delta$  for revising  $\Gamma$ , we use maximal contraction of  $\Gamma$  with respect to  $\Delta$  to characterize the revision result. In this paper, we use the lower case English letters  $a, b, c$ , etc. to denote atomic propositions and use the lower case Greek letters  $\alpha, \beta, \gamma$ , etc. to denote propositions.  $Atom(\Gamma)$  is the set of all atomic propositions occurring in  $\Gamma$ , and  $Atom(\alpha)$  is short for  $Atom(\{\alpha\})$ .

In [7], we proposed a syntax-based revision framework to calculate maximal contractions of  $\Gamma$  with respect to  $\Delta$ , which can be described as follows:

---

**Framework of REVISION**

---

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Initialize:  $\Lambda \leftarrow \emptyset ; \Sigma \leftarrow \Delta ;$ 
For each  $\alpha \in \Gamma$  do
    If  $\alpha$  is consistent with  $\Sigma$  do
         $\Lambda \leftarrow \Lambda \cup \{\alpha\} ;$ 
         $\Sigma \leftarrow \Sigma \cup \{\alpha\} ;$ 
    EndIf
EndFor
Return  $\Lambda ;$ 

```

---

It was proved that for any sets  $\Gamma$  and  $\Delta$ , if  $\Delta$  is consistent, the framework REVISION  $(\Gamma, \Delta)$  will return a maximal contraction of  $\Gamma$  with respect to  $\Delta$ . In [7], we calculated the truth values of  $\alpha$  under relevant delegate models to judge

whether  $\alpha$  is consistent with  $\Sigma$ . It is efficient but still improvable. In this paper, we also use the above framework, but propose a set of decomposing rules to check the consistency of any set and propositions, which is more efficient.

### 44.3 Decomposing Rules and Decomposition Tree

For any proposition, it is complex to check its truth values under all related models to judge its satisfiability. Therefore, we propose a set of structured decomposing rules to simplify the satisfiability judging process.

**Definition 1** If a set  $L$  only contains atomic propositions or negations of atomic propositions, we call  $L$  a total decomposition set.

**Definition 2** According to the semantic of logical connectives, there are four basic decomposing rules: $\wedge$  – rule :

$$\frac{L, \alpha, \beta}{L, \alpha \wedge \beta} \quad (44.1)$$

$\vee$  – rule :

$$\frac{L, \alpha \quad L, \beta}{L, \alpha \vee \beta} \quad (44.2)$$

$\rightarrow$  – rule :

$$\frac{L, \neg\alpha \quad L, \beta}{L, \alpha \rightarrow \beta} \quad (44.3)$$

$\neg$  – rule : if  $\alpha$  is not an atomic proposition, then  $\neg\alpha$  can be decomposed according to the rule (44.4), where  $\alpha$  and  $\alpha'$  are specified by Table 44.1:

$$\frac{L, \alpha'}{L, \neg\alpha} \quad (44.4)$$

For any set  $L$  of propositions, we can inductively use these rules to decompose  $L$  until only atomic propositions or negations of atomic propositions are left. And this process can be formally described by the concept of decomposition tree of  $L$ .

**Definition 3** Let  $L$  be a set of propositions, then tree  $T$  is called the decomposition tree of  $L$  if follows are satisfied: If  $T$  is a single note tree, the note  $L$  of  $T$  is a total decomposition set.

**Table 44.1** Specify cases of  $\neg$  – rule

$\alpha$	$\beta \wedge \gamma$	$\beta \vee \gamma$	$\beta \rightarrow \gamma$	$\neg\beta$
$\alpha'$	$\neg\beta \vee \neg\gamma$	$\neg\beta \wedge \neg\gamma$	$\beta \wedge \neg\gamma$	$\beta$

Suppose that  $T_1$  is a decomposition tree with root  $L_1$ . If the fraction (a) is an instance of  $\wedge$  – rule or  $\neg$  – rule (see Fig. 44.1 left), then we call  $T$  is a decomposition tree of  $L$ .

Suppose that  $T_1$  and  $T_2$  are decomposition trees of  $L_1$  and  $L_2$ , respectively. If the fraction (b) is an instance of  $\vee$  – rule or  $\rightarrow$  – rule (see Fig. 44.1 right), then we call  $T$  is a decomposition tree of  $L$ .

For any set of propositions, we can decompose it into a decomposition tree, and the following property holds

**Theorem 1** *If  $T$  is a decomposition tree of  $L$ , then  $L$  is satisfiable if and only if there exists a leaf of  $T$  which is satisfiable.*

*Proof* We prove the theorem by using structural induction on  $T$ .

1. If  $T$  is a single note tree and the note  $L$  is a total decomposition set, then it is obvious that  $L$  is satisfiable if and only if the leaf note  $L$  itself is satisfiable.
2. If there exists a decomposition tree  $T_1$  with root  $L_1$ ,  $L_1$  and  $L$  constitute an instance of  $\wedge$  – rule, then there exist  $L_0$ ,  $\alpha$  and  $\beta$  which satisfy  $L = L_0 \cup \{\alpha \wedge \beta\}$ ,  $L_1 = L_0 \cup \{\alpha, \beta\}$  and

$$\frac{L_0, \alpha, \beta}{L_0, \alpha \wedge \beta} \quad (44.5)$$

According to the semantic of  $\wedge$ ,  $L$  is satisfiable if and only if  $L_1$  is satisfiable. Since  $T_1$  is a decomposition tree with root  $L_1$ ,  $L_1$  is satisfiable if and only if there exists a leaf note of  $T_1$  which is satisfiable. As  $T$  and  $T_1$  share the same leaves, the property holds.

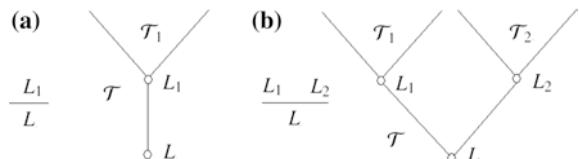
If  $L_1$  and  $L$  constitute an instance of  $\neg$  – rule, the property can be proved similarly.

3. If there exist two decomposition trees  $T_1$  and  $T_2$  whose roots are  $L_1$  and  $L_2$ , respectively,  $L_1$ ,  $L_2$  and  $L$  constitute an instance of  $\vee$  – rule, then there exist  $L_0$ ,  $\alpha$  and  $\beta$  which satisfy  $L = L_0 \cup \{\alpha \vee \beta\}$ ,  $L_1 = L_0 \cup \{\alpha\}$ ,  $L_2 = L_0 \cup \{\beta\}$

$$\frac{L_0, \alpha L_0, \beta}{L_0, \alpha \vee \beta} \quad (44.6)$$

According to the semantic of  $\vee$ ,  $L$  is satisfiable if and only if  $L_1$  or  $L_2$  is satisfiable. Since the property holds for  $T_1$  and  $T_2$ ,  $L_1$  (or  $L_2$ ) is satisfiable if and only if there exists a leaf of  $T_1$  (or  $T_2$ ) which is satisfiable. As the leaves of  $T$  are

**Fig. 44.1** Decomposition tree



composed by the leaves of  $T_1$  and  $T_2$ ,  $T$  is satisfiable if and only if there exists one leaf of  $T$  is satisfiable, the property also holds.

If  $L_1, L_2$  and  $L$  constitute an instance of  $\rightarrow$  –rule, the property can be proved similarly.

## 44.4 Revision Algorithm based on Decomposition

### 44.4.1 Decomposing Function

In the last section, we proposed the decomposing rules and the decomposition tree for set of propositions. In what follows, we will present a deductive function to implement the decomposing process, which is able to calculate all the consistent leaves of a decomposition tree.

**Definition 4** Let  $N$  be a set of total decomposition sets, then deductive function  $Div$  can be defined as follows:

$Div(N, \alpha) = \{L \cup \{\alpha\} | L \in N, \neg\alpha \notin L\}$  if  $\alpha$  is an atomic proposition or its negation;

$$Div(N, \alpha \wedge \beta) = Div(Div(N, \alpha), \beta);$$

$$Div(N, \alpha \vee \beta) = Div(N, \alpha) \cup Div(N, \beta);$$

$$Div(N, \alpha \rightarrow \beta) = Div(N, \neg\alpha) \cup Div(N, \beta);$$

If  $\alpha$  is not an atomic proposition,  $Div(N, \neg\alpha) = Div(N, \alpha')$ , where  $\alpha$  and  $\alpha'$  are specified by Table 44.1.

$Div$  is a deductive implementation of the decomposing rules, and it is more general. Specially, if  $N = \{\emptyset\}$ ,  $Div(\{\emptyset\}, \alpha)$  is the set of all consistent leaves of the decomposition tree of  $\alpha$ . According to Theorem 1,  $\alpha$  is satisfiable if and only if  $Div(\{\emptyset\}, \alpha) \neq \emptyset$ . More generally, we have

**Theorem 2** If  $N \neq \emptyset$ ,  $Div(N, \alpha) \neq \emptyset$  if there exists  $L \in N$  s. t.  $L$  and  $\alpha$  are consistent.

**Theorem 3** If  $N \neq \emptyset$ , for any model  $M$ , there exists  $L \in Div(N, \alpha)$  s. t.  $M \Rightarrow L$  if  $M \Rightarrow \alpha$  and there exists  $L' \in N$  s. t.  $M \Rightarrow L'$ .

Theorems 2 and 3 can also be proved by using structure induction on  $Div$ , which are similarly to the proof of Theorem 1.

Firstly, according to Theorem 2,  $Div(N, \alpha)$  can be used to judge whether there exists a set in  $N$  which is consistent with  $\alpha$ . Secondly, according to Theorem 3,  $Div(N, \alpha)$  also keep the specific consistency information between  $\alpha$  and the total decomposition sets in  $N$ . Therefore, we can use  $Div$  function to accomplish the consistency checking in framework REVISION.

#### 44.4.2 Revision Algorithm

Assume that  $\Gamma$  and  $\Delta$  are enumerated as  $\alpha_1, \dots, \alpha_{m_\Gamma}$  and  $\beta_1, \dots, \beta_{m_\Delta}$ , respectively, and they are input in the given order. Then, the algorithm based on decomposition rules can be described as follows Algorithm 1.1.

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**Algorithm 1.1 Algorithm REVISION-D**


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REVISION-D( $\Gamma, \Delta$ )
 $\Lambda \leftarrow \emptyset; \Sigma \leftarrow \emptyset; N \leftarrow \{\emptyset\};$ 
  for each  $\beta_i \in \Delta$  do
    if  $Div(N, \beta_i) \neq \emptyset$  then
       $\Sigma \leftarrow \Sigma \cup \{\beta_i\};$ 
       $N \leftarrow Div(N, \beta_i);$ 
    for each  $\alpha_i \in \Gamma$  do
      if  $Div(N, \alpha_i) \neq \emptyset$  then
         $\Lambda \leftarrow \Lambda \cup \{\alpha_i\};$ 
         $\Sigma \leftarrow \Sigma \cup \{\alpha_i\};$ 
         $N \leftarrow Div(N, \alpha_i);$ 
  return  $\Lambda;$ 

```

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In the algorithm,  $\Sigma$  is used to store all accepted propositions. Since  $Div(N, \alpha)$  keeps all the consistency information between  $\alpha$  and total decomposition sets in  $N$ , after replacing  $N$  with  $Div(N, \alpha)$ ,  $N$  will store all consistency information of  $\Sigma$ . Therefore,  $\Sigma$  and all its relevant operations in the algorithm are unnecessary actually and can be deleted.

Since the algorithm is a complete algorithm, its complexity is still  $O(2^n m)$ , where  $n$  is the number of atomic propositions in  $Atom(\Gamma \cup \Delta)$ , and  $m$  is the number of propositions in  $\Gamma \cup \Delta$ .

It should be noted that  $\neg$  — rule is a transform rule actually, and it can be combined with other decomposing rules. So, the times of applying decomposing rule have a linear relationship with the length of the given proposition.

*Example 1* Analyze the satisfiability of  $a \wedge b \rightarrow c$ .

If we use the assignment equivalence class-based method, all eight delegate models of  $a \wedge b \rightarrow c$  will be checked. Models satisfying  $\{a, b, c\}$ ,  $\{\neg a, \neg b, c\}$ ,  $\{a, \neg b, c\}$ ,  $\{a, \neg b, \neg c\}$ ,  $\{\neg a, b, c\}$ ,  $\{\neg a, b, \neg c\}$  or  $\{\neg a, \neg b, \neg c\}$  satisfy  $a \wedge b \rightarrow c$ .

If we use the decomposition-based method, the fraction (or decomposition tree)

$$\frac{\frac{\neg a \quad \neg b}{\neg(a \wedge b)} c}{a \wedge b \rightarrow c} \quad (44.7)$$

will be obtained, and models satisfying  $\{\neg a\}$ ,  $\{\neg b\}$  or  $\{c\}$  will satisfy  $a \wedge b \rightarrow c$

It is obvious that for each proposition, the decomposition-based algorithm has a better performance on both time and space perspective.

## 44.5 Conclusion

This paper proposed a set of decomposing rules for set of propositions. Set of propositions can be decomposed into a decomposition tree by using these rules. And we proved that a set is consistent if and only if there is a consistent leaf on its decomposition tree. According to this property, we constructed a deductive function *Div* to calculate all consistent leaves of a decomposition tree.

Based on the syntax-based revision framework and the deductive decomposing function *Div*, we proposed a new revision algorithm for calculating maximal contractions of  $\Gamma$  with respect to  $\Delta$ . The complexity of the algorithm is  $O(2^n m)$ , while for the preparation of each proposition, it can reduce both the checking times and the storage requirement. By analyzing one example, we find that this decomposition-based algorithm has a better performance than the one based assignment equivalence classes.

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# Chapter 45

## Supe-Cube Path-Link Algorithm of Reconfigurable Manufacturing Logistics Organization Structure

Yanyan Li, Wei Long and Jian Gao

**Abstract** In order to solve the problem of real-time scheduling and rapid information transfer in reconfigurable complex manufacturing logistics system, this paper established a new method called Supe-cube path-link algorithm deducing the formula to solve the reconfigurable logistics organization problem of complex manufacturing. Compared to other methods, the path planning of supe-cube was reconfigurable with the changes in production. The method was explained by example.

**Keywords** Supe-cube • Dynamic programming • Path link • Reconfigurable • Complex manufacture system

### 45.1 Introduction

Nowadays, introducing the intelligent, scale and reconfigurable modern manufacturing idea into the manufacturing system of high-end special equipment such as aeronautics, weapons, power of ships and precision machine tools arouses people's much attention. Due to the numberless varieties, types, fits and processes of many high-end special equipments, the logistics distribution system of manufacturing has become the major factor seriously restricting the manufacturing mode's upgrade, production efficiency's improvement and production cost's reduction. So, we should introduce a new transmission sensitive logistics organization mode and run mode.

The classic scheduling theory has developed steadily since the twentieth century. Many scheduling algorithm, such as pure integer programming, dynamic planning and branch and bound method, heuristic algorithm, has been used to

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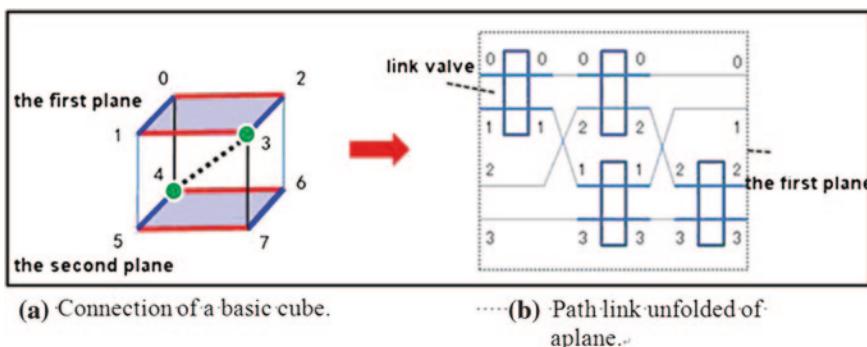
solve the production scheduling problem. Scholars led by M. Fox professor (Carnegie Mellon University) carried out the ISIS research based on the constraint that propagation is the symbol that the artificial intelligence began to be used to solve scheduling problems. Soon, intelligent scheduling becomes the mainstream of the production scheduling research [1]. Neural network, Petri nets, fuzzy mathematics, and the genetic algorithm, many agent technology and distributed artificial intelligence technology are the representative theory technology [2].

However, due to the complexity of the job scheduling problem and logistics job planning problem and the limitations of calculation, there is no any other theoretical method to solve multi-objective and multi-constrained planning scheduling problem. In practical applications, we often change the complex problems into simplified model; however, results of simplistic calculation are always far from the real answer. The inconsistency between theory and practice hindered the application of some planning scheduling theory [3].

Authors focus on the research of the variable multiple-nested high-end equipment complex manufacturing system, explore and build the transmission structure model of complex logistics distribution with reconfigurable self-organization configuration, study the new method of global logistics multi-task collaborative planning scheduling based on Supe-cube path-link algorithm, and realize the reconstruction of manufacturing resources, structure and processes [4].

## 45.2 Definition of Supe-Cube Path Planning

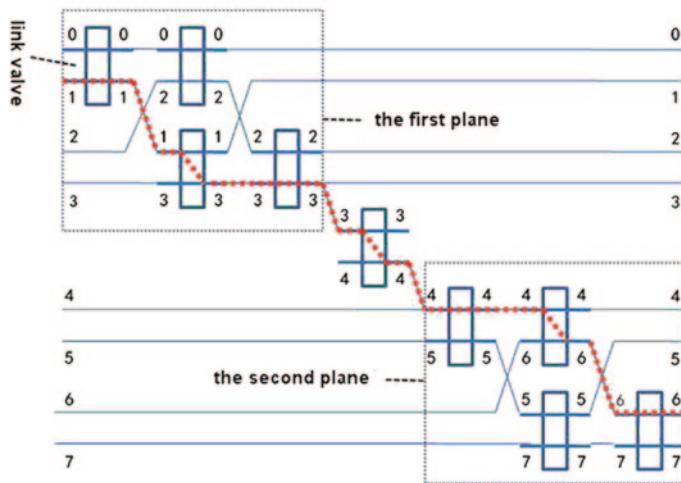
The idea of Supe-cube path planning derives from “Supe-cube” concept of mathematical physics. A cell from Supe-cube is got as a basic cube (see Fig. 45.1a) regarding each angle point as a processing station or storage due to the connectivity of eight angle points. When need to parallel processing stations or work flows among storage shelves, we can define the angle point according to certain rules.



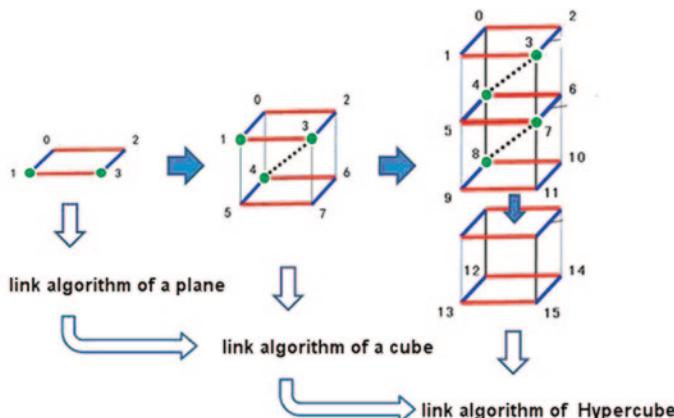
**Fig. 45.1** Supe-cube path planning

Suppose two adjacent angle points as a link statement and regard “face” as a basic unit, as shown in Fig. 45.1a), 0–1–2–3 plane and 4–5–6–7 plane. If we define a link statement as a “link valve” linking two angle points, then the four angle points of base plane can connect with each other. Fig. 45.1b shows the link unfolded drawing. If we use the ligature between angle points 3 and 4 in Fig. 45.1 to link the two base planes of the cube, then we can get a basic cube link unfolded drawing as shown in Fig. 45.2.

Based on this technology path, according to various kinds of typical workshop logistics operations and storage logistics operations form, we can get the algorithm model of complex multi-dimensional Supe-cube path link easily just like building blocks, see Fig. 45.3.



**Fig. 45.2** A basic cube link unfolded drawing



**Fig. 45.3** Technology path of Supe-cube path planning algorithm

### 45.3 Supe-Cube Path-Link Algorithm

Call the angle point 3–4 in Fig. 45.2 as “crosslink statement.” We can deduce the basic algorithm of Fig. 2 through logistics operations.

**Definition 1** Suppose “crosslink statement” function as  $link(x, y)$ , “ $x$ ” as the starting point and “ $y$ ” as the finishing point, its three binary expressions are given as blow:

$$x = (x_2x_1x_0), \quad y = (y_2y_1y_0)$$

**Definition 2** Suppose  $Box(i, j)$  as angle point link valve function, its state corresponds to the “position” state value of  $link(x, y)$ , and

When  $Box(i, j) = 0$ , indicate  $i$  linear link to  $j$ , or  $j$  linear link to  $i$ ;

When  $Box(i, j) = 1$ , indicate  $i$  cross-link to  $j$ , or  $j$  cross-link to  $i$ .

So, the position state of  $link(x, y)$  can be expressed as:

$$link(x, y) = [Box(x, j)Box(i, j)Box(i, y)] \quad (45.1)$$

For example, the link of point “0” and point “1” implies  $link(0, 1) = [10]$ , then  $link(01) = [Box(0, 1)Box(0, 1)] = [10]$ .

This shows the link valve of point “0”  $Box(0, 1) = 1$  means cross-link; the link valve of point “1”  $Box(0, 1) = 0$  means linear link.

**Definition 3** Suppose the computation rule of “link statement” as “bit plus” operations of binary system is to get the unit digit of the result of two binary numbers adding and use operators “ $\oplus$ ”. According to the definition, the link algorithm of angle points in the first base plane in Fig. 45.2 is as follows:

#### (1) Linear Link Statement of the Same Angle-Points

When  $x = y$

$$Link(x, y) = [00] \quad (45.2)$$

For example,

$$Link(0, 0) = Link(00, 00)_2 = [(0\oplus 0)(0\oplus 0)] = [00]$$

$$Link(1, 1) = Link(01, 01)_2 = [(0\oplus 0)(1\oplus 1)] = [00]$$

$$Link(2, 2) = Link(10, 10)_2 = [(1\oplus 1)(0\oplus 0)] = [00]$$

$$Link(3, 3) = Link(11, 11)_2 = [(1\oplus 1)(1\oplus 1)] = [00]$$

#### (2) Linear link Statement of the different Angle-Points

When  $x \neq y, y = 1$

$$Link(x, y) = [(x_0 \underline{\oplus} y_0)(0)] \quad (45.3)$$

When  $x \neq y$

$$Link(x, y) = [(0) \times (y - x - 1)(x_1 \underline{\oplus} y_1)(x_0 \underline{\oplus} y_0)] \quad (45.4)$$

For example,

$$Link(0, 1) = Link(0, 1)_2 = [(0 \underline{\oplus} 1)(0)] = [10]$$

$$Link(0, 2) = Link(00, 10)_2 = [(0)(0 \underline{\oplus} 1)(0 \underline{\oplus} 0)] = [010]$$

$$Link(1, 3) = Link(01, 11)_2 = [(0)(0 \underline{\oplus} 1)(1 \underline{\oplus} 1)] = [010]$$

$$Link(2, 3) = Link(10, 11)_2 = [(1 \underline{\oplus} 1)(0 \underline{\oplus} 1)] = [01]$$

### (3) Links of Interval Angle-Points

Due to the reversibility of linear link statement of the different angle points, we can make link path unique by linking different interval points. The link of interval angle points eliminates the beginning and the end state value after they link, for example,

$$Link(0, 3) = Link(0, 1) \underline{\odot} Link(1, 3) = [10] \underline{\odot} [010] = [110]$$

$$Link(0, 3) = Link(0, 2) \underline{\odot} Link(2, 3) = [010] \underline{\odot} [01] = [011]$$

$$Link(1, 2) = Link(1, 3) \underline{\odot} Link(3, 2) = [010] \underline{\odot} [01] = [011]$$

$$Link(1, 2) = Link(1, 0) \underline{\odot} Link(0, 2) = [10] \underline{\odot} [010] = [110]$$

### (4) “Link Statement” of Cross-Points

$$Link(x, y) = [Link(link(x, y)(1)(link(x, y)))] \quad (45.5)$$

For the link algorithm of angle points in the second base plane in Fig. 45.4, just use the angle points’ value minus  $(k - 1) \times 4$  ( $k$  is cube situation number), apply the link algorithm of the first base plane and bring the link values of the two base planes into cross-link statement. For example, for the link path of angle points “1” and “6,” according to the formula (45.4), then,  $link[1, 3] = [010]$ ,  $6 - (k - 1) \times 4 = 2$ ,  $link[1, 6] = [010]$ .

According to the formula (45.5),  $Link[1, 6] = Link[(010)(1)(010)] = [0101010]$

By formula (45.1), the value of  $Link(1, 6)$  shows the path of dotted line link in Fig. 45.2. From Fig. 45.2, the link path of this example is unique; the result is same when angle points range from “6” to “1.” So, when using reverse link, just according to the result of “from small to large,” link from the tail values to the first value. Define the above algorithms as “Supe-cube path-link algorithm.”

## 45.4 Logistics Model Based on Supe-Cube Path-Link Algorithm

Complex manufacturing logistics related multiple source polymorphism information and gathering of materials, transportation equipment and work path. The difficulty is how to make logistics organization planning and scheduling system response change the information from primary level in time. Supe-cube path-link algorithm is applied in the manufacturing logistics system, which has no path sluggish resistance and can carry the characteristics of the structure change, particularly perceive the form of the bottom logistics. Therefore, the technology path of Supe-cube path-link algorithm is as below [5].

Firstly, set up an interactive operating platform according to Supe-cube path-link algorithm, which is to design the logistics organization of objects. Secondly, build a “logistics organization structure about Supe-cube mode”; the role of the module is to describe an automatically generating corresponding logistics organization according to the object. Then, implant it in a “graphic simulation movement” module, to examine generated logistics organization structure to conform to the requirement of the structural description or not. Then, we can get many kinds of typical model of reconfigurable logistics organization structure [6].

## 45.5 Physical Model of Logistics Operations

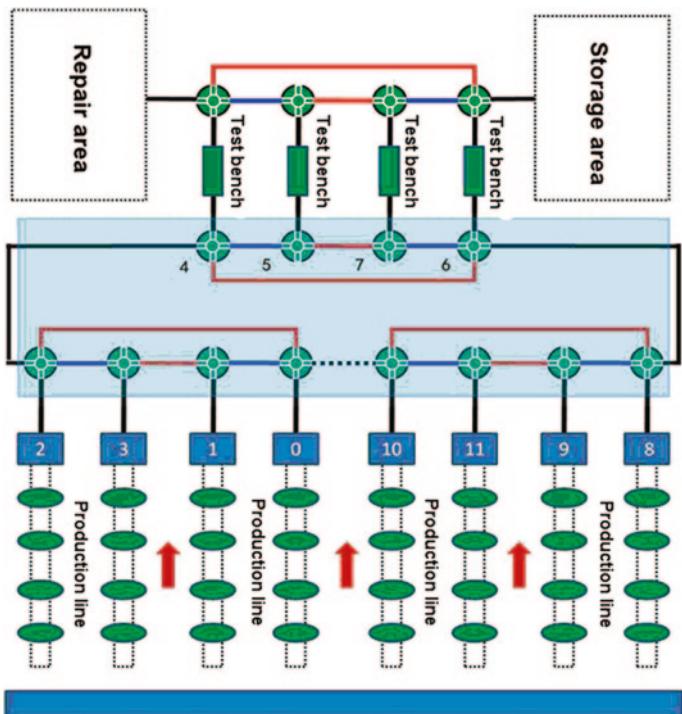
“Crosslink statement” in Supe-cube mode has different physical patterns according to different application systems. We build a physical authentication system of aviation engine assembly and test system. (See Fig. 45.4).

The physical structure authentication system is constituted by 12 trackless reversing location and 2–4 trolley cars, its Supe-cube mode as Fig. 45.5.

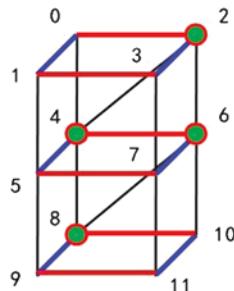
We can use the formula above to descript the links in planning and scheduling algorithm. When bottom information of organization changes (reconstruction), it can be automatically transmitted to the path model, which can quickly get change after link algorithm.

## 45.6 Summary

Research is performed on a new method called Supe-cube path-link algorithm to solve the reconfigurable logistics organization problem of complex manufacturing. The technical path is from a basic plane to a cube and to build a Supe-cube form and to get the formula of it. Based on the theory, we can study typical workshop logistics operations and plan reconfigurable logistics organization structure.



**Fig. 45.4** Aviation engine assembly system



**Fig. 45.5** Supe-cube mode to Fig. 45.4

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# Chapter 46

## Research on Computer Simulation of Knee Airbag

Liping Dong, Xichan Zhu and Zhixiong Ma

**Abstract** In vehicle frontal impact accidents, lower extremities are easily injured. And installing the knee airbag in the car is one of the effective measures of protecting the lower extremities. The paper studied and summarized the design and the development of the knee airbag. The size and the shape of the knee airbag were designed according to the coverage zone, and the accuracy of the coverage zone of the knee airbag was validated using the MADYMO. Finally, the frontal impact sled model was established, and the knee airbag model was combined with the sled model. The knee airbag can not only provide protection of the lower extremity but also increase the overall performance of the restraint system by comparing the movement state and injury of the dummy before and after the installation of the knee airbag.

**Keywords** Lower limbs protection • Knee airbag • Computer simulation • MADYMO

### 46.1 Introduction

In the car accident, the lower extremities are one of the very vulnerable parts. The study showed that 70 % of the wounds in legs occurred in the frontal collision [1]. In the frontal impact, the occupant's lower extremity is also difficult to gain a perfect score. One of the most important reasons is that there is limited space for the knees in the automobile cockpit and the lower legs. So, the dummy legs could not be fully protected because the stiffness of knee bolster and layout of the car internal are unreasonable. Up to now, there are some measures for the knee protection by increasing the space between the occupants' legs and the instrument board or using a pre-tensioned seat belt to strengthen the occupant's lower extremities

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constraint to limit the forward movement of the knee during an impact. However, all the measures are at the cost of vehicles and occupants performance [2].

The knee airbag (KAB) is another measure for knee protection. The KAB will not only play a key role in knee protection but also helpful to reduce the pelvic acceleration and chest injuries [3]. Hence, the overall performance of occupant safety system has been improved in frontal impact. In the future, the KAB will play an increasingly important role and will be used more and more widely.

Little researches have been conducted in the KAB at present. The earliest KAB which was designed by Raj S. Roychoudhury was based on blow-molded plastic active knee bolster and was fitted at Sportage of Kia company in 1996 [4]; Patrick Börde [5] introduced a kind of driver KAB which was called firework-type knee bolster by Faurecia; Zane Z. Yang [6] suggested an active KAB safety system by Delphi. These researches mostly focused on intermediate and high-level car market at abroad, yet there is little study at home.

This paper, based on a pre-verified car model, presented the positive development process of the KAB. Firstly, it started from the KAB geometric design and identified the KAB's size and shape in accordance with its coverage zone. Then, the KAB finite element model was set up and analyzed with CAE simulation. At last, the KAB module was integrated with the all-car system and established the 100 % frontal impact sled simulation model.

## 46.2 Knee Airbag (KAB) Geometric Design

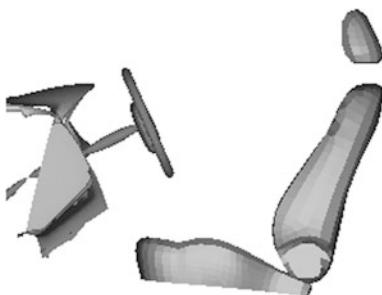
The KAB was arranged on the IP—Instrument Panel (knee bolster) and between IP (knee bolster) and occupant's legs in the frontal collision initiated. Because the space is rather narrow, KAB must unfold within 40 ms and absorb the impact energy in order to provide better protection for the lower limbs. Therefore, there are much greater challenges in KAB design compared with the head–chest airbag.

### 46.2.1 The KAB Coverage Zone

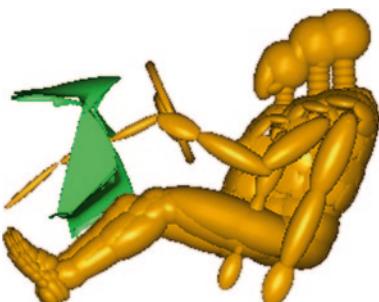
According to the KAB Coverage Zone [7], KAB geometric design must satisfy the following conditions: its size and shape should consist of several postures and different percentile dummy's knee regions and must meet the requirements of the following interiors geometry, as shown in Fig. 46.1, including the instrument panel, the steering wheel, steering column and driver seat.

Based on the above model, the dummy models including Hybrid 5th, 50th and 95th dummy were imported and adjusted to appropriate postures, as shown in Fig. 46.2. According to the seating distance and dummy H point reference coordinate provided by the motor manufacturer, the different percentile dummy positions and postures were identified as the requirement.

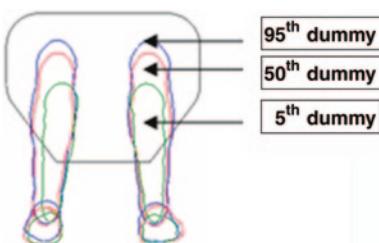
**Fig. 46.1** Finite element model of driver side



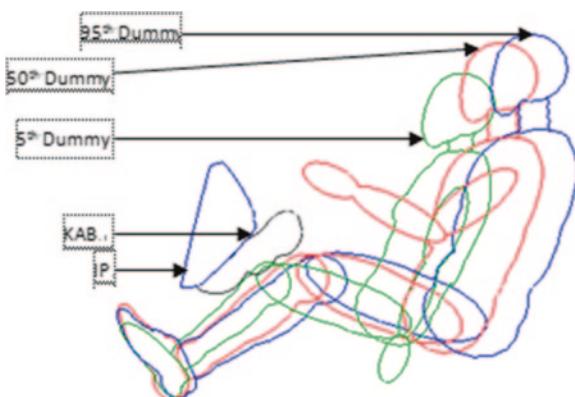
**Fig. 46.2** Positions of dummy and body



**Fig. 46.3** KAB initial geometry (front view)



**Fig. 46.4** KAB initial geometry (side view)



In accordance with KAB coverage protection scope, the KAB initial geometry is shown in Figs. 46.3, 46.4. It must provide sufficient protection area in the collision.

#### 46.2.2 The KAB Coverage Zone

Figure 46.5 shows the two straps of KAB. Two straps ended with a certain distance from the left and right sides of chamber, in order to form a ventilation space. Thus, the inflatable gas could flow along the ventilation space to bloat upward or along the two sides of the bag.

If the expansion thicknesses of upper and lower bags are equal, the KAB would cause larger extrusion and unnecessary harm to the tibia than the protection it could provide to the driver's knees. In addition, if the drivers are smaller in stature, they often place the seats nearer the front. So, the driver's knee may have a distance rather closer to the instrument panel and closer to the underside of the knee bolster. In this case, the KAB would not have perfectible protection to the smaller stature dummies if KAB has the same expansion thickness. Consequently, the width of the two straps is arranged differently along the movement direction of the vehicle, usually setting the upper width longer than the lower. This way can not only avoid the above occurrences, but at the same time, the KAB could quickly employ after the lower volume of KAB decreased.

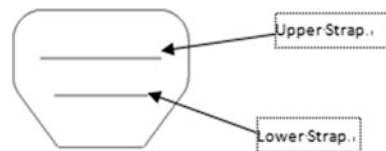
If the thickness of KAB is too small to have enough time of packing pressure, the knee may have a hard contact with the IP, so KAB would not protect the driver's knee fully. Otherwise, if the thickness is too large, KAB may not expand smoothly between the knee and the IP even cause severe impact on the legs during the inflatable process as by not affording sufficient space.

Considering the above factors, the initial width of upper strap along the movement direction of the vehicle is set to 80 mm and the lower is set to 50 mm, as shown in Fig. 46.6.

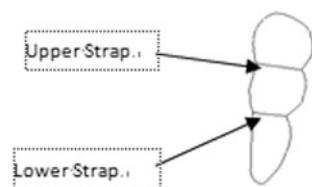
### 46.3 Validation of the Protection Zone of KAB

The KAB appeared so late that there are a few of application products in the market at present and little related research at home and abroad, so it is rather difficult to do relative study on KAB. This paper used computer simulation to study the KAB development process.

**Fig. 46.5** The two straps of the KAB (front view)



**Fig. 46.6** The two straps of the KAB (side view)



### 46.3.1 Design on KAB CAE Model

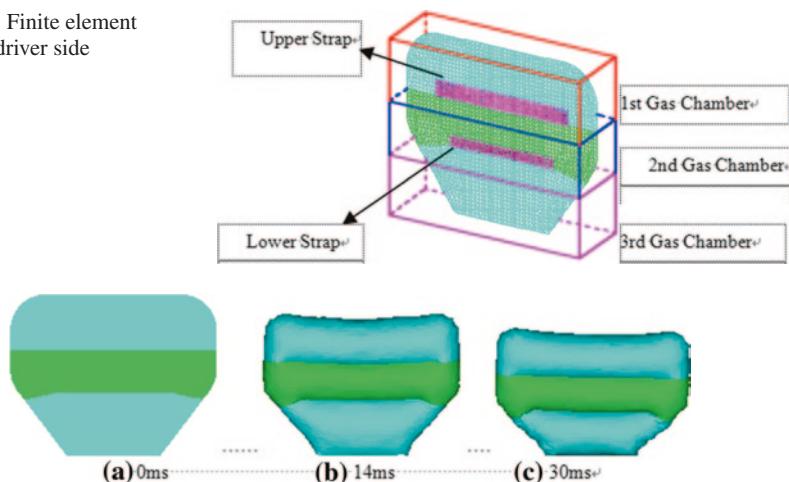
In this paper, the KAB includes two straps. The strap FE model is usually defined as a linear spring by using two masses nodes which only withstand tensile deformation in MADYMO software. However, the straps were meshed as a part of the air chamber in this paper because they had a certain width and length. Thus, this paper decided to establish a FE model with multiple air chambers. This KAB was divided into three gas chambers according to the distribution of the strap, as shown in Fig. 46.7. The lower strap belonged to not only the first gas chamber but also the second; the upper strap situated between the second air chamber and the third. The communication between the adjacent air chambers was completed by means of the space between the strap ends and the two sides of the airbag. The gas inflator was located in the first air chamber.

There are two inflatable algorithms of airbag simulation in MADYMO: one is based on the uniform pressure (UP), another is computational fluent dynamics (CFD). In this paper, the research on KAB is mainly at the normal seating posture and there was no need to accurately describe the airbag inflating process, so this paper decided to use UP inflatable model taking into account the lower computation efficiency of CFD inflatable model.

### 46.3.2 Analysis on the Process of KAB Deployment

The process of KAB static deployment is shown in Fig. 46.8. The airbag was brought to a maximum of volume at 14 ms, and this could also be seen from the

**Fig. 46.7** Finite element model of driver side



**Fig. 46.8** KAB static deployment process

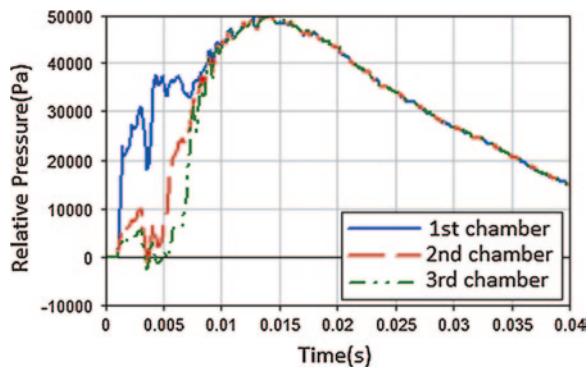
airbag pressure and volume curve (as shown in Figs 46.9, 46.10) of every gas chamber of KAB.

Besides, as shown in Fig. 46.9, the pressure in the first air chamber was greater than the second in the initial stage of inflating proceeding; likewise, the second's pressure was greater than the third's. That meant the gas flowed from the first gas chamber to the second and then to the third. At last, the pressure of the three air chambers reached into equilibrium and unity. Likely, as shown in Fig. 46.10, the volume of the first gas chamber was the biggest, and the third was the smallest in the initial inflating stage. All the results were concordant with the flowing direction of the gas.

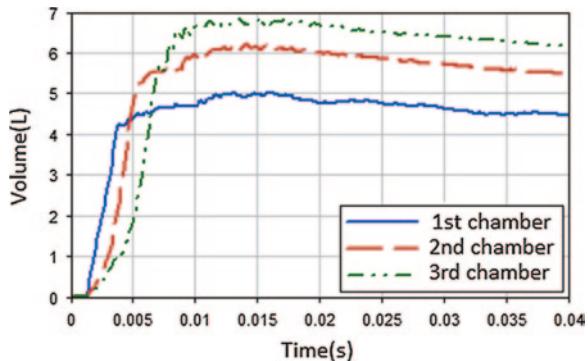
#### 46.3.3 Validation of the Protection Zone of KAB

KAB would have not only longitudinal expansion but also vertical contractions as it was inflated. The thickness of longitudinal expansion of KAB may be larger than the distance from the legs to IP, so the expansion could cause unnecessary impact injuries to the lower limbs. Vertical contraction may decrease the coverage

**Fig. 46.9** Relative pressure of gas chamber of KAB



**Fig. 46.10** Volume of gas chamber of KAB



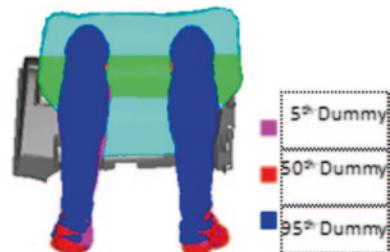
area of KAB, so the KAB may be insufficient for occupant protection. Hence, it needs a validation for the scope of protection of KAB after it deployed completely.

According to the covering scope of protection of KAB, this paper had established the unfold KAB CAE model after calculating and changing the size of KAB several times. In the static deployment simulation, the airbag volume reached the maximum coverage scope of protection in the 14 ms, as shown in Fig. 46.11, 46.12.

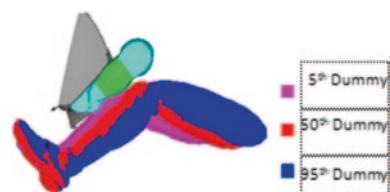
## 46.4 The System Integration and Analysis of KAB

In order to verify the validity of the KAB, the modified KAB FE model which was folded well was integrated into the all-car frontal impact simulation model, as shown in Fig. 46.13. Firstly, the all-car front model with dummy was established and made a benchmarking analysis with the vehicle test for the following studies. Then, KAB was integrated into that base model, defining the contact between KAB and dummy and the contact between KAB and IP. In the light of the

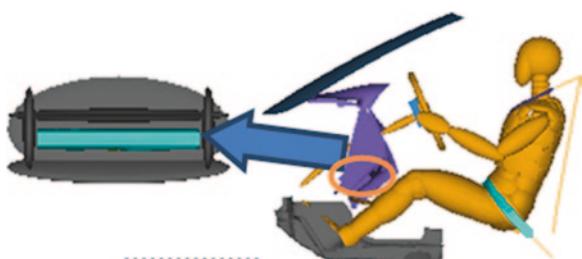
**Fig. 46.11** Coverage zone of inflated KAB



**Fig. 46.12** Bag thickness of inflated KAB



**Fig. 46.13** The system model instigated KAB

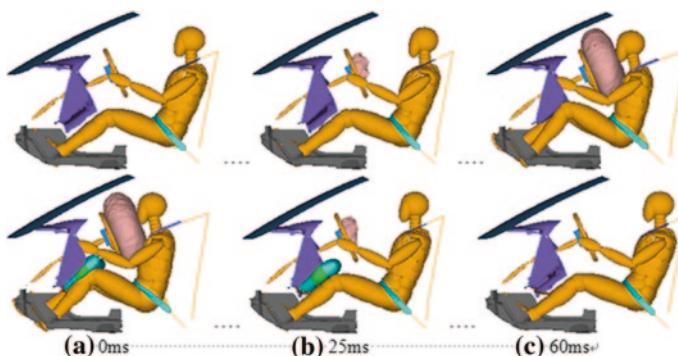


movement response of the based model in frontal impact simulation and the above analyses on KAB, the initial ignition time of KAB is set at 10 ms.

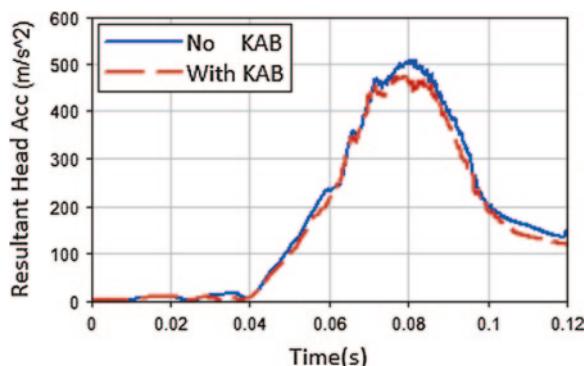
The movement response of dummy after installed KAB was compared with that uninstalled KAB, as shown in Fig. 46.14. It can be seen from the graph that the constraint of the dummy lower limbs was strengthened and the forward movement was also limited after installing the KAB. Then, the hard contact between the limbs and inner body of car had been avoided in the collision.

Figures 46.18, 46.19 show the comparative dummy's injury curves before and after installing KAB. From these graphs, it could be shown that the compression forces of the right and left femur were decreased by more than 30 %. Thus, KAB plays an effective role in the protection of the occupant's lower extremities.

From Figs. 46.15, 46.16, 46.17, it also can be seen that the head and chest injury indexes were cut down to a certain extent, especially, the maximum value of chest compression deformation had fallen from 25.6 to 18.9 mm—a decrease of 26 %. That is because KAB absorbed amount of impact energy, it decreased the forward movement of the chest and increased relatively the living space between the soft chest and the hard trims as well after installing KAB. Consequently, the

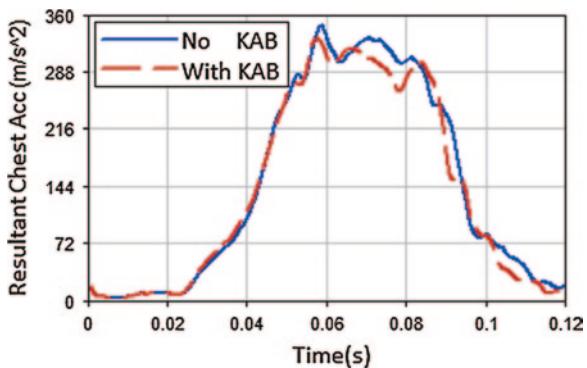


**Fig. 46.14** The movement response before and after installing KAB

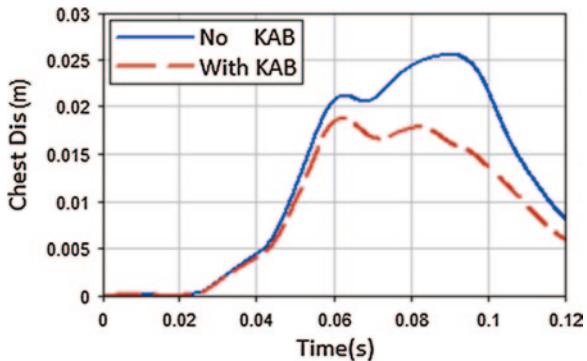


**Fig. 46.15** The resultant head acceleration

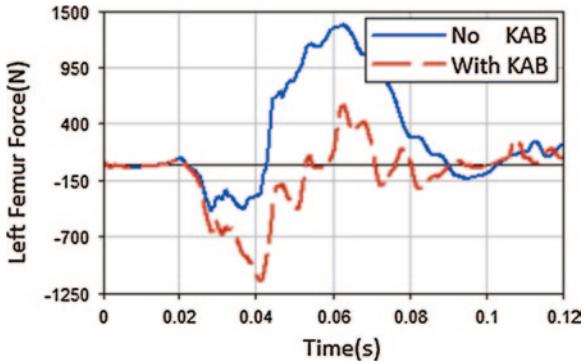
**Fig. 46.16** The resultant chest acceleration



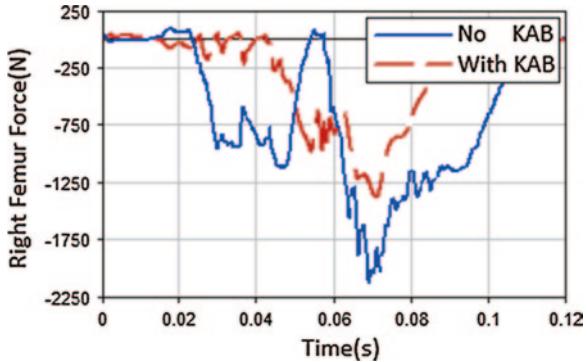
**Fig. 46.17** The chest compression deformation



**Fig. 46.18** The left femur compression force



**Fig. 46.19** The right femur compression force



installation of KAB could also reduce the other parts' injuries of the driver and improved the overall protection of occupant restraint system.

## 46.5 Conclusions

This paper studied the occupant protection performance of the knee airbag by the simulation calculation. And there will be equipped with a KAB sled test in the following studies. In this paper, the research is directed at normal seated occupant, on this basis, using CFD inflatable KAB model for further research on out-of-position occupant protection.

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# Chapter 47

## Dynamic Analysis of Flexible Bionic Pectoral Fin of Labriform Fish

Qiang Liu

**Abstract** Labriform mode is an important maneuvering locomotion mode which is largely applied to teleost fish. It takes the pectoral fin as the main maneuvering surface, accomplishing a variety of maneuvering locomotion such as hovering, forward-swimming, backward-swimming, braking and turning. These maneuvering performances with high-efficiency and flexibility are absent in the conventional underwater vehicle. Therefore, based on the pectoral fin structure and neuromuscular control mechanism, this paper designed a new flexible bionic pectoral fin and built the mathematical model of swing motion of pectoral fin rays as well as the dynamics model of bionic pectoral fin. Then, Simulink was utilized to simulate the dynamic performance. According to the result, this bionic pectoral fin has the excellent dynamic performance and can actualize locomotion morphology of real pectoral fin. In addition, the dorsal–ventral swing motion of middle rays of bionic pectoral fin was taken as under-actuated motion to reduce the quantity of control variables, which provides basis for making of the new bionic pectoral fin with more compact and simple structure.

**Keywords** Dynamic performance • Labriform mode • Pectoral fin • Simulink

### 47.1 Introduction

Pectoral fin plays an important role in the maneuvering locomotion of Labriform fish. For the exploration of new maneuvering surface of underwater vehicles, study on Labriform bionic pectoral fin is significant [1]. According to the structure of pectoral fin, Palmisano et al. [2] built the bionic fin ray and installed them on the fin base (viz. scapula, coracoid, radial bones, cartilage pad and so on) in line. Under the driving of electromotor, active deformation of the fin rays arose,

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with which the fin surface also became deformed. Then, the flapping locomotion of the whole fin surface was achieved by electromotor driving the fin base. Lauder and Tangorra et al. [3] built the bionic fin ray, and then, the elastic material was utilized to build the bionic fin base. Since the fin base is elastic and flexible, the bionic pectoral fin can achieve four kinds of single locomotion morphology such as expansion, curling, sweeping and cupping easily by the drive of nylon rope. The complex locomotion pattern could be created by superimposing the combinations of other three single locomotion pattern onto sweep motion. Tangorra and Gottlieb et al. [4] combined the flexible fin rays together according to the shape of fin base, of which each fin ray can achieve the rotation motion of two freedoms. Additionally, the nylon rope driven by the electromotor was used to control the rotation motion of fin rays with the aim of achieving all kinds of propulsion locomotion of pectoral fin. However, the freedoms of this bionic pectoral fin are numerous, its structure is also very complex and its complexity increases rapidly with the number of fin rays. In conclusion, the research on bionic pectoral fin is still insufficient [5].

Based on the existing problem, a new under-actuated flexible bionic pectoral fin was designed by utilizing the pull of the leading edge fin ray and the trailing edge fin ray.

## 47.2 Bionic Design of Pectoral Fin

For reducing the difficulty in the bionic design of flexible pectoral fin, the assumption on the structure of flexible pectoral fin, motion control mechanism and physical property is described as follows:

Both the fin rays and fin base of pectoral fins are rigid.

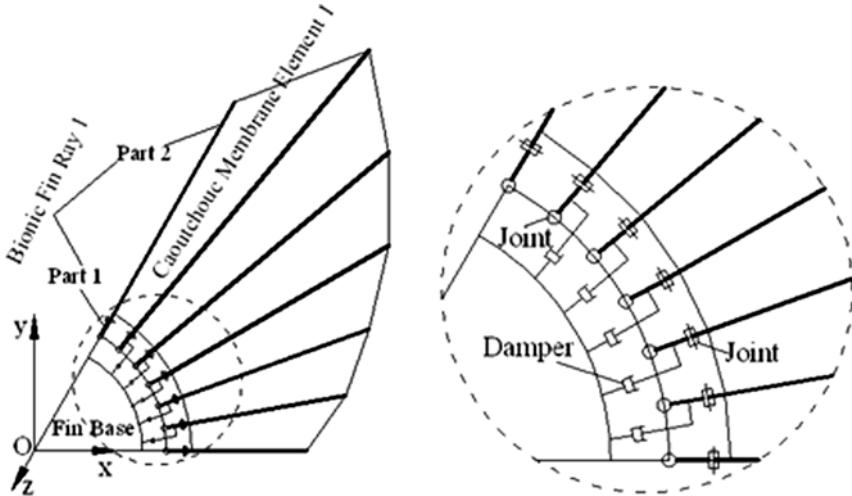
The dorsal–ventral rotation of median fin rays is caused by the pull of leading edge fin ray and trailing edge fin ray.

The flexible bionic pectoral fin shown in Fig. 47.1 composed of two parts (part 1 and part 2). Part 1 is actually a short link. It can swing dorsal–ventrally. Part 2 can swing laterally. Since the link is short, the bionic fin rays can imitate the swing motion of two freedoms of real fin rays well. The fin rays are connected with each other by means of caoutchouc membrane.

## 47.3 Mathematical Model of Bionic Pectoral Fin

### 47.3.1 Kinematic Model

During the fish forward steady swimming, the propulsion locomotion of pectoral fin can be divided into two phases, a recovery stroke (abduction) and a power stroke



**Fig. 47.1** Schematic diagram of flexible bionic pectoral fin

(adduction). At the recovery stroke, the pectoral fin rays primarily move anteriorly and ventrally. At the power stroke, the pectoral fin rays primarily move posteriorly and dorsally. Since the dorsal–ventral rotation of the median fin rays is passive, the kinematic models of other freedoms of all fin rays are built as follows [6].

Recovery stroke:

$${}^i\theta_1 = \frac{{}^i\tilde{\theta}_1}{2} [1 - \cos(\pi t / T_r)] \quad (0 \leq t \leq T_r, i = 1, 7)$$

$${}^i\theta_2 = \begin{cases} 0, \\ (\pi + {}^i\bar{\theta}_2)t / T_r \leq {}^i\bar{\theta}_2 \\ \frac{{}^i\tilde{\theta}_2}{2} \left\{ 1 - \cos \left[ (\pi + {}^i\bar{\theta}_2)t / T_r - {}^i\bar{\theta}_2 \right] \right\}, \\ (\pi + {}^i\bar{\theta}_2)t / T_r > {}^i\bar{\theta}_2 \end{cases} \quad (0 \leq t \leq T_r, i = 1 \sim 7) \quad (47.1)$$

Power stroke:

$${}^i\theta_1 = \frac{{}^i\tilde{\theta}_1}{2} [1 + \cos(\pi t / T_r)] \quad (T_r \leq t \leq T, i = 1, 7) \quad (47.2)$$

$${}^i\theta_2 = \begin{cases} {}^i\tilde{\theta}_2, \\ (\pi + {}^i\bar{\theta}_2)(t - T_r) / T_p \leq {}^i\bar{\theta}_2 \\ \frac{{}^i\tilde{\theta}_2}{2} \left\{ 1 + \cos \left[ (\pi + {}^i\bar{\theta}_2)(t - T_r) / T_p \right. \right. \\ \left. \left. - {}^i\bar{\theta}_2 \right] \right\}, (\pi + {}^i\bar{\theta}_2)(t - T_r) / T_p > {}^i\bar{\theta}_2 \end{cases} \quad (T_r \leq t \leq T, i = 1 \sim 7) \quad (47.3)$$

where  ${}^i\theta_1$  is the dorsal–ventral rotation angle of the  $i$ th fin ray;  ${}^i\theta_2$  is the lateral rotation angle of the  $i$ th fin ray;  ${}^i\tilde{\theta}_1$  is the dorsal–ventral rotation amplitude of the  $i$ th fin ray;  ${}^i\tilde{\theta}_2$  is the lateral rotation amplitude of the  $i$ th fin ray;  ${}^i\bar{\theta}_2$  is the phase delay of lateral rotation of the  $i$ th fin ray, it increases evenly from the fin ray 1 with  $0^\circ$  to the fin ray 7;  $T_r$ ,  $T_P$  and  $T$  indicate the duration time of the recovery stroke, the duration time of the power stroke and the propulsion locomotion period of pectoral fin, respectively.

### 47.3.2 Dynamic Model

The bionic pectoral fin is the rigid-flexible coupling system and has the complex fluid–structure interaction between the pectoral fin and fluid. For simplicity, the fluid force acted on the pectoral fin is neglected temporarily. The mass, the strain along the direction of fin ray and the thickness of the caoutchouc membrane element are neglected as well when the caoutchouc membrane element is stretched. Then, with the assumption that the caoutchouc membrane element is pure elastic element and it can only afford the pulling force, the dynamic model of the flexible pectoral fin can be established.

The dynamic model of bionic pectoral fin is established based on Lagrange method. After being transformed, the model can be described as follows.

$$\begin{cases} {}^iA_1 \dot{{}^i\theta}_1 + {}^iA_2 \dot{{}^i\theta}_1 \dot{{}^i\theta}_2 = {}^iQ_1 \\ {}^iB_1 \dot{{}^i\theta}_2 + {}^iB_2 \dot{{}^i\theta}_2^2 + {}^iB_3 \dot{{}^i\theta}_1^2 = {}^iQ_2 \end{cases} \quad (i = 1 \sim 7) \quad (47.4)$$

$$\text{where } {}^iA_1 = {}^i m_1 {}^i l_{c1}^2 + {}^i m_2 [{}^i l_1 + {}^i l_{c2} \cos({}^i\theta_2 + {}^i\theta_{20})]^2 + {}^i J_{c1} + {}^i J_{c2};$$

$${}^iA_2 = -2 {}^i m_2 {}^i l_{c2} \sin({}^i\theta_2 + {}^i\theta_{20}) [{}^i l_1 + {}^i l_{c2} \cos({}^i\theta_2 + {}^i\theta_{20})]^2;$$

$${}^iB_1 = {}^i m_2 {}^i l_{c2}^2 \sin^2({}^i\theta_2 + {}^i\theta_{20}) + {}^i J_{c2};$$

$${}^iB_2 = 2 {}^i m_2 {}^i l_{c2}^2 \sin({}^i\theta_2 + {}^i\theta_{20}) \cos({}^i\theta_2 + {}^i\theta_{20});$$

$${}^iB_3 = {}^i m_2 {}^i l_{c2} \sin({}^i\theta_2 + {}^i\theta_{20}) [{}^i l_1 + {}^i l_{c2} \cos({}^i\theta_2 + {}^i\theta_{20})]$$

${}^i m_j$ ,  ${}^i l_j$ ,  ${}^i l_{cj}$ ,  ${}^i J_{cj}$ ,  ${}^i \theta_j$ ,  ${}^i \dot{\theta}_j$ ,  ${}^i \theta_{j0}$  are mass, length, the distance between centroid and its end, the moment of inertia, the swing angle, the angular velocity and the initial angle of the part  $j$  of the  $i$ th two-link bionic fin ray respectively;  ${}^iQ_j$  is the generalized force acted on the  $i$ th bionic fin ray corresponding to the  $j$ th generalized coordinate;  $i$  is the serial number of the two-link bionic fin ray;  $j$  is the serial number of the part of the two-link bionic fin ray.

The generalized force  ${}^i Q_j$  acted on the  $i$ th bionic fin ray can be described as:

$${}^i Q_j = - \sum_{k=1}^2 {}^i m_k g \frac{\partial^i y_{ck}}{\partial^i \theta_k} + {}^i M'_j + {}^i M_j \quad (i = 1 \sim 7, j = 1 \sim 2) \quad (47.5)$$

where  ${}^i x_{cj}$ ,  ${}^i y_{cj}$ ,  ${}^i z_{cj}$  are the centroid coordinates the part  $j$  of the  $i$ th two-link bionic fin ray, respectively;  $g$  is the acceleration of gravity;  ${}^i M'_j$  and  ${}^i M_j$  are the generalized force of the caoutchouc membrane element and the driving motor(including the damper) to the  $i$ th two-link bionic fin ray, respectively, where  ${}^i M'_j$  can be described as:

$$\begin{aligned} {}^i M'_1 &= \int_0^{\frac{i-1 l_2 + i l_2}{2}} {}^{i-1} F_{x2} \left[ {}^i l_1 \sin({}^i \theta_1 + {}^i \theta_{10}) + l \sin({}^i \theta_1 + {}^i \theta_{10}) \cos({}^i \theta_2 + {}^i \theta_{20}) \right] dl \\ &\quad + \int_0^{\frac{i l_2 + i+1 l_2}{2}} -{}^{i-1} F_{x2} \left[ {}^i l_1 \sin({}^i \theta_1 + {}^i \theta_{10}) + l \sin({}^i \theta_1 + {}^i \theta_{10}) \cos({}^i \theta_2 + {}^i \theta_{20}) \right] dl \\ &\quad + \int_0^{\frac{i-1 l_2 + i l_2}{2}} -{}^{i-1} F_{y2} \left[ {}^i l_1 \cos({}^i \theta_1 + {}^i \theta_{10}) + l \cos({}^i \theta_1 + {}^i \theta_{10}) \cos({}^i \theta_2 + {}^i \theta_{20}) \right] dl \\ &\quad + \int_0^{\frac{i l_2 + i+1 l_2}{2}} {}^i F_{y2} \left[ {}^i l_1 \cos({}^i \theta_1 + {}^i \theta_{10}) + l \cos({}^i \theta_1 + {}^i \theta_{10}) \cos({}^i \theta_2 + {}^i \theta_{20}) \right] dl \end{aligned} \quad (47.6)$$

${}^i F_{x2}$ ,  ${}^i F_{y2}$ ,  ${}^i F_{z2}$  are the  $x$ ,  $y$ ,  $z$  component of the acting force of the  $i$ th caoutchouc membrane element (viz. caoutchouc membrane element between the  $i$ th and  $i+1$ th bionic fin ray) to part 2 of the  $i$ th bionic fin ray per unit of length, respectively, and the force component is zero for  $i = 0$  and 8 while others can be calculated by analyzing the caoutchouc membrane element.

$$\begin{aligned} {}^i M'_2 &= \int_0^{\frac{i-1 l_2 + i l_2}{2}} {}^{i-1} F_{x2} l \cos({}^i \theta_1 + {}^i \theta_{10}) \sin({}^i \theta_2 + {}^i \theta_{20}) dl \\ &\quad + \int_2^{\frac{i l_2 + i+1 l_2}{2}} -{}^{i-1} F_{z2} l \cos({}^i \theta_2 + {}^i \theta_{20}) dl \\ &\quad + \int_0^{\frac{i l_2 + i+1 l_2}{2}} {}^i F_{z2} l \cos({}^i \theta_2 + {}^i \theta_{20}) dl \\ &\quad + \int_0^{\frac{i-1 l_2 + i l_2}{2}} -{}^{i-1} F_{y2} l \sin({}^i \theta_1 + {}^i \theta_{10}) \sin({}^i \theta_2 + {}^i \theta_{20}) dl \\ &\quad + \int_0^{\frac{i l_2 + i+1 l_2}{2}} {}^i F_{y2} l \sin({}^i \theta_1 + {}^i \theta_{10}) \sin({}^i \theta_2 + {}^i \theta_{20}) dl \\ &\quad + \int_0^{\frac{i l_2 + i+1 l_2}{2}} -{}^i F_{x2} l \cos({}^i \theta_1 + {}^i \theta_{10}) \sin({}^i \theta_2 + {}^i \theta_{20}) dl \end{aligned}$$

The theory of elasticity shows that the stress and the strain are of linear relation [7]. If the surface strain coefficient is  $\sigma$ , the force of the caoutchouc membrane element to part 2 of the  $i$ th bionic fin ray at  $l$  which denotes the distance between the action point of force and the joint of part 1 and part 2 can be described as:

where  $d_{li}$ ,  $d_{li0}$  are the present distance and the initial distance between part 2 of the  $i$ th and  $i + 1$ th bionic fin ray at  $l$ ;  ${}^i x_{l2}$ ,  ${}^i y_{l2}$ ,  ${}^i z_{l2}$  are the coordinate of part 2 of the

$$\begin{bmatrix} {}^i F_{x2} \\ {}^i F_{y2} \\ {}^i F_{z2} \end{bmatrix} = \begin{cases} \sigma \frac{d_{li} - d_{li0}}{d_{li}} \begin{bmatrix} {}^{i+1} x_{l2} - {}^i x_{l2} & {}^{i+1} y_{l2} - {}^i y_{l2} & {}^{i+1} z_{l2} - {}^i z_{l2} \end{bmatrix}^T, & d_{li} - d_{li0} > 0 \\ \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}^T, & d_{li} - d_{li0} \leq 0 \end{cases} \quad (i = 1 \sim 6) \quad (47.7)$$

$i$ th bionic fin ray at  $l$ .

The damper installed on part 1 of the 2nd to the 6th bionic fin ray plays an important role in increasing the convergence rate of the oscillation of the fin ray [8]. The damping moment acted on the fin ray can be described as:

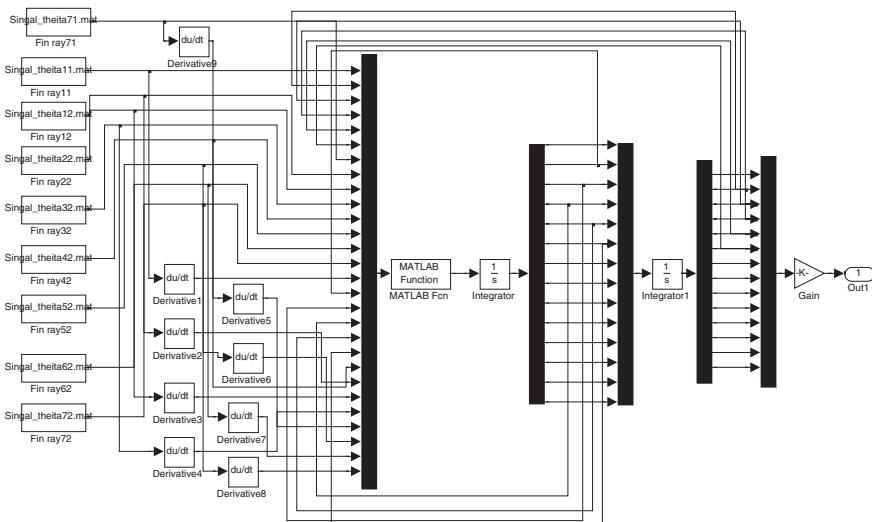
$${}^i M_1 = {}^i b^2 {}^i C \cos^2 {}^i \theta_1 {}^i \dot{\theta}_1 \quad (i = 2 \sim 6) \quad (47.8)$$

where  ${}^i b$  is the perpendicular distance from the action point of the damping force to the axis of part 1 of the  $i$ th bionic fin ray;  ${}^i C$  is the damping coefficient of the damper installed on the  $i$ th bionic fin ray.

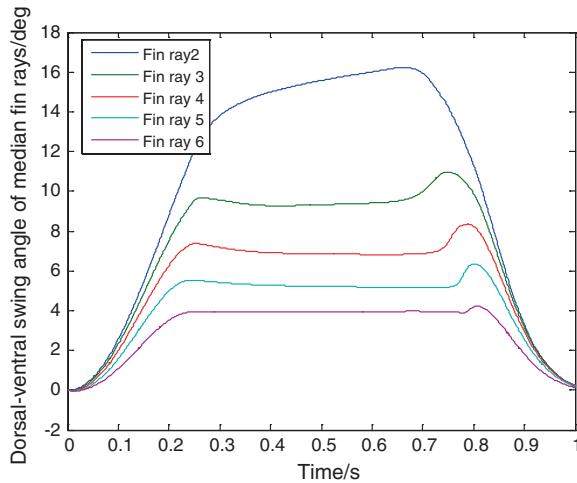
## 47.4 Simulation Analysis

Since the dynamic model of bionic pectoral fin is very complex, the Simulink is used to simulate the dynamic performance of bionic pectoral fin. The Simulink program is shown in Fig. 47.2. Meanwhile, assuming that the forward steady swimming velocity of fish  $U$  is 0.1 m/s, the surface stress coefficient  $\sigma$  is 0.1 MPa, the propulsion locomotion period  $T$  is 1 s, the duration time of the power stroke  $T_p$  is 0.5 s and the duration time of the recovery stroke  $T_r$  is 0.5 s. The simulation result is shown in Figs. 47.3 and 47.4.

According to the simulation result and observation result in references [1], the new bionic flexible pectoral fin designed in this paper has the excellent dynamic performance and can imitate the propulsion motion morphology of pectoral fin well. However, there are still some errors compared with the motion morphology of real fish pectoral fin. There are mainly two reasons for such errors. On one hand, simplification is made to the kinematic model of fish pectoral fin. On the other hand, rigid fin rays are used to take the place of flexible fin rays which can realize active or passive deformation. Therefore, in order to improve the performance of the flexible bionic pectoral fin, it is necessary to develop the research on the design of the bionic fin ray and the establishment of the kinematic model of real pectoral fin.



**Fig. 47.2** Simulink program of dynamic simulation of bionic pectoral fin

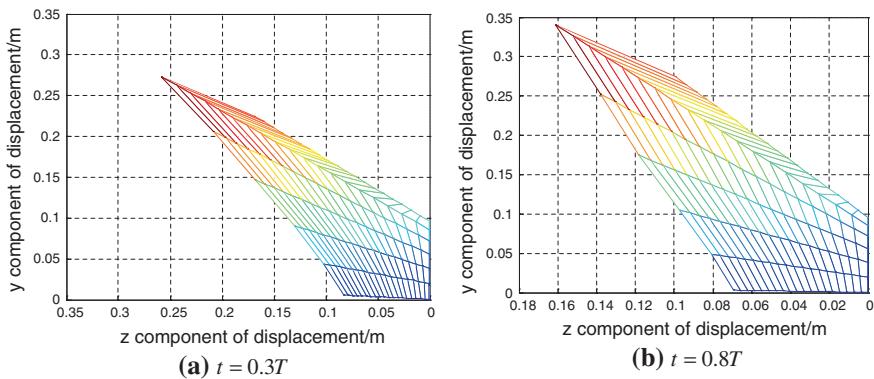


**Fig. 47.3** Dorsal–ventral motion of median fin rays

## 47.5 Conclusions

According to the analysis on the dynamic performance of the bionic pectoral fin, the following conclusions can be obtained.

- (1) The new bionic pectoral fin takes the dorsal–ventral swing motion of the middle fin rays as under-actuated motion to make the structure of bionic pectoral



**Fig. 47.4** Post view of motion morphology of bionic pectoral fin

fin more compact with small volume, which provided the theoretical basis for the making of new bionic pectoral fin.

- (2) The bionic pectoral fin has the excellent dynamic performance and can actualize the propulsion locomotion morphology of real pectoral fin well.

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**Part VI**

**Semantic Grid and Natural Language Processing**

# Chapter 48

## Research on License Plate Location Algorithm

**Qing Yan**

**Abstract** License plate location is an important step in car license plate recognition technology applications. Many scholars have developed many license plate detection algorithms; this paper will introduce some current technologies of license plate location. In this paper, several common license plate location methods are introduced briefly and compared.

**Keywords** License plate location • Texture analysis • Edge detection • Mathematics morphology • Wavelet analysis

### 48.1 Introduction

License plate recognition technology is the important means of traffic management automation. After a series of calculation, the technique can identify the vehicle license plate number within the visual field [1]. By using the digital image processing, pattern recognition, artificial intelligence technology, the acquisition of vehicle image processing methods, the technique can accurately identify the license plate numbers, letters and Chinese characters and give the recognition result that computer can be directly run data form; this lets the vehicle computer monitoring and management becomes a reality. Analyses of complex background image with the vehicle, after the license plate character location, character segmentation; license plate recognition technology finally automatically identifies the vehicle license characters. In order to ensure that the automobile license plate recognition system can play its due role in the complex environment, recognition system must meet the following requirements:

- (1) Robustness: In any case, the system can reliably work properly and has higher recognition rate.

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- (2) Real time: Regardless of the motor vehicle is stationary or high-speed operation, the system must be in a certain period of time identification plates all characters, to achieve real-time recognition.

License plate recognition technology comprises the following three parts: license plate location, character segmentation and character recognition. In which, license plate locating accuracy directly determines the character segmentation and recognition effect and affects the entire LPR system identification rate of primary factors. Therefore, license plate location technology is the most critical step of license plate recognition technique. Now license plate location methods are varied, which is typically include method of license plate location based on edge detection, method of license plate location based on color segmentation, method of license plate location based on wavelet transform, method of license plate location based on genetic algorithm, method of license plate location based on mathematical morphology and based on texture feature analysis, etc.

## 48.2 License Plate Region's Characteristic

Through the use of the license plate area characteristic to judge a license, license plate location method is to separate the area from the vehicle license plate image. License plate has many inherent characteristics; these features are different for different countries. From the visual point of view, China's license plate has the following features that can be used to locate:

- (1) License plate background color has bigger difference with the car's body color and characters' colors.
- (2) License plate has a continuous or discontinuous frame.
- (3) License plate has multiple, substantially horizontal arrangement of characters, rectangular area of license plate has a wealth of edge, showing a regular texture feature.
- (4) License plate space between characters have very uniform, the gray value of license plate characters and background has a big jump, the characters and the license plate has a more uniform gray.
- (5) In different image plates, the specific size and position of license plate are uncertain, but the length-width ratio has a certain range, there is a maximum and minimum length-width ratio.

The above characteristics are the concepts, the features alone are not unique to that vehicle license plate image, but they can be combined to uniquely identify the license plate. Among these characteristics, color, shape, and position are the most intuitive and easy to extract. Texture feature is more abstract, must go through a process or conversion of other features will be available for use characteristic index. Text features usually require at least through the character segmentation or identification can be useful features, is generally used to judge correctness of license plate recognition.

## 48.3 Introduction of Current Algorithms of License Plate Location

According to the different characteristics of license plate, we can adopt different positioning methods. Now license plate location methods are varied, which typically include method of license plate location based on edge detection, method of license plate location based on color segmentation, method of license plate location based on wavelet transform, method of license plate location based on genetic algorithm, method of license plate location based on mathematical morphology and based on texture feature analysis, etc. The following several positioning algorithms are briefly introduced.

### 48.3.1 The License Plate Location Algorithm Based on Edge Detection

The edge is around the pixel gray with step change of those pixels set. The edges of the sides were divided into two regions: each region has uniform gray, while the two areas have some differences in the characteristics of gray. Edge detection's task is to pinpoint the edge and noise suppression. The detection method has many kinds, such as Roberts's edge operator, Prewitt operator, Sobel operator, and Laplace edge detection [2]. These methods can detect the image edge by using the object edge gray of the characteristics of rapid changes. The operator on the different types of edges of different sensitivities produces different effects, through a large number of experimental analyses. Roberts's edge operator is a local variance operator for edge operator and is more accurate in location; the Prewitt operator and Sobel operator have a certain inhibition for the noise, but not completely exclude the false edge; Laplace operator is two-order differential operator, it can accurately locate the image of the step edge and rotation invariance, but it is easy to lose a portion of an edge direction information, at the same time, anti noise ability is poor. So, for different environments and requirements, we must select the appropriate operator for image edge detection in order to achieve good results. The process is shown in Fig. 48.1.

The method has higher positioning accuracy, fast response time, can effectively remove the noise, suitable for containing a plurality of license plate image, but on the license plate of severe fading conditions, the edge detection of character



**Fig. 48.1** The process of the algorithm of license plate location based on edge detection

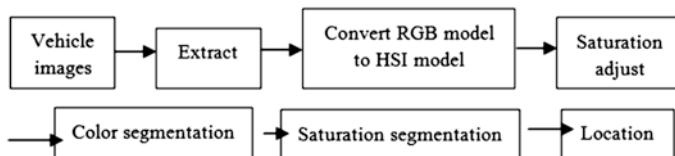
strokes can lead to failure. After locating, the region in the external interference and license plate tilt slightly larger than the license plate.

### 48.3.2 The License Plate Location Algorithm Based on Color Segmentation

The method includes color segmentation and target positioning; it segments color images by using a multi-layer perception network and then segments the potential region of the plate through the projection method [3]. In the time of color segmentation, the method uses neural network model, the general image uses RGB three primary colors, but the Euclidean distance and the color distance between two points are not a linear scale in RGB three primary colors. In order to better color segmentation, the RGB model of color image is converted to HSI mode, namely the hue, saturation, and brightness, and then adjusts the output image saturation. In order to reduce the amount of computation, the method pump dilutes color image and pattern transformation, and at the same time in order to reduce the illumination conditions on image segmentation effects, it uses logarithmic method to adjust the color saturation, and then uses color neural network segmentation for the color image after mode conversion, and finally according to the prior knowledge of plate background color and length-width ratio, it uses the projection method to segment a reasonable license plate area. When the color image quality is high, especially when the license plate region color and color difference are larger near the accuracy rate will decline.

The location algorithm's accurate rate is very high, but when the regional color and near the color are similar, because of using neural network computation, the calculation speed is slower. The processes are shown in Fig. 48.2.

The method has higher positioning accuracy, fast response time, can effectively remove the noise, suitable for containing a plurality of license plate image, and in many cases license plate image positioning speed is also very quick. But on the license plate of severe fading conditions, the edge detection of character strokes can lead to failure. After locating, the region in the external interference and license plate tilt slightly larger than the license plate.



**Fig. 48.2** The process of the algorithm of license plate location based on color segmentation

### ***48.3.3 The License Plate Location Algorithm Based on Wavelet Transforms***

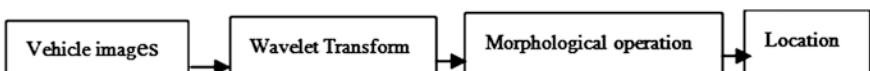
Wavelet analysis is an important analysis tool of image processing and has the characteristics of “microscope.” Wavelet decomposition coefficients in different direction of the high-frequency wavelet coefficients have different characteristics because of wavelet multi-resolution characteristics, so using orientation wavelet can reflect the image at different resolutions along any direction changing situation. Multi-scale decomposition characteristics of wavelet analysis are more consistent with human visual system.

The basic idea of wavelet transform is that original signals are decomposed into a series of different spatial resolution, different frequency and direction characteristic sub-band signal after stretching and translation; these sub-band signals have good time–frequency characteristics; through the use of these characteristics, the signal in the time domain and frequency domain analyses can be achieved.

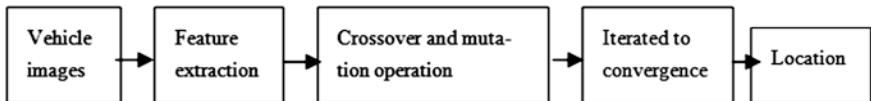
At present, the wavelet analysis algorithm of license plate location is mostly used in wavelet transform and in a variety of methods to achieve the purpose of more accurate and quick location [4]. For example, in the method of license plate location based on wavelet analysis and mathematical morphology, the method decomposes and extracts the edge sub-graph of clear texture and different spatial resolution and different edge directions through multi-scale wavelet and then realizes the sub-graph extraction by using plate target regions having horizontal direction perpendicular to the direction of high- and low-frequency characteristics. Finally, using mathematical morphological method for wavelet decomposition of image details a series of morphological operations, further eliminate useless information and noise, to locate the plate. In the smaller noise conditions, the method is good positioning effect and segmentation precision, and its shortcoming is slower; and in the larger noise, the probability of false location also increases. The processes are shown in Fig. 48.3.

### ***48.3.4 The Algorithm of License Plate Location Based on Genetic Algorithm***

The method uses genetic algorithm to optimize and search the image, then construct the fitness function based on the regional feature vector, finally find the optimal locating parameter of license plate region. License plate location is in line



**Fig. 48.3** The process of the algorithm of license plate location based on wavelet transform



**Fig. 48.4** The process of the algorithm of license plate location based on genetic algorithm

for a “regional characteristics of the license plate” best regional process, essentially is a problem that finds the optimal locating parameter from parameter space [5]. But in a real-time system, license plate location velocity is affected by genetic algorithm iterations influence. The processes are shown in Fig. 48.4.

### 48.3.5 *The Algorithm of License Plate Location Based on Mathematical Morphology*

The basic ideas of mathematical morphology image processing are that using a structural element to detect an image, checking whether the structure element is very good fill on the image or not, and at the same time validating whether the filling element’s method is effective or not. Corrosion, expansion, open and close are the basic operations of mathematical morphology. The processes are shown in Fig. 48.5.

The method cannot be precisely determined left-right boundary position of license plate, so it must be combined with other positioning method for precise positioning. For example, in the license plate location method based on mathematical morphology and edge characteristics [6], this method first preprocesses license plate image and then filters based on the vertical direction structure elements of corrosion computing, uses the closure operation to fill the license plate area’s tiny holes, enhances the license plate area, makes the license plate area became a regional connectivity, and finally provides accurate positioning by character edge characteristics of plate. The method combines the mathematical morphological operation and the characteristics of digital images, effectively improves the traditional method of license plate location, and improves the speed and accuracy of license plate location.

### 48.3.6 *The Algorithm of License Plate Location Based on Gray Image’s Texture Characteristic Analysis*

The traditional texture feature analysis of localization algorithms is based on gray image analysis, and the algorithm needs to preprocess the image; the color image is converted to gray image [7]. Then the line scanning is used to identify the image of each row that contains the license plate segment and to record their



**Fig. 48.5** The process of the algorithm of license plate location based on mathematical morphology



**Fig. 48.6** The process of the algorithm of license plate location based on gray image's texture characteristic analysis

initial coordinates and length. If the continuous lines are less than the plate lines, and the line number is greater than a certain threshold, that row direction to find the license plate of a candidate region, and to determine the candidate regions of the start line and height; in finding possible license plate area scanning, to determine the candidate regions of the start line and height as well as the starting column coordinates and length; thereby defining a region of the plate; continue in other possible license plate area, so until all the plate region candidates. The processes are shown in Fig. 48.6.

The algorithm has good results for license plate tilt, deformation, non-uniform illumination, weak or strong, but it is sensitive to noise, can be combined with a vertical projection method for complex background image to get the real license plate area, and can effectively solve the complex background of the license plate location.

## 48.4 Summary

License plate location technology is the very crucial step of license plate identification technique, in the positioning precision, calculation speed, and applicable reliability license plate location technology need to be further improved and enhanced. At present, for any background, position, and light car image, the algorithm that can meet the various property requirements is not available.

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# Chapter 49

## Expression of Temporal Topology Based on GML

Ningning Sui and Shanshan Zhang

**Abstract** Temporal topological relationships are an important part of the time and space characteristics of the geographic entities, but there is no good enough technology system about how to realize the temporal topology. The Geography Markup Language (GML) 3.1 has started to support temporal topology. In this paper, the temporal topology core schema in GML was introduced. Based on the structure of the temporal topological core schema in GML 3.2.1, combined with the classic temporal model framework “4I,” the 9I temporal model framework was extended from 4I which is suitable for GML to express temporal topology. At last, an analysis system was given which based on 9I framework.

**Keywords** GML • Temporal topology • 4I

### 49.1 Introduction

In recent years, various cadastral information systems are widely used due to the requirements of the “Digital Land.” However, most of the cadastral information system takes the temporal information in the cadastral data as a property to be stored in the database, this style to store temporal information is bad for the review of past, future projections and survey. Temporal topology proposed a solution how to store temporal data, like the storage of spatial topology data. It cannot only ensure the original function but also express and judge accurately the relationships of temporal objects and temporal process. The GML 3.1 standard provides a code of conduct about how to store temporal topology data and an accurate description and provisions of the elements of temporal topology schema. GML 3.1 builds a core schema to store temporal topology. It provides a standard solution for the user store data; this core schema has become more mature in GML 3.2.1 [1].

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Temporal topological relationship is an important part of data space–time semantics in the spatial–temporal database. The research of temporal topology originated in the mathematical model or the cognitive model of space–time contact in mathematics, cognitive science, philosophy and other subject. After nearly 20 years on the research of temporal topology, its technology is relatively mature. Langran thinks temporal topology is to divide the sequence of events relations, while Raafat thinks that temporal topology is the topological relations of a state, which is achieved by the time interval sequence. Ming-Zhi Huang believes that the temporal topological is the result of the generation, merge, split, demise of object. With the research on temporal topology, Shu Hong and Chen Jun presented the only description of the temporal topological 4I framework on the basis of philosophy, cognitive science, geography, and list the corresponding set of predicates. Based on point set theory, temporal topology is applied to moving object by Gao Yong and Liu Yu, and they complete the nine intersection model to describe the collection of temporal topology and space topology. Xue CunJin and Su Fenzhen extend the 4I model on the basis of point set theory and apply it to the uncertain object. The temporal topology is used to analysis, build and search temporal data, which can easily reproduce the existence state of spatio-temporal object of any historical time and space, and contrast to the existence state of spatio-temporal object, and effectively simplify temporal data management and maintenance [2].

## 49.2 The Temporal Topology in GML

As time is a one-dimensional topological space, temporal topology primitives shall be a time node corresponding to an instant and a time edge corresponding to a period. A time node is an abstraction of an event that happened at a certain instant as a start or an end of one or more states. A state is a condition—a characteristic of a feature or data set that persists for a period. A “static feature” in this International Standard means a feature that holds a consistent identifier during its life span. Time edge is an abstraction of a state and associates with time nodes representing its start and end. However, temporal topology primitives do not directly indicate “when” or “how long” [3].

A topology complex is a collection of topological primitives that is closed under the boundary operation. A temporal topology complex shall be a connected acyclic directed graph composed of time edges and time nodes [4]. A minimum temporal topology complex is a time edge with two time nodes at its both ends. For example, a life cycle of a parcel starts from signing a contract and end with contract cancelation. It can be described as a sequence of stages: plan, designing, construction, utilization, disposal and demolition. Each stage can be represented as a time edge. The boundary of each stage describing as a time node represents an event of decision making, which terminates the stage and also originates the next stage. Thus, a life cycle of a building is described as a temporal topology complex composed of a sequence of time edges connected with time nodes.

## 49.3 The Temporal Topology Schema in GML

The core schema about temporal topology in GML 3.2.1 is TemporalTopology.xsd. It has four main elements: GML: AbstractTimeTopologyPrimitive, GML: TimeTopologyComplex, GML: TimeNode, GML: TimeEdge.

Temporal topology primitives shall imply the ordering information between features and feature properties. The temporal connection of features can be examined whether they have temporal topology primitives as values of their properties. Usually, an instantaneous feature associates with a time node, and a static feature associates with a time edge. A feature with both modes associates with the temporal topology primitive: a supertype of time nodes and time edges [5].

A time node is a zero-dimensional topology primitive that represents an identifiable node in time. A node may act as the termination or initiation of any number of time edges. A time node may be realized as geometry, its position, whose value is a time instant.

A time edge is a one-dimensional topology primitive. It is an open interval that starts and ends at a node. The edge may be realized as a geometry whose value is a time period.

A temporal topology complex expresses a linear or a nonlinear graph. A temporal linear graph, composed of a sequence of time edges, provides a lineage described only by “substitution” of feature instances or feature element values. A time node as the start or the end of the graph connects with at least one time edge. A time node other than the start and the end shall connect to at least two time edges: one of starting from the node and another ending at the node.

## 49.4 The Temporal Topology Framework

### 49.4.1 The Expression of Temporal Topology in GML

In 1997, Shu Hong and Chen Jun proposed 4I framework of temporal topology. This framework takes the temporal target “ $I$ ” ( $= [t_s, t_e]$ ) as a point set in the Euclidean space “ $IR^1$ ”. “ $I^0$ ” is the internal of  $I$  and its value is the whole time except start time and end time( $I^0 = I - \{t_s, t_e\}$ ). “ $\partial I$ ” is the boundary of “ $I$ ” ( $I = \{t_s, t_e\}$ ). And “ $I^-$ ” is the outside of “ $I$ ” ( $I^- = IR^1 - I$ ). If we see  $I$  and  $J$  as two different temporal object, the formula of the topology relationship between  $I$  and  $J$  ( $T_{Top}(I, J)$ ) is as follows:

$$T_{Top}(I, J) = \begin{pmatrix} \partial I \cap \partial J & \partial I \cap J^0 \\ I^0 \cap \partial J & I^0 \cap J^0 \end{pmatrix} \quad (49.1)$$

According to actual situation of complete time set and the temporal target, there are eight kinds of temporal topology. Its aggregation of predicates is { $T_{disjoint}$ ,  $T_{meet}$ ,  $T_{overlap}$ ,  $T_{cover}$ ,  $T_{coverby}$ ,  $T_{equal}$ ,  $T_{inside}$ ,  $T_{contain}$ }.

Comparing the elements of 4I framework and the elements of GML temporal topology schema, 4I framework can be presented by the elements of GML temporal topology schema. The corresponding relation between them is as follows:

The predicates of 4I framework are completeness and uniqueness, but it lays more emphasis on using mathematical method to explain the temporal topology. However, GML pays more attention to the actual way to express temporal topology. Because of the particularity of the core schema named temporal topology in GML that every “TimeObject” includes at least a “TimeEdge” and “TimeNode,” and even each a time slice in a “TimeObject” can also be a “TimeObject” separately. And then, the temporal topology relationships between time slices which come from more than one “TimeObject” become more complicated. Comprehensive these cases, there are three kinds of temporal topological relationships: the temporal topological relationships between time slices come from the same “TimeObject,” the temporal topological relationships between more than one “TimeObject,” the temporal topological relationships between time slices come from more than one “TimeObject.” Therefore, some amelioration is made to develop 4I framework (Table 49.1).

The framework is described in GML also take the temporal object “ $I$ ” ( $= [T_{\text{start}}, T_{\text{end}}]$ ) as a point set in European space “ $IR^1$ .” “ $I^0$ ” is the internal of  $I$  and its value is the whole time except start time and end time, its set is  $I^0 = \{TE_1, TE_2, \dots, TE_n\}$ . “ $\partial I$ ” not only includes the start time and end time but also includes all of the “TimeNode,” its set is  $I = \{T_{\text{start}}, TN_1, \dots, TN_n, T_{\text{end}}\}$ . “ $I^-$ ” is the outside of “ $I$ .” It can be considered as one or more TimeTopologyComplex. If we see  $I$  and  $J$  as two different temporal object including “TimeNode” and “TimeEdge,” the formula of the topology relationship between  $I$  and  $J$  ( $T_{\text{Top}}(I, J)$ ) is as follows:

$$T_{\text{Top}}(I, J) = \begin{pmatrix} I \cap J & I \cap \partial J & I \cap J^0 \\ \partial I \cap J & \partial I \cap \partial J & \partial I \cap J^0 \\ I^0 \cap J & I^0 \cap \partial J & I^0 \cap J^0 \end{pmatrix} \quad (49.2)$$

Temporal topology has a very important property that it has nothing to do with the length of time which the “TimeObject” takes; 4I framework which is suitable for the rational knowledge of the geographic object is perfect and reasonable. The content of 9I framework is more than 4I framework and its purpose is to explain the temporal topological relationships between time slices come from more than one “TimeObject” by rule and line. Each intersection’s value in 9I framework is “ $\emptyset$ ” or “[ $\emptyset$ ]” values. Parcel, for example, if we need to know how many parcels

**Table 49.1** Corresponding relation between 4I and GML temporal topology schema

Elements of 4I framework	Elements of temporal topology schema in GML
$I$	TimeObject
$\partial I$	GML: TimeNode
$I^0$	GML: TimeEdge
$I^-$	GML: TimeTopologyComplex

are under construction on May 7, 1995, we can use the 9I framework to realize it. It can query all “TimeEdge” of all parcels and then get the searching results. But given that time is a one-dimensional objects particularity, the temporal relationship that it expresses is the same with 4I framework. Predicates of 4I framework is suitable for 9I framework, but the predicate that the three temporal topology relationships used is different. The temporal topological relationships between time slices come from the same “TimeObject,” its main expression is the order between time slices and its aggregation of predicates is { $T_{disjoint}$ ,  $T_{meet}$ }; The temporal topological relationships between more than one “TimeObject” can be explained by 4I framework. The temporal topological relationships between time slices come from more than one “TimeObject” are very complex. It needs to describe not only the temporal topology relationships between “TimeObject,” but also the time slices coming from different “TimeObject.” So, 4I framework is not enough to be used, and the 9I framework is needed. Note that when the relationship between temporal object “ $I$ ” and “ $J$ ” is “ $T_{disjoint}$ ,” the temporal topology between time slices from them only can be “ $T_{disjoint}$ ; when the relationship between “ $I$ ” and “ $J$ ” is “ $T_{meet}$ ,” the aggregation of relationships is { $T_{disjoint}$ ,  $T_{meet}$ }.

What the temporal topology concerned is the characters that are not changed when object changed. The sequence of temporal object is decided by the irreversible of event. Sometimes the order of temporal objects is more important than the temporal topology relationships.

#### **49.4.2 Realize the Predicate**

GML is essentially an XML document. It can be used to store data, but it cannot contain the type of code to compare. To realize the predicate, the first step is to parse XML document and get these “TimeNode” and “TimeEdge” which stored in the XML document, and then through the comparison between these “TimeNode” to realize the predicate. “TimeObject” can be imitated as one-dimensional real space “IR1,” the whole sequence relationship between the real number uses “ $\leq$ ” to express. It is suitable to express the situation “occurred and then follow.” This paper use a function named “Before ( $TN_m$ ,  $TN_n$ )” to sort the “TimeNode” order in time. The order between “TimeEdge” is judged by “Before.” The function named “Follow ( $TN_m$ ,  $TN_n$ )” to judge the relationship between two time slices is “occurred and then follow” or not. If two time slices are “occurred and then follow,” then “ $TN_m$ ” and “ $TN_n$ ” are equal. T return value of “Before” and “Follow” is only be “True” or “False.” The declaration of the function is stated below.

```
public static bool Before (DateTime TimeNode1, DateTime TimeNode2)
public static bool Follow (DateTime TimeNode1, DateTime TimeNode2)
```

“TimeNode1” and “TimeNode2” is the “TimeNode” that is needed to be compared. In this paper, cadastral data is taken for example. Because of cadastral data are dynamic object on the view of macroscopic only, so time’s precision is unfavorable and exorbitant.

**Table 49.2** The temporal topological relationships between time slices come from the same “TimeObject”

Predicate	Judgment
T <sub>disjoint</sub>	Before (I <sub>end</sub> , J <sub>start</sub> ) = false, Follow (I <sub>end</sub> , J <sub>start</sub> ) = false
T <sub>meet</sub>	Before (I <sub>end</sub> , J <sub>start</sub> ) = true, Follow (I <sub>end</sub> , J <sub>start</sub> ) = true

**Table 49.3** The temporal topological relationships between more than one “TimeObject”

Predicate	Judgment
T <sub>disjoint</sub>	Before (I <sub>end</sub> , J <sub>start</sub> ) = false, Follow (I <sub>end</sub> , J <sub>start</sub> ) = false
T <sub>meet</sub>	Before (I <sub>end</sub> , J <sub>start</sub> ) = true, Follow (I <sub>end</sub> , J <sub>start</sub> ) = true
T <sub>overlap</sub>	Before (I <sub>start</sub> , J <sub>start</sub> ) = true, Before (I <sub>end</sub> , J <sub>end</sub> ) = true, Before (I <sub>end</sub> , J <sub>start</sub> ) = false
T <sub>cover</sub>	Before (I <sub>start</sub> , J <sub>start</sub> ) = true, Follow (I <sub>end</sub> , J <sub>end</sub> ) = true
T <sub>coverby</sub>	Before (I <sub>start</sub> , J <sub>start</sub> ) = false, Follow (I <sub>end</sub> , J <sub>end</sub> ) = true
T <sub>equal</sub>	Follow (I <sub>start</sub> , J <sub>start</sub> ) = true, Follow (I <sub>end</sub> , J <sub>end</sub> ) = true
T <sub>inside</sub>	Before (I <sub>start</sub> , J <sub>start</sub> ) = false, Before (I <sub>end</sub> , J <sub>end</sub> ) = true
T <sub>contain</sub>	Before (I <sub>start</sub> , J <sub>start</sub> ) = true, Before (I <sub>end</sub> , J <sub>end</sub> ) = false

According to the classification of the temporal topology above, the following two tables (Tables 49.2 and 49.3) give the predicates and the corresponding distinguishing conditions, taking the temporal object “I” (= [I<sub>start</sub> I<sub>end</sub>]) and “J” (= [J<sub>start</sub>, J<sub>end</sub>]) for example.

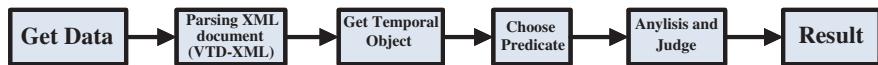
The temporal topology relationships between “I” and “J” can be expressed by the 4I framework. The aggregation of predicates and the corresponding distinguishing conditions are shown in Table 49.3.

For the temporal topological relationships between time slices come from more than one “TimeObject,” the first step is to determine the relationship is belonged to the aggregation{ T<sub>disjoint</sub>, T<sub>meet</sub> }. If it is, then just consider “T<sub>disjoint</sub>” and “T<sub>meet</sub>.”

## 49.5 Practice

This practice based on the land title investigation project in Shenzhen Nanshan District. All of the temporal data in database are dumped into the XML files which is built base on the application schema which is mainly based on “TemporalTopology.xsd (core schema in GML).” What this paper discussed is temporal topology, so the application schema is only for the temporal topology information storage.

After parsing XML document, we can obtain temporal information of all objects stored in XML document. The most important part is the information about “TimeNode” and “TimeEdge.” And use the function “Before” and “Follow” to “TimeNode,” and finally get the temporal topological information. The analysis process is shown in Fig. 49.1.



**Fig. 49.1** System analysis flowchart

There are mainly two ways for temporal topological analysis. One is to choose a temporal object, and then chooses a predicate, finally search other temporal objects which have the temporal topological relationship that the predicate expressed with the chosen object. The other is to choose two or multiple temporal objects and a predicate, then reason, the relationship between them whether it is right. The system takes each parcel as a temporal object. There is a checkbox before “TimeNode” and “TimeEdge.” If it is checked, the detail information was shown on the right.

## 49.6 Conclusions

It is feasible to use GML technology to create and store temporal topology. It can record the historical development process of the object completely, and divide every historic stage and reflect the temporal property very clearly. The topological query used in XPath technology has become mature that will promote the development of the temporal topology. Because the XML is using pure text to store data and focus on the data itself, it is very beneficial to the data sharing and interoperability. However, there are still a lot of work to do, such as how to get temporal topological information from other different data formats, and how to check validation of the temporal topology, especially the integration expression of space-time topology, and so on. All of this is needed further research.

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# Chapter 50

## High-Frequency Stratigraphic Cyclicity Identified Based on Blackman-Tukey Correlogram Analysis Method

Fu-qiang Lai

**Abstract** The purpose of this paper is to perform a spectral analysis method of Blackman-Tukey on high-resolution electrical borehole image log data to investigate whether the cycles in the sediments to interpret the high-resolution formation sequence. Firstly, in order to perform a spectral analysis on FMI data, it has to extract background conductivity log from the borehole image. Then, study how to use the Blackman-Tukey method to identify the stratigraphic cycles. Finally, use the spectral analysis method on the background conductivity data in the field case. The results show that the identified cycles in the sedimentary record match the Milankovitch cycles and prove the method is correct. This paper provides a new approach and idea on identifying stratigraphic and interpreting high-resolution sequence stratigraphy.

**Keywords** High-frequency • Stratigraphic cyclicity • Blackman-Tukey • Correlogram analysis method

### 50.1 Introduction

Detecting cyclic sedimentation patterns and temporal periodicities help the geoscientists understand the origin of sedimentary sequences and the importance of the various driving mechanisms. Thus, many researchers have suggested that orbital cycles influence sedimentary records, which lent substantial support to the Milankovitch theory on climate change [1]. Currently the study of detecting stratigraphic cycles is mainly based on outcrop, core, log and seismic data, especially Fullbore Formation MicroImager (FMI, mark of schlumberger) data are the highest resolution (5 mm) and best continuance geological information. There is some

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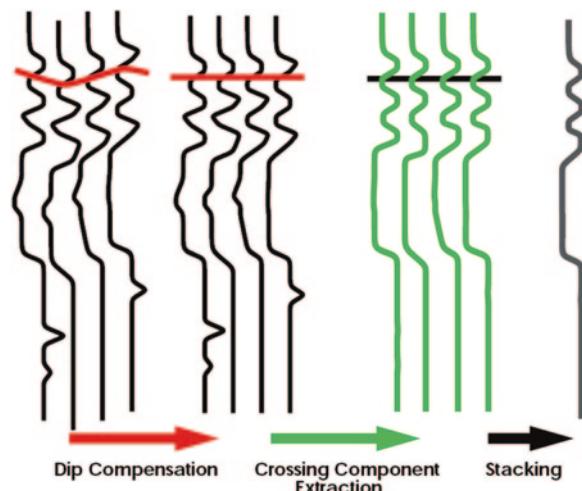
relevant research based on log data to detect stratigraphic cycles, such as Prokoph [2] used the conventional log data to analysis the noncontinuous of sedimentary rate, and Wang [3] develops the wavelet transformation to divide the stratigraphic sequence. But current researches are mainly focused on using the spectral analysis method to analyze conventional log curve and the resolution of the result is generally low. Moreover, the detected cycles did not convert from depth domain to time domain, so the results cannot match the Milankovitch cycles and do a further analysis. This paper performs a spectral analysis method of Blackman-Tukey on high-resolution electrical borehole image log data to detect the stratigraphic cycles. Meanwhile, with the good tie of the paleomagnetic log [4] and the geomagnetic polarity time scale (GPTS) to obtain the sedimentation rate. Finally, convert the stratigraphic cycles from depth domain to time domain and match the Milankovitch cycles.

## 50.2 Data Preprocessing

The studied data in this paper are FMI data, which provide a resistivity image of the borehole wall from microresistivity measurements of 192 electrodes with a vertical and azimuthal sampling rate of 2.5 mm [4]. From these images, sedimentary and tectonic structures such as bedding planes, faults and fractures can be identified with a resolution of about 5 mm. But here, in order to perform a spectral analysis of FMI data, it is necessary to preprocess the recorded 2D image data to extract 1D data which named background conductivity curve.

The processing sequence in Fig. 50.1 illustrates the various steps needed to extract background conductivity curve from microelectrical image data. After dip

**Fig. 50.1** Principle to extract background conductivity (BC) from FMI image data



compensation, the components common to the various curves are retained and stacked into one single channel. This curve is background conductivity curve. Thus, the background conductivity is based on borehole-crossing features.

### 50.3 Blackman-Tukey Correlogram Analysis Method

The classical model for a discretely sampled time series is a realization  $x(t)$ ,  $-\infty < t < \infty$  of a discrete random process. If the process is a wide-sense stationary (WSS) process, based on the Wiener-Khinchin theorem, it is meaningful to define the power spectral density (PSD) of  $x(t)$  as [5]:

$$P(f) = \lim_{M \rightarrow \infty} \Delta t \sum_{m=-M}^{M} R(m) e^{(-2\pi i f m \Delta t)} \quad (50.1)$$

where  $f$  is the frequency,  $\Delta t$  is the sampling interval,  $R(m)$  is the autocorrelation function of  $x(t)$ ,  $i$  is the imaginary unit,  $m$  is the lag coefficient.  $P(f)$  is a density function (power per unit of frequency), it describes how the variance of a random process is distributed with frequency. In the spectral density graph, the frequency of wave peak corresponds with the signal cycle, so it could detect the signal cycle by the PSD.

From Eq. (50.1), assuming a finite sequence of autocorrelation estimates, we obtain the PSD estimator:

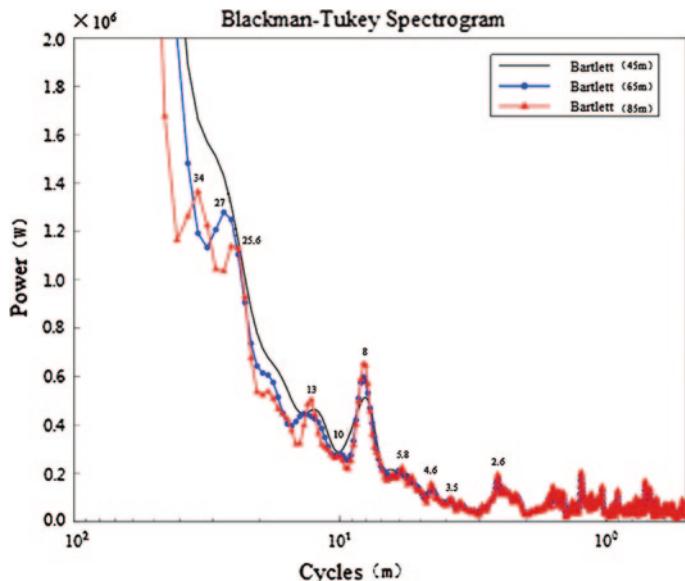
$$\tilde{P}(f) = \Delta t \sum_{m=-M}^{M} \tilde{R}(m) e^{(-2\pi i f m \Delta t)} \quad (50.2)$$

where  $M \leq N - 1$  and the autocorrelation estimate is,

$$\tilde{R}(m) = \frac{1}{N} \sum_{t=1}^{N-|m|} x(t)x(t+|m|), \quad m = -M, \dots, M \quad (50.3)$$

Since the correlogram is a statistically unstable estimate, in order to reduce the effect of power leakage due to the implicit window, Blackman and Tukey develop the “windowed correlogram.” Based on the Wiener-Khinchin theorem, which states that if the Fourier transform of a series  $x(t)$  is  $X(f)$ , and if the autocorrelation function of the series is  $r$ , then the Blackman-Tukey power spectrum  $P(f)$  is estimated by

$$P(f) = \left| \sum_{k=0}^{M-1} w(k)r(k)e^{-j2\pi fk} \right| \quad (50.4)$$



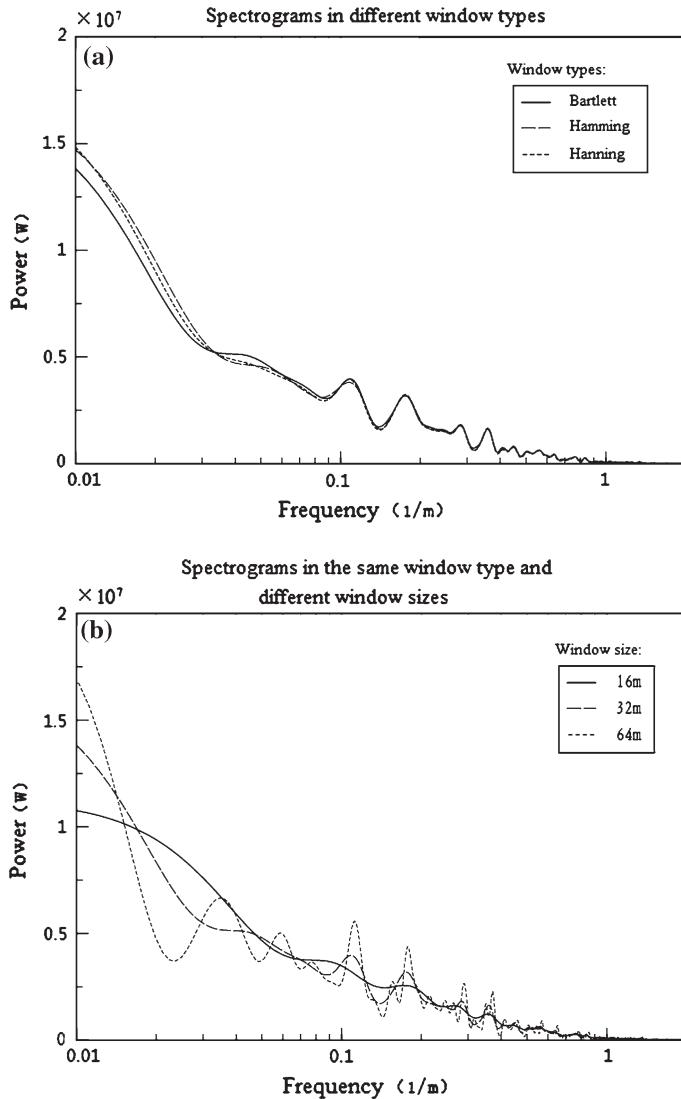
**Fig. 50.2** The spectrogram of the entire lower pannonian in XX-21 well

where  $r(k)$  is the autocorrelation estimate at lag  $k$ ,  $M$  is the maximum lag considered and window size, and  $w(k)$  is the windowing function which decides the window shapes.

## 50.4 Stratigraphic Cyclicity Identifying Method

On the basis of Blackman-Tukey correlogram analysis method principle, the stratigraphic cycles can be detected from the background conductivity data by the BT-Correlogram Module of SSA-Toolkit Software. In the spectral analysis procedure, the frequency value and PSD value can be calculated out when the sampling interval, window shape, window size and sampling datablocks are chosen. The spectrogram was plot as Fig. 50.2 whose x-axis displays the cycles which are changed from frequencies and y-axis is spectral power. In the spectrogram, the position of wave peak is the position of dominant frequency, which represents the main stratigraphic cycle. Thus, detecting stratigraphic cycle can be achieved by searching for the position of wave peak. In the application, how to choose the window type and window size should be noticed.

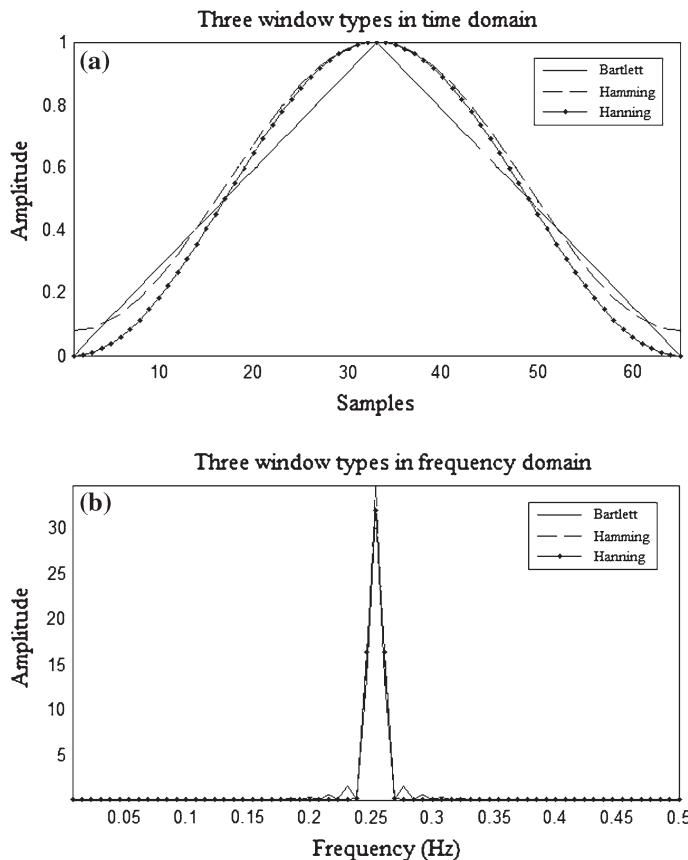
Choosing window type: Several window shapes are available: Bartlett (triangular), Hamming (cosinusoidal) and Hanning (slightly different cosinusoidal). Figure 50.4 displays that the shapes of the three windows both in time domain and



**Fig. 50.3** Spectrograms in different window types (a) and in different window sizes (b)

frequency domain are similar. Moreover, the various window types of the same window width give similar PSD results [see Fig. 50.3(a)]. Thus, there is no large difference to choose any window function to analysis, so this paper chose Bartlett window type.

**Choosing window size:** The more important choice is how wide the windows should be. The resolution of the spectrogram is correlate with window size. Figure 50.3(b) shows that wider windows yield higher spectral resolution, and vice



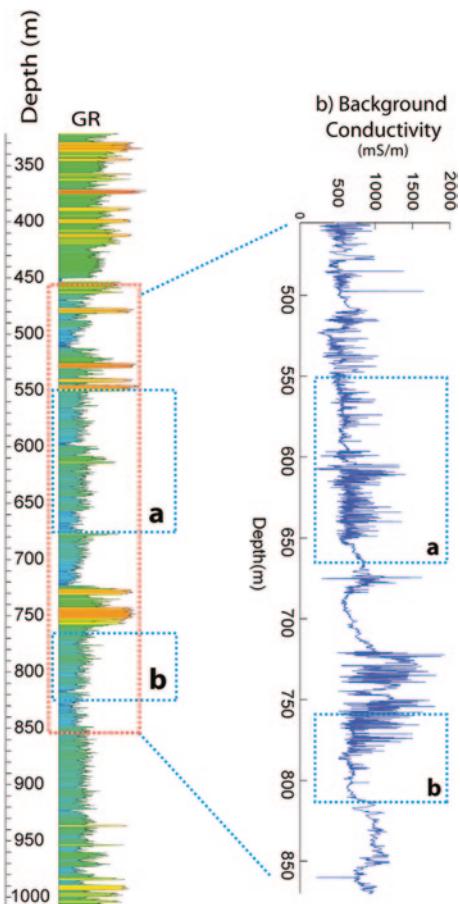
**Fig. 50.4** Three window shapes in time domain (a) and in frequency domain (b)

versa. However, there is a trade-off between higher resolution and increasing variance of the spectral estimate. In practice, this paper recommends that windows should be no more than one-fifth to one-tenth the total number of data points in order to obtain desired estimate-variance reductions and not too much smaller (in order to retain the ability to distinguish between powers at neighboring frequencies and to obtain the desired leakage reductions).

## 50.5 Application

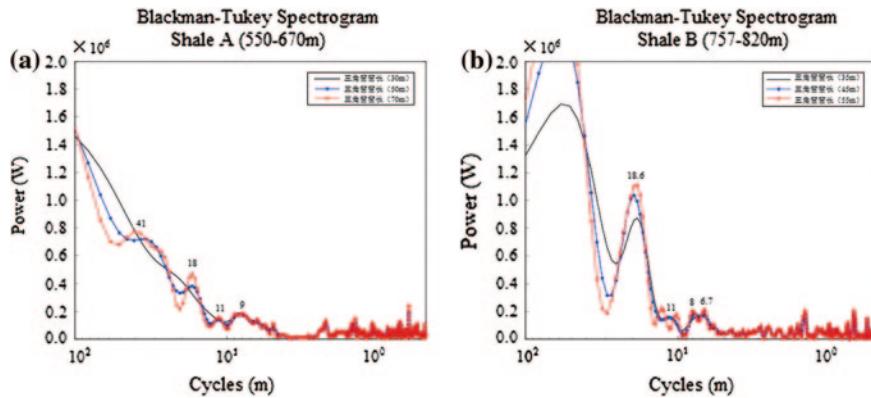
This paper takes a field example for spectral analysis in Vienna basin. The FMI data and conventional log data are obtained from the appraisal well XX-21. Because of the abundance in magnetic reversals in the Lower Pannonian interval and the continuous nature of this sequence, there is good control on the

**Fig. 50.5** The graph of two shale intervals is separated by Gamma Ray log



chronostratigraphic framework and therefore on the sedimentation rates. So this paper takes the Lower Pannonian interval (from 455 to 870 m) as the study interval.

Firstly, the background conductivity curve was extracted from the FMI data by the method of Fig. 50.1. Then, the Blackman-Tukey correlogram analysis method was performed on the BC of the entire Lower Pannonian interval and the spectrogram results with three window sizes 45, 65, and 85 m display in Fig. 50.2. The resulting Blackman-Tukey correlogram yields a variety of spectral peaks. This prevents the correlation of dominant cyclicities to the Milankovitch cyclicities. Because the sedimentary rate of the shale interval is more stable, so this paper separates two shale intervals [(a) 550–670 m and (b) 757–820 m] from the Lower Pannonian interval by Gamma Ray log (see Fig. 50.5). These shale intervals are cross-checked with the spectral methods. Figure 50.6 displays the detected stratigraphic cycles results of shale (a) 9, 11, 18, 41 m and shale (b) 6.7, 8, 11, 18.6 m.



**Fig. 50.6** The spectrogram results of the shale (a) and shale (b)

## 50.6 Discussion

Finally, the results should be compared with the additional available information on the age of the sediments in the borehole to interpret the encountered cyclicity. These could be depositional mechanisms controlled by forcing mechanisms such as the Milankovitch cycles [1]. From this a high-resolution quantification of sedimentation rates through time can be made, mapping the changes in sedimentation rate and linking these to tectonic events in the evolution of the basin and climatic control.

In order to reach the purpose, this paper uses the other results of chronostratigraphic framework and sedimentation rates to compare from Paulissen. With a good tie of the measured polarity reversals from the paleomagnetic log to the GPTS in the Lower Pannonian interval, minimum average sedimentary rates were calculated. By the sedimentary rate, the stratigraphic cycle can be converted to time domain and the Milankovitch cycle can be converted to depth domain too. In the shale interval A(550–670 m), the sedimentary rate is 0.45(0.47) m/ka, so the Milankovitch cycle 19, 23, 41, 100 ka can convert to 9, 10(11), 18(19), 45(47) m, which match with the detected stratigraphic cycles results of shale (a) 9, 11, 18, 41 m. And in the shale interval B(757–820 m), the sedimentary rate is 0.39 m/ka, so the Milankovitch cycle 19, 23, 41, 100 ka can convert to 7, 9, 16, 39 m which match with the detected stratigraphic cycles results of shale (b) 6.7, 8, 11, 18.6 m. These consistent results have proved the Blackman-Tukey spectral analysis method in this paper is correct. At the same time, the method can apply to the other fields.

## 50.7 Conclusions

This paper applies the Blackman-Tukey spectral analysis method on high-resolution electrical borehole image log data to investigate cyclicities in the sedimentary. There are a series of conclusions can be summarized as follow: High-resolution background

conductivity log has been extracted from the borehole image to prepare for spectral analysis; The Blackman-Tukey correlogram analysis method has been applied in the Lower Pannonian of the Vienna basin; The spectral analysis results can match the corresponding Milankovitch cycles which linking the tectonic events in the evolution of the basin and climatic control.

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# Chapter 51

## An Efficient Stereo Matching Algorithm Based on Intensity Weighted Correlation

Xiaoyan Yu, Qinyou Yang and Xianwei Rong

**Abstract** This paper presents an efficient intensity weighted matching algorithm for stereo vision applications. The proposed algorithm makes use of intensity weighted values instead of grayscale value for each pixel in the support window in order to improve the quality of disparity map. The idea is derived from the bionics fundamentals, namely retinal center detector commonly permits high resolution in the interested regions, whereas others do not require the identical resolution. Therefore, this algorithm enables the intensity weight of the kernel pixel to be the highest in the window. With the proposed algorithm, the disparity map is improved significantly with little incremental computation cost compared with the fixed-window (FW) SAD algorithm. Experimental evaluation is performed using benchmark stereo pairs. The simulation results demonstrate that the proposed algorithm can achieve bad pixel percentage of disparity map lower than the SAD algorithm.

**Keywords** Stereo matching • Intensity weighted correlation • SAD

### 51.1 Introduction

Stereo matching is vital for reconstructing 3D objects and computer vision. Stereo matching is an exciting and challenging field, so a large number of stereo matching schemes specific to concrete applications have been presented in the decades [1–3]. The existing algorithms are generally grouped into two different strategies, namely local algorithms and global algorithms. Compared with pixel-based matching approach, local algorithms use the simple winner takes

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all (WTA) disparity selection strategy but increase the signal to noise ratio by aggregating matching costs over a support window. Global algorithms search for disparity assignments that minimize an energy function over the whole stereo pair with a pixel-based matching cost. The latter one commonly generates more accurate disparity map image at the expense of sophisticated matching calculation compared with the former one, so that it is hard to satisfy real-time application requirements. In practice, local algorithms, especially fixed-window (FW) approach, are applied in real-time stereo vision system thanks to easy implementation and limited memory requirements as well as less computational load. Nevertheless, FW approaches generally endure the unsatisfied disparity map image, especially in the less textured and depth border regions.

According to the matching contents, the existing stereo matching techniques are broadly classified into intensity-based stereo matching [4, 5] and feature-based stereo matching [6, 7]. The former can directly establish dense disparity map for the modern applications of stereo such as view synthesis and image-based rendering, which requires the depth estimation in all image regions in spite of some occluded or less textured regions [8]. Nevertheless, the latter cannot generate dense disparity map directly so that they require extracting the interested features for matching and interpolation techniques for obtaining disparity map [9–11]. Therefore, the feature-based matching approaches usually endure more sophisticated matching computation than the intensity-based ones.

Accordingly, our stereo matching algorithm contains two novelties. First, matching cost computation is performed by means of sum of absolute difference between weighted (WSAD) pixel intensities instead of sum of absolute difference (SAD) between pixel intensities, which aims at enhancing the kernel pixel in the support window. Second, the proposed algorithm using WSAD has been demonstrated experimentally that it can produce dense disparity map by implementing on personal computer by C. Especially, the proposed algorithm can obtain lower match errors than SAD.

## 51.2 The Proposed Algorithm

According to the bionics principle, the conventional FW-based stereo matching algorithm is modified to improve the matching precision especially in the depth borders. To further decrease the computational load, the area-based matching cost employs the SAD other than sum of squared differences (SSD) and normalized cross correlation (NCC), even though SSD and NCC may produce more accurate disparity map image than SAD [1]. Accordingly, the proposed algorithm is adapted to the lower-precision vision, such as the interested object detection and traffic navigation. Thus, the compromise of matching cost computation simplicity and reasonable matching precision is considered when designing the WSAD algorithm.

### 51.2.1 WSAD Pixel Intensities

In order to simplify the matching cost computation, most of the existing stereo algorithms are presented on the basis of the standard stereo vision system, in which two optical axes of stereo cameras used for acquiring the stereo pairs are parallel to each other. Given stereo camera in a standard form, the searching domains for homologous points in the stereo pair can be narrowed from two dimensions (2D) to one dimension, namely the corresponding points are constrained on the identical scanline [1]. The proposed algorithm also rely on the assumption that stereo rig is in stand form so that the epipolar line and scanline coincide with each other.

The simplest area-based matching cost is SAD represented as Eq. (51.1).

$$SAD(x, y, d) = \sum_{i,j=-n}^n |R(x + j, y + i) - T(x + d + j, y + i)| \quad (51.1)$$

where  $x$  and  $y$  are the horizontal and vertical coordinates of the central pixel in the reference ( $R$ ) and target ( $T$ ) windows, respectively;  $d$  denotes the difference between x-coordinate of two central pixels;  $i$  and  $j$  denote the row and column indices of the support window; the size of the support window is  $(2n + 1) \cdot (2n + 1)$ .

Each SAD represents the cost of the correspondence between the reference window and target window. The cost aggregation strategy adopts the disparity selection WTA, namely in the situation of the minimum SAD within the searching range the difference between the x-coordinate of two central points in the reference window and the target window is the disparity ( $d$ ) of corresponding points in the stereo pair, which is denoted as the Eq. (51.2).

$$d = x_R - x_T \quad (51.2)$$

SAD-based FW stereo algorithms commonly endure the unsatisfactory depth image quality. Moreover, the size of window significantly impacts on the matching precision especially in the special domains such as less texture and depth discontinuities. The large size of the support window will result in the typical inaccurate matching in the depth discontinuity domains. On the other hand, too small window will make the less textured domains poor matching results. In general, the optimal size of the support window is acquired empirically. However, in practice, in spite of its limitation, the SAD-based stereo algorithms are most frequently used for real-time applications due to very low computation cost.

To improve the matching accuracy of the conventional FW stereo algorithm, the sum of absolute difference between the weighted pixel intensities, named as WSAD, is presented based upon the SAD described in Eq. (51.1). WSAD is formulated as Eq. (51.3). Compared to Eq. (51.1), only the weight is additional in Eq. (51.3).

$$WSAD = \sum_{i,j=-n}^n w_{i,j} |R(x + j, y + i) - T(x + d + j, y + i)| \quad (51.3)$$

where  $w_{i,j}$  is the weight of the pixel in the support window. The weight for each pixel is relevant to the distance from the central pixel in the support window, that is, weight is higher for the pixels close to the central pixel, otherwise small weight. The large support window includes too more information to make incorrect decision for corresponding points in the stereo pair, while small support window may not contain enough information. Therefore, the proposed algorithm partially reduces the impact of window size on the depth image quality by means of weighted pixel intensity.

### **51.2.2 Procedure for the Whole Image**

As mentioned above, stereo correspondence for a standard stereo vision system can take full advantage of epipolar constraint to find the homologous points in the stereo pair. The concrete steps of the proposed algorithm can be summarized as:

**Input of the Algorithm** The appropriate stereo pair, such as rectified images, is first selected, and then, the suitable size of block is decided based upon the input image magnitude and disparity range. The size of support window obviously affects the quality of depth image since either over large or too small window cannot acquire the smooth disparity map. Additionally, the choice of the optimal weight map of the support window is done empirically. Then, the optimal weight map is another input of the proposed algorithm.

**Stereo Correspondence Computation with WSAD** The corresponding points can be found by means of WSAD. The reference window can be considered as a template.  $i$  is the indices of pixels in the support window. The shifting window is moved in integer increments along the epipolar line, the corresponding window could be obtained by using a SAD metric can be calculated by WSAD, namely less value is WSAD; the higher similarity is these two windows. Thus, two support windows with the minimum WSAD are the corresponding windows. After that, the disparity of horizontal direction for two blocks can be obtained from the difference of axis coordinates.

**Depth Computation** Given the disparity map, the baseline and the focal length, triangulation computes the depth of a 3D scene point. Then, the depth is transformed into the grayscale image. Closer points are brighter in the depth map image. Finally, a grayscale disparity map image was outputted.

## **51.3 Experimental Evaluation**

The experimental evaluation of the proposed algorithm was performed using benchmark stereo pair with different features, that is, “Tsukuba” with dimensions of 384 pixels by 288 lines and “Sawtooth” with dimensions of 434 pixels by 380.

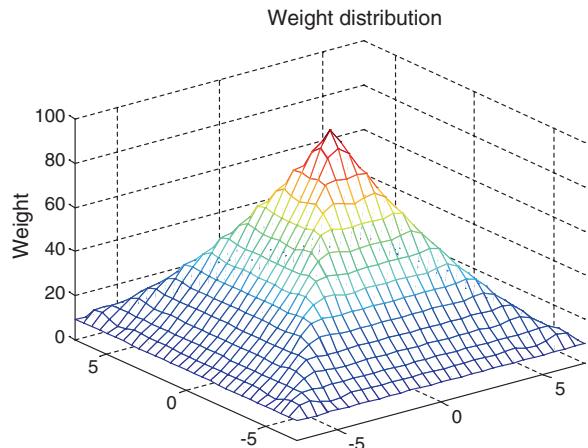
Lines as well as “Map” with dimensions of 284 pixels by 216 lines. The “Tsukuba” contains objects at different depth, some occluded regions and less textured regions. The “Sawtooth” includes three planes, in which frontal plane is slanted and forms a Sawtooth shape. The “Map” includes the occluded and depth discontinuity as well as smooth domains. The experiments focus on testing disparity map quality along with the variable size of support window as well as the performance comparison between the conventional SAD FW stereo algorithm and the proposed algorithm.

The weight distribution of the support window used is illustrated in Fig. 51.1, in which Z-axis represents the weight ( $w$ ); x-axis and y-axis denote the size of the support window. It can be seen that the highest weight is allocated for central pixel, while the neighbor pixels possess the weight that is relevant to the distance from the central pixel. That is to say, the neighbor pixels are farther from central pixel and they are distributed with lower weight. Therefore, pixels in the support window play diverse roles on the cost aggregation by means of the weighted intensities.

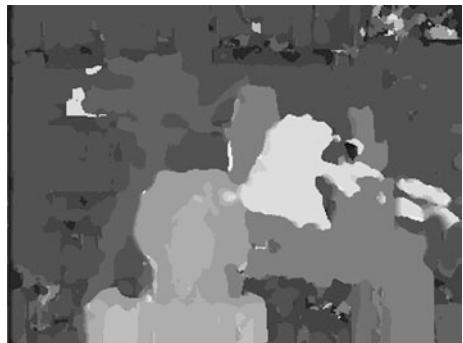
The raw disparity map of “Tsukuba” with the proposed algorithm for the window size of  $11 \times 11$  was illustrated in Fig. 51.2. It can be observed that the rough 3D structure has been recovered: a trestle of the camera on the background has been reconstructed and the statue as well as lamp.

The performance comparison focuses on bad pixel percentage. Figures 51.3, 51.4, and 51.5 depict the matching error percentage using SAD and WSAD for “Map,” “Sawtooth,” and “Tsukuba,” respectively. It can be observed that the proposed algorithm using “Map” and “Sawtooth” can achieve bad pixel percentage lower than the existing SAD stereo algorithm with little increased computation cost. However, for the “Tsukuba,” the proposed algorithm produces matching error percentage little higher than SAD algorithm for the window size less than  $11 \times 11$  due to its complex background. It can be derived that the bad pixel percentage produced by the proposed algorithm would be decreased significantly along with the larger size of the support window.

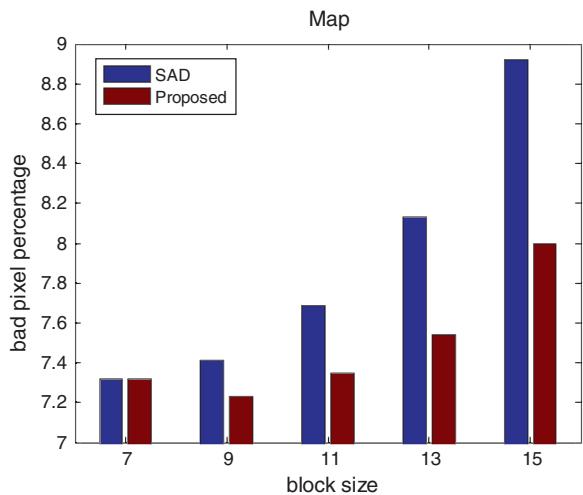
**Fig. 51.1** The weight distribution



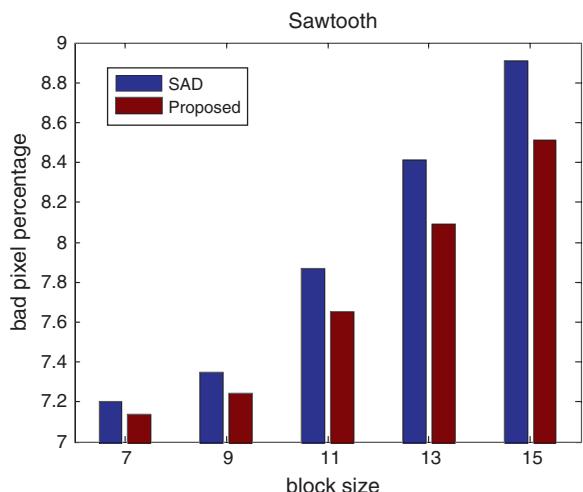
**Fig. 51.2** “Tsukuba” disparity map



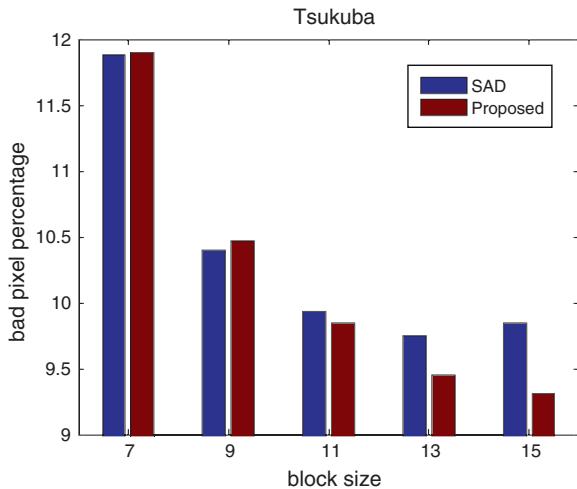
**Fig. 51.3** The comparison of bad pixel percentage between SAD and the proposed algorithm using Map



**Fig. 51.4** The comparison of bad pixel percentage between SAD and the proposed algorithm using Sawtooth



**Fig. 51.5** The comparison of bad pixel percentage between SAD and the proposed algorithm using Tsukuba



## 51.4 Conclusion

In this paper, an intensity weighted stereo matching algorithm has been proposed for generating dense disparity map. The experimental results demonstrate that the weight distribution heavily affects matching accuracy along with varied window, and the proposed algorithm is more suitable for the large support window. Moreover, the proposed algorithm can produce the bad pixel percentage of the disparity map lower than the conventional FW SAD algorithm. Furthermore, the proposed algorithm has potentially numerous applications in real-time computer vision due to its low computational load. WSAD as a matching cost computation coupled with other refinement algorithms is capable of high-level matching applications such as teleconference.

In our future work, the optimal weight distribution will be examined by numerous experiments. The parallelism inherent in the proposed algorithm is going to be exploited, and then, a parallel stereo vision system will be developed for various real-time applications. Additionally, several image filtering techniques such as median filtering and bilateral filtering will be used to refine the raw disparity map in order to further improve the performance of the proposed algorithm.

**Acknowledgments** The benchmark stereo pairs are obtained from the web site <http://www.middlebury.edu/stereo/>. The work is partially supported by the science and technology project-sponsored by Educational Commission of Heilongjiang Province under Grant No. 11551126.

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# Chapter 52

## Event Detection and Recommendation Based on Heterogeneous Information

Bo Yuan, Qingcai Chen, Yang Xiang and Xiaolong Wang

**Abstract** Previous research on event detection only handles with text data, and there is still no agreed standard except for the reports amount on judging whether a set of information should be pushed as a hot event. In this paper, we present an event detection framework based on heterogeneous information. Firstly, the coarse classification of structured data is transplanted to text data to make the information set more precise, and then twice clustering using multi-features is attempted to enhance the performance of event detection. Meanwhile, data fluctuation of structured data is monitored to determine the event priority. The experiment results and online system proved the availability of our method.

**Keywords** Event detection • Heterogeneous information • Clustering • Multi-features

### 52.1 Introduction

Over the recent years, development and applications of hot topic detection have significant advancements. Especially, the TDT evaluations [1, 2] promote the research on detection methods and feature selection [3, 4]. Nonetheless, the difficulty of the solution based on clustering [5, 6] or language model [7] is how to automatically decide whether a cluster of web documents should be extracted as an event and be recommended. Text information is the only data source of traditional topic detection and the researchers have to set thresholds such as documents amount or texts similarity [8]. The adaptability of the algorithm is the limitation for the thresholds may not be same in different domains. In view of the structure and diversity of web information, we try to analyze the heterogeneous

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information to give a quantitative standard of topic recommendation. Meanwhile, twice clustering based on multi-features is attempted to enhance the topic detection performance.

Firstly, the definition of heterogeneous information is given. Heterogeneous information contains unstructured information which shows as text data and structured information which shows as quantitative data. The unstructured data such as news report, comment, and blog have no uniform formats and cannot be easily extracted. The structured data such as stock price, oil price, and other indexes can be easily analyzed by users and computer for the clear classification and uniform format. Researchers focused on the text processing and rarely considered the connection of the two kinds of data. In fact, the event or topic described in the unstructured data often has some influence on structured data. We take advantage of the restrain of heterogeneous information to optimize performance of text clustering and decide whether a cluster of documents should be recommended as topic. The financial domain data are selected as experiment data.

The rest of this paper is organized as follows: Sect. 52.2 reports coarse classification based on structured data, and then we present the time alignment of the two kinds of data. Section 52.3 discusses first-layer clustering with time features and second-layer clustering with multi-features. Section 52.4 illustrates the experimental results of coarse classification, event detection, and topic recommendation. Discussions are also provided. Finally, Sect. 52.5 summarizes the contributions.

## 52.2 Constraint from Structured Data

Because of the magnanimity and rapid updates of web information, the topic generated by clustering or language model still needs to be well organized. The classification system and the fluctuation of structured data could be used to optimize the topic detection process. The constraints contain the classification of news documents according to structured data and the time alignment of two kinds of data.

### 52.2.1 Coarse Classification Based on Name Entity Occupancy

We build matching model according to each stock name entity (*NE*) and use variance distribution (DS) to compute the occupancy of *NE*. The word frequency (DF) is used to strengthen the occupancy of *NE*.

$$\text{Occupy}(\text{NE}) = \frac{\sigma \times n \times \sum_{i=1}^n (P_i - \bar{P})^2}{n - 1} \quad (52.1)$$

$n = \text{DF}(NE)$ ,  $\sigma$  is parameter of DF,  $\frac{\sum_{i=1}^n (P_i - \bar{P})^2}{n-1}$  is distance variance. In view of the synonyms, we replace the company name, alias, former name, and stock id with the same  $NE$ . If single document contains several  $NEs$  and one of them has larger  $\text{Occupy}(NE)$  than threshold, it means this  $NE$  is used more frequently. We could decide this document would mainly talk about this  $NE$ .

### 52.2.2 Time Alignment of Data

The fluctuation of stock index is affected with the substantive information which is illustrated as hot topic or event. Obviously, the abnormal change of stock data is much easier to be detected and this can help provide a judgment basis for recommending hot events to users. And the formulas are shown as below:

$$\text{increase} = \frac{\text{price(today)} - \text{price(yesterday)}}{\text{price(yesterday)}} \quad (52.2)$$

$$\text{volume} = \frac{|\text{volume(today)} - \text{volume(yesterday)}|}{\text{volume(yesterday)}} \quad (52.3)$$

$$\text{fluctuate} = \frac{|\text{price}_{\text{high}}(\text{today}) - \text{price}_{\text{low}}(\text{today})|}{\text{price}_{\text{low}}(\text{today})} \quad (52.4)$$

We suppose that when the abnormal change of structure data appears, there should be some news reported near the time point.

## 52.3 Event Detection Using Twice Clustering

Text clustering is the basic method to solve the hot topic detection problem. The clustering methods and their application have been elaborated in [9, 10]. Firstly, the time feature of text is used to generate the first clustering result. Then, the dictionary feature and TFIDF feature are used in second hierarchical clustering.

### 52.3.1 First Clustering Using Time Feature

As an important feature of news report, time feature has been widely used in text clustering. In [11], the equidistant time slice is set to divide the data and the clustering process is held inside the data sets preferentially. In [5], the time feature is used as weighted attribute. The weakness in [11] is that the size of time slice and the initial position are difficult to set. If the size is too big, it will lose

the significance; otherwise, an unbroken topic might be divided. The merge of clustering result proposed in [11] is not fit for our design. In [5], the weight of time feature should not be constant for in a time period there may be more than one event, and if the weight is too large, other weakened features would make different topics be merged; otherwise, using time feature is meaningless.

In fact, the news reports always centralize in several periods, and in other areas, there are no reports or a few. However, in practical application, splitting by 0 reports may cut the text data too detailed. We only use time feature and set threshold for hierarchical clustering (HAC) to generate several temporal centralized data groups.

### 52.3.2 Second Hierarchical Clustering Using Multi-Features

The multi-features used in second clustering contain TFIDF, dictionary feature, and time feature.

#### 52.3.2.1 Multi-Features

TFIDF and Time Feature

*TF-IDF* is a widely used feature in text processing. To solve the data sparsity and 0 divisor, we give the formulas below:

$$TF(d, t) = \begin{cases} \alpha & freq(d, t) = 0 \\ 1 + \log(1 + \log(freq(d, t))) & \text{other case} \end{cases} \quad (52.5)$$

$$IDF(t) = \log \left( \frac{1 + |d|}{|d_i| + \beta} \right) \quad (52.6)$$

$$TFIDF(d, t) = TF(d, t) * IDF(d), \quad (52.7)$$

The values of smoothing factors  $\alpha$  and  $\beta$  are 0.01, the base of logarithmic function is 2. We select the words of which  $TF >= 2$  to compute *IDF* and then select the words of which the *TF-IDF* values are top 40 as the news representation to reduce dimension. Cosine similarity is used to compute the distance of *TF-IDF*.

Time feature is also used in second-layer clustering, but its weight should be low because the news reports in this layer have similar time points and time feature does not have as much effect as it has in the first layer.

Dictionary Feature

In the previous studies, the weighted *NE* and its synonyms expansion [11, 12] are used in computing the event similarity. In [13], Ontology is also used in this area.

In fact, as the core movement of event, the predicate word is more helpful in the similarity computing. We built a predicate dictionary which contains predicate words and hierarchical structure. The dictionary contains 13 categories and 311 words which represent the financial event.

### 52.3.2.2 Twice Hierarchical Clustering

The HAC is used to generate the hot topic in this part. The twice clustering process with multi-features (HACBT) is illustrated as algorithm HACBT.

#### Algorithm

HACBT

Input: all the documents of single stock

Output: events of the according company

Begin

    initialize the text data, set thres1 as threshold for first clustering and thres2 as threshold for second clustering

    first hierarchical cluster using time feature and result\_level1 = HAC(thres1)

    pass the event with single document

    For each cluster in result\_level1

        second hierarchical cluster using multi-feature and result\_level2 = HAC(thres2)

    End for

    pass the event with single document

    every set of document is seen as an event

    output the result

End

The thres1 selection in Algorithm 1 is broad and 15 days is set as thres1 in the online system.

## 52.4 Experiments and Discussion

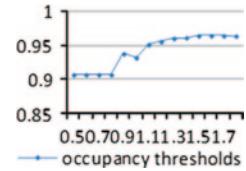
We randomly select 14 stocks from Chinese stock market as structured data. According to the structure data, the financial news reports from 2011-1 to 2011-7 are selected to build unstructured data set.

### 52.4.1 Experiment of Coarse Classification

We give the result of using *NE* occupancy to pass the texts of which the events are not relevant with the stocks.

$$\text{Precision} = \frac{c}{n} \quad (52.8)$$

**Fig. 52.1** Precision of coarse classification with different occupancy thresholds



Through adjusting the threshold of  $NE$  occupancy, we get the curve in Fig. 52.1. It shows that the low threshold nearly has no effect. The reason is if a document contains several name entities with similar occupancy, there is always a stock which has largest occupancy. This document should be removed by higher threshold. When the threshold value is 52.6, the highest precision is 96.44 %.

#### 52.4.2 Event Detection Evaluation

The precision, recall, F1-Measure of clustering results are used to evaluate the event detection. For there are multi-categories in the evaluation, the average precision, recall, and F1-Measure are used.  $|c|$  is the number of total documents of clustering result,  $|c_i|$  is the number of documents of category  $i$ .

$$\text{Avg}(P) = \frac{1}{|c|} \sum_{i=1}^k |c_i| \times \text{Precision}(i) \quad (52.9)$$

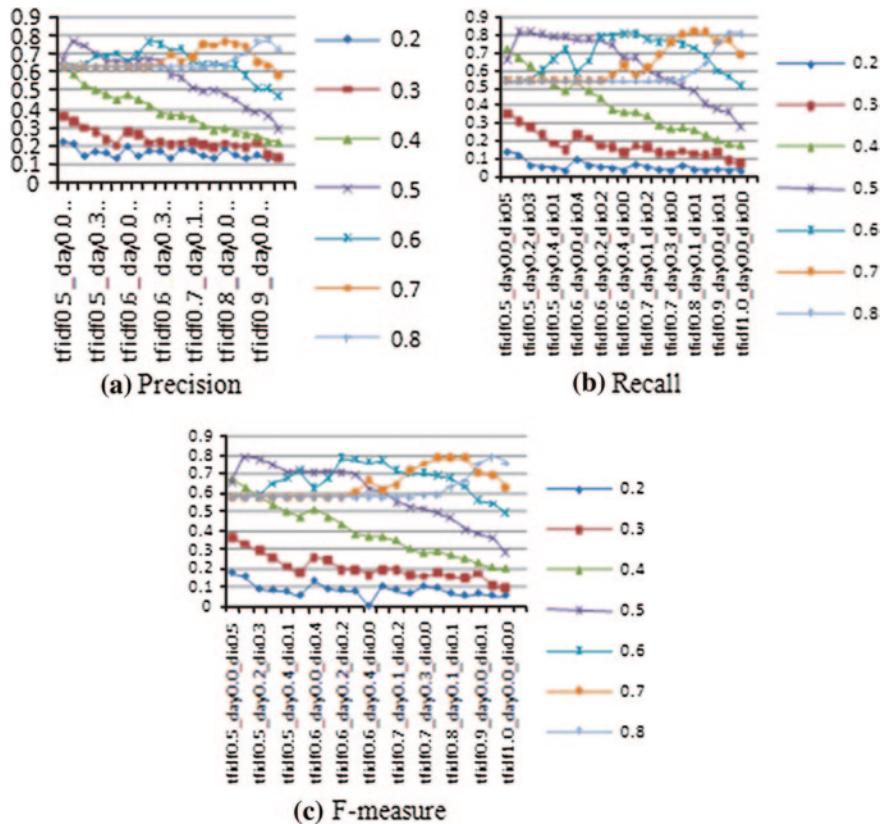
$$\text{Avg}(R) = \frac{1}{|c|} \sum_{i=1}^k |c_i| \times \text{Recall}(i) \quad (52.10)$$

$$F = \frac{\text{Avg}(P) \times \text{Avg}(R) \times 2}{\text{Avg}(P) + \text{Avg}(R)} \quad (52.11)$$

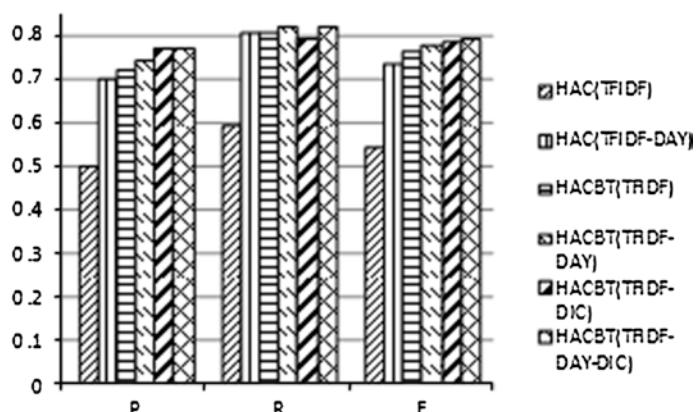
The performance of HACBT with different feature combination threshold is shown in Fig 52.2. The horizontal axis is a feature combination; for example, tfidfo.6\_day0.1\_dic0.3 means the combination of TFIDF, time feature, and dictionary feature is <0.6 0.1 0.3>.

We give the best performance of HACBT with TFIDF, time feature (HACBT (TFIDF-DAY)), HACBT with TFIDF, dictionary feature (HACBT (TFIDF-DIC)), and HACBT with TFIDF feature, time feature and dictionary feature (HACBT (TFIDF-DAY-DIC)) in Fig 52.3. The best combination of <TFIDF, DAY, DIC, > is <0.5 0.1 0.4>. The threshold of similarity is 0.5. The average precision is 77.16 %, average recall is 81.88 %, and average F is 79.45 %.

Finally, we give the result of HACBT on 14 stocks in Table 52.1. The experimental results show that our method HACBT performs better than the traditional clustering method HAC. But there is still space to enhance the event detection



**Fig. 52.2** Precision, recall, and F-measure of HACBT in different thresholds and feature combination



**Fig. 52.3**  $P$ ,  $R$ , and  $F$  of HAC and HACBT with different feature combination

**Table 52.1** Performance of HACBT

Stock id	News reports number	Cluster number after first-layer clustering	Cluster number after second-layer clustering	Cluster number after filtering single report cluster	Standard cluster number
000001	41	6	13	4	4
000009	142	6	15	15	19
000063	69	7	14	12	14
000100	160	7	18	15	19
000587	58	8	11	7	7
000752	103	6	18	15	18
000787	43	4	5	3	5
000998	58	6	10	5	6
002024	82	7	14	7	11
002431	33	5	5	5	7
600315	51	7	11	10	12
600703	56	8	15	8	12
601186	39	5	10	7	8
601899	101	9	20	13	13
Total	1,036	91	179	126	155
P%	R%		F%		
77.1573	81.8841		79.4504		

performance. For example, the dictionary size is small and the dictionary feature does not have obvious effect on clustering result.

#### 52.4.3 Evaluation of Event Recommendation Based on Data Time Alignment

The evaluation of event recommendation is whether a cluster of news reports always has an uncommon change of structured data with it. The structured data contain all stocks and the events are clustered from total news reports by HACBT. In Table 52.2, the size of cluster means the documents amount in the cluster set is more than the number in the row. For example, there are 4,949 events of which the size is more than 2 and 2,276 events have uncommon change point around.

The time period between the event and uncommon change point is from one week before the event to one month after the event. What we care about is whether a generated cluster should be pushed to users. Although the hit rate is not so good, the experimental result shows the structured data change can help recommend hot events. The news report set is not complete and data collection is a part of our future work.

**Table 52.2** Hit rate and cluster size

Cluster size ( $\geq$ )	Hit events	Total events	Hit rate (%)
2	2,276	4,949	45.99
3	1,246	2,588	48.15
5	459	949	48.36
7	227	471	48.20
10	101	210	48.10
15	36	80	45

## 52.5 Conclusion

Traditional hot topic detection uses clustering methods or language model to extract a series of news reports on some hot events. But the standard of judging a group of information should be pushed to user as a topic still has some shortcoming and the clustering performance needs to be enhanced. In this paper, the hot topic detection based on heterogeneous information is proposed. The constraints according to structured data are defined and confirmed in the experiment. Moreover, we explore the two layers HAC using multi-features (HACBT). The performance of our method is better than that of traditional HAC. The hot event detection system has been running on line (<http://finance.haitianyuan.com/burstdta>).

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# Chapter 53

## Security Analysis of National E-Government Based on Information Systems

Fei Yan

**Abstract** The security of information system directly related to national e-government's security, and also the guarantee of national government agencies and state secrets; this paper starts with the current security risks of information system and e-government affairs which combining the classification of governmental information resources, the characteristics of national e-government affairs, content infrastructure, and the attributes of functional bureaus. After the integration of each bureau's business, a classification security program of information system is proposed to do multilevel security control, multilateral security control, and software security control. Finally, compared with the present situation of the information system, several security advices are put forward to safeguard the national e-government.

**Keywords** Security risk • Information system • E-government • Classification security program

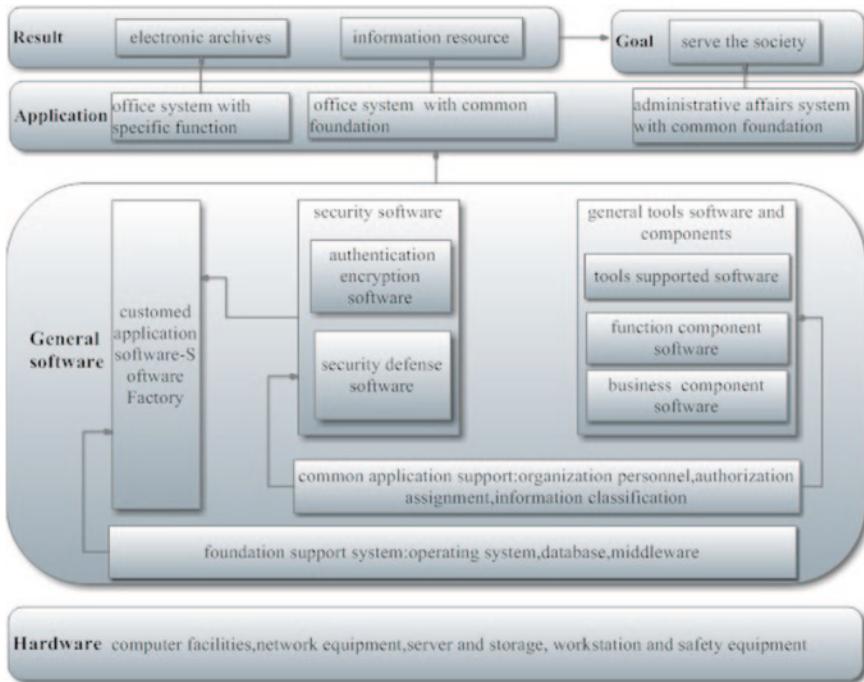
### 53.1 Introduction

The rapid popularization of the Internet and the widespread application of information technology means our entrance to the age of information. Meanwhile, the government and all walks of life are also constructing varied information systems, and the information systems have become the important national infrastructure, therefore, the security of these information systems has been promoted to the stage of national security and national sovereignty strategy. If there is no information security, there will never be the real political safety, solid economic development, and military security. And the related factors in e-government construction are as shown in Fig. 53.1.

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**Fig. 53.1** Related factors in e-government construction

## 53.2 The E-Government Affairs and Information Security

At present, China's e-government affairs have made some achievements, but there are also many needs for improvements. The governmental information systems are mostly developed in an independent closed system environment, which caused the behind of information service, the slow processing of business or office affairs, and informational and technical barriers [1]. All these could be improved by a seamless, collaborative technical statement, which establish an electronic government platform with the function of communication, interaction, and compatibility. And the information security industry is similar with arms industry, which can only rely on national industry except the foreign countries, generally speaking, the information security work of our country is still at the beginning stage, which existing the following problems:

- (1) The awareness of informational safety and safety ability are weak, and the information security lags behind the development of informatization;
- (2) The unclear objectives during the construction and management of information system security process;
- (3) The focuses of information security are not enough highlighted;

- (4) The lack of supervision and standards on information security and the corresponding regulatory system is yet to be perfect;
- (5) From industry perspective, laws and regulations of information security need to be further developed and capacity of information security needs to be strengthened.

### ***53.2.1 The Security Risks of Information System***

From the overall consideration, the safety of information systems mainly includes: operation security (mostly is the platform consisted by the network and computers), transaction security (the data's safety during the process of transmission), content security, individual or organizational privacy protection [2]. But what really worthy thinking is the reason of more and more security problems occurs currently under the protection of technologies with strong defense? In China, which is the biggest hidden danger of information security? And the results indicate that the threats of information system's security can be divided into two aspects: the vulnerability of information technology and the vulnerability of management.

#### ***53.2.1.1 The Vulnerability of Technology, Such as Physical Environment, the Security of Application Systems***

Reference the OSI open systems interconnection model, mainly considering the following aspects: the physical layer, network layer, the system layer, and the application layer.

##### **The Security Risk of Physical Layer**

The security risk of physical layer mainly refers to the blocking of network equipment and whole line, which caused by surrounding network environment and physical properties; it is the premise of whole network system's security; to solve this problem, some disaster protection strategies on emergencies can play a protective role.

##### **The Security Risk of Data Transmission**

The data transmission mentioned here, including three parts: the data transmission between the local area network, the data transmission among the several local area network, the data transmission [3] between the local area network and the Internet. But through the firewall (VPN), IPS/IDS, the system of security isolation and

information exchange, inspectional tools of information security and the network access system are to ensure the confidentiality and integrity of data.

### The Security Risk of Network Boundary

Connecting the different security levels of the network will generate several network boundaries. Generally speaking, the security problems of network boundary including the following aspects: information leaks, the invaders attacks, and network viruses. From the security of the external network, the main solution is the protection and monitoring; meanwhile, the nets brake system and the information “one-way” import system could be adopted. From the security of the internal network, the tracking of the user’s behavior by identification, authentication, and audition is the so-called audit of behavior.

### The Security Risks of System Layer

Among the various contents involved in the security of information system, the safety problems of the operating system, network system, and database management system are the core; if there is no support from a safe operating system, the database could not have the credibility of access control and be impossible to ensure the security of network system, neither the security of information processing when running an application software.

### The Security Risk of Application Layer

There are a lot of application services in the whole network system environment, such as web services, mail service, OA service, database services, etc. With all of these services, there are inevitably existing security vulnerabilities. These may be caused by service system itself, and also could be the improper configuration management.

#### **53.2.1.3 Management Vulnerability: Including Technical Management and Organizational Management**

##### Technical Management

Technology management mainly refers to the management of safety strategy about the various network equipments and network security equipments. The security strategy of firewalls, physical isolation equipments, intrusion detection equipments, the router, and the management of safety strategies would be effective only when these are practical. Meanwhile, technical management also includes the password management and reasonable strategy of data backup.

## Organizational Management

Organizational management mainly refers to the information personnel management: strengthening the security education of information personnel, keeping relative stability of information personnel, especially the network management personnel and security management personnel, preventing the disclosure of organizational secrets, and running the signed licensing system and the monitoring system on network equipments, servers, storage equipments.

In short, during the information system security process, the first priority is to rationalize the relationship between the technology and management. Solving the information security issues is not only to consider the technology sides, but also should consider combining the strengthen of the management and the training of information personnel. Meanwhile, we must, according to specific network and applicational needs, make a targeted and effective security strategy as our guideline to carry out network information security construction.

## 53.3 The Demand Analysis

### 53.3.1 *Three Kinds of Demand in E-Government Information System*

#### 53.3.1.1 The Needs of Office and Business Affairs

The governmental working affairs could be highly concluded into two aspects: the foundational government affairs and administrative office affairs. This kind of information partly can be moved to the external network and released to the public or interacted with the public on the office affairs, foundational government affairs, specific reference to the functions of the work which is organized by each bureau, and may be derived from the cooperation between governmental departments and public emergency system; administrative office affairs namely the personnel, financial, assets and other relative things inside each bureau. The relationship between them is shown in Fig. 53.2.

#### Integrating the Official Information Resources

The two kinds of office system mentioned above have the general characteristics of the traditional working object and the working content, namely the objects and contents of information resources, designing an information system which computer can run smoothly [4]. Therefore, it should conclude, classify and refine the traditional working contents in order to generate a new information resources classification system which not only conforms to the traditional working way, but is also



**Fig. 53.2** The classification of information system in e-government

suitable for the computer system features, and this system can also be specifically pointed as “office and business information resources,” “e-government foundational information resources,” and “system supported information resources.”

#### Concluding the Office Information Resource’s Needs

This refers to draw out the shared, basic, related, independent, and stable information content, and in each unit, all have their own characteristics; this kind of information is easy for business work to be drawn out from many information resources with individual characteristics. The e-government information system is about to make the three kinds of information unified planning, unified classifying, unified application, unified storage, unified management, and unified access controlling safe and reliable to share.

##### 53.3.1.2 The Needs of Management

###### Comprehensive Management Needs

Management needs mainly include how to utilize the information system to realize traditional management work among different levels of leadership and different departments. The traditional management performs as scattered and executes according to the requirements of managers; meanwhile, the performance of information system’s auxiliary management is united, and may execute according to the requirements of managers.

###### The New Set of Various Kinds of Standards and Regulations System Requirements

To realize the use of computer system to satisfy the various business requirements, and the innovation pattern that combines with all kinds of technology and management, a new management model should be designed, formulating, perfecting

the relevant software, the relevant standards and regulations, and also the detailed rules for the implementation of work.

The core thing of the electronic government affairs system is to use the theories of system engineering and realize the three categories of demand: “office management affairs, comprehensive security, and technological implementations,” and finally, realizing unified planning, unified designing, unified standards, and unified constructing.

### **53.3.1.3 The Needs of Technology Implementation**

#### **The Needs of Various Hardware Equipments**

Including the network hardware equipments, such as computer room, network equipments related to server and security equipments, is necessary for e-government affairs system.

#### **All Kinds of Needs for Software Research and Development**

The requirements include the needs of software research and development of operating system, database, the foundational supporting platform system (namely, the e-government system, specific for united personnel, unified information classification, unified rights management), the authentication encryption, safe defense, the general character of governmental office affairs, and the individual character of government affairs office.

#### **The Needs of Comprehensive Security Technology**

As our country’s e-government affairs, it could be divided into technical security and privacy, and security according to the nature; and it can be divided into: the internal and external security prevention according to the function. But the detailed division should be based on the practical application.

#### **The Security of Technology**

How to guarantee the treasury information “no damage, not lose” [5] when the information is processed, transmitted, saved, and backuped.

#### **The Need of Privacy and Security**

How to use a traditional entity computer system to ensure the security of auxiliary storage and the information, and preventing “the personnel who inside and outside

the organization to open files illegally” is a key issue in information management system.

### The Security of Intranet

Its characteristics are the high confidential degree and low concurrent operand, and we should focus on how to ensure the increment of secret-involved information system’s comprehensive confidential coefficient [6]. Therefore, the comprehensive security cannot solve through a single security products, and needs to realize it through the cross-control of multilevel software and hardware products’ comprehensive security function, and the key to the Intranet security is to solve the demands of comprehensive security.

### The Security of Extranet

Its characteristics are the high concurrent operations but low confidential degree [7]; we should focus on how to ensure the demand of efficiency during a large concurrent operation; the safety problem of this field can be solved through the single security products, also the security of extranet should mainly solve the demands of technical security.

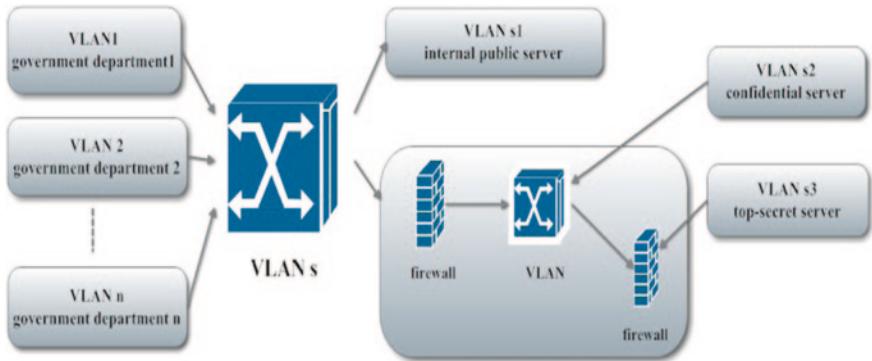
Therefore, the security needs of the Intranet and extranet should be formulated separately, and the e-government should plan, design, and implement separately the security of technology, confidential information, and the Intranet and extranet.

### **53.3.2 *The Classification Security Program of Information System***

Through the analysis of the e-government’s demand, the author puts forward the classification security program of information system to safeguard the information system.

#### **53.3.2.1 The Multilevel Security Control**

Based on the “one-way” safety isolation system and “internal public domain” buffer pool, we can import the Internet information and data into the secret area. With the multilevel security control mentioned above, we adopt single import equipment to do the boundary control, in this way, we not only meet requirements of information flows among security domains in different levels, but also satisfy the demand issues of import Internet information and data during the practical application.



**Fig. 53.3** The diagram of multilateral security control

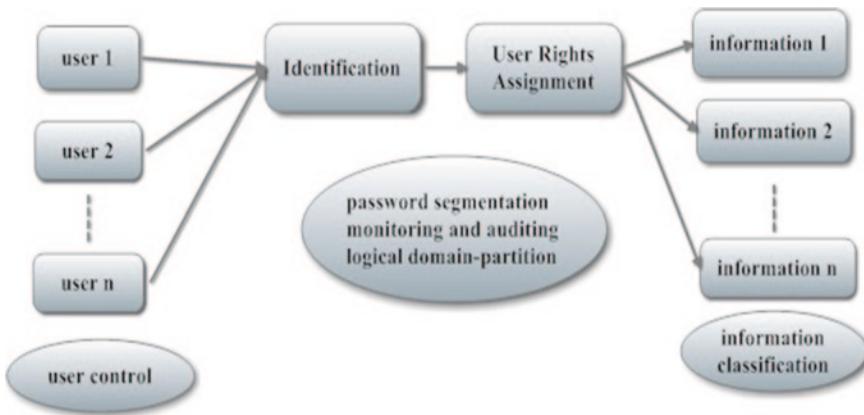
### 53.3.2.2 The Multilateral Security Control

Through the use of VLAN, MAC address binding, firewall technology, and related products, we could do overall division; realizing multilateral security control could ensure the security of the whole system upon the users' equipment, servers, and network equipments within the information system as shown in Fig. 53.3.

According to the different users, we divide the user equipment, which connected with information system, into different classes. And we also can divide different departments' users into different VLANs. The user equipments were connected to the server through the switches and related network equipments. The users who were not involved in state secrets could be connected directly to the internal public server. The users who need to deal with the secret, confidential information, could link with different severs according to the different security strategy configuration of firewalls, switches, and other network equipments.

### 53.3.2.3 The Security Control of Software

Through identification, access control, and the password techniques deployed in the information system, the security of the confidential information can be ensured. During the process of “unified user management,” we classify these users into 16 levels and “unified division of information management” is basic on the foundation of five categories, namely: “open information, internal information, secret information, classified information, and top secret information.” According to the information’s content, attribute or features combined with the business application can be divided into various categories. “Unified identity authentication” provides different intensity levels of authentication mechanism for visiting different categories of information. “Unified rights management” focuses on



**Fig. 53.4** The diagram of software security control

comprehensive management to all kinds of authentication. Under the supervision of the identification, combined user management with information classification can produce different authority levels to a single user as shown in Fig. 53.4.

### 53.4 Conclusion and Prospects

Our country has given enough attention on information security, and made compulsive regulation to various industries on strengthening information security construction. Developing the key technologies, such as network existence real-time protection, safety initiative storage, network antivirus, malicious attack prevention, high-trusted network software platform, embedded software, and software system integration, provides the overall solution. All of these will greatly promote the development of our country's information security market. Therefore, the author put forward the following steps, which can improve the security of our country's e-government affairs: (1) establishing China's own principle of combining the information security products' technology specifications and the legal standards; (2) setting up the scientific safeguarding idea of information security laws and regulations; (3) constructing scientific laws and regulation systems of information security to promote e-government; (4) perfecting the information security protection system and strengthening the pulling ahead efficiency of the information security regulations; (5) taking the initiative to integrate international information security laws and regulations system.

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# Chapter 54

## Investigations of Evolutionary Game Between Individual Safety Behavior and Stimulus Mechanism

Weixi Hu, Nie Baisheng, Dai Linchao, Ruming Zhang and Zhao Caihong

**Abstract** In order to study the relationship between staff's safety behavior and stimulus mechanism, the evolutionary game model for them was established, and the duplicate dynamic equation and dynamic evolution equation of the game parties are derived. By performing stability analysis of the duplicate dynamic differentials, the evolution stability strategy for individual safety behavior and stimulus mechanism was obtained, and some suggestions were put forward to improve the habit of individual safety behavior from stimulus point of view.

**Keywords** Individual safety behavior • Stimulus mechanism • Evolutionary game • Evolution stability strategy

### 54.1 Introduction

According to the statistics of China State Administration of Work Safety, 363,383 accidents occurred in total in China in 2010, claimed 79,552 deaths, including 8,431 accidents in enterprises that led to 10,616 deaths [1]. Work-related injury statistical data indicated that 50–85 % of the injury accidents in China are related to the unsafe behaviors of peoples. Change of behavioral habits needs to adhere to Maslow's Hierarchy of Needs. The theory opines that people's demand tiers are ranked in a down-to-up way. Only when the lower demand has been met, can the higher demand become new stimulus factor [2]. Therefore, the author is of the opinion that the process where people's behavior is being changed, is a process where people's demand is continuously satisfied, also a process where people's behavior is continually stimulated.

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Stimulus mechanism is an important component among safety culture construction. According to the nature of stimulus, stimulus mechanism can be classified into positive and negative stimulus mechanism. The two mechanisms combined exert on the habit of individual safety behavior [3, 4]. Positive stimulus measures adopted by positive stimulus mechanism can repeatedly and continuously enhance the staff's safety behavior. Under such stimulus mechanism, an organization's safety performance keeps improving [5, 6]. Negative stimulus mechanism can also restrain staff's unsafe behavior. As individual demand is continuously met, and the organization's safety performance continually improved, the organization also needs to keep changing and improving its stimulus mechanism [7].

## 54.2 Evolutionary Game Model for Individual Safety Behavior and Stimulus Mechanism

The game model  $G$  is given

$$G = \{I, S, U\} \quad (54.1)$$

where,  $I$  is the collection of game participants, that is, individual safety behavior and stimulus mechanism;  $S$  is the strategy space of the game parties,  $S = \{S_1, S_2\}$ ,  $S_1$  denotes the strategy space of individual safety behavior,  $S_1 = \{\text{violation, non-violation}\}$ ;  $S_2$  denotes the strategy space of stimulus mechanism,  $S_2 = \{\text{positive stimulus, negative stimulus}\}$ ;  $U$  is the income of the game parties. To simplify the problem analysis, the following assumptions for the game model are given:

1. Expected income obtained by an enterprise's staff in violation  $E$
2. Punishment to the staff in violation  $F$
3. Other social costs caused by the staff's violation  $Q$
4. Awards to the staff under positive stimulus mechanism in case of non-violation  $R$
5. Cost consumed in positive stimulus measures adopted under positive stimulus mechanism  $C$
6. Positive social effects caused from negative stimulus mechanism when an organization has poor safety performance (behavior restriction role)  $N$
7. Positive social effects caused from positive stimulus mechanism (good social reputation, etc.)  $P$ .

Individual safety behavior is prone to violation by a probability  $x$  and non-violation by a probability  $1 - x$ . An enterprise is prone to take positive stimulus mechanism by a probability  $y$  and to take negative stimulus mechanism by a probability  $1 - y$ . At the same time, this model assumes that the expected income brought by the staff from fluke mind is less than the loss, that is,  $R < E - Q < F$ ; moreover, the stimulus mechanism is feasible, that is,  $P > C$ . The income matrix produced from the game between individual safety behavior and stimulus mechanism is shown in Table 54.1.

**Table 54.1** Income matrixes of the game parties

		Stimulus mechanism	
		Positive stimulus (y)	Negative stimulus (1-y)
Individual safety behavior	Violation (x)	E-Q, 0	E-F-Q, N
	Non-violation (1-x)	R,P-C	0,0

The expected income obtained by individual safety behavior in adopting violation and non-violation strategy is  $U_{b1}$  and  $U_{b2}$ , respectively. The average expected income of individual safety behavior is  $\overline{U_b}$ ; then,  $U_{b1}$ ,  $U_{b2}$  and  $\overline{U_b}$  are

$$U_{b1} = (E - Q) y + (E - F - Q) (1 - y) \quad (54.1)$$

$$U_{b2} = Ry + 0 (1 - y) \quad (54.2)$$

$$\overline{U_b} = x U_{b1} + (1 - x) U_{b2} = (E - F - Q) x + Ry + (F - R) xy \quad (54.3)$$

The expected income obtained by the stimulus mechanism in adopting positive and negative stimulus is  $U_{a1}$  and  $U_{a2}$ , respectively, and the average expected income of the stimulus mechanism is  $\overline{U_a}$ ; then,  $U_{a1}$ ,  $U_{a2}$  and  $\overline{U_a}$  are, respectively, given:

$$U_{a1} = 0x + (P - C) (1 - x) = (P - C) - (P - C) x \quad (54.4)$$

$$U_{a2} = Nx + 0 (1 - x) = Nx \quad (54.5)$$

$$\overline{U_a} = y U_{a1} + (1 - y) U_{a2} = (P - C) y + Nx - (P + N - C) xy \quad (54.6)$$

Both staff individual and enterprise management have the basic empirical judgment ability. After some time, both staff individual and enterprise management will find different strategies bring different incomes to them, which means the probability  $x$  and  $y$  change with time. It can be known from the games theory the dynamic change rate of  $x$  and  $y$  is as follows:

$$\frac{dx}{dt} = x(U_{b1} - \overline{U_b}) = x(1 - x)(U_{b1} - U_{b2}) \quad (54.7)$$

$$\frac{dy}{dt} = y(U_{a1} - \overline{U_a}) = y(1 - y)(U_{a1} - U_{a2}) \quad (54.8)$$

Substituting Eqs. (54.1, 54.2, 54.4 and 54.5), respectively, into Eqs. (54.7 and 54.8), obtain:

$$\frac{dx}{dt} = x(1 - x)[(E - F - Q) + (F - R)y] \quad (54.9)$$

$$\frac{dy}{dt} = y(1 - y)[(P - C) - (P + N - C)x] \quad (54.10)$$

Equations (54.9) and (54.10) are the time evolution model of individual safety behavior and stimulus mechanism, respectively, namely dynamic duplicate equation. It reflects the time evolution process of individual safety behavior choosing violation or non-violation and of stimulus mechanism choosing positive and negative stimulus mechanism. The model embodies the dynamic adjustment process of individual safety behavior and stimulus mechanism.

Equation (54.9) is divided by Eq. (54.10), obtain:

$$\frac{dy}{dx} = \frac{y(1-y)[(P-C)-(P+N-C)x]}{x(1-x)[(E-F-Q)+(F-R)y]} \quad (54.11)$$

Integrating Eq. (54.11), obtain:

$$(y-1)^{R+Q-E} \cdot y^{E-F-Q} = A \cdot (x-1)^N \cdot x^{P-C} \quad (54.12)$$

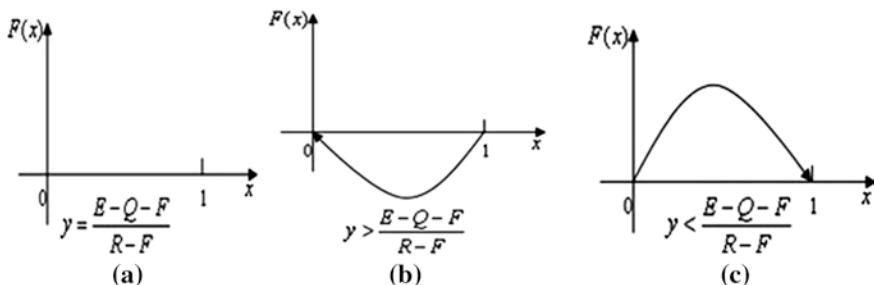
Equation (54.12) is the mathematical description of the game relation between individual safety behavior and stimulus mechanism.

## 54.3 Discussions on the Game Model for Individual Safety Behavior and Stimulus Mechanism

### 54.3.1 Analysis of Evolutionary Game Process of Stimulus Mechanism

Let  $F(y) = dy/dt$ , the duplicate dynamic equation of individual safety behavior denoted by Eq. (54.10) can be represented by Fig. 54.1.

It can be known from the stability analysis of the game model for individual safety behavior and stimulus mechanism that for the stable state of the game parties' stimulus mechanism  $y_1^* = 0$  and  $y_2^* = 1$ , the critical point is  $x^{**} = \frac{P-C}{P+N-C}$ , when  $x^{**} < \frac{P-C}{P+N-C}$  stimulus mechanism tends to "positive stimulus," namely, when individual safety behavior tends to "non-violation," under good safety performance, stimulus mechanism tends to "positive stimulus." On the contrary, when



**Fig. 54.1** Dynamic duplicate phase diagram of individual safety behavior

$x^{**} > \frac{P-C}{P+N-C}$ , namely, staff's individual safety behavior tends to "violation," under poor safety performance, stimulus mechanism tends to "negative stimulus" to prevent staff violation behavior occurring.

Seek partial derivative of critical point  $x^{**}$  as to  $P - C$  and  $N$ , respectively, obtain

$$\frac{\partial y^{**}}{\partial (E - Q)} = \frac{1}{R - F} < 0 \quad (54.16)$$

$$\frac{\partial y^{**}}{\partial F} = \frac{R + Q - E}{(R - F)^2} < 0 \quad (54.17)$$

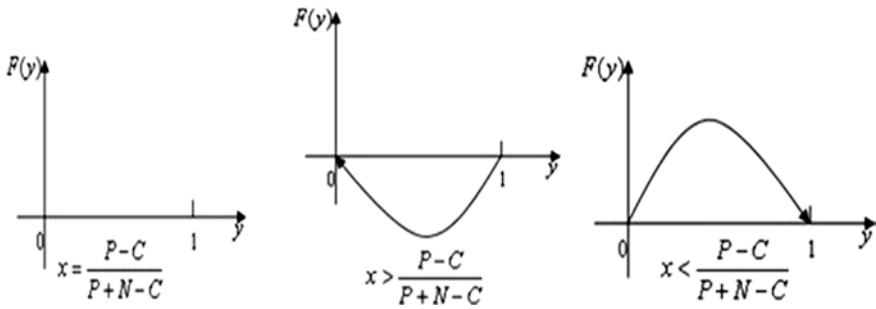
$$\frac{\partial y^{**}}{\partial R} = \frac{(E - F - Q)}{(R - F)^2} < 0 \quad (54.18)$$

The solutions of the partial derivatives show that the larger the income of individual violation  $E - Q$  is, the higher awards  $R$  the staff obtain under positive stimulus mechanism; the more the amount of fines  $F$  is, the more the enterprise tends to adopt negative stimulus. The reality is also the same: the larger the income  $E - Q$  obtained by staff violation, the more the profit space brought to individual from violation is, and the more the people tend to violation. When the proportion of violation individuals is increased to some extent, the enterprise must adopt "negative stimulus" mechanism to prevent deterioration of safe production environment. Hence, it can be seen from Eq. (54.16) that the tendency  $y^{**}$  of positive stimulus weakens as income of violation  $E - Q$  increases. On the contrary, the tendency of "negative stimulus" strengthens as income of violation  $E - Q$  increases. The more the amount of fines  $F$  is, the more the enterprise obtains from "negative stimulus" culture, and the more the enterprise tends to adopt "negative stimulus" mechanism. It can be known from Eq. (54.17) that as the amount of fines  $F$  increases, the enterprise tends less to adopt "positive stimulus" mechanism. On the contrary, the enterprise tends more to take "negative stimulus" mechanism. The more the awards  $R$  obtained by individual non-violation is, the higher cost the organization pays in adopting "positive stimulus" mechanism. From the organization point of view, the less its income is, the more it tends to adopt "negative stimulus" mechanism. Eq. (54.18) also validates the author's viewpoint.

### 54.3.2 Analysis of Evolutionary Game Process of Individual Safety Behavior

Let  $F(x) = dx/dt$ , the duplicate dynamic equation of individual safety behavior denoted by Eq. (54.9) can be illustrated by Fig. 54.2.

It can be known from the stability analysis of the game model for individual safety behavior and stimulus mechanism that for the stable state of the game parties'



**Fig. 54.2** Dynamic duplicate phase diagram of individual safety behavior

stimulus mechanism  $y_1^* = 0$  and  $y_2^* = 1$ , the critical point is  $x^{**} = \frac{P-C}{P+N-C}$ , when  $x^{**} < \frac{P-C}{P+N-C}$  stimulus mechanism tends to “positive stimulus”, namely, when individual safety behavior tends to “non-violation”, under good safety performance, stimulus mechanism tends to “positive stimulus”. On the contrary, when  $x^{**} > \frac{P-C}{P+N-C}$ , namely, staff’s individual safety behavior tends to “violation”, under poor safety performance, stimulus mechanism tends to “negative stimulus” to prevent staff violation behavior occurring.

Seek partial derivative of critical point  $x^{**}$  as to  $P - C$  and  $N$ , respectively, obtain

$$\frac{\partial x^{**}}{\partial (P - C)} = \frac{N}{(P + N - C)^2} > 0 \quad (54.19)$$

$$\frac{\partial x^{**}}{\partial N} = \frac{-(P - C)}{(P + N - C)^2} < 0 \quad (54.20)$$

Both “positive stimulus” and “negative stimulus” can play a role in prevention and control of unsafe behavior, but to appropriate extent. Superficially pursuing the income obtained from “positive stimulus” measures will however give rise to more unsafe behaviors. Explanation to such scenario in reality is excessively tolerant system “indulges unsafe behavior” instead. It can be seen from Eq. (54.19) that the probability of individual behavior tending to violation increases with increasing income ( $P - C$ ) of “positive stimulus” strategy. On the contrary, it can be seen from Eq. (54.20) that,  $x^{**}$  decreases with increasing  $N$ . That is to say, appropriate “negative stimulus” can better restrict occurrence of unsafe behavior.

## 54.4 Conclusions

With the methodology of evolutionary game theory, the game relation between individual safety behavior and stimulus mechanism is investigated. It is revealed that there exists “cat-catching-mice” relation between individual safety behavior and stimulus mechanism. Some conclusions are drawn as follows:

The game between individual safety behavior and stimulus mechanism is a dynamic evolutionary process, and both parties will keep adjusting their separate strategy according to incomes. “Stimulus is a two-edged sword”. For an enterprise to maintain its safety management performance, it must seek an appropriate proportion between “negative stimulus” and “positive stimulus.”

“Punishment substituting for management” mode cannot restrain staff’s violation behavior for a long time. When there are more violations, the enterprise tends to adopt “punishment assisted by awards” stimulus mechanism strategy. When the enterprise’s violations enter into a smaller and steady period, it needs to adopt “awards equal to punishment” management mode.

In order to control occurrence of individual unsafe behavior, the enterprise needs to establish a self-improvement cultural system. Stimulus mechanism is a new means to control staff’s unsafe behavior. The enterprise should create a group safety atmosphere through education, propaganda, award, or punishment, so as to continuously enhance its staff’s safety level and consequently improve their safety awareness and behavior.

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# Chapter 55

## A Sequential Multi-Signature Scheme Based on ElGamal Meteorological File

De-Sheng Fu and Jiao Yang

**Abstract** In this paper, a sequential multi-signature scheme based on ElGamal algorithm was presented, which allows multiple signers to sign the same message. This scheme used zero-knowledge proof during the part of key forming to avoid attack from signers. The experiments show that this scheme is safer and improve the signature efficiency in meteorological field.

**Keywords** Multi-signature • Meteorological file • ElGamal • Sequential • Zero-knowledge proof

### 55.1 Introduction

With the development in information technology and the office automation, single digital signature cannot satisfy the need, and in many cases, an electronic document needs many people signed to take effect, resulting in the multiple digital signatures. In 1994, Harn and Xu [1] proposed ElGamal digital signature—designing rules and gave the all safety ElGamal digital signature scheme. Li and Yang [2] used paper [1], a list of all ElGamal digital signature schemes to select an appropriate one to design two digital multi-signature schemes: sequential digital multi-signature and broadcasting multi-digital signature, but since the schemes did not verify the public key of the members in the signature verification process, they could easily be forged by internal members. At the same time, in paper [2] and paper [3], there exists a problem that they require the first  $i$  signature have to be sent  $r_i$  to all future signers and the verifier and have to be validated before  $i - 1$  signature. This increases communication cost and redundant workload [4, 5].

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This paper proposes a sequential digital multi-signature scheme based on the ElGamal digital signature algorithm [6, 7]; in the key generation process, we use the discrete logarithm zero-knowledge proof to verify a user's public key to prevent the forging by internal members, which differs from the method used in papers [2 and 3]. This scheme simplifies the validation process between signers and improves the signature efficiency, and so in the field of meteorology, it is safer and more practical.

## 55.2 ElGamal Signature Scheme

A trusted center selects a large prime number  $p$ , and  $g$  is the primitive element of  $GF(p)$  [8, 9]. A one-way hash function  $h$  and open  $p$ ,  $g$  and  $h$  are selected.

If the signer Alice signs on message  $m$ , Alice selects a random number  $x_A \in [1, p - 1]$  and calculates  $y_A = g^{x_A} \bmod p$ . She uses  $x_A$  as her private key and  $y_A$  as her public key.

In the signature operation, Alice selects a random number  $k \in [1, p - 1]$  and calculates  $r = g^k \bmod p$ .

Alice calculates the equation  $m'x_A = rk + s \bmod (p - 1)$  and gets  $s$ ; among them,  $m' = h(m)$ . Then,  $(m, (r, s))$  is the message signature of Alice for message  $m$ .

In the verification operation, other people can detect whether the equation  $y_A^{m'} = r^r g^s \pmod{p}$  is established to determine the validity of the signature [10, 11].

## 55.3 Sequential Digital Multi-Signature Scheme

### 55.3.1 System Initialization

If  $n$  signers  $U_1, U_2, \dots, U_n$  sign with a message  $m$ , a large prime number  $p$  is selected and  $g$  is the primitive element of  $GF(p)$ . A one-way hash function  $h$  and open  $p$ ,  $g$  and  $h$  are selected. The signature center sets constant number  $N$  to limit the signer retransmission signature no more than  $N$  times.

### 55.3.2 Key Generation

In the key generation part, in order to prevent forging by internal members, we use a discrete logarithm zero-knowledge proof to test every signer's public key  $y_i$ , described in detail as follows:

Every signatory  $U_i (i = 1, 2, \dots, n)$  randomly selected  $x_i \in [1, p - 1]$  as the private key of  $U_i$  and calculated  $y_i = g^{x_i} \bmod p$  as public key of  $U_i$ .

The signature center randomly selected  $x_s \in [1, p - 1]$ , calculated  $y_s = g^{x_s} \bmod p$  and sent  $y_s$  to all signers. The signer calculated  $y_u = y_s^{x_i} \bmod p$  and sent  $y_i$  and  $y_u$  simultaneously. After the signature center received  $y_i$  and  $y_u$ , it verified whether  $y_u = y_s^{x_i} \bmod p$ ; if true,  $y_i$  is the correct public key of  $U_i$ ; otherwise, the request is repeated.

### 55.3.3 Signature Generation Process

The signature center designs a signature sequence  $(U_1, U_2, \dots, U_n)$  and sends this order to all signers. Signature center determines the message  $m$  and then we can calculate  $m' = h(m, T)$ ; message  $(m, m')$  is sent to the first signer  $U_1$ , each signer and the signature verifier the time signature sign  $T$ . Based on requiring the user  $U_i$  to send the signature in the given time  $\Delta T_i$ , we can prevent the signature replay.

The first signer  $U_1$  calculates  $T_1 = \Delta T_1 + T$ ; if the message  $(m, m')$  arrives before  $T_1$ , we verify whether  $m' = h(m, T)$ ; otherwise,  $U_1$  repeats request message. If the message  $(m, m')$  at  $T_1$  has not arrived yet,  $U_1$  sends a time-out information, which means the signature is failure.

The random selection  $k_1 \in [1, p - 1]$  calculates

$$\begin{aligned} r_1 &= g^{k_1} \bmod p, \\ s_1 &= m' x_1 - r_1 k_1 \bmod (p - 1), m' = h(m, T) \end{aligned}$$

The signed message  $(m (s_1, r_1))$  and  $r_1$  will be sent to the next signatory  $U_2$ ; at the same time,  $r_1$  will be sent to signed center.

Every signatory  $U_i (i \geq 2)$  calculates  $T_i = \Delta T_i + T$ ; if the signed message  $(m, (s_{i-1}, r_{i-1}))$  of  $U_{i-1}$  arrives before  $T_i$ , we go to the step ② operation; otherwise,  $U_i$  requests  $U_{i-1}$  to repeat the message. If the signed message of  $U_{i-1}$  in time  $T_i$  has not arrived yet,  $U_i$  will send time-out information to  $U_i$ , which means signature failure.

The signature verification of  $U_i$  is as follows:

$$g^{s_{i-1}} r_{i-1}^{r_{i-1}} = y_{i-1}^{m'} \bmod p \quad (55.1)$$

If the equation is set up, go to the third step or refuse to sign the message and ask  $U_{i-1}$  to again sign the message.

The random selection is as follows:  $k_i \in [1, p - 1]$ , and the calculation is as follows:

$$r_i = g^{k_i} \bmod p$$

$$s_i = s_{i-1} + m' x_i - r_i k_i \bmod (p - 1).$$

The signed message  $(m, (s_i, r_i))$  and  $r_i$  will be sent to the next signatory, and at the same time,  $r_i$  will be sent to the signed center.

### 55.3.4 Signature Verification Process

Signature center receives signed message  $(m, (s_n, r_n))$  of the last signer  $U_n$  and then verifies the signature

$$g^{s_n} \prod_{j=1}^n r_j^{r_j} = \prod_{j=1}^n y_j^{m'} \pmod{p} \quad (55.2)$$

If the equation is established, then the signature is valid; otherwise, the signature is invalid.

## 55.4 Security Analysis of the Scheme

- (1) Among the proposed sequential digital multi-signature schemes in the paper, the security of the scheme is based on the difficulty in solving discrete logarithm. If the attacker wants to solve the private key  $x_i$  from each user  $U_i$ 's public key,  $y_i$  is equivalent to solving the discrete logarithm problem. Similarly, if the attacker wants to solve  $k_i$  from every signatory, public transport of  $r_i$  is equivalent to solving the discrete logarithm problem.
- (2) Different from paper [2], this program controls and manages signature member key generation process, process of signature by the signature center and discrete logarithm zero-knowledge proof signature to guarantee public key generation of  $y_i$  and can prevent the attack proposed in paper [3]. If an internal member attempts to publish false public key to forge a signature, then the signature center can, through  $y_u = y_s^{x_s} \pmod{p}$ , test whether  $y_i$  is the public key of  $U_i$ .
- (3) The scheme also joined the time stamp  $m' = h(m, T)$ , where  $T$  is a signature time, to prevent re-attack. Even if the attacker intercepts the signed message  $(m, T, (s_i, r_i))$  and changes  $T$  to the current time,  $h(m, T)$  in  $s_i$  is unable to get rid of change, so the attack will not succeed.
- (4) The scheme sets a constant number in system initialization if the authentication type (1) in 1.2.2 does not hold, and it requests signature repeat. Meanwhile it calculates its retransmission times if greater than  $N$  and receives the termination process of signature. It can effectively limit the number of attempts of the attackers and enhance system security.
- (5) Different from papers [2 and 3], this paper simplifies the signature verification process, each signer  $U_i$  only verified the last signer  $U_{i-1}$ 's signature, and the signature center verifies all signers' signatures. Therefore,  $U_i$  does not need to broadcast  $r_i$  to all its subsequent signers, and it only needs to send  $r_i$  to the next signer and to the next signature center. It reduces the communication cost of the weather system; especially, when the number of meteorological sector signature is large, the advantages are obvious.

## 55.5 Conclusion

This paper designs sequential digital multi-signature scheme based on the discrete logarithm problem based on the ElGamal digital signature algorithm. It overcomes the shortcomings of the papers [2, 3], effectively prevents forging by internal members of the meteorological system, simplifies the validation process between signers, reduces the communication cost and improves the signature efficiency; therefore, this method is safer and more practical.

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# Chapter 56

## Research of Website Optimization Strategy Based on Search Engine

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**Abstract** Currently, search engine is the network application that has most of users and the highest of use frequency. Moreover, search engine optimization (SEO) that in order to improve website ranking in search results is the focus recently. This paper researches in detail the website optimization strategy based on search engine. By optimization of the website search engine, convenience of search engine, the rank of website, so as to enhance the website visitors, and achieve the aim of website promotion, to bring the opportunity for enterprise, to realize more profit.

**Keywords** Search engine optimization • Optimization strategy • Website optimization • SEO

### 56.1 Introduction

The emergence of the internet helps us to communicate all over the world; the search engine development provides to convenience all mankind. Search engine competitive rankings became the chased focus; however, the competitive ranking has a big deficiency: the expensive advertising costs, because the confusion of the network economic order, etc. So, people are also looking for a new solution; so that the website optimization appears at the historic moment. Website optimization or say search engine optimization (for short SEO) is to make the website design, to conform the search engine retrieval habit, accordingly to improve the search engine ranking of the keywords, so that the potential customers could search the website through the product keywords in the search engines, to enhance the effect of search engine marketing [1]. Nowadays, in order to reduce the cost of advertising investment, no matter small- and medium-sized enterprises or large enterprises are using the SEO to

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optimize the website, to improve the search engine ranking of the keywords, thus to bring more flow, and to reduce unnecessary investment network promotion, and finally to improve the invest return rate. This paper mainly researches in the keywords selection, the web structure, and the web links, etc.

## 56.2 The Theory of Search Engine Optimization

Search engine is a tool that could help users to provide information search, information collection and user query in the internet, and through a series of program offer up all the sorting information on the internet to the user. In a sense, it is not only navigation needle of the information query on the internet but also an important bridge between users and network information. From the user's point of view, this software system provides a web interface, and users could submit keywords (word or phrase) through the browser, and the system to return a sort information resources related users input content [1–4].

The Principle of Search Engine, as the five steps: 1. To analyze the user data: search engine analyzes users input data, such as keywords, title. 2. To build users database: after analyzed the user data, to build a related user input data or similar meaning database. 3. To grab the page from internet : mainly through the network spiders grab including HTML, pictures, doc, PDF, multimedia, dynamic web pages, and other format of information content. 4. To establish index database: the analysis index system analyzes the web page of grab, extraction related web information (including web URL, coding in type, page content of keywords, the position of the keywords, and the formation of time, size and other web links relations), according to a relevance ranking algorithm performance, a large number of complex calculations get every last web page for the keywords of degree of correlation(or importance) in the content and the hyperlink, and then use this information to create a web page index database. 5. To sort in the index database: to find all of the relevance web pages that comply with the keywords from the web page index database, the page generation system to return the sequencing information to the user that contain the page links address and abstract the page content the of all the search results [1–6, 9]. The web page order of the retrieval to return principles that mainly based on the web link quantity, link quality, the position of the keywords, the arisen frequency, the measurement click, and competitive ranking, etc. So, website optimization based on search engine mainly aims at search engines retrieval, analysis, index, and the principle of rank, mainly to optimize the keywords, links, web page content, and structure, in order to improve the rank in the search engine retrieval.

## 56.3 The Strategy of the Website Optimization

The website optimization by search engine has several pats, which are the keyword choice, link structure analysis, web content, page layout, the web page description, code optimization, etc.

### **56.3.1 The Strategy of Keywords**

Research keyword is fundamental to SEO and is the most important chain of optimization. The research keywords actually analyze all the website reader's behavior, because keywords are produced by internet users other than imagination, in other words, it is determined by the market.

#### **56.3.1.1 The Way to Determine Keywords**

The way to determine the keywords comes from the following aspects [1, 3, 6–10].

1. To a specific website, list the keywords that you want to express;
2. Check up your website statistics, to survey how visitors get through to visit your website from the search engines or other links by what kind of keywords, or use keywords tools, such as “baidu index,” “Google Suggest” could also to determine the popularity of keywords;
3. Go and look at your competition website, download their web page, to check in the HTML code what kinds of keywords they use, also reference the keywords.
4. To do some market survey, ask your friends, net friends, BBS friends, to collect the relevant information of their concerns similar website, and this is one of the keywords produce channel.

#### **56.3.1.2 The Strategy of Choice Keywords**

The long tail theory: The long tail theory is proposed by the Chris Desen of USA. The long tail theory that people only focus on important person or important matter, if use normal distribution curve to portray these people or things, people focus only on the head of the curve, and the tail of the curve that expend more energy and cost attention to most of ignored people or things. The long tail theory is very useful for the strategy of keywords for SEO [8]. Though a few core or common keywords could bring more than half of the page view of the website, but those search number is not much and clear keywords that is the long tail keywords also could bring considerable page view, and the customer of use long tail keywords search has higher conversion rate, usually much higher than the conversion rate of the common keywords. On the other hand, it has low competition intensity and low cost of the long tail keywords; Once the users use the long tail keywords to search, often show that the user professional stronger and demand more specific [6]. For example, a visitor use of general vocabulary “SEO” to visit the website compare with a visitor use “chongqing SEO”, the latter more easily transform the potential customer of the website.

The two eight principles and the strategy of SEO keywords: one hundred years ago, the two eight principles is proposed by Italian economist Pareto. He thought:

in any a group of things, the most important accounts for only a part of, about 20 %, with the remaining 80 % although is most, but it is the minor [7]. To do the SEO of the project, we first have to find the enterprise's core business keywords and then analyze the long tail keywords that captures the flow by using two eight principles, and potential customers flow by using the long tail theory, to avoid the risk of a long shot gamble.

In general, we have to choose keywords scientifically, analyze “long tail keywords,” and also consider the “two eight principles.”

### ***56.3.2 The Strategy of Web Page Optimization***

The value of web page optimization is that your web page subject should be consistent to the keywords, but not just repeat keywords, and you should perfect integrate the title and the keywords of your web page. These specific strategies are as follows [3, 6, 8].

1. To specify the theme of the web and the theme of the website is different of the pages theme; for the web name, we should use the name less complicated and search friendly.
2. Search engine usually use the title of the page as the source text to presents your site links to users search, so we should be sure very important page titles, which should pay attention to the useful and outstanding keywords, to control the length and frequency of the title words;
3. Use web page describing sentences and keywords tag to introduce your web content;
4. The keywords placed the web page title's head tag; this tag should include the most important keywords, and according to the strength of the keywords put it in six titles by use different font;
5. To optimize the website that is most important to optimize the text, it should be based on keywords to organize the content, and to master the keyword density, to update usually, to use original keywords.

### ***56.3.3 The Strategy of Source Code Optimization***

In the search engine retrieval, the web page description tag is very important in web HTML files, because the tag usually could be said a probably introduction of your web content. The description between <head> and </head> in HTML of web page, in order to facilitate said, for example, of chongqing normal university, its main description on “ecms:”

```
<title>ChongQing Normal University</title>
<meta content = "ecms" name = "keywords"/>
```

```
<meta content = “ecms” name = “description”/>
<meta http-equiv = “Content-Type” content = “text/html; charset = gb2312”>
<META content = “MSHTML 6.00.2800.1106” name = GENERATOR>
<link href = “css/style.css” type = “text/css” rel = “stylesheet”/>
```

Writing is very important for description tag, search engine through reading it to understand the web pages, and always quote it as search results of the “web extract” to provide the uses. So, we should make full use of web page description and keywords, but should avoid excessively repeat. As search engines can not read pictures very well, each image has his own name, such as:<td width = “1003” height = “and” colspan = “3” background = “/images/index\_01. JPG” > ; in this picture label, we could improve “index\_01. JPG” to “ChongQing Normal University beautiful campus.”

#### **56.3.4 The Strategy of Website Structure Optimization**

Rational website column structure could correctly express the basic content and the content hierarchical relationships, which is stand in the user’s point of view and help users expediently to obtain information from site, not lost. At the same time, match make the website structure to search engine retrieval is very important in the improvement of ranking retrieval. The website structure based on search engine should be flat, because the flat network structure benefit to the web spiders crawl and grab. The specific optimization strategy based on the flat website structure is as follows [3, 9, 10].

1. The frame of the web page: search engine index technology is not able to index website frame structure. If frame structure is already in use, it is suggested that the code of the frame structure to join “noframe” to improve the search engine friendly degrees.
2. The directory structure: directory structure directly reflects in URLs, clear brief directory structure and standard name are not only beneficial of the user experience and site communication, but also it is friendly embodiment of the search engine. As for its length, the most ideal should within the 65 characters, URL page level best control within the two layers.
3. The web page size: through use external the CSS and JS code could reduce the web page code, to enhance loading speed of the web page, to let the spider fast index to the important content.
4. The use of FLASH: do not design as FLASH for all the pages; we should embed it in HTML. That means, the key button links of going into web are outside the FLASH files with independent express by pure text links.
5. The use of pictures: generally speaking, search engine read only text content, and not the image content. At the same time, the image files directly increase delay time and grab burden the search engine. Therefore, the core of image optimization has two points: on one hand, it is use the ALT attribute of pictures, to

- increase visible text of search engine. On the other hand, it is to keep the quality of the images in the case as far as possible to compress the image size.
- 6. The static dynamic web: recently, many websites have a database driven generated URL that means dynamic URL, this will not benefit to grab the page by search engine, will influence the website ranking, and usually through the technical solutions to change the dynamic URL to static URL form such as <http://www.A.com/hi.aspx?Name=Beijing> change to <http://www.A.com/hi/> Beijing.
  - 7. The site map: Site map is the rules page that guides the spider to grab; when spider group comes to this site and analyzes whether the site map is updated or not, the reasonable manufacture directly affects the grab result of the entire site page content.

### 56.3.5 *The Analysis of Link Strategy*

According to the PR algorithm of website ranking, the web link quantity, the link quality, and the effective like based on the SEO are very important. Commonly, the single page export links do not more than 15, this control within 10 of the home page [6]. No matter export links, import links, or internal links should contain keywords in the link text when internal links a site page often the page links to each other. Such as the article behind of “relevant article” list will link other articles of the same theme in the web site, and not only convenient visitors, but also beneficial index page by search engine. At the same time, more pages link the same page, to help the search engine ranking. External links should choose the related theme or complementary website. This indicates the professional of web site and also to increase the chance of search engine retrieval [6]. At the same time should be avoid the 404 mistakes of web page. Http 404 error means that links to web page does not exist, to get the “404” state, that know the page to lose efficacy, no longer index the page and to delete this page from index database [7].

## 56.4 Conclusion

The site optimization based on search engine aims to improve the structure and content of the site other than competitive ranking, so as to provide convenience and fast source information to search engine, to help users more find these sites information with easy. By use a good SEO website, really bring users, but to attract and keep these users is the content of the web site. So, we can not excuse optimization in the purpose of optimizing and even by cheat or opportunist to search engine, because website is facing users, not for search engines. In the website construction site in early and marketing, combining the SEO and website content is very important.

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## Chapter 57

# A PSVIOQ-CICQ Solution Based on CICQ

Xiuqin Li and Xiliang Yang

**Abstract** A PSVIOQ-CICQ solution for differentiated quality of service (QoS) based on CICQ is proposed. The design of PSVIOQ-CICQ introduce virtual queue technology, input buffer is set to N VOQ, collaborate with the load balancer complete the balanced allocate of load. Output buffer is set to N VIQ, collaborate with the cell integrator complete the cells forward in order and provide QoS guarantee. Simulation shows that PSVIOQ-CICQ has good fairness and load balancing and achieves the design objects overall.

**Keywords** Parallel switch • Differentiated QoS • Combined input and cross-point queue (CICQ) • Scheduling algorithm

## 57.1 Introduction

In recent years, due to the development in Internet business by leaps and bounds, the traffics in Internet will be more and more abundant and variety. But all of these developments make the network switching equipment to face the problems that how to improve exchange rate and capacity, in order to meet the requirement of more and more business volume. At the same time, the network switching equipment also faces the problem that how to improve the quality of service (QoS) support capability of it. In the past few years, PPS [1, 2] has been considered a powerful mean to reduce the bandwidth requirement [3, 4] and to improve the exchange rate and capacity of switch system. But PPS cannot support QoS [5, 6], although the DS-PPS proposed in literature [7] can provide a certain degree of QoS guarantee, but the complexity of its scheduling algorithm is too high. A new dimension sequence PPS structure based on CIOQ is proposed in

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literature [2], compared with the mainstream PPS design in current, which has the best delay performance, but it cannot provide QoS guarantee also. The main problem of PPS design is how to lower the communication overhead to maintain the order of packets for each flow, provide QoS guarantee for different traffic requirements, and the system can implement simply.

In order to solve the problems above, the PPS structure PSVIOQ-CICQ is proposed in this paper, which is based on CICQ and supports different QoS. PSVIOQ-CICQ can not only complete the cells forward in order, but also provide QoS support for different service requirement traffics.

## 57.2 Switch Structure PSVIOQ-CICQ

The switch structure model of PSVIOQ-CICQ is shown in Fig. 57.1, divided into three parts: input part, switch part and output part. The structure of middle switch planes is CICQ;  $k$  is the number of middle switch planes;  $N$  is the number of ports in PPS system;  $R$  is the biggest line rate of input port.

Using CICQ as middle switch module is the first feature of the structure, which can make good use of the advantage of CICQ. The second feature of PSVIOQ-CICQ is the VIQ structure adopted in output cache, which is proved to effectively guarantee the sequence of traffic cells.

## 57.3 Related Concepts and Conventions

Based on PSVIOQ-CICQ, according to the load balance and keep cells order requirement of PPS, RR-DDRRP (round robin and dynamic dual round robin preserving algorithm) scheduling algorithm is proposed in this paper, which can guarantee the cells keep in order after they through the switch system, and at the same time, the scheduling algorithm has load balancing and high-throughput performance.

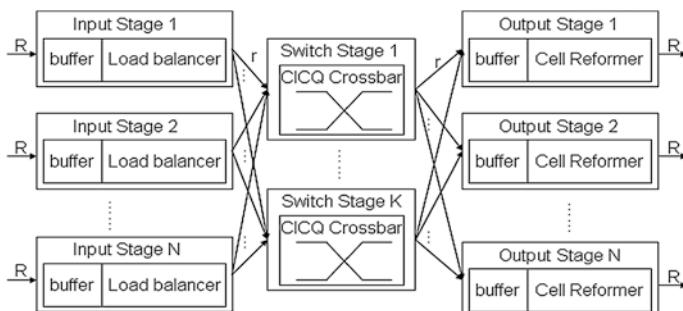
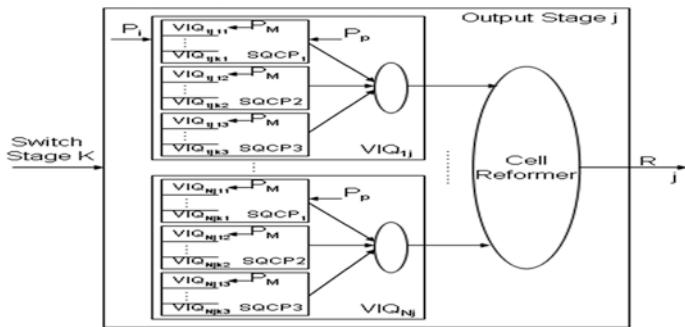


Fig. 57.1 PSVIOQ-CICQ structure



**Fig. 57.2** Output part structure with priority queue

Suppose that PSVIOQ-CICQ use fixed-length packet as the processing unit, in order to facilitate the description, we call it as fixed-length packet cell.

$H_{ijm}$  : the mth cell of GD entered into PPS, input port is i, and output port is j.

$M_{ijm}$  : the mth cell of GB entered into PPS, input port is i, and output port is j.

$L_{ijm}$  : the mth cell of LG entered into PPS, input port is i, and output port is j.

$VOQ_{ij}$  : the cache queue in demultiplexer, which is used to store the cells that come from input port i and go to output port j temporarily.

$VOQ_{ijk}$  : the cache queue in the kth middle switch plane CICQ, which is used to store the cells that come from input port i and go to output port j temporarily.

$VIQ_{ij}$  : the cache queue in multiplexer, which is used to store the cells that come from input port i and go to output port j temporarily.

$VPQ_{ijp}$  : the priority queue in demultiplexer, which is used to store the cells that come from input port i and go to output port j and has priority P temporarily.

$VIQ_{ijkp}$  : the priority queue in multiplexer, which is used to store the cells that come from input port i and go to output port j and has priority P temporarily.

The cells will forwarded through switch system by middle switch plan k.

$SPQC_p$  : the assembly of  $VIQ_{ijkp}$  in multiplexer j which has the same priority is shown in Fig. 57.2.

## 57.4 Distributed Cell Dispatch Algorithm for Load Balance

Load balancer uses time slot as the basic time unit for work, and every time slot needs to complete N scheduling. Using round robin way provides service for VOQ, and each round robin starts from the priority pointer to find VOQ has cell need to be forward. After found, the status of link that corresponds to the middle switch plane to which the cell will go is judged. If the link is free, then the waited cell is forwarded to the destination middle switch plane. At the same time, according to the information of VOQ, the cell that will be forwarded to next time slot and then to the middle switch plane to which the cell will go is determined. Otherwise,

continue to look for VOQ until find one or all VOQ were traversed. Cells belonging to the same VOQ are forwarded to middle switch planes in round robin, and every k cell is a cycle.

## 57.5 Distributed and QoS Supported Cell Integrator Algorithm

After forwarded, the cells belonging to the same traffic flow first enter into  $VIQ_{ij}$ , and then, according to the different middle switch plane that the cells passed and the different type of the cells, they will enter into  $VIQ_{ijkp}$ ; finally,  $1 \leq i, j \leq N, 1 \leq k \leq m$ , m is the number of middle switch planes,  $1 \leq p \leq P$ . According to the traffic model defined in the solution, PIR (peak information rate) is defined, and it represents the highest bandwidth that GD traffics can obtain; CIR (commit information rate) is defined, and it represents the lowest bandwidth that GB traffics can obtain. In order to support QoS, the reservation bandwidth mechanism was introduced to cell integrator algorithm DDRRP, the reservation bandwidth for GD traffic is  $RB_1 = 1.1PIR$ , the reservation bandwidth for GB traffic is  $RB_k = CIR_k$ , at the same time sets a counter in multiplexer for each traffic, which is used to count the actual bandwidth that is obtained by every traffic type, called BS (Bandwidth Statistic). When the algorithm DRRP provides service for a certain type of traffic, it will compare BS and RB of the traffic, and if  $BS < RB$ , the algorithm will provide service for it; otherwise, the algorithm will not provide service for it.

## 57.6 Simulation Analysis

The effectiveness of PSVIOQ-CICQ was certificated by simulation, which evaluates the performance of the system from the aspects of load distribute balanced degree, bandwidth allocation fairness degree, delay and throughput. Simulation system also implements the VIQ PPS, in order to compare analysis the effective of the PPS system. In the input ports, the proportion of GD, GB and LG are 30, 50 and 20 %, respectively, while the bandwidth reservation was 0.30, 0.50 and 0.20, respectively, and then, the load changes from 0.1 to 1. A single simulation cycle is 100,000 (105) time slots.

As can be seen from the Fig. 57.3, before the load reached 0.3, bandwidth acquired of the three businesses are on the rise, the access bandwidth and the arrival rate of them are respectively equivalent. This is because the volume of business is not up to overload conditions at this time, and three types of business are all not subject to the bandwidth limitations of their appointment. When the load is more than 0.3, the business volume overload, three kinds of operations obtain the corresponding bandwidth under the limitation of their bandwidth reservation. Data of Fig. 57.3 indicate that the starvation phenomenon caused by the competition for

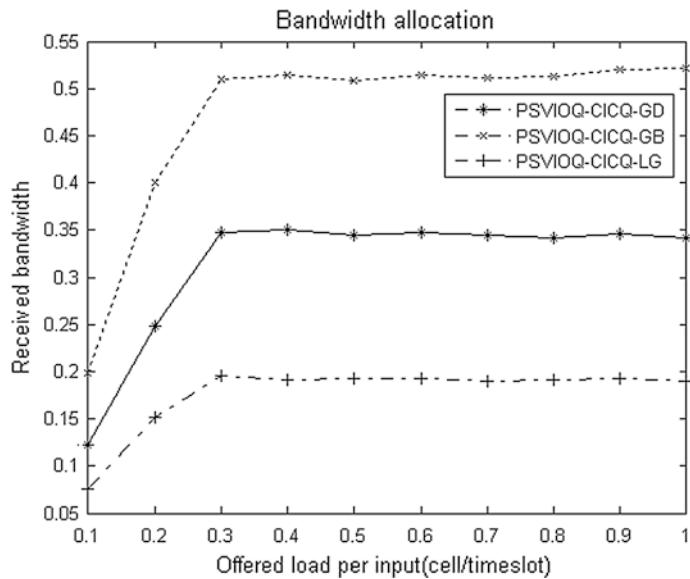


Fig. 57.3 Bandwidth allocate

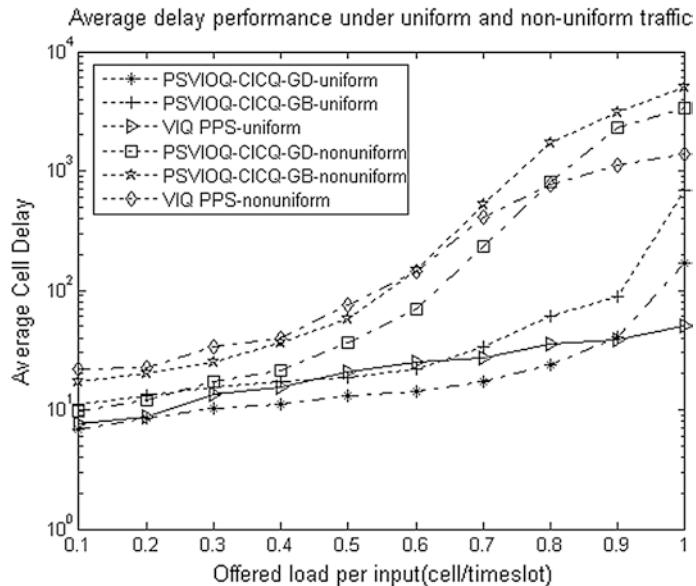


Fig. 57.4 Average delay of GD and GB under uniform and non-uniform traffic

bandwidth between low-priority traffics and high-priority traffics under overload does not exist. The PSVIOQ-CICQ system has good fairness performance.

As can be seen from the figure, the two traffics have better delay characteristic when the load is light, and when the load is heavy, the delay performance will

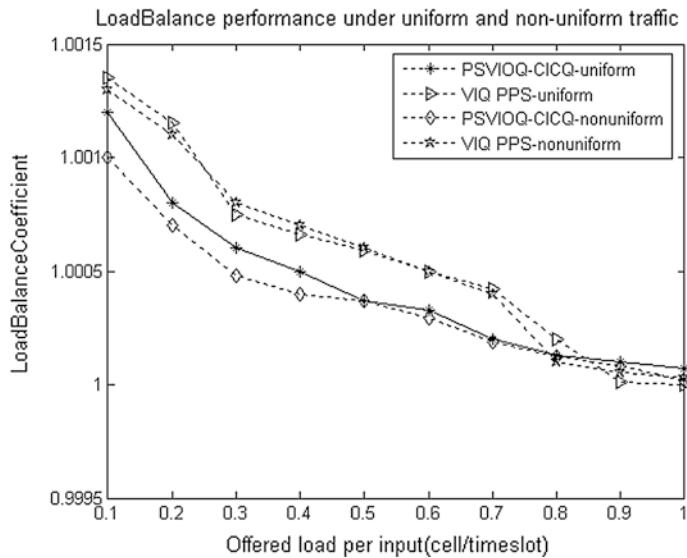


Fig. 57.5 Load balancing factor under uniform and non-uniform traffic

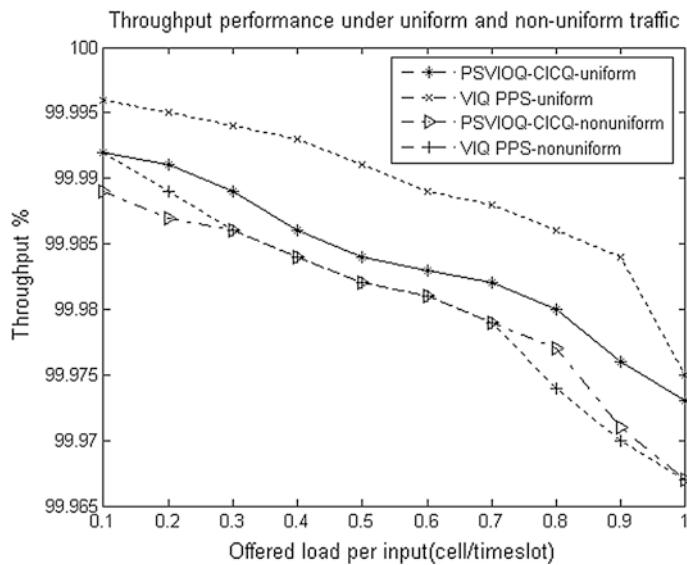


Fig. 57.6 Throughput under uniform and non-uniform traffic

deteriorate rapidly; this is mainly because when the load increased to a certain extent, the exchange network congestion levels will continue to increase as the load becomes larger under the same processing condition of switch system, and as a result, processing capacity of switch system decreases, the cell waits for a long time, and the delay performance get lowered. At the same time, we can see

from Fig. 57.4, compared with VIQ PPS, under non-uniform traffic source, when the load is lower than 0.8, GD traffics have better delay performance in PSVIOQ-CICQ, and GB traffics have similar delay performance. Under uniform traffic source, when the load is lower than 0.9, GD traffics have better delay performance in PSVIOQ-CICQ, and GB traffics have similar delay performance. The experimental results in VIQ PPS [2] indicate that among the distributed scheduling PPS system, VIQ PPS has the best delay performance, which illustrates that PSVIOQ-CICQ can meet the requirement of design objective.

Figure 57.5 responses load balancing factor changes with the load changes. As can be seen from the figure, load balancing factor changes in the range of (1, 1.0012), which means the cell numbers that enter different exchange planes have little difference, compared with VIQ PPS, and they have the similar load balancing performance. From Fig. 57.6, we can see that throughput declines with the increase in the load, but is small; even at the maximum load condition, the system throughput can reach more than 99 %, and the system has good throughput performance.

## 57.7 Summary

A PPS solution PSVIOQ-CICQ is proposed in this paper, which is based on CICQ and supports different QoS. In the design of the solution, we introduced VIQ into output cache, in order to guarantee keeping the cells in forward order. Scheduling algorithm of load balancers and packet integrators designed based on it can provide QoS support for different traffics that have different service requirement. From the analysis of simulation experimental results above, we can see that the PPS solution can distribute load into the balanced system obtained. More than 99 % throughput in the case without internal acceleration and can according to the reservation bandwidth to allocate the bandwidth of output links, and ensure packets have an upper delay bound. The solution has basically reached the requirements of design objects overall.

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**Part VII**

**Computer Graphics and Image Processing**

# Chapter 58

## An Image Recognition Method Based on Scene Semantics

Y. Zhang and Y. Ma

**Abstract** Aimed at the image recognition between scenes and objects, we propose a sort of image recognition method based on scene semantics (IRMSS). In IRMSS, the landmark objects of various scenes are collected to form a feature database named Symbolic Objects Database and marked firstly; secondly, the remaining objects in the image could be identified one by one according to scene semantics known from the step forward; and thirdly, the scene of the image would be repeated validated and continuous concreted by using recognition results of each time to form a feedback system for the recognition of image semantics. At final, the simulation experiments showed that IRMSS could sharply promote the accuracy and efficiency of image semantic recognition in the case of strong semantic scene.

**Keywords** Image recognition • Image semantics • Scene semantics

### 58.1 Introduction

To the massive image data and many semantic content of the image, the image scene not only contains the general knowledge of an image, but also provides a basis to further identify the other elements of the image. Hence, it is how to make computer automatically classify the images into different semantic categories by simulating human cognitive understanding mechanism of the image recognition and identify image objects according to specific scene semantics that become the key issues.

According to the different ways of describing images, the current scene classifications can be divided into two categories—based on global features and based on the “word bag model.” The early scene classification is based on global statistical

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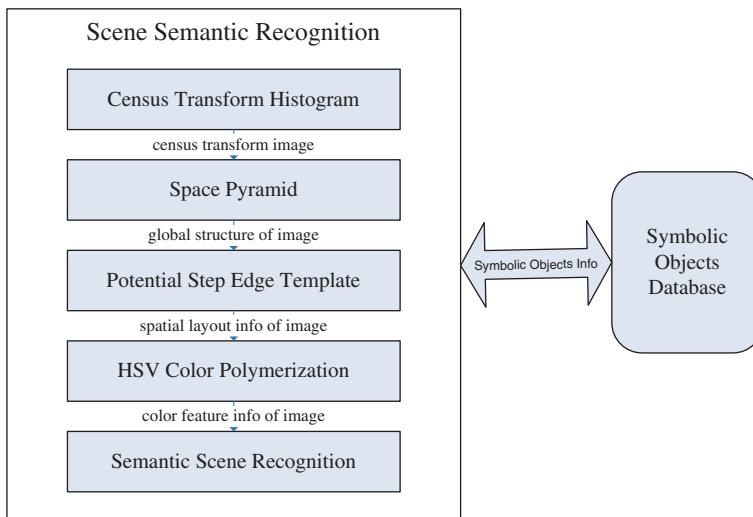
characteristics of image content to describe the scene, for example, Oliva et al. [1] proposed a set of visual perception attributes such as naturalness, wide, roughness, stretch degree, and dangerous. In recent years, the mainstream scene classification is to express image content by the Bag-Of-Word (BOW) [3, 4], and the basic idea of this approach is to firstly define the concept of the image blocks with different semantics called the visual and then use these visual word frequency as the content of the image scene to find the image most likely to belong to the scene category by using supervised learning methods. Based on the BOW model, Fei-fei [5] and Bosh [6] used latent Dirichlet allocation (LDA) [4] model and the probabilistic latent semantic analysis (pLSA) [5, 6] model to get the subject or latent semantics of the image to complete the scene classification of the image; Lazebnik et al. [6] used space pyramid model to extract the spatial distribution of visual words to complete the scene classification [7, 8].

## 58.2 Image Recognition Model Based on Scene Semantics

As the interaction between scenes and objects in the image recognition, image recognition model based on scene semantics (IRMSS) is shown as Fig. 58.1.

Known from Fig. 58.1, the basic workflow of the IRMSS is as follows:

1. The landmark objects of various scenes such as sofa, coffee table, and bed were collected to form a feature database named Symbolic Objects Database;
2. The scene expressed by the image semantics is initially determined and marked by using the image of the landmark objects;



**Fig. 58.1** Image recognition model based on scene semantics

3. The remaining objects in the image could be identified one by one according to the scene semantics known from the step 2;
4. The scene of the image would be repeatedly validated and continuous concreted by using the recognition results of each time to form a feedback system for the recognition of the image semantics.

## 58.3 Algorithm for IRMSS

### 58.3.1 *Scene Semantic Recognition Based Space PACT*

The space PACT is a new features expression to identify the scene instance and category, in which PACT is combined with the latest recognition framework for the semantic scene—space pyramid to get a higher recognition rate. In the IRMSS, the potential step edge template and color characteristics information would be introduced into the space PACT for the higher efficiency and capability of the semantic recognition.

#### 1. Principal component analysis of Census transforms histogram

The Census transform is a nonparametric local transform in which the transform value of one pixel could be got by using the intensity values of eight neighboring pixels. As a visual approach, a “Census Transform Image” could be got by replacing the intensity value of a pixel for its Census transform to retain the global and local features of the image; the more compact feature representation would be got by using the principal component analysis of the Census transform histogram to eliminate the correlation of all kinds of Census transforms.

#### 2. Space pyramid

The space pyramid divides an image into many subregion in which the relevant results could be integrated. In order to ensure that the number of pixels contained in each block of each calculation is consistent, the size of the image should be changed before connecting the PACT of all the pieces form a global feature vector.

#### 3. Potential step edge template

In the space PACT approach, the image feature information would be obtained by statistical Census transform histogram. What practically describe image characteristics are mainly edge points of images which are the points with large gray changes in the image, and the maximum gradient pixels which could be calculated by difference are edge points of images. Because the values of adjacent pixels in the Census transform have a strong correlation whose transitivity of transformation constraints could make the Census transform histogram imply the information which describes the global structure as well as some bins in the histogram exactly correspond to the ladder of potential edge points, the image semantic features could be characterized by counting the potential edge points with the definition of the potential step edge templates to simplify the Census transform histogram. As for the scene semantic recognition, the most important thing is not the image

details but the local images features of the spatial layout information, so compared with the original Census transform image, the potential edge points from the potential edge template hold the local features of the spatial layout information clear.

#### 4. HSV color polymerization

The HSV color polymerization corresponds to three elements of visual color characteristics of human eye—Hue (H), Sautartino (S), and Value (V) with independent channels. The HSV color polymerization uses the color moments to express the color distribution of images. As the color distribution information concentrates in the low moments, the IRMSS takes mean, variance, and skewness with its mathematical expression:

$$\mu_i = \frac{1}{N} \sum_{j=1}^N p_{ij} \quad (58.1)$$

$$\sigma_i = \left( \frac{1}{N} \sum_{j=1}^N (p_{ij} - \mu_i)^2 \right)^{\frac{1}{2}} \quad (58.2)$$

$$s_i = \left( \frac{1}{N} \sum_{j=1}^N (p_{ij} - \mu_i)^3 \right)^{\frac{1}{2}} \quad (58.3)$$

In order to make up the defect that the color histogram and color moments can not express the color space location of the images, the IRMSS introduces the color coherence vector. The color would be discretized into N-bins, and the pixels belonged to each bin of the histogram would be divided into two parts—if the continuous region occupied by some of the pixels within the bin larger than a given threshold, the pixels in the region would be seen as polymerization pixels; else the pixels in the region would be seen as non-polymer pixels.

#### 5. Semantic Scene Recognition

The color feature information is introduced into the space PACT to get the feature representation, which could be used for the semantic scene recognition:

$$C_{\text{space}} = [\omega_1 \times \text{space}, \omega_2 \times \text{color}] \quad (58.4)$$

where space is feature vector obtained by the space PACT algorithm, color is the color feature vector obtained by the color feature extraction algorithm, and  $\omega_1$  and  $\omega_2$  are the weights of the two vectors.

The most important thing is to ensure the accuracy of semantic scene categories, which means that the matched scenes should be similar in the spatial distribution characteristics on which the strong semantic recognition of color features could be done, so the weight  $\omega_1$  of spatial distribution characteristics should be larger than the weight  $\omega_2$  of color features.

To each image, the strong semantic feature histogram could be got by the formula (58.2), and the matching among features could be done by using  $\chi^2$ , similarity criteria in the formula (58.3) to find the matching with the most similar semantics.

$$\chi^2(h_i, h_j) = \frac{1}{2} \sum_{k=1}^K \frac{[h_i(k) - h_j(k)]^2}{h_i(k) + h_j(k)} \quad (58.5)$$

### 58.3.2 Object Recognition Based on Neural Network

In view of the object recognition part of the IRMSS is a self-learning feedback system; the BP neural network could be chosen to produce its algorithm.

#### 1. Image preprocessing

In this step, the gray scale adjustment, noise removal, and feature normalization would be done to the input image in order to extract image feature such as the texture, the structure characteristics, and the coefficient of variation features effectively to construct the image feature set  $P_{ij}$ .

#### 2. Feature Selection and Extraction

In this step, the features which could identify the object most effectively would be selected to be the input vector of the BP neural network from a number of features.

If the feature values chosen is less, the network is difficult to converge; if the input vector is too large, the network convergence time would be extended. So, IRMSS extracted the edge property, the fifth-order invariant feature, and twelfth-order invariant feature, and its specific method would be that the images would be divided into 8 parts in which the number of would be took as 8 features and the number of pixels in the middle two horizontal lines and two vertical rows would be took as 4 features.

#### 3. Attribute reduction

According to the data sheet provided by the system, the coordination of data tables would be considered firstly, and then, each condition attribute would be deleted in proper order according to the condition that if the deletion of the attribute makes the table incompatible, the attribute should be retained, otherwise the attribute should be omitted.

#### 4. Design and learning of BP neural network

As the BP network in a supervised training process can be carried out automatically for effective learning, so IRMSS used BP network as the basic network structure and divided it into four layers:

Input layer: the input data are condition attributes after reduction, and the number of neurons is the number of condition attributes;

Hidden layer: the m-input would be mapped to the next level by a nonlinear relationship;

Supposed that the connection weight matrix between input layer and hidden layer is  $\omega_{ij}$ , the output of H layer would be calculated as follows:

$$H_j = f_1 \left[ \sum_{i=1}^m \omega_{ij} \times X_i + \alpha_i \right], \quad j = 1, 2, \dots, q \quad (58.6)$$

Rule layer: the number of neurons is the number of rules generated after reduction in which one neuron is on behalf of one rule;

The output of R layer would be calculated as follows:

$$R_j = f_2 \left[ \sum_{j=1}^q \omega_{jk} \times H_i + \beta_i \right], \quad k = 1, 2, \dots, s \quad (58.7)$$

Conclusion layer: the output would be the final recognition results.

The output of C layer would be calculated as follows:

$$C_r = f_3 \left[ \sum_{k=1}^s \omega_{kr} \times R_k + \theta_i \right], \quad r = 1, 2, \dots, n \quad (58.8)$$

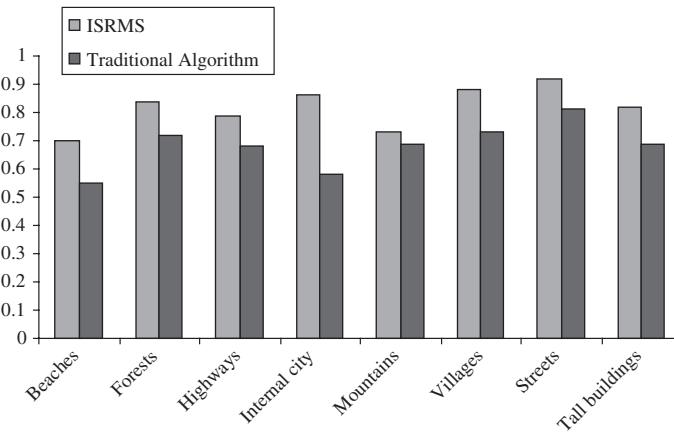
## 58.4 Simulation

In order to verify the validity of the IRMSS, the MIT standard image database which hold 2,688 images under 8 classes of scenes such as beaches, forests, highways, internal city, mountains, villages, streets and tall buildings would be used.

In the part of the scenes recognition, the entire image database are randomly divided into training set and test set, and 50 images are randomly selected to join the training set for each type of scene as well as 50 images were randomly selected to join the test set for each type of scene.

Firstly, a SVM classifier with radial basis function as its core function would be selected for each type of scene; then, the output confidence value of scene classifier for each test image would be calculated by using the formula (58.1) to the formula (58.3), and the highest value would be chosen as the scene of the image. In this simulation experiment, the entire image library is done 10 random divisions by following the steps above to generate the corresponding training and test sets; then, the classification accuracy of each division would be calculated, and the mean classification accuracy of the 10 divisions is seen as the final average classification accuracy rate.

In the part of the objects recognition, the multi-input single-output 3-layer structure is used, in which 16 nodes are set in the input layer according to the eigenvector, 8 nodes are set in the rule layer according to the number of required classification, 1 node is set in the output layer, the activation function are logsig and purelin, the training function is traingdx, the learning function was learningdm, the learning rate is 0.1, and the error rate is 0.002. The result is shown as Fig. 58.2.



**Fig. 58.2** IRMSS compared with traditional algorithm

Seen from Fig. 58.2, for all the images, the accuracy of the images semantic recognition based on the scene is higher than the traditional ways. The most performance-upgraded is internal city, because the most images in this type of scene had similar semantics although showing a great difference in the visual features, as for the scenes with obvious texture properties such as forest; there is no significant increase in the recognition performance, because the visual characteristics of the image itself can be fully reflected in its semantic. Therefore, the results show that IRMSS could greatly enhance the accuracy and efficiency of the image semantic recognition in the case of the strong scene semantics with relatively insignificant texture properties.

## 58.5 Conclusion

This paper presents a IRMSS, in which the potential step edge template and color characteristics information are introduced into the space PACT to identify the scene semantics of the image, and then, each object in the image would be identified according to the semantic scene, and the scene of the image would be repeatedly validated and continuous concreted by using the recognition results of each time to complete the image semantics recognition. The experiments show that in the scene semantic recognition, IRMSS could ensure the similar of the spatial layout information as well as the similar of the color feature; in the image semantics identification, IRMSS could identify the image according to the known scene information by using the neural network and finish self-learning by using recognition results obtained, which can improve the accuracy of the object recognition.

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# Chapter 59

## A Synthesis Method for Personalized 3D Face Reconstruction

Yu-chen Yan, Hai-bin Liao, Qing-hu Chen and Cheng-Yi Xiong

**Abstract** In order to balance modeling time and modeling accuracy of 3D face reconstruction, in this paper, we propose an integrated modeling approach combining shape-from-shading (SFS) and local morphable model (LMM), which can rapidly create a realistic 3D face model on the basis of a single 2D image. This method obtains 3D face (which is called 3D contour face) quickly by SFS firstly; then, recovers local accurate 3D data by LMM; lastly, reconstructs a 3D face model of high accuracy by carrying out interpolation smoothing on the 3D contour face with local 3D accurate data. Experimental results show that the method has the advantages of modeling with higher accuracy and lower complexity, and can reconstruct personalized 3D face model from a single real-world photo in a short time.

**Keywords** 3D face modeling • Shape-from-shading • 3D morphable model • Radial basis function interpolation

### 59.1 Introduction

3D face modeling is a fundamental problem of 3D face synthesis, analysis, animation, face detection and recognition. Realistic face modeling is the prime focus of graphics computation, machine vision and so on; it plays an increasingly important role in the applications of face recognition, video calling, computer aided instruction (CAI), facial medicine, video games, virtual reality, etc.

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Face shape modeling can be divided into two categories according to the data sources: one is to establish the visual model based on 3D face data directly [1, 2] and the other is to reconstruct a special 3D face model by deforming a standard model derived from 2D images or videos [3, 4]. The latter is currently the focus of most research, and one of the practical, efficient methods is single-image-based 3D face modeling. One of the popular methods is shape-from-shading (SFS) [5, 6]. For face image, SFS can recover the depth information of the part of cheek and forehead well, but the organ parts of face bad. The two advantages of this method are low modeling conditions (single image only) and short modeling time, while the disadvantage is its low accuracy. Another approach is to learn the set of allowable reconstructions from a large number of faces in a database. This can be achieved by embedding all 3D faces in a linear space [7, 8]. For example, Blanz et al. proposed a morphable model method which uses 3D face database as a priori knowledge to constrain the face model, and successfully obtains automatic reconstruction of 3D faces from a single image. The method can achieve accurate reconstructions, but the model requires further development to reduce iteration times as well as point-wise correspondence between all the models. Additionally, the model matching algorithm is over-dependent on the initial value, easily leading to failing modeling caused by the local optimal solutions [9].

Summarizing the existent methods of 3D face modeling, there are three deficiencies: (1) rigorous condition demand; (2) unsatisfactory modeling accuracy and (3) bad speed quality. It is very difficult to solve the three deficiencies using only one method at the same time, and the blending of several methods together is the trend of developing in future. For example, Fua and Leclerc, who proposed a 3D face modeling method based on stereo vision and SFS [10], shared the same idea that stereo vision makes a complement to SFS. This method can improve the modeling accuracy and shorten matching time in certain degree, but demand the input of two orthogonal images or many multi-view images as well as the most difficult registration. For another example, Wallraven et al. have proposed a combining method which combines the stereo vision and morphable model skillfully, which improves the modeling accuracy [11]. Compared with the traditional morphable model methods, this method also needs settle the difficult problems of denseness corresponding and matching, which affects the machine time. Aiming at the three deficiencies in 3D face modeling, this paper mainly probe into how to reduce the modeling condition, improve modeling accuracy and accelerate modeling process. In order to meet the requirements of realistic application, we propose a combined method based on SFS and local morphable model (LMM) for the sake of solving the three problems above; the established model has flexible application and expansibility quality.

## 59.2 Rapid Recovery of 3D Contour Face

In the fields of computer vision, the techniques to recover shape are called shape-from-X techniques, where X can be shading, stereo, motion, texture, etc. SFS is one of the techniques that recover shape from a gradual variation of shading in the image. To solve the SFS problem, it is important to study how the images are formed. A simple model



**Fig. 59.1** SFS-based depth recovery results: the *left image* is the input 2D gray image and the *right image* is the facial surface depth recovered by SFS

of image formation is the Lambertian model. However, real images do not always follow the Lambertian model. Even if we assume Lambertian reflectance and known light source direction, and if the brightness can be described as a function of surface shape and light source direction, the problem is still not simple. Therefore, SFS is an ill-posed problem, it needs to introduce additional constraints and be converted to a regular optimization problem. In this paper, we applied the intensity gradient constraint [12], instead of a smoothness constraint [13], and used B-spline variation method to solve SFS problem. Figure 59.1 shows the results of the SFS algorithm.

Mark the 3D shape data solved by SFS. Firstly, we marked the key points in 2D face image and divide face image into seven local organs. Secondly, we denoted  $V = \{x_j\} \subset R^3$  as the set of all vertices of the 3D face solved by SFS, and denoted  $V_b = \{x_i\}_{i=1}^{N_b} \subset V$  as subset, where  $N_b$  is the vertex number of eyebrow area, which is obtained from the first step. Eyes, nose, mouth, forehead, cheek and chin area are as follows, respectively  $V_e = \{x_i\}_{i=1}^{N_e} \subset V$ ,  $V_n = \{x_i\}_{i=1}^{N_n} \subset V$ ,  $V_m = \{x_i\}_{i=1}^{N_m} \subset V$ ,  $V_f = \{x_i\}_{i=1}^{N_f}$ ,  $V_c = \{x_i\}_{i=1}^{N_c}$ , and  $V_{c2} = \{x_i\}_{i=1}^{N_{c2}}$ , where, eyebrows, eyes, nose and mouth areas need to be repaired.

### 59.3 3D Organ Data Recovery Based on Morphable Model

Prototypic 3D faces in BJUT-3D face database [14] are used as prior information. The 3D facial point-to-point denseness correspondence is executed firstly. After dense correspondence, we can build the LMM for face organ. Taking nose area shape  $s_i$ , for example, it can be denoted by a vector:

$$s_i = (x_1, y_1, z_1, \dots, x_k, y_k, z_k, \dots, x_n, y_n, z_n) \in R^{3n} \quad (59.1)$$

where  $i = 1, 2, \dots, m$ ,  $m$  is the number of noses, and  $n$  is the vertices' number of nose shape.  $(x_k, y_k, z_k)$  is the coordinates of the  $k$ -th vertex. Take  $m$  vectors of nose shape to form a linear subspace, which can be expressed by the matrix  $S = (s_1, s_2, \dots, s_m) \in R^{3n \times m}$ . To any new nose shape,  $s_{\text{new}}$  can be denoted by a linear combination of the known vectors ( $v$ ):

$$s_{\text{new}} = \sum_{i=1}^m a_i \cdot s_i = S \cdot \alpha, \quad \alpha = (\alpha_1, \alpha_2, \dots, \alpha_m)^T \quad (59.2)$$

where  $\alpha_i \in [0, 1]$ , and  $\sum_{i=1}^m \alpha_i = 1$

In order to eliminate the correlation between noses and reduce data volume, principal component analysis (PCA) for reducing dimension is required. Getting the  $m'$  columns of nose swshape eigen matrix  $Q = (q_1, q_2, \dots, q_{m'})$  built by the  $m' (\leq m - 1)$  eigenvectors of the covariance matrix  $\sum_s$  whose corresponding eigenvalues are dominant, then, Eq. (59.2) can be denoted as:

$$s_{\text{new}} = \bar{s} + Q \cdot \beta = \bar{s} + \Delta s \quad (59.3)$$

where  $\beta = (\beta_1, \beta_2, \dots, \beta_{m'})^T \in R^{m'}$ ,  $\bar{s} = \frac{1}{m} \sum_{i=1}^m s_i$

Equation (59.3) indicates that a special nose shape can be obtained by adding a deviation  $\Delta s$  to an average nose. The holistic deviation  $\Delta s$  is calculated according to  $\Delta s^f$  of  $k$  key feature points. The feature points' coordinates of the special nose can be expressed by vector  $s^f \in R^{2k}$ , then:

$$s^f = Ls, \quad L : R^{3n} \rightarrow R^{2k} \quad (59.4)$$

where  $L$  is a connotative mapping, which is a projection operation for feature selection? Likewise, changing eigen matrix  $Q$  to  $L$  transformation and getting eigen matrix based on the feature points:

$$Q^f = LQ = (q_1^f, q_2^f, \dots, q_m^f) \in R^{2k \times m} \quad (59.5)$$

Based on Eqs. (59.3) and (59.4), thus:

$$\Delta s^f = L(s - \bar{s}) = L(Q \cdot \beta) = Q^f \cdot \beta \quad (59.6)$$

To compute  $\beta$  directly from Eq. (59.6) may lead to over-fitting and even get un-nose because of noises. An alternative solution given by Vetter et al. [15] is using a statistical optimum approach to get the coefficients. The object function based on Bayesian posterior probability is given as:

$$E(\beta) = \|Q^f \cdot \beta - \Delta s^f\|^2 + \eta \|\beta\|^2 \quad (59.7)$$

where the first term represents reconstructing error of the control points, and the second term is a regularization to control the plausibility of the reconstruction.  $\eta \geq 0$  is a weight factor to control a trade-off between the precision of feature point matching and prior probability. It has been proved that:

$$\arg \min \|E(\beta)\| = V \left( \frac{\lambda_i}{\lambda_i^2 + \eta} \right) \cdot U^T \cdot \Delta s^f \quad (59.8)$$

where  $U \in R^{2k \times 2k}$ ,  $V \in R^{m' \times m'}$ ,  $\Lambda = \text{diag}(\lambda_i) \in R^{2k \times m'}$ , according to singular value decomposition (SVD),  $Q^f = U \Lambda V^T$ .

The same operation is applied to other face organs in order to set LMM separately (since the 3D contour face recovered by SFS has high accuracy in the area of forehead, chin and cheek area, morphable model need not to be built in these

three areas to recover their depth) and then optimize them to obtain respective model coefficients. Because every part is comparatively independent, a parallel algorithm is utilized to build model so as to improve modeling speed.

After the 3D contour face and the 3D face organ shapes (eyebrow, eyes, nose and mouth) have been recovered by SFS and LMM, respectively, we can reconstruct a personalized 3D face. The results of SFS perfectly display the changing trend in the areas of the forehead, cheek and chin, therefore, the 3D date of these areas recovered by SFS can be used directly. As to the points on the area of inner face organs, the recovery of SFS may present sunken area, so these parts can be replaced by the results achieved from LMM. A personalized 3D face will be obtained by fusion of these parts. In order to smooth the junction area between the parts, radial basis functions (RBF) interpolation algorithm is utilized to integrate each part intermittently.

## 59.4 Experiments and Analysis

### 59.4.1 Reconstructing Performance Evaluation

Randomly choose 200 individuals (the half is female) from BJUT-3D face database to act as testing set. Firstly, a 2D image testing set is created by carrying the 3D face images in the testing set into orthogonal projection; then, the 3D faces are rebuilt based on the 2D testing set, and compared with the corresponding 3D model (which is the standard model). To evaluate the quality of a reconstruction (with respect to its ground truth), we need an appropriate distance measure to compare two 3D faces. The sum of the Euclidean distances over all vertices of the shapes is the most obvious choice. So we use the average Euclidean distance error  $e_{ed}(\cdot, \cdot)$  between reconstructing model's vertex and the standard model's vertex as the shape similarity evaluation function, which is defined as:

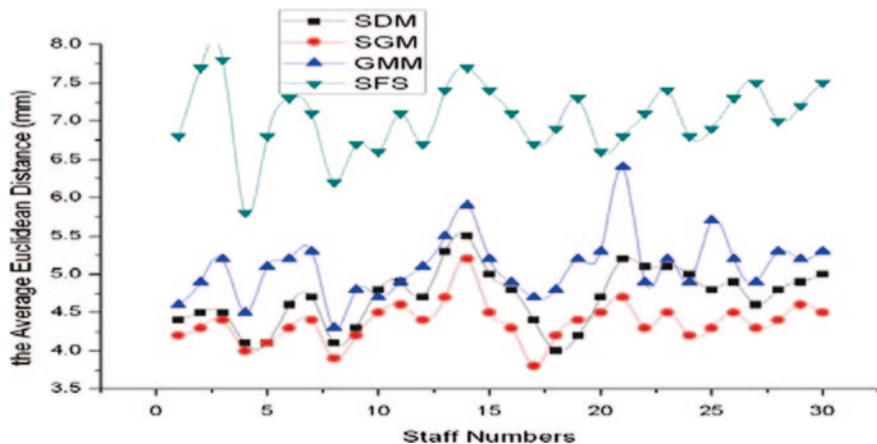
$$e_{ed}(s_r, s_s) = \frac{1}{|V|} \sum_{i \in V} \|v_{r,i} - v_{s,i}\| \quad (59.9)$$

Here,  $s_r, s_s$  are the two 3D models,  $V$  is the set of all vertices of the 3D face and  $v_{r,i}, v_{s,i}$  are the corresponding vertices of  $s_r, s_s$ .

In order to verify the accuracy and speed of the proposed modeling method, in this section, a comparison is made among the proposed method (SGM), the traditional 3D face modeling method based on the global morphable model (GMM), the SFS method and the state-of-the-arts 3D face modeling from single face image (SDM) [16].

The adjustable parameter is  $\eta = 0.0001$ . For SGM and GMM, we chose 1,200 features to build 3D face model; for SDM, we chose 171 landmark points. The part reconstruction error curve can be seen in Fig. 59.2. It can be see from the figure that the SGM method combining SFS and LMM is apparently superior to SFS and GMM method.

The reconstruction error statistics can be seen in Table 59.1: we can see that the reconstruction accuracy of SFS is the worst and GMM is normal; SDM and SGM



**Fig. 59.2** Comparison of reconstruction error

**Table 59.1** Reconstruction error table (mm)

	Mean	SD	Minimum	Maximum
SGM	4.373	0.228	3.8	5.2
GMM	5.103	0.365	4.3	6.4
SDM	4.7	0.3832	4.0	5.5
SFS	7.04	0.4192	5.8	7.8

**Table 59.2** Comparison of reconstruction time

	Reconstruction error (mm)	Reconstruction time (s)
SGM	4.373	4.55
GMM	5.103	12.75
SDM	4.7	6.25
SFS	7.04	2.05

are better and basically meet the requirements of practical application. Table 59.2 shows the machining time of these four methods. Apparently SGM method needs less machining time than GMM, and only lags behind 2 s than SFS scheme, while superiority to SFS on accuracy. We can regard SGM method as a kind of trade-off between modeling time and modeling accuracy, which fully takes advantage of rapidity of SFS and high accuracy of GMM. The SDM method can obtain high accuracy in the key points, but has lower overall accuracy than SGM.

#### 59.4.2 Reconstruction in Real Image Based on SGM

Test results show that the SGM method reconstructs 3D faces quickly and accurately, in this section, we applied the method to several real images that were photographed by us. Reconstructed 3D face textures are projected for greater realism.



**Fig. 59.3** Real-world photos and virtual reconstructions

The results are shown in Fig. 59.3. We can still see that fairly convincing reconstructions are obtained and the reconstructed face models are realistic enough for basic visual applications. Note in particular our method can accurately reconstruct faces under a large variety of uncontrolled expressions (left column) and pose (right column) conditions.

## 59.5 Conclusions

Take advantage of the rapidity and integrity of SFS method and the stability and accuracy of morphable model method, this paper has brought forward a 3D face modeling method based on SFS and LMM, which exerts their advantage, respectively, to solve the problems of rigorous condition, insufficient modeling accuracy and time consuming. Unlike the traditional method of morphable model, the proposed approach attempts to build LMM about the key organs in order to recover its depth information. In this way, we can settle two key conundrums: denseness corresponding and computing complexity as well as design parallel algorithm easily.

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# Chapter 60

## NMF Face Recognition Method Based on Alpha Divergence

Aiming Huang

**Abstract** This paper proposed NMF decomposition method based on Alpha divergence for face recognition, which uses Alpha divergence as a distance measure standard to obtain the corresponding NMF decomposition expression. Through the parameter values derived from the expression, a variety of decomposition iteration expression can be obtained. In each iteration process, the differences are calculated to determine the optimal parameters of the next step. Such decomposition can converge to the global optimum to improve the accuracy of face recognition.

**Keywords** NMF • Alpha divergence • Face recognition

### 60.1 Introduction

Most of the face recognition systems need to be used in a non-ideal environment. For example, under the conditions of different expressions, gestures and lighting, the system efficiency will be affected. Especially, under the interference from noises or complex backgrounds, the recognition rate will be greatly reduced. In order to improve the robustness of the face recognition system, many scholars have made various attempts and have gained some achievements. For example, the subspace methods can have successful applications in face recognition, which include principal component analysis (PCA) [1], Fisher's linear discriminant analysis (FLDA) [2], independent component analysis (ICA) [3], non-negative matrix factorization (NMF) [4, 5]. In this article, the NMF method based on alpha divergence has been proposed for face recognition. This method uses alpha divergence as the measure of distance, and a variety of iterative factorization expressions can be obtained through different parameter values in the corresponding NMF expressions. The difference degree is computed at each step of iteration to determine

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the optimal parameter at the next step, so as to ensure that NMF converges to the global optimum and improve the precision of face recognition.

## 60.2 NMF Algorithm

For an  $n \times m$  non-negative matrix  $V$ , with the NMF algorithm, we can obtain an  $n \times r$  non-negative matrix  $W$  and an  $r \times m$  non-negative matrix  $H$ , namely

$$V \approx W \times H \quad (60.1)$$

Among them,  $(n + m)r < nm$ .

NMF algorithm does not allow negative elements in  $W$  and  $H$ . This constraint leads to the implementation of only addition but without subtraction operations in the process of using the parts to represent the whole. In NMF algorithm, the new values to iterate  $W$  and  $H$  each time are obtained by multiplying the current value with a certain coefficient, and these coefficients depend on the approximate degree in the formula (60.1). To iterate based on this rule, it can be ensured that  $W$  and  $H$  can converge to the local optimum matrix factorization. NMF uses  $V$  and the divergence of  $V$ 's approximate value  $WH$  as the measure of the cost of factoring  $V$  to  $WH$ . The divergences which are traditionally used as the objective functions are LS distance (Euclidean distance) and Kullback–Leibler divergence [6, 7].

LS distance is expressed as

$$D_F(\mathbf{A}, \mathbf{X}) = \frac{1}{2} \|\mathbf{Y} - \mathbf{AX}\|_F^2 = \frac{1}{2} \sum_{i=1}^m \sum_{k=1}^N |y_{ik} - [\mathbf{AX}]_{ik}|^2 \quad (60.2)$$

Kullback–Leibler divergence is expressed as

$$D_{KL}(\mathbf{Y} || [\mathbf{AX}]) = \sum_{ik} \left( y_{ik} \log \frac{y_{ik}}{[\mathbf{AX}]_{ik}} + [\mathbf{AX}]_{ik} - y_{ik} \right) \quad (60.3)$$

NMF cannot guarantee the consistency of the original matrix and the factorized matrixes. To measure their differences, if their divergence functions are different, their iterative factorization formulas are also different. Therefore, NMF column optimization problem will be transformed into the reduction in the distance between the matrix  $Y$  and the matrix  $\mathbf{AX}$ .

$$\begin{aligned} \min_{B, H} \quad & D(V || WH) \\ \text{s.t.} \quad & W, H \geq 0, \quad \sum_i b_{ij} = 1 \end{aligned}$$

According to the formulas (60.2) and (60.3), the gradient method can be used to obtain the corresponding multiplicative iterative formula.

Through the solution of the least value in the formula (60.2), the iterative formula of LS distance can be obtained as follows:

$$a_{ij} = a_{ij} \frac{[\mathbf{Y}\mathbf{X}^T]_{ij}}{[\mathbf{A}\mathbf{X}\mathbf{X}^T]_{ij}}, \quad x_{ij} = x_{ij} \frac{[\mathbf{A}^T\mathbf{Y}]_{jk}}{[\mathbf{A}^T\mathbf{A}\mathbf{X}]_{jk}} \quad (60.4)$$

Through the use of the multiplicative iterative rule for the objective function (60.3) of KL divergence, we can obtain

$$x_{jk} \leftarrow x_{jk} \frac{\sum_{i=1}^m a_{ij} (y_{ik} / [\mathbf{A}\mathbf{X}]_{ik})}{\sum_{q=1}^m a_{qj}} \quad (60.5)$$

$$a_{ij} \leftarrow a_{ij} \frac{\sum_{k=1}^n x_{jk} (y_{ik} / [\mathbf{A}\mathbf{X}]_{ik})}{\sum_{p=1}^n x_{jp}} \quad (60.6)$$

### 60.3 Alpha Divergence-Based NMF

In order to improve the speed of iteration and convergence and to make sparse limits on matrixes, Alpha divergence can be used as the measure of NMF. Alpha divergence, also known as Rayleigh divergence, is a generalized expression of KL divergence, Hellinger's divergence and  $\chi^2$  divergence. To take it as the measure of NMF can effectively help people adapt to the situations of noises from images to complex backgrounds during face recognition, so that a better recognition result will be obtained.

When Alpha divergence is taken as the measure, the different degrees of  $V$  and  $WH$  are expressed as

$$D_\alpha[\mathbf{V}||\mathbf{WH}] = \frac{1}{\alpha(1-\alpha)} \sum_{i=1}^m \sum_{j=1}^n \alpha v_{ij} + (1-\alpha)[\mathbf{WH}]_{ij} - v_{ij}^\alpha [\mathbf{WH}]_{ij}^{1-\alpha} \quad (60.7)$$

The formula (60.7) is usually expressed as follows

$$D_A^\beta(\mathbf{WH}||\mathbf{V}) = \sum_{ik} v_{ik} \frac{(v_{ik}/z_{ik})^{\beta-1} - 1}{\beta(\beta-1)} + \frac{z_{ik} - v_{ik}}{\beta} \quad (60.8)$$

$$z_{ik} = [\mathbf{WH}]_{ik}, \quad \beta = (1 + \alpha) / 2$$

With the gradient method, NMF's multiplicative iterative formula when Alpha divergence is taken as the measure is expressed as follows.

$$h_{jk} \leftarrow \left( h_{jk} \left( \sum_{i=1}^m w_{ij} \left( \frac{v_{ik}}{[\mathbf{WH}]_{ik}} \right)^\beta \right)^{\omega/\beta} \right)^{1+\alpha_s} \quad (60.9)$$

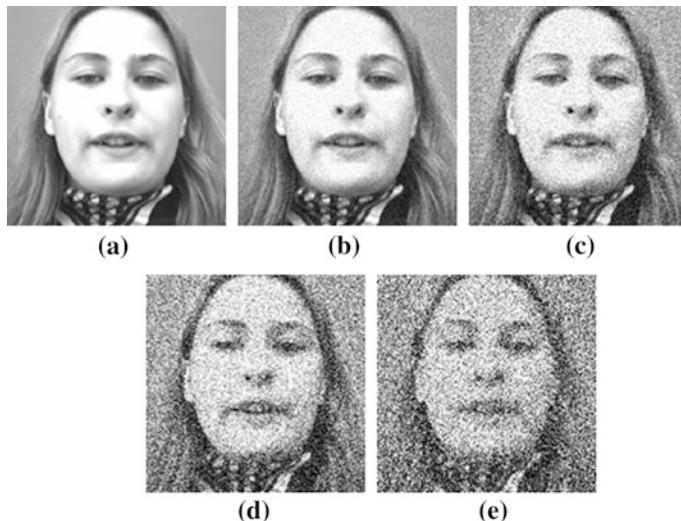
$$w_{ij} \leftarrow \left( w_{ij} \left( \sum_{k=1}^n h_{jk} \left( \frac{v_{ik}}{[\mathbf{WH}]_{ik}} \right)^\beta \right)^{\omega/\beta} \right)^{1+\alpha_s} \quad (60.10)$$

$$w_{ij} \leftarrow w_{ij} / \left( \sum_p w_{pj} \right) \quad (60.11)$$

Among them,  $\beta \in (0.5, 1, 2)$  is a parameter of a divergence type;  $\alpha_s$  is a sparse factor, whose value ranges from 0.001 to 0.005. When it is positive, it increases the sparseness of the matrix; when it is negative, it reduces the sparseness. The value of  $\omega$  ranges from 0 to 2, which is an over-relaxation parameter of a matrix.

The basic idea of Alpha divergence-based face recognition is as follows:

1. Choose an appropriate training set and construct the initial matrix  $V$ ;
2. Factor the matrix to get the basis image  $W$  and the weight matrix  $H$ ;
3. The test image  $U$  is projected onto the subspace  $W$ , so as to get the projection vector  $M$ ;
4. Compute  $W'$  based on the formula (60.10) with the projection vector  $M$  and compute  $H'$  based on the formula (60.9) with  $W'$  and  $M$ ;
5. Recognize the categories of  $H$  and  $H'$  based on the nearest neighbor classifier, so as to judge whether it is the same face.



**Fig. 60.1** Sample images with noises: **a** original image, **b** add 20 % noises, **c** add 40 % noises, **d** add 60 % noises and **e** add 80 % noises

**Table 60.1** Recognition rates of images with different noise percentages under different measures

## 60.4 Experimental Analysis

Cambridge ORL face database is used as the experimental subject. The database contains 40 distinct persons, and each person has ten different images, with a total of 400 images which were shot under different time, lighting conditions and expressions. Full faces are generally shown, with slight left and right rotations. Each data set contains a person's 10 images, which are randomly divided. Five images are randomly chosen as a training set and the other five images as a test set. Then, the training set is used to train NMF algorithm, and the test set is used for face recognition effect evaluation. Pixel percentage is chosen for each test image to process noises. Figure 60.1 contains the original image, and the sample face images with 20, 40, 60 and 80 % noises are added. In order to eliminate the randomness of single selection of samples, for any image with a noise, independent repeated experiments are performed 10 times, and at last, the average recognition rate is taken as the final recognition rate. Alpha divergence-based NMF has parameter requirements. The optimal parameters, namely  $\alpha_s$ ,  $\omega$  and  $\beta$ , can be obtained by experiments. Generally speaking, for the face image with over 50 % noises, the human eyes can hardly recognize it. However, with Alpha divergence-based NMF algorithm, the proper face recognition can be realized. This experiment has proved that when  $\alpha_s = 0.002$ ,  $\omega = 0.1$  and  $\beta = 0.5$ , the image recognition with noises can achieve the best effect with the NMF algorithm based on Alpha divergence. The experimental results are shown in Table 60.1.

Seen from Table 60.1, Alpha divergence method is far better than other methods. When the image noise percentage is 70 %, the recognition rate can still reach more than 80 %. The recognition rates from other methods are significantly reduced when the noise percentage is greater than 50 %.

## 60.5 Conclusion

In this article, we have put forward a new NMF algorithm based on Alpha divergence, which is used for face recognition. The use of Alpha divergence as the measure of NMF can ensure that iterations converge to global optimum and can make sparse limits on matrixes. It can be found from experiments that the recognition rate can be effectively improved with the NMF algorithm based on Alpha divergence in the face image recognition under noise interferences or complex backgrounds, whose effect is better than those of other measures. However, at present, this method has relatively longer parameter training time and the higher average times of iterative convergence compared with the standard NMF method. The future study mainly focuses on the sparsity and smooth processing of matrixes in the iterative factorization process, as well as the reduction in its convergence time to make it more suitable for timing of treatment.

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# Chapter 61

## A New Denoising Method of SAR Images

Jianguo Zhang

**Abstract** In this paper, we proposed a new approach to separate noise and source signals from SAR images. In the first stage, we used EMD to decompose the SAR image as a collection of some oscillatory basis components termed intrinsic mode functions (IMFs). At the second stage, PCA is applied to these IMFs to produce uncorrelated and dominant basis components. The most important advantages of our method are as follows: (1) It is not necessary that the components in the SAR images to be linear. (2) Separation process can be performed using only a single mixture. In this paper, we employed the proposed separating model to separate speckle noise from SAR images. Experimental results confirmed the strong potential of the proposed method for speckle noise suppression.

**Keywords** Empirical mode decomposition • Independent component analysis • Synthetic aperture radar image • Speckles removal

### 61.1 Introduction

Various spatial-domain filters have been proposed for the speckle reduction [1, 2]. However, [3, 4], the performance of these filters is heavily dependent on the choice of the size and orientation of the local window. Jain [5] introduces a homomorphic approach, where a SAR image is log-transformed to make the multipli-cative speckle noise additive. The log-transformed image is subjected to Wiener filtering, followed by an exponential operation on the filtered output to obtain the despeckled image. However, this method essentially being low-pass filtering blurs many important signal features. In recent years, the multiscale wavelet transform has been used with considerable success for recovering signal from noisy data

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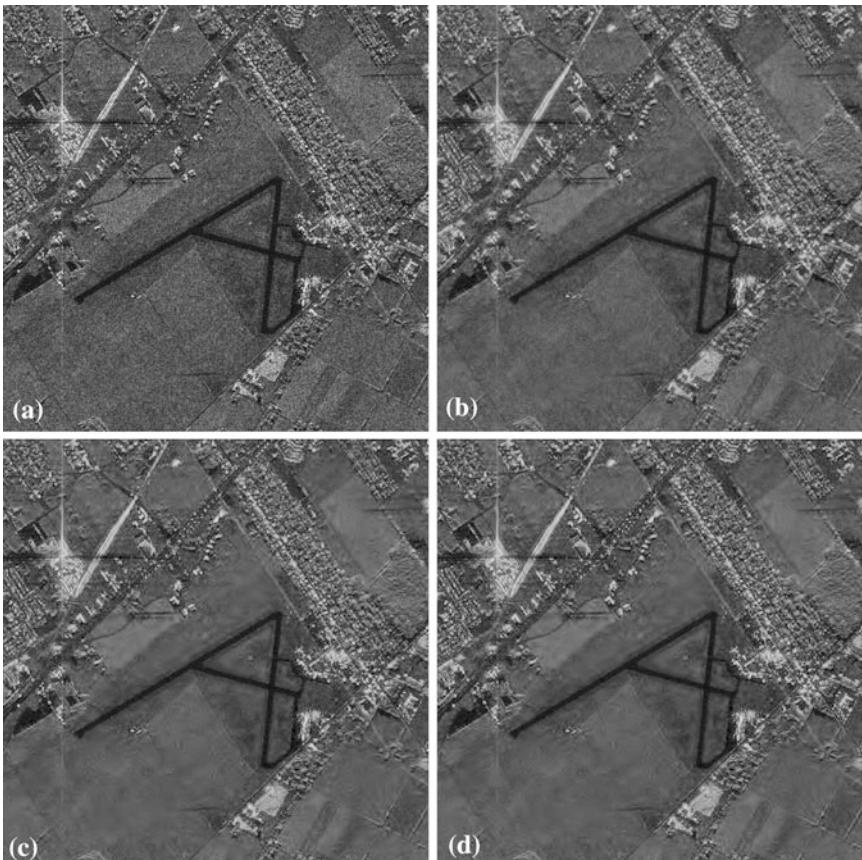
[6]. It has been show that wavelet thresholding in a homomorphic framework can provide a better reduction in the speckle noise when compared with that of the spatial-domain filters. However, by employing wavelet shrinkage based on Bayesian formalism, it is possible to recover signals from the noisy data more effectively than by using the thresholding technique [7]. Thus, a number of authors have developed homomorphic methods [8], wherein a suitable probability density function (PDF) is used as a prior model for describing the wavelet coefficients corresponding to the log-transformed SAR image are denoised by means of a Bayesian estimator developed using the prior PDF. Achim have developed a maximum a posteriori (MAP) filter using the symmetric alpha-stable PDF as a prior model. However, the alpha-stable PDF does not have a closed-form noisy data, and increasing the complexity of the Bayesian estimation process.

The paper brought forward the particle noise filter algorithms for SAR image. The main idea of them is to decompose the image by EMD method on columns and rows, respectively, then get the result by removing the intrinsic mode function (IMF) containing the particle noise. The particle noise is wiped off. The method works well on given noise. In this article, the empirical mode decomposition method is introduced to SAR speckle filtering, by combining PCA algorithm; a new speckle noise filtering algorithm is produced. The result shows that this algorithm is powerful to speckle noise suppression and can preserve fine details in the interferogram SAR images.

## 61.2 Empirical Mode Decomposition

The empirical mode decomposition is a signal processing technique to decompose any non-stationary and nonlinear signals into oscillating components with some basic properties [7]. The key benefit of using EMD is that it is automatic and fully data adaptive.

EMD decomposes a time series  $x(t)$  into a sum of bandlimited time functions  $f_m(t)$  by empirically identifying the physical timescale intrinsic to the data. Each extracted mode  $f_m(t)$  named IMF contains two basic conditions. First, in the whole data set, the number of extrema (maxima and minima) and the number of zero crossings must be the same or differ at most by one. Second, at any point, the mean value of the envelope defined by local maxima and the envelope defined by the local minima is zero. There exist many approaches for computing EMD. The sifting process will be continued until the final residue is a constant, a monotonic function, or a function with only one maximum and one minimum from which no more IMF can be obtained. The IMFs are the foundations for representing the time series data. Being data adaptive, the basis usually offers a physically meaningful representation of the underlying processes. There is no need of considering the signal as a stack of harmonics, and therefore, EMD is ideal for analyzing non-stationary and nonlinear data.



**Fig. 61.1** Comparison of experimental result. **a** Origin image. **b** Lee filter. **c** EMD denoising. **d** Our method

### 61.3 Proposed Separation Method

In our proposed method, we use a separation model of three stages.

- Step 1: In this stage, we apply EMD algorithm to the SAR image  $X(t)$  and obtain  $R$  IMF components.
- Step 2: In this stage, in order to find uncorrelated dominant basis components, PCA algorithm is used. PCA is implemented by employing SVD. The SVD of  $Y_{L \times R} = Y_{R \times L}^T$  is a factorization of the form  $Y_{L \times R} = U_{L \times L} D_{L \times R} V_{R \times R}^T$  where  $U$  and  $V$  are orthogonal matrices (with orthogonal columns), and  $D$  is a matrix of  $R$  singular values  $\sigma_r = \sigma_{r \times r}$ , where  $\sigma_1 \geq \sigma_2 \geq \dots \geq \sigma_R$ .
- Step 3: After applying PCA, we obtain uncorrelated basis vectors. These basis vectors are not statistically independent. To derive the independent basis

vectors, a further procedure ICA must be carried out. The ICA expresses the observation vector  $U_{P \times L} = U_{L \times P}^T$  as the product of mixing matrix  $A$  and the statistically independent vector  $S$ :  $U_{P \times L} = A_{P \times P} S_{P \times L}$

## 61.4 Experimental Results and Analysis

Figure 61.1a is a SAR image containing a river which breaks into two branches. The size of it is  $256 \times 256$ . After applying EMD to the image, we get the first IMF whose content is mainly high frequency information. The primary element of high frequency information is noise. Moreover, it has a little structure information (detail and contour information). So, when we deal with this layer, we cannot regard it as noise completely. In this layer, we should restrain the noise while preserving the structure information.

## 61.5 Conclusion

The aliasing of the speckle noise and echo information of SAR blurs the structure character of SAR image. It is difficult that to enhance structure character of SAR images. Aiming at this difficulty, we propose an amalgamation frame based on EMD and PCA algorithms. The frame can effectively filter the speckle noise and enhance the structure character which finally can be seen by people's eyes. Using the proposed method, the speckle noise of SAR image in different scale is filtered. At last, we obtain the new denoised SAR image. The experiment result indicates that speckle noise of our result is substantially decreased, and the structure character and texture of the result are clearer. And, ours result eyes can distinguish the character of SAR image.

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# Chapter 62

## Compression on Chirped Parabolic Pulse Based on Normal Dispersion-Decreasing with Distributed Amplification

Wenyan Yang

**Abstract** In order to obtain a high-quality pulse compression, propose a novel method for generating a parabolic pulse by use of a dispersion-decreasing and distributed-amplifying fiber with normal group-velocity dispersion. Through theoretical analysis and numerical simulation, the results show that the input pulse can evolve into a parabolic pulse with a higher linear chirp and larger pulse power, and the higher linear chirp in the parabolic pulse allows for more efficient and higher-quality pulse compression. The method has the guiding significance for experiments.

**Keywords** Nonlinear optics • Dispersion-decreasing fiber • Parabolic pulse • Pulse compression

### 62.1 Introduction

The generation of ultra-short optical pulse with high repetition rate is one of the key techniques in the high-speed optical time-division multiplexing (OTDM) systems. The optical pulses generated from the semiconductor lasers often have a large pulse width. Therefore, in order to satisfy the demand of the OTDM system, the technique of optical pulse compression [1, 2] must be applied. Nowadays, nonlinear pulse evolution in a fiber with a normal group-velocity dispersion followed by an anomalously dispersive medium is commonly used for compressing picosecond optical pulses into femtosecond regime [3]. When a high-intensity optical pulse is launched into the normal dispersive fiber, the pulse evolves into a linearly chirped, nearly rectangular pulse, in which the chirp

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induced by self-phase modulation is linearized gradually by normal GVD in the middle of the pulse. And compensation of the chirp by anomalous GVD compresses the original pulse. However, the chirp is only linear in the middle of the rectangular pulse, so an obvious ripple is appeared in the edge of the compressed pulse [4], which is deleterious to pulse transmission.

Recently, the parabolic pulse with a linear chirp was generated in a fiber with a distributed amplification [5, 6] or a dispersion-decreasing fiber with a normal dispersion [7]. The parabolic pulse has unique features such as resistance to optical wave-breaking, self-similarity in shape, and an enhanced linearity chirp in almost whole pulse. By virtue of its features, a high efficient pulse compression can be expected. Based on the two schemes, we proposed a novel scheme for parabolic pulse with higher linear chirp and more pulse power that uses a dispersion-decreasing and distributed-amplifying fiber with normal group-velocity dispersion. The numerical simulations show the scheme includes the attractive features of the previous two schemes, compared with the parabolic pulse generated from the previous two schemes, the parabolic pulse have a better linear chirp, and the pulse energy is enlarged extremely. More research shows that the parabolic pulse with a better linear chirp using the anomalously dispersive medium can achieve a higher compression factor and pulse peak intensity.

## 62.2 Theoretical Model and Analysis

In this paper, the distributed gain is used for the absence of gain saturation, and our theoretical analysis considers the spectral bandwidths of the evolution pulses are less than the amplifier bandwidths. In this case, propagation can be described by the NLSE with gain and decreasing dispersion:

$$i \frac{\partial A}{\partial z} = \frac{1}{2} \beta_2(0) D(z) \frac{\partial^2 A}{\partial T^2} - \gamma |A|^2 A + i \frac{g_0}{2} A \quad (62.1)$$

where  $A(z, T)$  is the slowly varying envelop of pulse,  $z$  is the transmission length,  $T$  is the retarded time ( $T = t - z/v_g$ ,  $t$  is time,  $v_g$  is the group-velocity in fiber),  $D(z)$  represents the normalized variation in the GVD ( $D(0) = 1$ ),  $\beta_2(0)$  is the GVD value at  $z = 0$  and  $\beta_2(0) > 0$ ,  $\gamma$  is the nonlinearity coefficient which is considered to be uniform along DDF, the higher-order effects of picosecond pulse are negligible,  $g$  is the distributed gain coefficient following Ref. [7], we introduce a new coordinate through:

$$\xi = \int_0^z D(z') dz' \quad (62.2)$$

With this coordinate, Eq. (62.1) is transformed into a NLS equation with a constant dispersion:

$$i \frac{\partial A}{\partial \xi} = \frac{1}{2} \beta_2(0) \frac{\partial^2 A}{\partial T^2} - \frac{\gamma}{D(\xi)} |A|^2 A + i \frac{g_0}{2D(\xi)} A \quad (62.3)$$

We further defined new amplitude:

$$u(\xi, T) = \frac{A(\xi, T)}{\sqrt{D(\xi)}} \quad (62.4)$$

Using Eqs. (62.3) and (62.4) is transformed into new NLSE:

$$i \frac{\partial u}{\partial \xi} = \frac{1}{2} \beta_2(0) \frac{\partial^2 u}{\partial T^2} - \gamma |u|^2 u + \frac{i}{2} g u \quad (62.5)$$

where  $g = \Gamma(\xi) + \frac{g}{D(\xi)}$ ,  $\Gamma(\xi) = -\frac{1}{D} \frac{dD}{dz}$

When  $g$  is constant, the NLS Eq. (62.5) is shown to permit self-similar propagation of a linearly chirped parabolic pulse as an asymptotic solution [7, 8]. And using Eqs. (62.1) and (62.4), the solution is:

$$A(z, T) = \begin{cases} \sqrt{P(z)} \left\{ 1 - \left[ \frac{T}{T(z)} \right]^2 \right\}^{1/2} \exp[i\phi(z, T)], & |T| \leq T(z) \\ 0, & |T| > T(z), z \rightarrow \infty \end{cases} \quad (62.6)$$

$$P(z) = \frac{E_0^{2/3}}{4} \left[ \frac{2g^2}{\gamma \beta_2(0)(1+gz)} \right]^{1/3} \quad (62.7a)$$

$$T(z) = 3E_0^{1/3} \left[ \frac{\gamma \beta_2(0)(1+gz)}{2g^2} \right]^{1/3} \quad (62.7b)$$

$$\phi(z, T) = -\frac{g}{6\beta_2(0)} T^2 + \gamma \int_0^z P(z') dz' \quad (62.7c)$$

where  $E_0$  is the energy of the input pulse, using the phase expression (62.7c), the chirp of parabolic pulse is:

$$\Omega(z) = -\frac{\partial \phi(z, T)}{\partial T} = \frac{g}{3\beta_2} T \quad (62.8)$$

Equation (62.8) shows the parabolic pulse has a rigorous linear chirp.

However, in most of cases,  $g$  is the function of the length  $z$ , in fact, due to the weak influence of  $g$ , the pulse has the same property such as linear chirp. In the next section, the theoretical model is numerically investigated when  $g$  is the function of the length  $z$ .

## 62.3 Numerical Analysis and Discussion

In this section, an input Gaussian pulse is investigated, that is given:

$$A(0, T) = \sqrt{P_0} \exp\left(-\frac{T^2}{2T_0^2}\right) \quad (62.9)$$

where  $P_0$  is the peak intensity of the input pulse,  $T_0$  is the half width at 1/e intensity, the dispersion length is defined:  $L_D = T_0^2 / |\beta_2(0)|$ .

In the numerical simulations, the used data are: the input pulse center wavelength  $\lambda_0 = 1,550$  nm, pulse width  $T_{FWHM} = 10$  ps,  $\beta_2(0) = 20$  ps<sup>2</sup>/km,  $\beta_2(L) = 2$  ps<sup>2</sup>/km,  $\gamma = 3$  w/km,  $E_0 = 30$  pJ,  $L = L_D$ . We consider the GVD is linear decrease and the distributed gain is constant in Eq. (62.1) in the process of numerical calculations.

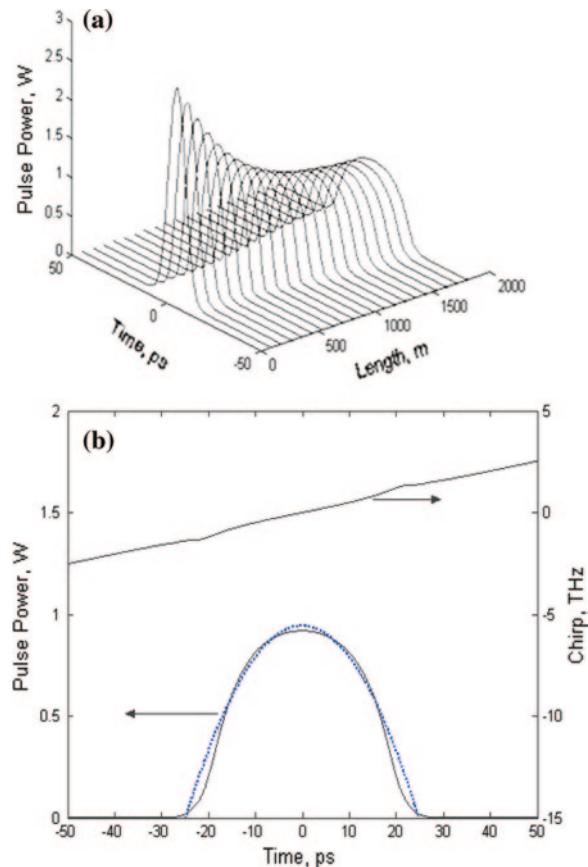
### 62.3.1 The Property of the Output Pulse Through ND-DDF and Distributed-Amplifying Fiber

The pulse evolution in ND-DDF or distributed-amplifying fiber and the property of the output pulse for picosecond pulse can be discussed by numerically solving the NLS Eq. (62.1). When the pulse evolves in the ND-DDF, the gain coefficient  $g_0$  is zero under neglecting the fiber loss.

From Fig. 62.1a, we can find, when propagating in the ND-DDF, the pulse width increases gradually and the peak intensity decreases gradually. In the ND-DDF, the normal dispersion has an obvious effect on the pulse, different velocity in different frequency leads the pulse to expand, and self-phase modulation accelerates the pulse expand. Figure 62.1b shows the shape and chirp of the output pulse after propagating along the ND-DDF. It is obvious that the output pulse (solid line) nearly accords with the parabolic shape (dotted line) and has a good linear chirp, which testifies the previous conclusion that a linearly chirped parabolic pulse can be generated from the ND-DDF.

Figure 62.2a shows the pulse evolution in the distributed-amplifying fiber with a normal dispersion when the gain of fiber is 15 dB. When propagating in the distributed-amplifying fiber, the pulse width increases gradually, and the pulse energy is enlarged rapidly. Figure 62.2b shows the shape and chirp of the output pulse after propagating along the distributed-amplifying fiber. We can find that the output pulse energy achieves an effective amplification and a good linear chirp; the shape (solid line) accords with the parabolic shape (dotted line). Using the distributed-amplifying fiber with a normal dispersion, the pulse can also achieve a linearly chirped parabolic pulse.

**Fig. 62.1** **a** Evolution of the transmitted pulse in the ND-DDF. **b** The shape and chirp of the output pulse

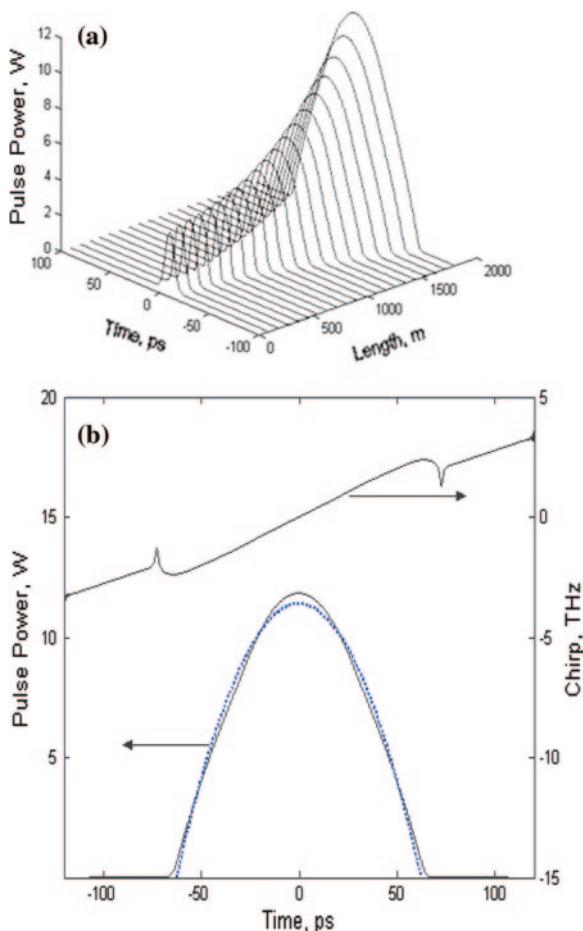


### 62.3.2 The Properties of the Output Pulse Through ND-DDF with Distributed Amplification

We have studied the pulse evolution in ND-DDF or distributed-amplifying fiber and the properties of the output pulse for picosecond pulse. In the two cases, the linearly chirped parabolic pulse can be achieved. In the next section, we will study the case the pulse evolution in ND-DDF with a distributed amplification and the properties of the output pulse.

Figure 62.3a shows the pulse evolution in ND-DDF with a distributed amplification, when the gain is 15 dB. We can see that the pulse energy enlarged rapidly and the pulse width increases gradually. Compared with Fig. 62.2a, the spreading speed of the pulse becomes slow, and the peak power increases more quickly. Figure 62.3b shows the shape and chirp of the output pulse after propagating along ND-DDF with a distributed amplification. In the figure, the output pulse shape (solid line) accords with the parabolic shape (dotted line) very well, and the pulse

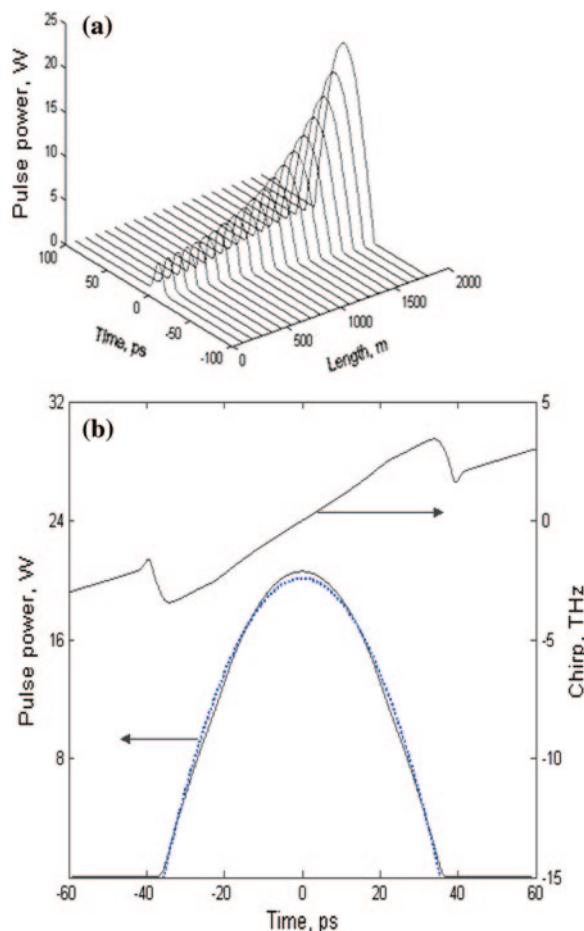
**Fig. 62.2** **a** The pulse evolution in the distributed-amplifying fiber with a normal dispersion. **b** The shape and chirp of the output pulse



has an enhanced linear chirp. When traveling in ND-DDF with a distributed amplification, the pulse is affected by the decreasing dispersion and a distributed amplification. The two effects quicken the formation of the parabolic pulse and enhance the linear chirp, and the output pulse has not only a good parabolic shape but also an enhanced linear chirp. Meanwhile, the pulse energy is enlarged obviously by the distributed amplification. The properties of the output pulse are the basic of the more efficient and higher-quality compression and also testify the correctness of our scheme.

We will analysis the influence of the gain in ND-DDF. Figure 62.4a is the chirp curve in different gain, and the gain values of curve a, b, c, d, e, and f are  $-5$ ,  $0$ ,  $5$ ,  $10$ ,  $15$ , and  $20$  dB, respectively. From the figure, we can find that the chirp is enhanced with the increasing gain, which shows the gain has an obvious effect on the chirp. Otherwise, the study also shows that although the output pulses have an

**Fig. 62.3** **a** The pulse evolution in ND-DDF with a distributed amplification. **b** The shape and chirp of the output pulse

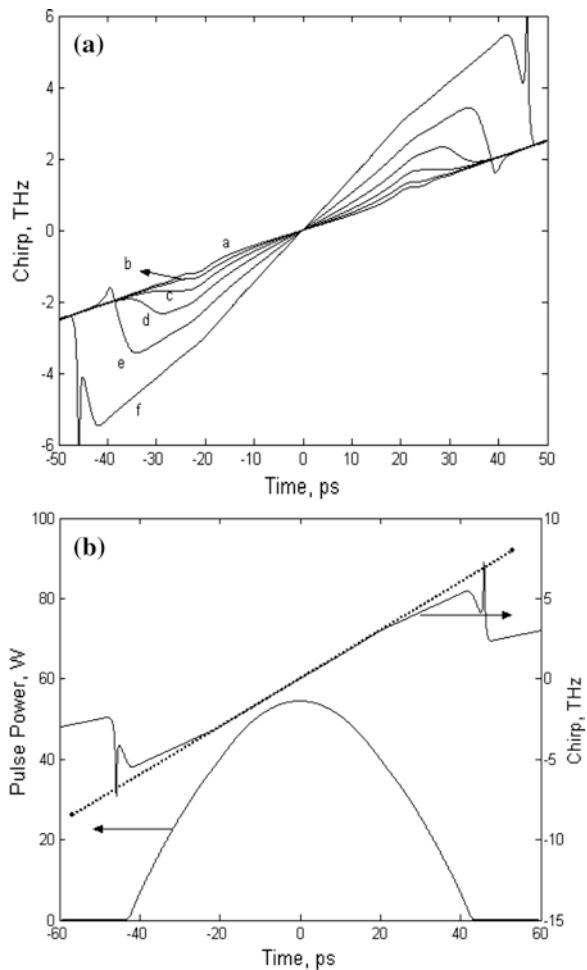


approximate parabolic shape, the chirp cannot satisfy the linear condition very well when the gain is too large; this is consistent with the theoretical condition of the linear chirp that only generates in the range of  $|T| \leq |T(z)|$ . Figure 62.4b is the shape and chirp of the output pulse generated from the ND-DDF with the distributed gain of 20 dB. The result shows that although the chirp in the whole pulse can be considered to be approximately linear, but the chirp is only linear in the middle of the pulse and in the edge of the pulse and cannot satisfy the linear condition exactly.

### 62.3.3 The Pulse Compression After Compensating the Chirp

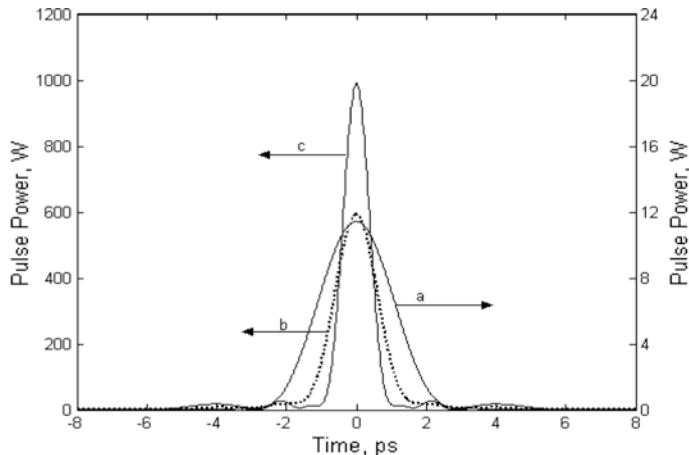
We have studied the properties of the output pulse by using different schemes such as ND-DDF, the distributed-amplifying fiber with a normal dispersion, and the

**Fig. 62.4** **a** The chirp curves *a*, *b*, *c*, *d*, *e*, *f* with the gain values with the gain of 20 dB. **b** The shape and chirp of the output pulse are -5, 0, 5, 10, 15, and 20 dB, respectively



ND-DDF with the distributed amplification. Next, the compression quantity will be studied when the chirp is compensated.

Figure 62.5 shows the pulse shapes after the chirp is compensated; curves *a*, *b*, and *c* represent the pulse shapes after the chirp of the parabolic pulse generated from ND-DDF, the distributed-amplifying fiber with a normal dispersion, and the ND-DDF with the distributed amplification is compensated by a high abnormal dispersion. From the figure, we can find that when the chirp is compensated, the pulse generated from the ND-DDF with the gain of 15 dB achieves a larger compression factor that is 12.4, corresponding to the pulse width of 0.81 ps. However, the compression factor of the parabolic pulses generated from the ND-DDF and the distributed-amplifying fiber with a normal dispersion is 4.5 and 7.6, respectively, corresponding to the pulse width of 2.2 and 1.3 ps. Meanwhile, the pulse



**Fig. 62.5** The pulse shapes after the chirp is compensated

peak power of curve c is near 1 kw, and the pulse pedestal is nearly minimal. So the parabolic pulse generated from the ND-DDF with a distributed amplification has not only the better linear chirp but also a more pulse energy that is the basic of the high-quality pulse compression.

## 62.4 Conclusion

In this paper, we have proposed and investigated the chirped parabolic pulse generated by using the ND-DDF with a distributed amplification. Compared with the pulses generated from the ND-DDF and the distributed-amplifying fiber with a normal dispersion, the parabolic pulse generated from the ND-DDF with a distributed amplification has a better linear chirp, and the pulse energy is enlarged obviously. The simulation results also show that the chirp becomes even obvious with the increasing of the gain, but the gain cannot be too large because the large gain is destructive to the linearity of the chirp.

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# Chapter 63

## A Color Image Segmentation Method Based on Improved K-Means Clustering Algorithm

Ran Jin, Chunhai Kou, Ruijuan Liu and Yefeng Li

**Abstract** How to effectively segment objects in the color images is the key point in the computer vision and image analysis. All kinds of segment algorithms have been proposed by many scholars, which could be basically divided into three categories. This paper presents repeated usage of the optimal threshold for roughly extracting the largest target area of the color image. Then an improved K-means clustering algorithm is used to improve the accuracy of the segmentation from the target area. Experimental results show that this method can effectively extract color image from an object. It has also a certain degree of robustness to the noisy image.

**Keywords** Image segmentation • Optimal threshold • K-mean clustering algorithm • Robustness

### 63.1 Introduction

In the computer vision and image analysis, it has been the key point as how to effectively segment objects out of image. All kinds of segment algorithms have been proposed by many scholars, which could be basically divided into three categories. Category 1, named as threshold algorithm, which segments objects utilizing the whole or partial of the image. This knowledge is generally presented by histogram graphics. This tool is very popular and the easiest segment method characterized by fast speed processing and low cost. The threshold algorithm could automatically determine the

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threshold value, which generally includes the P rate threshold algorithm, histogram contour analysis threshold algorithm and the optimal threshold algorithm, etc. [1]. The determination of threshold value and noise in the image signal will directly impact the efficiency of segmentation. Category 2, contour-based segment, which replies on the detector to locate the image peripheral and the located peripheral, presents the discontinuity of images in regard to gray value, color and stripe. Methods are commonly used to include threshold of image contour, blurry contour and Hough exchange segmentation, etc. Yet this segmentation may probably lead to errors like creating contours that do not exist and with missing image boundary that is supposed to be there. These errors are due to the noisy signal or other unnecessary signals in the useful image signals. Category 3, region-based segment, it satisfies the conditions of complete segmentation and conformity of maximum region. It features the ability of robustness to image noise signals. Methods are widely used to include region merge, region split, automatic seeded region growing, etc. This methodology of segmentation may probably cause image distortion due to non-perfect parameter configuration like under growing (excessive regions) or over growing (short regions). Different characteristics could be utilized for algorithms of contour-based segmentation and region-based segmentation like brightness, stripe and velocity field. For the automatic seeded region growing algorithm, many scholars introduce the pyramid and quad crossing data structure to describe the image and thus achieve good outcome of segmentation. But there's a drawback for the pyramid data structure and quad data structure to describe the image as they heavily rely on the orientation, location and the relative size of object [2]. It may end up with pretty different demonstrations of pyramid or quad data crossing format for two similar images with little difference or even two images of same description with the minor background changing. Recently, some scholars propose the idea of clustering algorithm to segment gray-valued image, and the experimental results are very positive, yet the initial classification of the sample base and the selection of sample points will greatly affect the outcome of segmentation. The effective color image segmentation based on the improved K-means clustering algorithm is presented in this article, first of all the coarse segmentation is executed to extract the targeted area utilizing the optimal threshold algorithm, the next step is to mark the continuity of segmented area in order to identify the contour of the maximum-sized continuity area, finally the targeted area is precisely segmented by the means of the improved K-means clustering algorithm. For those excessively small-area images leftover during the process, a merge methodology is introduced to deal with over-segmented images. And experiments have shown that this theory is very effective to segment natural images and proves to be very positive and exciting [3, 4]. Furthermore, it shows its robustness to noisy signals [5, 6].

## 63.2 The Optimal Threshold Algorithm

The optimal threshold algorithm is to have probability density function of two or more normal distributions approximately represent the image histogram, the threshold value is the closet gray value of lest probability of the maximum value of

the two or more normal distributions and it results the most accurate segmentation. The general segmentation for the optimal threshold is by the means of iteration methodology to get the best segmentation of images, the initial threshold value is

$$T^0 = (f_1 + f_m)/2 \quad (63.1)$$

The  $f_1$  represents the min gray value,  $f_m$  represents the max gray value.

The threshold value  $T^k$  of the  $k$ th iteration will separate the image into two parts, target image and background image, thus the mean gray value of  $f_0$  and  $f_B$  can be calculated per below formula [7, 8],

$$f_0 = \frac{\sum_{f(i,j) < T^k} f(i,j) \times W(i,j)}{\sum_{f(i,j) < T^k} W(i,j)} \quad (63.2)$$

$$f_B = \frac{\sum_{f(i,j) > T^k} f(i,j) \times W(i,j)}{\sum_{f(i,j) > T^k} W(i,j)} \quad (63.3)$$

The  $f(i,j)$  represents the gray value of point  $(i,j)$  in the image, the  $W(i,j)$  represents the weighted coefficient of point  $(i,j)$ . If the  $(k+1)$ th iteration threshold value of version 1.0 is  $T^{k+1}$ .

$$T^{k+1} = (f_0 + f_B)/2 \quad (63.4)$$

### 63.3 The Mark of Image Pixel of Continuity Region

If the image is shared by many regions using the threshold segmentation, it is necessary to have them marked in order to extract them. The effective and simple way to mark the segmented binary image in the different region is to check the continuity between each individual pixel and the adjacent pixels. Scan the binary images from left to right and from top to bottom, if the gray value of pixel is 1, mark it as objected pixel of continuity, and if it shares the continuity with two or more objects they will be treated as same ones and connects them all. But if during the process of scan, the gray value of 0 is identified, a new object mark would be added. The method of eight-region continuity is adopted in this article, check the left and top side of the pixel and two adjacent pixels of top diagonal [9–11]. The scan will start from the first row and will only look at the continuity of adjacent pixel on the left of the current pixel, then just look at the continuity of adjacent pixel on the top of the first column of the current pixel, finally it will scan the last column continuity of adjacent pixels both on the left and on the top of the current pixel.

### 63.4 The Improved K-means Clustering Algorithm

The optimal threshold algorithm is adopted in the RGB space of the colorful image to get the binary value of R, G and B space individually, then identify the binary continuity of image region by the use of eight-region continuity method and determine the maximum region's external contour by locating the coordinates of leftmost, rightmost, topmost and bottommost pixel. Locate the maximum regional contour and classify it by evenly dividing the region into fine sub-regions, calculate the means for the five sub-regions by following formula,

$$m_{ij} = \frac{1}{N_i} \sum_{y_j \in \xi} y_j \quad (i = 1, \dots, 4, 5; j = r, g, b) \quad (63.5)$$

$m_{ij}$  represents the mean value of the  $i$ th sub-region under the  $j$ th space,  $N_i$  represents the number of pixels,  $y_j$  represents the pixel gray value under the  $j$ th space,  $\tau_{ij}$  represents the scope of the  $i$ th sub-region under the  $j$ th space. For example,  $m_{2r}$  represents the mean value of the second sub-region under the  $r$ th color space.

The distance measurement in between each pixel and mean  $m_{ij}$  of each external contour is described per following formula,

$$J_i = \sum ||y_j - m_{ij}||^2 \quad (i = 1, 2, 3, 4, 5; j = r, g, b) \quad (63.6)$$

$y_j$  represents the gray value of external contour under the  $j$ th space.

When the  $J_i$  is the minimum among the five ones, classify the current one into the category  $C_i$  and then dynamically adjust the clustering center by following formula,

$$m_{ij} = \frac{1}{N_i} \sum_{y_j \in C_i} y_j \quad (i = 1, \dots, 4, 5; j = r, g, b) \quad (63.7)$$

$N_i$  represents the number of pixels in the category  $C_i$ , when  $N_i$  is less than the threshold value set the  $N_i$  as infinity and merge the category quantity accordingly.

### 63.5 Processing of Image Signals Identified as Tiny Region

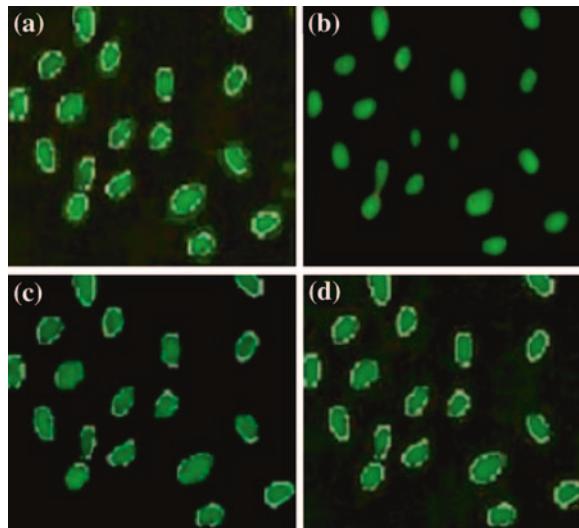
For those excessively small-area images leftover during the process of segmentation, they can be treated as noise and less important signals. They might be reorganized and merged into the adjacent regions per following steps:

1. Search for the smallest image region  $R_{\min}$ .
2. Locate the closest one ( $R$ ) among the adjacent clustering center regions according to the center of  $R_{\min}$  and merge the  $R_{\min}$  into  $R$ .

3. Repeat steps 1 and 2 till all tiny regions are merged whose sizes are less than the predetermined scale.

### 63.6 Experiment Analysis

The methodology of iterated coarse segmentation in the color image space of RGB which is presented in this article will lead to the extraction of the maximum subregion and reduce the amount of the clustering center of the targeted areas, which is very helpful to precisely segment images by the adoption of the K-means dynamic clustering algorithm. This experiment is divided into non-noise images segmentation and adding “Salt and Pepper” and “gaussian” noise image segmentation. The number of continuity region of binary images in the Fig. 63.1 and in the Fig. 63.2 is 19 and 9, respectively. It segments the images for each connected region



**Fig. 63.1** Experimental result contrast. **a** Original image. **b** The algorithm of region grow. **c** The C-means clustering algorithm. **d** Method in this article



**Fig. 63.2** Noise image segment. **a** Original image. **b** The K-means clustering algorithm. **c** Method in this article

accurately by the use of K-means dynamic clustering algorithm and merges the leftover tiny-sized images into the adjacent regions according to Euclidean distance finally. Here is the experimental result and analysis.

Figure 63.1 analyzes the way how the clustering algorithm decides and classifies the sample and the key sample point's selection will greatly affect the segmentation result. It is obvious that there is still a partial background image in the picture c of Fig. 63.1 after the C-means clustering algorithm segmentation. For the picture b in the Fig. 63.1, it is clear that the object image contour is not completely segmented out of the background image using the algorithm of region grow and in this case the over grow problem arises(two objects in the bottom left corner are connected to each other). This is because there is always a possibility of over grow or under grow if the parameter configuration is not to optimal for the segmentation algorithm based on the region grow. The picture d is the experiment result using the algorithm presented in this article and much better compared with the other two.

Figure 63.2 analyzes that partial background images may not be completely segmented using the algorithm presented in this article when noisy signal is mixed, but the algorithm presented in the article is able to completely segment the two small flowers in the bottom left corner compared with the clustering algorithm, so it shows the robustness to noise signal.

## 63.7 Conclusions

In this article, it presents the coarse segmentation of the color image to identify the maximum subordinate target region, then implements the accurate segmentation based on the K-means clustering algorithm. The experiments have proved better performance using this methodology, but it will take more time if there are many and small-sized sub-targets in the color image. The future research will be focused on the real-time segmentation of color image.

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# Chapter 64

## Research of Sub-Pixel Image Registration Based on Local-Phase Correlation

Shiwen Li and Xiaoxiao Liang

**Abstract** A fast and effective sub-pixel image registration algorithm based on image local-phase correlation is presented. Using phase assessment methods, initial shift is performed by calculations. And the maximum cross-correlation value is obtained according to fast Fourier transform (FFT) of the local power spectrum after upsampling on the local area of the image. The experimental results show that the algorithm exhibits high running speed and it can work on common computers; moreover, it can restrain noise well.

**Keywords** Local-phase correlation • Fast fourier transform • Sub-pixel image registration • Image processing

### 64.1 Introduction

Image registration is the process of overlaying images (two or more) of the same scene taken at different times, from different viewpoints and/or by different sensors [1]. Image registration is one of the most important steps in image processing, machine vision, and medical imaging. It is the basis of multi-source image analysis, and it has wide applications in the fields of remote sensing, motion estimation, computer vision, medical imaging, image fusion, and splicing as well as image enhancement and restoration [2]. In some cases, there is small portion of image needed to process or recognize. In dealing with remote sensing measurements, medical image recognition, image recognition, etc., the image is difficult

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to meet people's requirements as a result of the complex conditions of image noise and movement of the imaging object [3]. Therefore, in order to get more efficient, faster image registration as well as able to be used in the harsh environment, people have undertaken extensive researches and put forward a variety of image registration algorithms [4]. In general, its applications can be divided into three main groups according to the manner of the image acquisition.

Spatial correlation, the disadvantage of such method is that it cannot be used for the images of different resolutions and features. Transform-based registration method: it has been applied to the image of the same nature and not for heterogeneous image. Feature-based registration method: in such methods, we need to firstly find feature points which are appropriate for the given task and then the two images are registered according to the feature points [5]. If we use the traditional method for data processing registration, such as fast Fourier transform (FFT), the operator computation would be very large, which not only increases the load on the computer memory, but also reduces the image registration accuracy; especially, it is very demanding on the computer memory. For example, in the process of  $1,024 \times 1,024$  resolution image, if the registration accuracy of images requirements reaches 0.01 pixel, it needs to store and compute  $102,400 \times 102,400$  resolution using inverse fast Fourier transform (IFFT). Therefore, it is difficult to implement in the general computer for high-pixel image registration [6].

In this paper, we present an efficient, fast, and accurate registration algorithm based on the local phase of the sub-pixel image. Using the whole image cross-power spectrum, the pixel location is determined, and the sub-pixel precise peak value of phase cross-correlation spectrum is found using computing matrix Fourier of the sampling the image of the local neighborhood. By virtue of the peak value, we can register images precisely. This registration algorithm inherits the frequency characteristics of FFT. In the upsampling process, it omits information unrelated to the template region; thus, the storage requirements and computation are reducing sharply. Therefore, one can obtain higher registration accuracy with our algorithm using cross-correlation spectroscopy; we adopt amplitude normalization operation which is robust under noise and imaging environment.

## 64.2 Phase Correlation Image Registration Principle

In general, there are three transformation relationship between target image  $f(x, y)$  and pending registration image  $g(x, y)$ : rotation, zooming, and panning [wenx]. After decoupling, three parameters can be estimated; one can obtain rotation and scaling parameters of the two images with resorting to Fourier analysis, and so on. If we convert spatial space of images into frequency domain, we will deduce shifted parameter estimation methods on phase correlation [7].

$$E^2 = \frac{\sum |g(x, y) - f(x, y)|^2}{\sum |f(x, y)|^2} \quad (64.1)$$

According to Ref. [1], we will find the minimum value of  $E^2$ :

$$E^2 = \min_{a, x_0, y_0} \frac{\sum_{x,y} |ag(x - x_0, y - y_0) - f(x, y)|^2}{\sum_{x,y} |f(x, y)|^2} = 1 - \frac{\max_{x_0, y_0} |r_{fg}(x_0, y_0)|^2}{\sum_{x,y} |f(x, y)|^2 \sum_{x,y} |g(x, y)|^2} \quad (64.2)$$

Let  $M \times N$  be the size of the image; then, the value of  $r_{fg}(x_0, y_0)$  may be shown to be

$$\begin{aligned} r_{fg}(x_0, y_0) &= \sum_{x,y} f(x, y) g^*(x - x_0, y - y_0) \\ &= \sum F(u, v) G^*(u, v) \exp \left[ i2\pi \left( \frac{ux_0}{M} + \frac{vy_0}{N} \right) \right] \end{aligned} \quad (64.3)$$

It is known as cross-correlation power spectrum; here,  $F(u, v)$  is the Fourier transform of  $f(x, y)$ , and  $G^*(u, v)$  denotes the complex conjugate of the Fourier transform of  $g(x, y)$ . The corresponding translational coordinates are obtained by the maximum of  $r_{fg}(x_0, y_0)$ .

### 64.3 Sub-Pixel Registration

Generally, sub-pixel level image registration can be achieved based on calculating the sampling matrix data of the image space of FFT with zero-padding method. However, this method will cause a sharp increase in storage requirements and decrease in computational efficiency. Consequently, the application is greatly restricted. Here, a local-phase technology to achieve high-precision image registration is present. On the basis of initial peak value obtained from the generally phase correlation by FFT, we sample the cross-power spectrum within a small region of the peak value. And we use Fourier transform on the sample matrix above to achieve local-phase correlation. Meanwhile, we refine the peak position in the accuracy of the sampling to achieve sub-pixel registration. This method only omits the information which is nothing to do with the area we concern and reduce the demand for storage space; meanwhile, it improves the operation efficiency and it does not lose any valuable information.

In order to facilitate analysis, we only consider one-dimensional image  $f(x, y)$ . And  $f(x)$  is transformed into  $F(u)$  using FFT.

$$F(u) = \sum_{n=0}^{N-1} f(n) e^{-i2\pi xu} \quad (64.4)$$

Here,  $n = 0, 1, \dots, N-1$ . And the discrete Fourier transform of  $f(x, y)$  is given as follows

$$F(u, v) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) e^{-i2\pi \left( \frac{ux}{M} + \frac{vy}{N} \right)} \quad (64.5)$$

For simplify, we define that

$$\begin{aligned} E_1 &= e^{-\frac{i2\pi ux}{M}} \\ E_2 &= e^{-\frac{i2\pi yv}{N}} \end{aligned} \quad (64.6)$$

The dimension of  $f(x, y)$  is  $N_A \times M_A$ . The dimension of  $E_1$  is  $N_B \times N_A$ . The dimension of  $E_2$  is  $M_A \times N_B$ ; especially, the Eq. (64.5) become DFT when  $M_A = N_B = N$  and  $dx \cdot du = 1/N$ .

Using discrete Fourier transform, frequency domain sampling step becomes  $K/N \ll 1$  from 1; here,  $k$  is the local sampling of scale and a partial sampling is achieved.

During the process of sub-pixel level image registration, we may obtain cross-correlation power spectrum according to Eq. (64.3). Its inverse Fourier transform is the Dirichlet function. The coordinates of the maximum of Dirichlet function are located at  $(\bar{x}_0, \bar{y}_0)$ , the estimated parameters of the initial translation. Using sample matrix Fourier transform method, we sample on the neighborhood of  $(u_k, v_k)$ , the neighborhood of the initial shifted parameters. Suppose multiples of the sampling are  $\lambda$  ( $\lambda$  is the sample scale factor). It can be set so as to achieve sub-pixel registration accuracy. Correspondingly, the registration accuracy is  $1/\lambda$  pixels. Therefore,  $N_B = m \times \lambda$ . And we will get the local power spectrum.

Through the sampling process, we obtain local power spectrum of  $N_B \times N_B$ . Its maximum coordinates are offset  $(\Delta x_0, \Delta y_0)$  in shifted parameters of the sub-pixel level. After amendment of the initial shifted parameters, we may get estimated parameters. The process is called the local-phase correlation.

The specific steps of the algorithm are as follows:

1. Enter an image as reference image.
2. Shift the reference image  $(\Delta x_0, \Delta y_0)$  to get pending registration image  $g(x, y)$ : The object image and reference image come from the same scene. Thus, their position is relatively fixed.
3. Determine  $(\Delta x'_0, \Delta y'_0)$  between  $f(x, y)$  and  $g(x, y)$  by means of  $r_{fg}(x_0, y_0)$ : The main function of this step is to locate the pixel level registration point.
4. Give the value of sample factor  $\lambda$ : The size of the sampling factor determines the size of the basis points in the neighborhood which to be take, the greater its value, higher accuracy while the operation speed is slower.
5. Output the registration image.
6. Calculate the error according to the registration image and reference image.
7. Output time complexity.

## 64.4 Performance Analysis

**Storage and computing scale:** According to traditional sampling methods, it have to store  $100 M \times 100 N$  points to reach 0.01 registration accuracy ( $M$  and  $N$  are registration image pixel sizes). While using our method, it only need to store  $100 \lambda \times 100 \lambda$  points; here,  $\lambda$  is between 1 and 2. As a result, image registration accuracy has been increased and the load on the computer has been decreased.

The complexity of algorithm: The advantage of Fourier transform in sample matrix is that there is no need to pad zero in the cross-power spectrum. We directly sample on a small neighborhood specified by the spectrum. When  $\lambda \ll N$  ( $N$  is the smaller value between  $N$  and  $M$ ), the Fourier transform complexity of local sampling matrix is  $O(N^2\lambda)$ , while that of algorithm is  $O(N^2\lambda^2\log_2 N)$ . Thus, the local-phase correlation has improved greatly than the latter.

## 64.5 Experimental Results and Analysis

In figure lenna, we set phase number 2 and accuracy 0.01, corresponding to the sample scale factor  $\lambda = 100$ . In this case, we shift the image (5.65, 12.09), (15.658, 10.349), and (7.1658, 10.5345), respectively, in the meantime and plus  $f = 0.06$  impulse salt noise to the object image. And then calculate the error between the registration image and the reference one. Images processed, including before and after experiment, are shown in Figs. 64.1, 64.2, and 64.3. The related parameters are shown in Table 64.1.



**Fig. 64.1** Reference images (a), the object image (b), and after shifted (5.65, 12.09) and the registered image (c) with  $\lambda = 100$



**Fig. 64.2** Reference images (a), the object image (b), and after shifted (15.658, 10.345) and the registered image (c) with  $\lambda = 100$



**Fig. 64.3** Reference images (a) with salt noise, the object image (b), and after shifted (9.49543, 8.7465) and the registered image (c) with  $\lambda = 100$

**Table 64.1** Comparison results of the estimated parameters of sub-pixel image registration

Phase	$\lambda$	Shifted(unit: pixels) ( $x_0, y_0$ )	Error of registration and reference image ( $\Delta x, \Delta y$ )	Running time
2	100	(5.65,12.09)	(0,0)	0.5279
		(15.658,10.345)	(0.002,0.005)	0.5221
		(7.1658,10.5345)	(0.0042,0.0045)	0.56
	1,000	(5.65,12.09)	(0,0)	1.2
		(15.658,10.345)	(0,0)	1.21
		(7.1658,10.5345)	(0.0002,0.0005)	1.207
6	100	(5.65,12.09)	(0,0)	0.5551
		(15.658,10.345)	(0.002,0.005)	0.5443
		(7.1658,10.5345)	(0.0042,0.0045)	0.5837
	1,000	(5.65,12.09)	(0,0)	1.2298
		(15.658,10.345)	(0,0)	1.21
		(7.1658,10.5345)	(0.0002,0.0005)	1.24

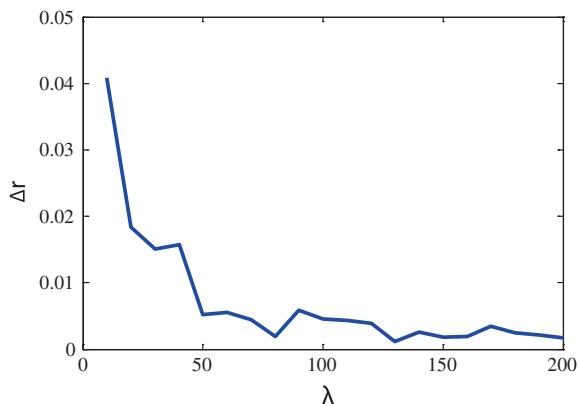
From the result, we can find that whether the movement unit is 0.01 pixels, the accuracy is also achieving 0.01 pixels, and the error is zero after registration. If moving accuracy exceeds 0.01 pixels, the registration error increases relatively, but its value is also less than 0.01. The increase in phase has little impact on error of phase-based image, but running time is affected slightly (it decreases with increasing phase). Accuracy increases by 10 times, while the running time increases by more than 100 times. Therefore, it fully reflects the characteristics of the running speed, registration error remained unchanged after adding impulse noise which mean that the good robustness of the proposed algorithm.

The comparative values between algorithm and algorithm (with an accuracy of 0.001) referred in reference are shown in Table 64.2.

From Table 64.2, it can be concluded that the proposed algorithm has higher registration accuracy than the algorithm in Ref. [1]. Nonetheless, this algorithm in this paper has certain advantages. So this algorithm has high registration accuracy.

**Table 64.2** values of the two algorithms

Shift value( $x_0, y_0$ )	Algorithm in Ref. [6]	Algorithm in the paper (with an accuracy of 0.001)
(10.7866,20.6167)	(10.79,20.62)	(10.7787,20.617)
(0.4537,0.8961)	(0.45,0.89)	(0.454,0.8962)
(10.6457,10.4356)	(10.64,10.61)	(10.646,10.43599)

**Fig. 64.4** Relationship between the sample scale factor  $\lambda$  and registration error  $\Delta r$ 

When the level shifted of image (17.48574, 8.73837) pixels. The registration error is defined as follows ( $\Delta r$ ):

$$\Delta r = \sqrt{\Delta x^2 + \Delta y^2} \quad (64.8)$$

The relationship between sampling scale factor  $\lambda$  and the registration error  $\Delta r$  is shown in Fig. 64.4. It can be seen that the registration error  $\Delta r$  error of image registration decreases with the increasing of sampling scale factor  $\lambda$ . The size of the sampling scale factor is determined by the requirements of image registration. The higher the value of  $\lambda$ , the more the computer's storage space required, and the longer algorithm execution time. Therefore, the efficiency of the algorithm is greatly reduced. Thus, in order to avoid the increase in computer load, we just need to make image registration meet the requirements.

## 64.6 Conclusion

Image registration is the most popular areas in the image processing and analysis. It has wide applications in medicine, remote sensing, and machine areas. There are many techniques for image registration, but these methods take up space on computer and have high time complexity and long running time; especially, they have high requirements on the imaging environment. They cannot take effective registration on

low-quality images caused by noise. Our algorithm is calculated by the smallest root mean square error theory. On the basis of traditional phase shift parameters, we propose a method of local-phase correction to get sub-pixel level image registration.

A large number of experiments show that the proposed algorithm has high registration accuracy, low complexity, and good robustness. Therefore, it can play a good role in practical applications.

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# Chapter 65

## Efficient Big-Size Light Region Splitting Scheme for High-Resolution SAR Imagery

**Yongfeng Cao, Caixia Su and Jianjuan Liang**

**Abstract** Building detection is a key step to extract information about urban regions from high-resolution synthetic aperture radar (SAR) images. Light features of building often merge into a big-size region in SAR images due to SAR imaging mechanism and geometric layout of building, and make it difficult to further extract building information. A method that is a hybrid of morphological operators for building detection from high-resolution SAR images is proposed. This method first detects buildings by a combination of two intensity thresholds and morphological reconstruction, then to the big-size light region, a hybrid of several morphological operators are used to split it into proper number of small segments. The proposed method performs better than classic K-means and ISODATA in testing high-resolution TerraSAR-X data, in both shape preservation and building number estimation.

**Keywords** SAR imagery • Building information extraction • Hybrid morphological operators

### 65.1 Introduction

High-resolution synthetic aperture radar (SAR) sensors (airborne SAR sensors and spaceborne RADARSAT-2, TerraSAR-X, COSMO Skey-Met, etc.), delivering images with metric or sub-metric resolution, have made it possible to extract and analyze detailed urban information [1]. Building information has promising applications in many aspects such as urban and rural planning, natural resource protection, diseases and population distribution, population estimation and environmental and disaster evaluation.

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Building detection is a key step to extract information about urban regions using high-resolution SAR images. Most research works [2, 3] in urban analysis of high-resolution SAR images, detect buildings by extracting information about the light layover and double-bounce regions [4, 5]. However, these features of different building often merge into a big-size light region in SAR images due to SAR imaging mechanism and geometric layout of urban areas, and make it difficult to further extract building information.

This paper addresses splitting the big-size light regions in SAR images into proper number of small patches, each of which corresponds to a free-standing building. Based on the result of our method, extracting building information such as height, area, building density and unit number of a certain region will be made easy.

We first detect layover and double-bounce regions by a combination of two intensity thresholds and morphological reconstruction, and then a hybrid of morphological erosion, distance transformation and watershed transformation is used to split big-size light regions detected into small patches, each of which corresponds to a free-standing building. Comparison with classic K-mean and Iterative Self-Organizing Data Analysis Technique (ISODATA) [6] is also given. With the advantage in shape analysis, our method performs better than K-means and ISODATA in analyzing high-resolution TerraSAR-X data.

## 65.2 Splitting Big-Size Light Region by Hybrid Morphological Operators

### 65.2.1 Building Detection by Morphological Reconstruction Based on High and Low Thresholds

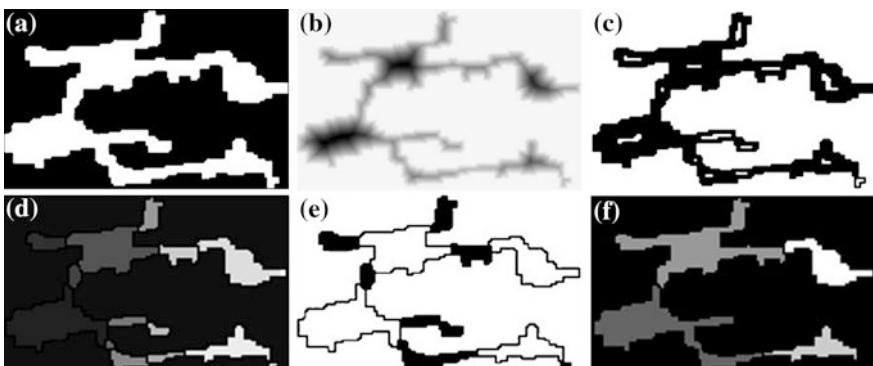
It is well known that buildings show bright features such as layover and double-bounce effect in high-resolution SAR images. So detecting buildings by thresholding the SAR intensity data is reasonable. An optimal threshold may exist for a small region, but not for a large region because of the nonlinear relationship between the double-bounce response and building orientation angle and complex surroundings [7]. To overcome this problem, two thresholds, high and low, are used. We begin by applying a high threshold. This mark out the building points we can be fairly sure are genuine. Starting from these, building area can be expanded through the image. While expanding, we apply the lower threshold, allowing us to find the faint section of buildings as long as we find a starting point. This process is similar to that in the famous canny edge detector [8]. We understand this process by a morphological reconstruction operator with the high-threshold result as mark image and low-threshold result as mask image.

### 65.2.2 Hybrid Morphological Operators for Splitting Big-Size Light Regions

Results of building detection in the above section may include many big-size light regions, which is often caused by very high buildings (a high building often cause a long and big light region toward the radar incidence direction; this long and big light region will connect many separate light regions into a very big one) or dense building area such as city–village. We use a hybrid of morphological erosion, distance transformation and watershed transformation to split big-size light regions into small patches that each one corresponds to a free-standing building. We choose morphological operators instead of spacial clustering methods (such as K-means and ISODATA) due to their advantage in shape preservation of building. Our method consists of four steps:

**Obtaining building-kernel by ultimate erosion:** Morphological erosion shrinks the foreground object by removing pixels on object boundaries. The number of pixels removed from the object in an image depends on the size and shape of the structuring element. We use a  $3 \times 3$ -unit matrix as the structure element of erosion. To a given big-size light object (the light region is set 1 and background 0), erosion operations are carried out repeatedly till no foreground pixels are left. During this process, some disconnected regions will appear and every region will at last disappear. All connected regions that will disappear in the next erosion step, are called ultimate erosion result. In our case, the ultimate erosion result (see Fig. 65.1c) is just the building-kernels we wanted.

**Constructing distance image:** Distance transformation provides a metric of the separation of points in the image. We use it to calculate the distance between each pixel that is set to 1 and the nearest zero pixel for the binary image



**Fig. 65.1** **a** A big-size light region. **b** Distance image of a. **c** Marker image obtained by ultimate erosion. **d** Segmentation result of marker-controlled watershed transformation on distance image b. **e** Reconstructed marker image. **f** Final segmentation result

containing a big-size foreground object. Let  $\text{Dis}$  denote the distance image. We finally use a new distance image  $\text{nDis} = \max(\text{Dis}) - \text{Dis}$  (see Fig. 65.1b).

**Watershed transformation with building-kernels as markers:** The most commonly used watershed transformation method [9] works on a gray scale image and normally will lead to an over-segmentation. We choose the building-kernels obtained by ultimate erosion as markers and the distance image  $\text{nDis}$  as the gray scale image to do a marker-controlled watershed transformation (for segmentation results, see Fig. 65.1d).

**Eliminate small segments:** There will be many trivial parts in the segmentation result of watershed transformation. We here use an area threshold to eliminate them. We do not delete those segments or merge them with neighboring ones, but just redo another marker-controlled watershed transformation. The marker is constructed based on the segmentation result with those segments bigger than area threshold (see Fig. 65.1e).

### 65.3 Experiments and Analysis

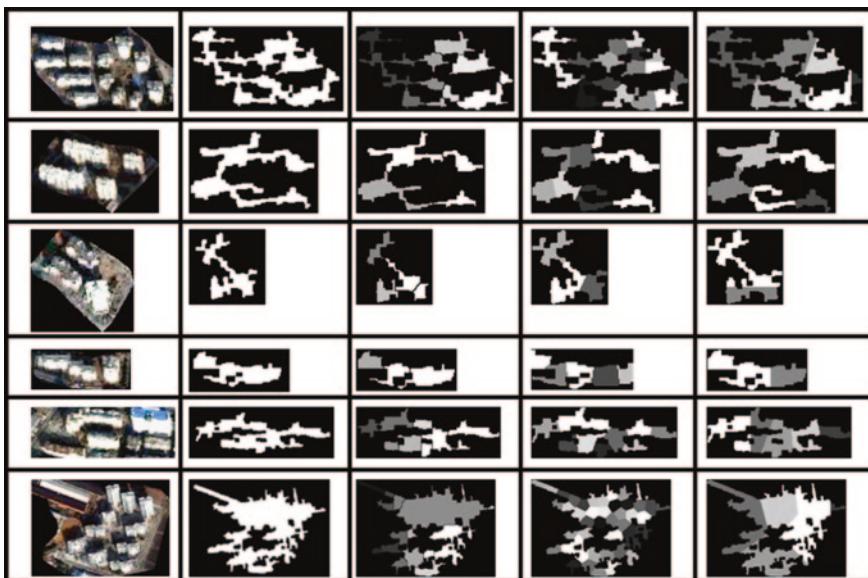
The proposed method is tested on a TerraSAR-X intensity image covering part of Wuhan city of China, with spatial resolution of  $1.25 \times 1.25$  m per pixel (over sampled from  $3 \times 3$  m per pixel). Two thresholds, 700 and 400, are used for building detection. The thresholds were set by direct visual inspection on the dataset. The direct interactive approach is good for simulating the real-case scenario where usually no reference data are available for training. Figure 65.2 shows one part of the test SAR image and the corresponding building detection result.

The area threshold for eliminating small segmentations of watershed results is set as 100, which is half the mean area of light regions in the test image. Fig. 65.3 shows segmentation results of our method, K-means and ISODATA



**Fig. 65.2** *Left* TerraSAR-X intensity SAR image of a part of the test site. *Middle* Building detection result of the left image. *Right* Result of splitting big-size light region with our hybrid morphological operators

method on 6 big-size light regions of the test image. We use the classic K-means method, which randomly selects K points as initial centroids. The parameter K is set to the ratio of the area of big-size region and that of standard building area (mean area of light regions in the test image). The ISODATA method can estimate K dynamically, but needs too many user-defined parameters. In our case, we set searching number of classes from Min = 2 to Max = 20, the minimum pixels in class as 50, maximum intra-class standard variance as 5, minimum inter-class distance as 20, maximum merge pairs per iteration as 2, and the maximum iteration time as 10. It can be seen from Fig. 65.3 that K-means and ISODATA poorly preserved the spatial shape of building regions. This is because they all prefer spherical cluster, and clusters are expected to be of similar size. Our method performs well in shape preserving. From Table 65.1, it can be seen that our method estimates the number of building in a big-size light region better than ISODATA.



**Fig. 65.3** Segmentation results of our method (*the third column*), K-means (*the fourth column*) and ISODATA method (*the fifth column*). Optical images of the scenes according to six big-size light regions (*the second column*) being segmented are given in the *first column*

**Table 65.1** True building number and detected building number of the 6 regions in Fig. 65.3

	Region1	Region2	Region3	Region4	Region5	Region6
Real building number	12	4	3	3	7	11
ISODATA	6	5	2	2	5	5
Our method	12	4	4	3	9	19

## 65.4 Discussion and Conclusion

A method that is a hybrid of morphological operators for building detection from high-resolution SAR images is proposed in this paper. This method first detects buildings by a combination of two intensity thresholds and morphological reconstruction, then to the big-size light region, a hybrid of several morphological operators are used to splitting it into proper number of small segments. With the advantage in shape analysis of morphological operators, this method performs better than classic K-means and ISODATA in testing high-resolution TerraSAR-X data. Some further work can be carried out to improve the accuracy of building number estimation in a big-size light region, such as optimizing energy function defined on the features of the big-size region and its segments. This will be part of our further research work. Also, we will try to get some useful information on urban regions in the future, such as building density, based on our building detection results.

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# Chapter 66

## Research of Image Segmentation Base on PCNN Method

Rong Zhu and Degang Yang

**Abstract** The space incoherent and small changes in the amplitude of input image can be compensated by utilizing the character of PCNN that the similar input neurons can pulse simultaneously. And then the small regions of the image can be segmented very well by means of adjusting a threshold parameter of PCNN, therefore, the complete information of the image can be preserved and the quality of the image can be improved too. It is more effective to enhance the segmentation quality of the image than the method that enhanced an image through the image enhanced function DECORRSTRETCH of MATLAB and carrying out the information of spectral bands which will be normalized, finally adjusting the threshold.

**Keywords** PCNN • Image segmentation • Small regions • Threshold adjustment

### 66.1 Introduction

In the 1990s, Eckhorn and his colleagues studied the visual cortex of cats and other small mammals. Similar stimulate input synchronous oscillation phenomenon in the different positions of the local area of the visual cortex [1], so Eckhorn thought this phenomenon was because there was some mechanism in the visual system, local properties could be linked to a holistic features, and he verified this idea, then presented a pulse-coupled neural network model. This model is further modified to make it more suitable for image processing applications by Johnson et al.

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Foreign Preliminary research shows that the PCNN and the traditional artificial neural network compared to a lot of different points, PCNN has been successfully used for image segmentation [1], image smoothing [1], feature extraction [1], edge detection [2], object recognition [2], image recognition [3], image restoration [4], communication [5], decision-making optimization [3], etc. [6]. Therefore, it has broad application prospects. In particular, the PCNN for image segmentation, can better handle to be split image target and the background gray-scale range overlap [2], and can be ignored within the same region gray difference and spatial discontinuity.

Single neurons of PCNN are consisted of three parts by the receiving part, the modulation section and the pulse generator. Receiver section is divided into two branches, one for receiving includes external feedback input of the input signal F (Feeding the Inputs), its operator relations:

$$F_{ij}(n) = e^{-a_F} F_{ij}(n-1) + S_{ij} + V_F \sum_{kl} M_{ijkl} Y_{kl}(n-1) \quad (66.1)$$

Also receives the input of connections  $L_{ij}$  between neurons within the network, its operation relations:

$$\begin{aligned} L_{ij}(n) &= e^{-a_L} L_{ij}(n-1) + S_{ij} + V_L \sum_{kl} W_{ijkl} Y_{kl}(n-1) \\ E_{ij}(n) &= e^{-a_E} E_{ij}(n-1) + V_E Y_{ij}(n) \end{aligned} \quad (66.2)$$

Among them, the weight matrix  $M_{ijkl}$  and  $W_{ijkl}$  (usually  $M_{ijkl} = W_{ijkl}$ ) are respectively coupling connection matrix of the feedback input field  $F(F_{ij}(n))$  and in the domain  $L(L_{ij}(n))$ .  $Y_{ij}(n)$  is an output pulse sequence when PCNN produce outputs, that is whether neurons are ignition or not. And  $V_F$ ,  $V_L$  and  $V_E$  are respectively magnification factors of feedback input field F, coupled connection domain L and dynamic threshold E.  $a_F$ ,  $a_L$  and  $a_E$ , respectively, are decay time constants of the feedback input field F and coupled connection domain L and the dynamic threshold E, between them to meet  $a_L > a_E > a_F$ .  $S_{ij}$  is an external stimulus signal that the neuron  $ij$  accept (Here it is pixel gray values of the  $ij$  of the matrix of image pixels) [6]. PCNN processing the digital image model, consistent with the number of neurons and the number of pixels, each neuron-one correspondence with each pixel, each neuron is in the center of a  $n \times n$  connection weights matrix  $M_{ijkl}$  and  $W_{ijkl}$ , the connected weights between each neuron and its neighboring neurons can have a variety of options, such as neurons  $ij$  with neuron connection weight value:  $W_{ijkl} = \frac{1}{(i-k)^2+(j-l)^2}$

In order to avoid too many parameters, we will make the following improvements, each neuron regards stimulatory signals  $S_{ij}$  from the external as the feedback input  $F_{ij}$ ,  $F_{ij} = S_{ij}$ , Internal activities are got through input connections coupled with a positive offset (normalized for 1) multiplying and modulation with the feedback input  $F_{ij}$ , the computational formula is:  $U_{ij}(n) = F_{ij}(n)[1 + \beta L_{ij}(n)]$

Where  $\beta$  is a connection modulation index of the internal activities, in most cases, it is a constant in the interval  $[0, 1]$ .

PCNN neuron accepts feedback inputs  $F_{ij}(n)$  and connection inputs  $L_{ij}(n)$ , then formation of the internal activities  $U_{ij}(n)$  in its internal neurons activity system.

When  $U_{ij}(n)$  is greater than the dynamic threshold  $U_{ij}(n)$ , the PCNN is generated the output pulse sequence  $Y_{ij}(n)$ . Neurons of the pulse generator to produce the binary output according to the internal activities of a step function, and automatically adjust the size of the threshold  $\theta_{ij}$  according to the ignition state of neuron  $ij$ . If  $U_{ij}(n)$  is bigger than the threshold function  $\theta_{ij}$  at time  $i$ ,  $Y_{ij}(n)$  is 1, known as neurons  $ij$  ignition, then a pulse or pulse sequence is outputted,  $\theta_{ij}$  is rapidly improved through feedback; otherwise  $Y_{ij}(n)$  is 0, said neuron  $ij$  is not ignition, then stopping pulsing,  $\theta_{ij}$  begins to decline. If neuron  $ij$  is ignition, the threshold function will be adjusted in accordance with the following two equations according to  $V_\theta$ .

$$\begin{aligned}\theta_{ij}(n) &= e^{-a_\theta} \theta_{ij}(n-1) + V_\theta Y_{ij}(n-1) \\ Y_{ij}(n) &= \text{step}(U_{ij} - \theta_{ij}) = \begin{cases} 0, \text{otherwise;} \\ 1, U_{ij} > \theta_{ij}. \end{cases}\end{aligned}\quad (66.3)$$

Where,  $a_\theta$  is the attenuation coefficient of the threshold  $\theta_{ij}$ , and  $V_\theta$  is the default threshold.

PCNN for image segmentation, the two-dimensional image matrix  $M \times N$  can be understood for  $M \times N$ -number PCNN neuron model, the gray value of each pixel is corresponds to the input of each neuron  $S_{ij}$ , in which if there is one similar gray value pixel stimulated and producing pulse output in the neighborhood of the internal connection matrix  $M$  and  $W$ , then it can lead to other similar gray-scale pixel stimulated the corresponding neurons and produce pulsating output sequence  $Y_{ij}(n)$ . It is obvious that the sequence  $Y_{ij}(n)$  contains the image area, edge, texture features and other information. In this way, similar neurons constitute a neuron cluster which likes giant neurons, simultaneously releases a pulse.

A neuron clusters correspond to the same gray area in the image, different neuron clusters are corresponding to different regions in the image. The binary image consisted of this output sequence is the outputted segmentation images of the PCNN. Therefore, using the sync pulse triggered by the PCNN pulse propagation characteristics, image segmentation can be achieved. This is the PCNN principle for image processing.

The attenuation coefficient  $a_\theta$  determines the change in amplitude of  $\theta_{ij}$ , affects the number of iterations of the PCNN computing, and relates to the efficiency of PCNN for image processing. How to make full use of that image segmentation and image statistics to determine adaptively will be described below.

## 66.2 The Optimization of the PCNN Attenuation Coefficient A

### 66.2.1 Information Curve

We will utilize the unit entropy to reveal the relationship between the image pixel gray and the amount of information it contained in its neighborhood.

The unit entropy of size  $m \times n$  image is divided into a number of pixels for each pixel or sub  $P \times Q$  images, each sub-image is called a unit, the unit entropy  $H_1$  is defined as:

$$H_1 = -p_0 \times \log_2 p_0 - p_1 \times \log_2 p_1 \quad (66.4)$$

Where A and B, respectively, are the Q probability of 0 and 1.

To calculate the unit entropy for each unit, the original image can be used by a  $P \times Q$  dimensional unit entropy vector H,

$$H = \{H_{11}, H_{12}, \dots, H_{1Q}, H_{21}, H_{22}, \dots, H_{2Q}, \dots, H_{P1}, H_{P2}, \dots, H_{PQ}\} \quad (66.5)$$

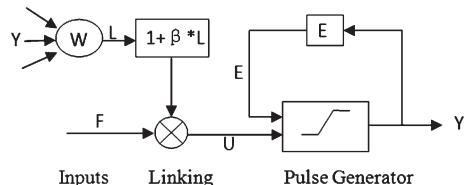
Computing the unit entropy of the pixel neighborhood and counting the unit entropy through the index of pixel grayscale. To further enhance the computing speed, the gray scale—unit gradient approximation grayscale—Entropy, it shows the corresponding relations between each gray level of a digital image and the gray-scale pixel-related neighborhood gradient sum. Assume that the total number of pixels of a digital image is N, gray level d is C, the number of pixels of gray scale value  $d_k$  is  $n_k$ , the pixels corresponding to the unit entropy is  $H_{d_k}$ , then the  $k$ -th gray level  $d_k$  represents the amount of information:

$$h_k = \sum_{n=1}^{n_k} H_{d_k}(k), k = 0, 1, \dots, C - 1 \quad (66.6)$$

The above relationship can be shown by the information curve, that is, the image is divided into a series of sub-images and then calculates the amount of information each sub-image contained that equals to the pixel gray value of original image, and finally create an image graph by taking the center of the pixel gray of the image as the index. The ‘mandi’ image, for example (see Fig. 66.1), in which the curve is composed of a series of gray values perpendicular to the horizontal axis line segments, each segment length is proportional to the  $h_k$ . The figure is essentially a high-end histogram which reveals the distribution of each gray level image associated with the amount of information relations, shows the size of the amount of information represented each gray level in the image, it has the nature of a two-dimensional histogram, but the form still is the one-dimensional, so it has a high level of search efficiency. The total amount of the thresholds divide information is the area under the curve.

The main source codes are:

**Fig. 66.1** The basic PCNN neuron



```

X = imread('mandi.tif');
x = double(X);
subplot(2,2,1);
imshow(uint8(x));
title('mandi grayscale');
subplot(2,2,2);
imhist(uint8(x));

```

Assume that  $H_{\max}$  is the amount of information in an image,  $H_e$  is the amount of segmentation target information,  $H_f$  is the amount of information of the background,  $\theta$  is the threshold value, so  $H_e = \sum_{i=0}^{\theta} h(i)$ ,  $H_f = \sum_{i=\theta}^{255} h(i)$  when

$\theta = 0, H_e = 0, H_f = H_{\max}$  when  $\theta = 255, H_f = 0, H_e = H_{\max}$ .

Searching  $\theta$  from 0 to 255,  $H_e$  is increasing,  $H_f$  is declining. When  $H_e = H_f$ , the amount of information of the image segmentation results is maximum, so after traversing the image information curve, a gray value  $g'$  will be searched, and  $H_e = H_f$ , the gray value  $g'$  is the best grayscale segmentation threshold based on the amount of information.

### 66.2.2 Determining the Attenuation Coefficient $a_\theta$ of PCNN

The attenuation coefficient  $a_\theta$  determines the change in amplitude of the threshold  $\theta$ , impacts on the number of iterations of the PCNN operator.

Assuming that the maximum image gray is  $g_{\max}$  the best grayscale segmentation threshold by searching the curve of the image information is  $g'$ , then the PCNN parameter  $a_\theta$  meets  $e^{a_\theta} = \frac{g'}{g_{\max}}$ . To multi-grayscale target image, the image information curve must be multi-peak shape. Assume that  $v$  is the number of multiple peaks in the curve of the image information,  $g'[v]$  is the sequence of best grayscale segmentation threshold, an algorithm of calculating  $g'[v]$ :

- Step 1: Generating 256 grayscale image curve;
- Step 2: According to the gray values 1–255 traversing the ring along the transverse direction, reading non-zero amount of information on the data of the longitudinal axis;
- Step 3: Comparing the amount of information value corresponded to each level gray value: assuming a gray value  $g[k]$  corresponded to the amount of information value is  $H[k]$ ,  $H[k] < H[k - 1] \& H[k] < H[k + 1]$ , so  $H[k] = 0$ ;
- Step 4: Repeat Step 2 until there are no  $H[k]$  to meet  $H[k] < H[k - 1] \& H[k] < H[k + 1]$ ;
- Step 5: Recording the gray value corresponded to the remaining amount of information data is best gray-scale segmentation threshold sequence  $g'[v]$ .

The PCNN attenuation coefficient sequence

$$a_\theta[v] a_\theta[k] = \ln g'[k] - \ln g'[k - 1], k = 0, \dots, v.$$

### 66.3 Experiments

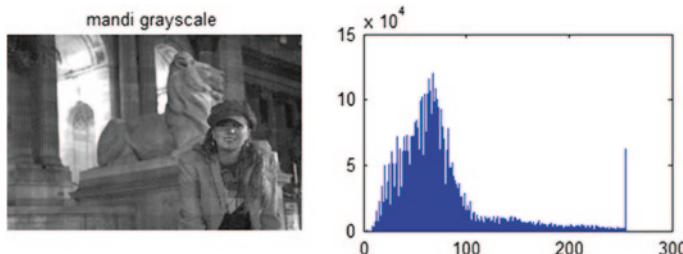
The test sample reconstruct image is  $256 \times 256$ , and the gray level is 256, the image blocks to compute unit entropy using  $4 \times 4$  program, the model parameters of the PCNN are  $V_L = 0.2$ ,  $V_E = 15$ ,  $\beta = 0.1$ . The output of the segmentation results after the operation of the network is shown Fig. 66.2.

Known by the experiment, the amount of information rating can be adjusted according to actual needs. In general, the smaller  $a_\theta$  is, the more pulse level neurons issue, and the more split levels of the amount of image information are, the more sophisticated segmentation results are, the greater levels are; the bigger  $a_\theta$  is, the less split levels of the amount of image information are, the rougher segmentation results are [7].

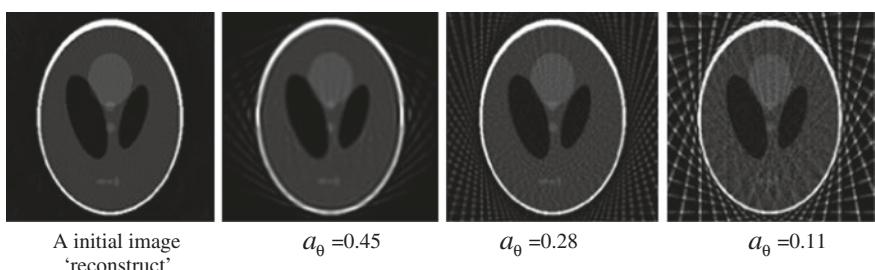
The above methods will be compared with the method mentioned below.

As shown in Fig. 66.3, the initial image ‘courtesy of space imaging’ is an earth resources satellite images taken in the USA. We use the following method to segment regions contained a large amount of green vegetation in this image.

The contrast of the initial image (1) is unobvious. A function DECORRSTRETCH of image processing tool in MATLAB is used to enhance the image, as shown in (2).



**Fig. 66.2** Mandi’s grayscale gray value information curve



**Fig. 66.3** Segmentation results of ‘reconstructs’

In order to eliminate the impacts of uneven lighting that clouds and mountains brought, the information of near-infrared spectroscopy NIR and infrared spectroscopy RED will be took out separately to calculate their difference, and then normalize  $NVDI = (NIR - RED) / (NIR + RED)$  to the  $[-1, 1]$  range to display the image, as shown in (3), dark area in the figure is the river, the white areas is green vegetation.

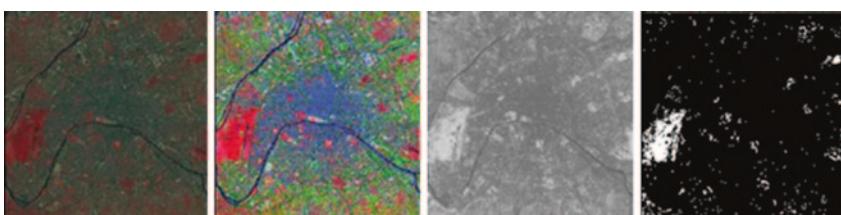
In order to make green vegetation areas in the normalized image more obvious, threshold is used to process the image to get the binary image, as shown in (3). Visibly, wide-scale green vegetation areas are white, small-scale vegetation areas and others are black.

This method can segment the wide-scale green vegetation region, but small-scale vegetation areas can't be separated, but the small area of the image can be split so well by adjusting threshold  $a_\theta$  of PCNN that the information of the image can be retained completely. It is found that good threshold of PCNN to image segmentation is a good way. As shown in Fig. 66.4.

## 66.4 Conclusions

PCNN has been improved in this paper by the means of transforming the initial input of the connection part into the edge information of image. At the same time, it can expedite the segmentation of image by adjusting the threshold, and then makes the quality of segmentation improved. However, that PCNN model applied to image segmentation still have a lot of disadvantages, such as the network coefficient is difficult to determine, pulse threshold processes complexly and the number of iterations can't determine, etc. It is hoped that these disadvantage can be got further improvements.

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A initial image ‘courtesy of space imaging’ (1) a enhanced image (2) a normalized image (3) a after-threshold image (4)

**Fig. 66.4** Segmentation results of ‘courtesy of space ‘imaging’.

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# Chapter 67

## Linear Data Relocation and Reconstruction Algorithm for Vector Map

Sha Liu and Taolin Ma

**Abstract** To protect the copyright of the two-dimensional vector map, this paper analyzed the well-known digital watermark algorithms in the domestic and international and proposed the linear data relocation and reconstruction algorithm. The innovation of this algorithm was based linear data instead of feature points to embed the watermark images into the vector map. It extracted the coordinates of vertices of line entities and sorted. Then, it relocated the vertices coordinates and embedded the scrambled binary watermark images. Finally, it calculated the similarity between the original watermark images and the extracted ones. We judged the correctness of the watermark information according to the similarity. The experiments show the linear data relocation and reconstruction algorithm has strong robustness in random noise attack, distortion, cropping and deletion of the map, without great amount calculation.

**Keywords** Digital watermark • Vector map • Line entity • Robustness

### 67.1 Introduction

Digital map has been widely used in geographic information system (GIS). It can be classified into the raster map and the vector map. Compared with raster map, two-dimensional vector map has small data, high accuracy and other virtues. Especially, the vector map can be resized, rotated and then transformed randomly without sacrificing the quality. Thus, as an important part of GIS, the vector map has been widely used in various fields. However, nowadays, when the network is highly developed, the digital map is also facing serious challenges as other digital products. It is vulnerable to be pirated illegally and tampered maliciously, which brings a large challenge to the copyright of digital maps.

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Digital watermark technology is able to provide effective solutions to protect the copyright of the digital map. To protect the copyright, how to embed robustly watermark information into the vector map is a subject worth studying.

## 67.2 The Current Situation Analysis to Algorithms at Home and Abroad

At present, most of the digital watermark algorithms existing are mainly applied to the raster map, while those to the vector map are lacking reports. Algorithms proposed by references [1–4] either cause distortion of the vector map easily or fail to possess a strong robustness. Algorithms presented in references [5–8] are to change the vector map into the raster map by embedding digital watermark into vector maps, which reduces the robustness of algorithms. The most successful robust watermark algorithm is introduced by Praun [9], but this algorithm has a disadvantage of the great amount of calculation. The MQUAD algorithm presented in reference [10] has strong robustness, but there are substantial defects in its security. The algorithms are proposed by literatures on the basis of MQUAD algorithm, and they overcome the defects of MQUAD algorithm. But for algorithm, the recovery of watermark information is sensitive to deletion of map spatial elements and to cropping of map sheet. The algorithm in reference [4] needs a lot of calculation, which slows down the algorithm. In fact, the above watermark algorithms are based on the feature points, while these points are distributed very unevenly in maps. As a result, the watermark information is hidden unevenly, which leads directly to the unstable anti-cropping and the poor anti-distortion of algorithms. To improve the robustness of algorithms, this paper establishes an innovative algorithm based on the linear data relocation and reconstruction algorithm.

## 67.3 The Linear Data Relocation and Reconstruction Algorithm

### 67.3.1 *The Basic Idea of the Linear Data Relocation and Reconstruction Algorithm*

The linear data relocation and reconstruction algorithm is a kind of spatial domain algorithm, studying mainly linear data such as CIRCLE, ARC and SPLINE in vector map. The algorithm chooses raster images as embedded watermark images and converts watermark images into one-dimensional (1-D) binary watermark sequences, which would be embedded into vertices of vector map linear data according to certain rules. Ultimately, it accomplishes the embedding of the watermark information by the limitations of human visual resolution. When detecting

the watermark, this algorithm calculates the similarity between the original vector map and the watermarked vector map and then extracts watermark image sequences based on detection result. These watermark image sequences should be returned to two-dimensional images whose size is as same as the original watermark images. We can judge whether the robustness of the algorithm is great or not according to the recovery of watermark images or determine whether the copyright of the vector map is legal or not.

### **67.3.2 Embedding Watermark**

#### **67.3.2.1 Generating and Processing the Watermark Images**

We define the given watermark image as  $W$ , and it is the binary image whose size is  $M \times M$ . It can be expressed as below:

$$w(x, y) = \{0, 1\} \quad (67.1)$$

where,  $x = 1, 2, \dots, M; y = 1, 2, \dots, M$ .

The location information of the watermark images would be dealt with by scrambling to hide  $M \times M$  binary watermark images. The purpose of that is even if the watermark information is attacked or extracted illegally, the attackers fail to get the contents of the watermark information because they do not know the rules of scrambling. Furthermore, scrambling can avoid pixels loss of watermark images caused by the deletion of entities as a whole in vector map. It also prevents vertices from relocating to centralized, otherwise human visual sense would be affected by slight transformation of the map. As a result, the robustness of the algorithm would be improved, and the ability of anti-attack of watermark images gets increased. The rules of scrambling are controlled by secret keys. The specific approach is to carry out pseudo-random scrambling on binary watermark images that is  $W$ , eliminating their correlation in the spatial domain. A progressive scan on all scrambled watermark images is made, and they are arranged in a one-dimensional sequence as below:

$$W' = \{w'_i\}, i = 1, 2, \dots, M^2 \quad (67.2)$$

#### **67.3.2.2 Extracting Coordinates of Vertices in the Vector Map**

According to the MQUAD algorithm, the linear data relocation and reconstruction algorithm divides the vector map into rectangular grids based on density of vertices. In every grid, the number of vertices should not be less than a certain value of  $M \times M$ , to ensure that every rectangular grid can be embedded watermark information once or more. The neighboring rectangular grids which belong to the same hierarchy and contain the least points are combined if there are rectangular grids containing points less than  $M \times M$  after division. The rectangles which contain the least points are chosen when there are more than one neighboring rectangles ready for the combination.

The algorithm sorts divided quad-tree structure rectangular grids by depth-first principle. Vertices coordinates of line entities are extracted orderly in every rectangle. The number of effective vertices which need to be extracted is  $M \times M$  which is enough to embed watermark information into every line entity once. Vertices coordinates arranged in a one-dimensional sequence are put in precedence order as below:

$$\{v\} = (v_1, v_2, \dots, v_{M^2}). \quad (67.3)$$

According to requirements, a vector map can be divided into N sub-blocks, so there are N one-dimensional sequences. They are expressed as below:

$$\{v_j\} = (v_{j1}, v_{j2}, \dots, v_{jM^2}) \quad (67.4)$$

where  $j = 1, 2, \dots, N$ .  $N$  may represent the strength of the algorithm, which depends mainly on the number of vertices of line entities in map and also on the number of watermark image pixels.

### 67.3.2.3 Embedding Watermark Information

The digital watermark can be embedded into either the horizontal axis or the vertical axis of vertices, or both. Watermark embedding formula is as follows:

$$v'_{jx} = v_{jx} + c \cdot \beta \cdot W' \quad (67.5)$$

$$v'_{jy} = v_{jy} + c \cdot \beta \cdot W' \quad (67.6)$$

The  $v'_{jx}$  represents the horizontal axis of vertices of linear entities in the  $j$ th sub-block in watermarked map. The  $v_{jx}$  is in original vector map. The  $c$  and the  $\beta$  indicate, respectively, the scaling of the map and the adjustment factor. They are set based mainly on the scale and the requirement of data accuracy. The purpose of that is to reduce the visual perceptible degree caused by vertices displacement, without affecting the map accuracy.

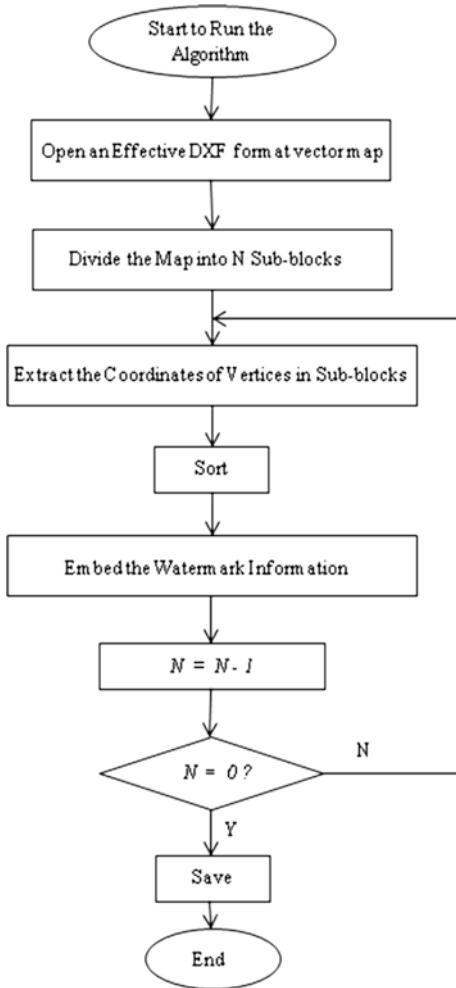
The new vertices which are constructed by formula (67.5) and (67.6), combined with the original vertices not involved in the transformation in vector map, constitute the watermarked vector map which is defined as  $V'$ . Figure 67.1 shows the flowchart of embedding watermark information.

### 67.3.3 Extracting and Detecting the Watermark Information

#### 67.3.3.1 Determining the Value of $c$

The first step is to calculate and determine the scaling of the vector map before extracting watermark images. The algorithm defines the value of  $c$  as the ratio of

**Fig. 67.1** Flowchart of embedding watermark information



two values. The one is the distance between two feature points in a sub-block of the vector map which is to be detected and the other is the distance between two feature points in the corresponding sub-block in the original map. The formula is expressed as follows:

$$c = \frac{\sqrt{(v'_{(j+k)x} - v'_{jx})^2 + (v'_{(j+k)y} - v'_{jy})^2}}{\sqrt{(v_{(j+k)x} - v_{jx})^2 + (v_{(j+k)y} - v_{jy})^2}} \quad (67.7)$$

There,  $k \in \{1, 2, \dots, M^2\}$ . And the  $k$  needs to keep a certain distance from  $j$  to ensure the number of significant digits of  $c$ . If the vector map has not been cropped, the view information can be read directly, without determining the value of  $c$ .

### 67.3.3.2 Extracting the Watermark Information

The first is to lay rectangular grids on the original map and the watermarked map, which is same as the division when embedding watermark information. In this process, the scaling of vector map that is  $c$  should be considered. The second step is to extract watermark information with a sub-block as a unit, as follows:

$$\{v_j\} = (v_{j1}, v_{j2}, \dots, v_{jM^2}), j = 1, 2, \dots, N \quad (67.8)$$

$$W''_j = \begin{cases} 1, & \frac{v'_{jx} - v_{jx}}{c\beta} \approx 1 \\ 0, & \frac{v'_{jx} - v_{jx}}{c\beta} \approx 0 \end{cases} \quad (67.9)$$

The third step is to integrate and anti-scramble watermark information extracted from sub-blocks, combining with the private key. Then, every sub-block is restored to be a two-dimensional watermark image whose size is  $M \times M$ . Now, we can obtain the watermark images from each sub-block. Extracted watermark images are defined as  $\tilde{w}_{ij}$ .

### 67.3.3.3 Calculating the Similarity

Finally, the algorithm calculates the similarity between the extracted watermark images and the original ones. A certain threshold expressed by  $T$  is set. If the similarity is larger than  $T$ , we can decide that extracted watermark images are certifiable mark. The formula is as follows:

$$corr(W, W'_j) = \frac{\sum_i (w_i \times \tilde{w}_{ij})}{\sqrt{\sum_i (w_i)^2} \times \sqrt{\sum_i (\tilde{w}_{ij})^2}} \quad (67.10)$$

## 67.4 Analysis of the Algorithm

In this paper, we carried out an experimental research to analyze the linear data relocation and reconstruction algorithm and chosen DXF format vector map as the experimental object. The raster watermark image adopted the  $64 \times 64$  binary image. For the experiment in this article, we embedded the watermark information into the horizontal axis of vertices and kept the vertical axis unchanged. Watermark embedding formula is as follows:

$$\begin{cases} v'_{jx} = v_{jx} + c \cdot \beta \cdot W' \\ v'_{jy} = v_{jy} \end{cases} \quad (67.11)$$

The adjustment factor,  $\beta$ , is set to 0.0001. The threshold of similarity is  $T = 0.8$ .

In the experiment, the watermarked vector map has been manipulated by rotating, zooming in or zooming out, cropping, random noise and so on.

As shown in the experiment results, this algorithm can resist the random noise, the deletion of map, similarity transformation, image compression and other attacks. And it possesses a relatively high level of robustness against distortion, cropping and other translations of vector map.

## 67.5 Conclusion

The paper presented the linear data relocation and reconstruction algorithm which is the private watermarking algorithm based on line entities. Based on the principle of the MQUAD algorithm and drawing on the thinking of the double-threshold combination detection algorithm, it overcomes the shortcomings of the MQUAD algorithm and combines the advantages of three algorithms. The paper introduces the algorithm idea and algorithmic process and then carries out the experimental analysis of the algorithm. Experimental results show that the algorithm achieves satisfactory robustness against deletion of map, image compression, distortion, cropping and other translations of the vector map.

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# Chapter 68

## Research on Remote Sensing Image Management Based on Computer Technology

Hong-wei Wang, Ji-cheng Quan, Yu Liu, Xiu-ying Zhao and De-jun Li

**Abstract** With the rapid development of remote sensing technology these years, the resolution of remote sensing image is more and more advance. Facing with massive remote sensing data, it is an urgent question that how to manage image data effectively. In this paper, it describes the current management of remote sensing image and foreign remote sensing image management system, and then based on the ways discussed above, the insights into the author are raised at the last.

**Keywords** Remote sensing image • Image management • Image pyramid • Web sharing

### 68.1 Introduction

As high-capacity information storage, remote sensing image data are widely used in many fields because of its timely, reliable, and easily providing a variety of information. However, remote sensing image data with multi-source, multi-scale, multi-temporal characteristics coupled with the rapid growth of remote sensing image data in recent years and the resolution of the continuous improvement of remote sensing image data, which are all reasons of remote sensing image data becoming a massive resource. Therefore, data collection, organization, management, and sharing have become the most important problem of data producers and users.

With the massive amounts of image data, how to get required data quickly and accurately is becoming particularly important, and then there is an urgent need for research on massive image data management and distribution.

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## 68.2 Remote Sensing Images Management

### 68.2.1 *The Indirect Management of Image Data-Images Metadata Management, Spatial Indexes Supported Management*

Remote sensing images metadata describe a variety of image attribute information, such as the image source, image resolution, image covering space range, and using these information, we can effectively manage the remote sensing images and user-friendly search images what we want. In Remote Sensing and GIS Research Center of Beijing University, Deng Xiaolian advanced a way of managing remote sensing images, which is based on the image metadata and fast viewing of remote sensing image (fast shown in Figure manner precise positioning management system) [1]. The remote sensing image management system AGRS of Chinese Resource Aero Geophysical Survey and Remote Sensing Center and satellite department of the Chinese Academy of Sciences showing fast retrieval of images is of such image management method.

Remote sensing images are a kind of spacial resources, the spatial distribution of the features that make the establishment of regional spatial index to manage the remote sensing image as possible, and domestic and foreign scholars have carried out some studies based on this feature. In order to facilitate customer inquiries about their imaging products, the Quick Bird Company launched video search services, for example, the Quick Bird image retrieval system. The technology, graphical indexing mechanism, it uses based on space and its geographical positioning while providing the corresponding metadata and quick view. Customer may need to select the appropriate image ordering [2].

### 68.2.2 *The Direct Management of Image Data-an Image Pyramid and Image Sub-Block Management*

With multi-resolution features of remote sensing images and maps of large volumes of data and large coverage area, what users usually need to query is based on a small area of a certain resolution images, and due to online query, the traditional image management method, and network bandwidth limitations, it is difficult to give good support. Different regions, different spatial resolution remote sensing image retrieval and extraction needs, academia and software engineering communities are many ways to solve, which is widely used is the pyramid algorithm. At present, the central GISs and remote sensing processing software, such as ArcGIS, Mapinfo, Erdas, SuperMap, the GeoImageDB of domestic geographic information system, all above could manage massive image data using the pyramid algorithm [3].

The so-called remote sensing image pyramid and data structure of image sub-block, that is sampling to get the number of pixels in accordance with certain rules and gradually less and less based on the original image, the resolution is getting

smaller and smaller image, after the original image and the sampling of the image from top to bottom constitutes a pyramid image level, all levels of the pyramid image sub-block, and note the space index, see Fig. 68.1.

Image pyramid and image sub-block structure are able to adapt to the requirements of multi-resolution, small-area image retrieval, to meet the requirements of the image data network transmission bandwidth limitations. The pyramid algorithm is the key in a reasonable stratification of the image data and sub-block, see Fig. 68.2.

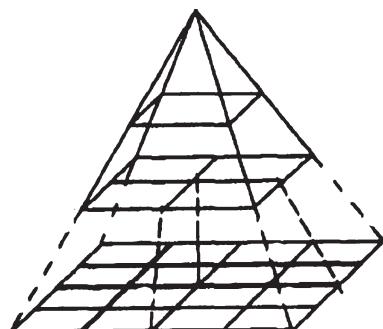
After following the TerraServe, Windows Live Local just launched in the near image retrieval service, it uses the same graphics of the pyramid block retrieval mechanism, and the client is built based on Ajax technology, roaming, and retrieve a high response speed and improve availability. Google map of the United States released satellite image data on the Internet, users can view any area of the image of different resolutions, the Google map using image pyramids and the image data block technology, integration of Ajax and data cache, the client browser image data smooth, no larger delay.

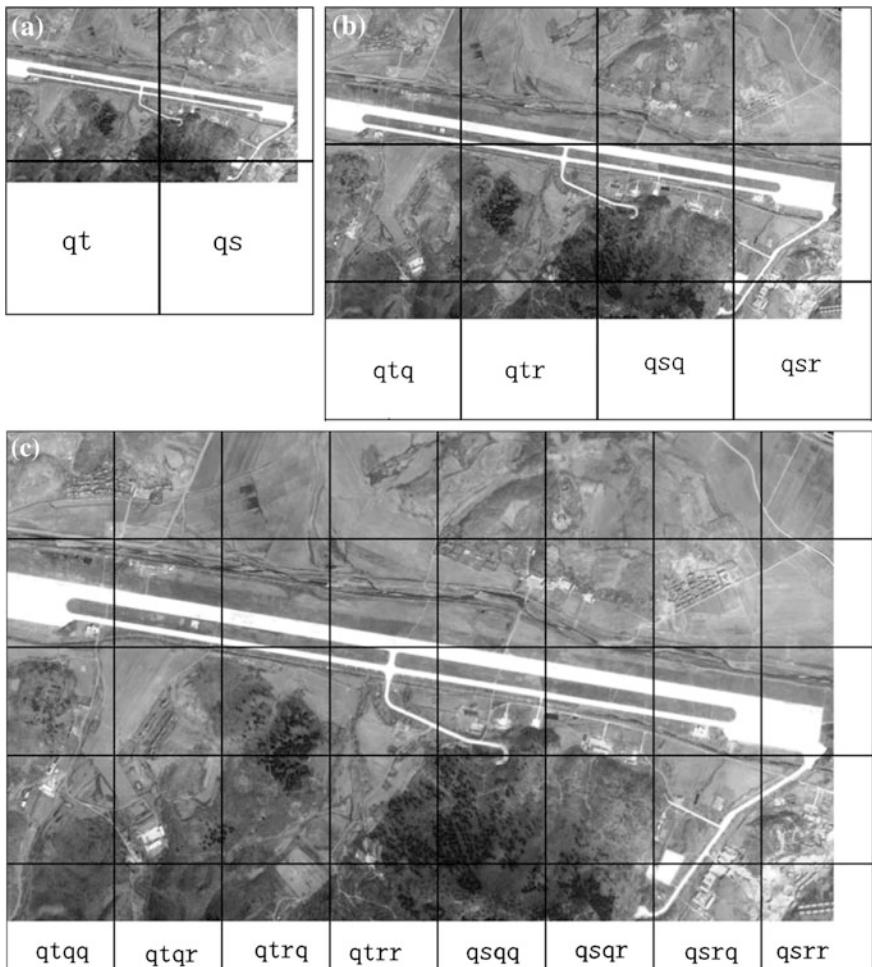
Domestic scholars also made a lot of research on the image pyramid and image data management ways, such as the development of a massive image database system based on the full relational database management system and network of Component Object Model (Internet Mass Image Database) IMIDB, a part of domestic geographic information system-based platform MapG1S, and the representative is Wu Xincai. IMIDB has method to achieve the management of multi-resolution remote sensing images to create an image pyramid, and to adopt multi-resolution given area image retrieval block-level image data [4].

### 68.3 Remote Sensing Images Sharing

The development and maturation of computer network technology not only bring us the dissemination and circulation of remote sensing images with the new ways, but also give us use of distributed storage space and computing resources in the network environment, the practical possibility of massive remote sensing data management system. The images of remote sensing imaging network have been released in two ways: LAN and WAN release.

**Fig. 68.1** Levels of the pyramid image sub-block, and note the space index





**Fig. 68.2** **a** Top picture; **b** Middle picture; **c** Bottom picture

## 1. The images of the LAN released

LAN image released in a unit or department image transfer. This technique is simple and easy to maintain, and it has high efficiency of image transfer but limited in scope. Wuhan Gio's GeoImageDB release product is the LAN-based remote sensing image management, distributed storage of image data, to support large-scale commercial databases, the system requirements for a more relaxed environment, suitable for local area network image sharing.

## 2. The images of the WAN released

Images WAN manner that the maximum extent of information sharing, with the advantage of the Internet information dissemination, users can easily use the

remote sensing images, the development trend of future remote sensing images released. Image-based WAN, the release of the way there are two major architecture, C/S structure and the B/S structure [5]. U.S. Google Earth typically based on C/S structure of image management products and its function is very powerful, and the released product is an excellent remote sensing image management. B/S structure image released products are Earth Resource Mapping's Image Web Server, Google Inc., Google map, and they are using the regular IE browser, in which user can query for a remote sensing image information.

## 68.4 Conclusion

The twenty-first century is the information age, and the efficient use of information resources is of strategic importance. Remote sensing images as an important data resource carry a wealth of information, and efficient utilization of mining can give us convenience. In recent years, with the rapid development of computer technology, the management of remote sensing images published; research and development of products have gained a lot of progress, and they have been widely used in military, national economy, the environment, and resources, and also have achieved very good effect.

Based on extensive literature and analyzed data, an efficient product technology of remote sensing image management should cover the following aspects:

1. Remote sensing image data are stored in large commercial relational databases, and using the data management, concurrent things, security, and other advantages of large commercial database, we can improve the efficiency of the image data.
2. Using the distributed technologies and reducing access to remote sensing image data, we can relieve pressure of the Central Server, enhance efficiency of image data access and system stability, and then the manage system would load balancing.
3. With the advantage of the Internet information distribution, we can maximize the extent of remote sensing images sharing and improving the use value.
4. GIS data and other useful information loaded on the image data would enrich the connotation of remote sensing images data, and providing integrated management and applications, all discussed above will promote using value of remote sensing image data.

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# Chapter 69

## An Improved Key Frame Extraction Algorithm of Compressed Video

Xiaoping Wang

**Abstract** The key frame extraction technology is the basis of content-based video retrieval, and a key frame extraction algorithm is based on the lens for compressed video sequence. Its core is based on the compression encoding characteristics of video sequences, only need to be part of the decoding, use the DC component of I-frame information to construct DC thumbnail, and combine the important difference of different areas of the image frame's DC information to make the similarity measure, and thus achieve key frame extraction. The experiments show that the algorithm is significantly improved than the traditional one about the two indicators of the recall and retrieval time, especially for the more dramatic news documentaries, films, and other local sports video sequences.

**Keywords** Key frame extraction • Compressed domain • The MPEG

### 69.1 Introduction

Presently, the key frame extraction based on the shot, light, movement descriptor to a variety of methods. Among them, the most common method is lens-based key frame extraction. A video is divided into the lens, the first frame of each scene (or the first and last frames) as the key frame of the lens. This method is relatively simple, regardless of the contents of the lens; the number of key frames is relatively OK (the first frame, last frame, or both are selected), the drawback is less stable, because the first and last frames of each scene are not always able to reflect the main content of the lens. The key frame extraction method based on the lens is studied mainly from two areas: the pixel domain and compressed domain.

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### ***69.1.1 Lens-Based Key Frame Extractions in the Pixel Domain***

In the so-called pixel domain, this refers to the space/time domain compared with transform domain, the video data exists in the form of people's daily scene, people's accustomed features (such as color, texture, shape, and motion vectors). Pixel domain detection is the use of these features to get the clip of a video sequence. The key for the shot segmentation is to find the difference between the different camera images. Currently, we have developed some more mature ways to do key frame extraction, full use of the video data, time/space, global/local, static/dynamic, and other kinds of information. Histogram comparison method is the most traditional and common method. In a continuous video sequence, if there is no special treatment, a small gap is formed between the adjacent two frames. In this way, the characteristics of adjacent frames are also almost the same. There are many algorithms for comparing two frame histogram differences that typically include the Euclidean distance, X the square of detection, dual-threshold comparison method, and the sub-block division method.

### ***69.1.2 Lens-Based Key Frame Extractions in the Compressed Domain***

More and more video data are saved in compressed form such as JPEG, MPEG2X; thus it is necessary to study compressed video sequence key frame detection method. This test is carried out usually two ways:

1. First, full-decompression (e.g., Huffman decoding, DPCM decoding, DCT inverse transform and motion compensation) is used to form a video sequence and then used the pixel domain-based approach to realize key frame extraction. The disadvantage of this method is to calculate more and low efficiency.
2. Second, partial decompression, which directly uses the features in the compressed video data to analyze and process, saving decoding time and reducing the computational complexity at the same time.

Currently, image and video compression aspects of international standards, such as JPEG, MPEG, of H. 261 and H. 263, are based on DCT. DCT is converting the pixel values of the two-dimensional space into two-dimensional frequency domain coefficient values; the frequency domain transform coefficients and the pixel domain are closely related and express the contents of the image frame to a certain extent. Early Arman and others used DCT coefficients to detect MPEG; this method was later extended to the MPEG compressed stream for the shot segmentation.

## 69.2 The Improved Key Frame Extraction Algorithm Based on the Lens

### 69.2.1 Algorithm Basis

The adjacent image frames of the video sequence have similarity and continuity, which is the theoretical basis of the key frame extraction based on lens. Yang Sheen et al. construct the key frame extraction system accordingly.

Known in the MPEG21/2 international standard (video part), MPEG21/2 video sequence is constituted by a number of image groups (group of picture GOP), and each GOP is composed by a range of the I, P, B frames of mutual interval forecast and generation; in each group, the first frame is always I-frame; I-frame adopts coding information of the image itself, and P, B frames are obtained by the forecast. Each shot must include the I-frame and has been confirmed by experiment (MPEG21/2 video encoding requires an I-frame in 13 frames in every shot. The lens, which is composed of the uninterrupted consecutive frames, and its playing time should be by s unit that can make sense, so calculating the frame rate (24 fps), each lens must include I-frames). Therefore, the key frame established in the lens can completely delete P and B frames and generate video sequence file that is composed only by the I-frame. In addition, considering the image compression in MPEG21/2 standards is based on the DCT, the transformation is the basic unit of  $8 \times 8$  sub-blocks for the transformation, can decode the I-frame to a certain extent, remove the DC coefficients, and restore DC thumbnail. And then adopt the template matching method; use the difference between the thumbnails as a similarity measure between the two frames to achieve the key frame extraction.

### 69.2.2 Algorithm Thinking

The analysis found that for the two image frames within the same lens, they are very similar from the statistical sense; two images belong to a different lens, which is very small in similarity. Solutions starting from the sub-block, considering the sub-block in the middle position of each image frame in the video sequence depicts visual information of the scene core, compared with sub-block in the same image frame surrounding the location, and the sub-block information at the center position are more important [1]. As a result, the difference of the sub-block at the center position plays an especially important role in determining the difference between the two adjacent image frames and should be treated specially [2]. This article on the basis of literature introduces the DC coefficient of the weight difference, design, and proposes an improved key frame extraction algorithm based on the lens in the compressed domain [3]. According to the theoretical thinking, the sub-block difference of the image frame at the middle position gets more reference

value than the sub-block difference at the peripheral location and constructs weight difference of the DC coefficient schematic diagram (Fig. 69.1).

In Fig. 69.1, each sub-block corresponds to a DC coefficient; the depth degree of color shows the importance of sub-block information in a different location. The deeper the color shows that it is more important position in the current image frame, it is necessary to give a larger weight value of the corresponding DC coefficient in the similarity measure. Finally, the difference of thumbnail as a similarity measure of the two adjacent image frames is calculated as follows:

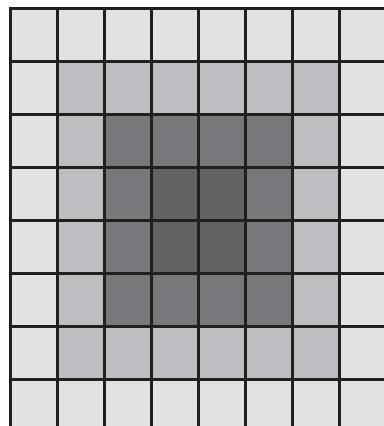
$$D(I_i, I_{i+1}) = \sum_{k=0}^n [H_i(k) - H_{i+1}(k)]^2 / [H_i(k) + H_{i+1}(k)]^2$$

Of which,  $I_i I_{i+1}$  represents the first  $I$  and  $I + 1$  frame, respectively;  $H_i H_{i+1}$  represents the  $I$  and  $I + 1$  of the  $I$ -frame DC thumbnail histogram information. When  $D(I_i, I_{i+1})$  reaches a peak, and then identifies the two  $I$ -frames from a different lens, extraction the first frame of the lens as a key frame. The essence of the proposed algorithm can be vividly interpreted as the amplification of the sub-block difference in the image frame.

### 69.3 The Analysis of Experiments and Results

For the improved algorithm, the selection of the characteristic parameters and decision rules of determining the key frame is the key. Specifically speaking, how to select the so-called core area scope, how to determine the weight values of the DC coefficients in the range of the core region, and how to select frame difference threshold to extract the key frames. These issues directly affect the performance of the merits of the proposed algorithm.

**Fig. 69.1** The schematic diagram of  $8 \times 8$  sub-block DC coefficient about weight difference



### 69.3.1 Experimental Performances

The recall and accuracy of the test model to measure the improved algorithm in this article were adopted. Retrieving the integrated query, the description, matching, and extraction processing have the possibility of success and failure. According to the principle of pattern recognition, you can get four conditions in Table 69.1, corresponding to the four basic parameters.

Using the basic parameters in Table 69.1 can define the commonly used recall and precision in order to characterize the retrieval performance. Defined as follows:

Recall rate = associated with the correct search results

All associated with the results =  $[A/(A + C)] \times 100\%$

Precision = associated with the correct search results

All retrieved results =  $[A/(A + B)] \times 100\%$

This paper selected the animation, film, advertising, science, education, and other video clips to test the effectiveness of the key frame extraction algorithm designed in this paper. The properties of the test video clips are shown in Table 69.2.

### 69.3.2 Analysis of Experimental Data

Followed by template matching method, Euclidean distance is divided into sub-block method, I-frame DC coefficient method; retrieval results of the improved algorithm for key frame extraction in compressed video sequences. The

**Table 69.1** The basic parameter of expressed retrieval ability

Result of retrieval	Associated	No association
Retrieved	Retrieved correctly (A)	Retrieved wrong (B)
No retrieved	Missing retrieved (C)	Right refuse (D)

**Table 69.2** Test the property of video fragment

Video source	Characteristic	Test frame	Key frame	Screen feature
Animation	Scene change fast more movement	625	24	No color 352*288
Film	Scene change slowly more movement	859	18	No color 352*288
Ad	Scene change fast more switch	527	16	Color 160*120
Science and education	Scene change slowly	385	6	No color 352*240

detection time represents T (unit: s), the number of key frames K (unit: frames), and video sequence length L (unit: frames).

Experimental results show that, after full decoding, key frame extraction results in pixel domain in the precision of this indicator are slightly better than the compressed domain methods. Rich and complete image information was obtained after full decoding, which sub-block partition method is the best.

But the large-scale decoding of the compressed file may result in longer detection time and less effective real-time detection. Although take compressed domain methods, such as I-frame DC coefficient method and the improved algorithm, it is better than the pixel domain methods in the detection time, and the partial decoded image information is limited, so it is slightly worse in the indicators of precision. From the experimental results, the compressed domain methods in the recall rate showed a good performance; unit time of the recall percentage is higher than the detection method of the pixel domain.

It can be seen from the data in Tables 69.3, 69.4, and 69.5; the improved algorithm in this article has improved retrieval time and the recall rate compared with the traditional division of the sub-block detection method. It increases the sensitivity of the image motion of the center of the lens position, making it

**Table 69.3** Test result of animation ( $L = 530$ ,  $K = 20$ )

Test method	The number of correlate images	The number of valid images	Recall rate percentage	All retrieved results percentage	Test time
Template matching	28	16	82.1	62.1	31"460
Euclidean distance	20	12	76.9	62.4	36"420
Sub-block divide	24	13	82.6	71.2	46"620
I-frame DC coefficient	18	12	76.5	65.4	25"830
My algorithm	25	15	86.6	70.8	26"250

**Table 69.4** Test result of film ( $L = 820$ ,  $K = 22$ )

Test method	The number of correlate images	The number of valid images	Recall rate percentage	All retrieved results percentage	Test time
Template matching	36	24	81.5	61.6	1'16"260
Euclidean distance	30	27	86.2	73.8	1'24"210
Sub-block divide	32	24	84.8	76.1	1'39"510
I-frame DC coefficient	25	25	80.7	68.4	56"280
My algorithm	28	26	96.2	72.5	59"650

**Table 69.5** Test result of AD ( $L = 410$ ,  $K = 20$ )

Test method	The number of correlate images	The number of valid images	Recall rate percentage	All retrieved results percentage	Test time
Template matching	27	16	84	61.6	18"25
Euclidean distance	25	15	79	62.7	23"27
Sub-block divide	23	16	84	71.3	27"73
I-frame DC coefficient	24	15	80	63.8	16"14
My algorithm	26	17	81	68.5	18"15

more suitable for more intense news documentaries, films, and other local sports video sequences; the key frame in the lens is not missing, but there will be a small amount of redundancy.

## 69.4 Conclusions

This paper put forward an improved key frame extraction algorithm based on lens in the compressed domain. Considering the encoding characteristics in the compressed video sequence domain, the proposed algorithm only use the DC component of the I-frame information and in accordance with the theory that sub-block difference of the image frame in the middle position is more valuable than the ones of the peripheral location, the proposed algorithm only use the DC component of the I-frame information. Experimental results show that the extracted key frames using the proposed algorithm can better reflect the contents of the video lens.

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**Part VIII**  
**Mathematics and Computation**

# Chapter 70

## 3D Model Simplification Method with Maintaining Local Features

Fangyi Liu, Xing Chen, Weiyuan Sun and Xingchen Gu

**Abstract** Current 3D model simplification algorithms only maintain the principal characteristics of the models, leading to the loss of the important characteristics of the local region. Therefore, these algorithms do not facilitate the human understanding of objects. The paper proposes a novel algorithm for simplifying 3D models, which can maintain the local important characteristics. The presented method combines the mesh segmentation algorithm and the simplification algorithm to extract the local visual features while ensuring the high fidelity of the whole mode. Experiments show the proposed algorithm is effectiveness.

**Keywords** Local feature • Mesh simplification • Mesh segmentation

### 70.1 Introduction

With the development of 3D scanning device and relevant technology, models are highly complex and detailed. However, the full complexity of such models is not always required, and it is useful to have simpler versions of complex models, as the computational cost of using a model is directly related to its complexity.

Nowadays, Triangular meshes are the most common drawing manner in computer graphics. Mesh simplification attempts to reduce its polygonal number while maintaining the appearance of the final object as much as possible. Since James Clark proposed the idea of 3D model simplification, global scholars have presented many model simplification algorithms. Typical algorithms [1, 2] include vertex deletion, vertex clustering, edge collapse and triangle collapse and so on. However, these simplification algorithms only focus on the fidelity of the whole model.

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According to the study of the psychophysics of human cognitive process, human understanding of things primarily concerned with the overall outline of things and then depends on the division that a complex object is divided into a few simple parts, and last focuses on the local features of each part. However, current 3D model simplification algorithms only focus on the principal characteristics of the whole models, ignoring the importance of local characteristics. How to extract the local features of the models is the key to this problem.

The paper proposes a novel algorithm for simplifying 3D models, which can remain the local important characteristics. The presented method combines the mesh segmentation algorithm and the simplification algorithm to extract the local visual features while ensuring the high fidelity of the whole mode.

## 70.2 Relevant Knowledge

### 70.2.1 Mesh Segmentation

Mesh segmentation partitions a mesh into a set of connected and visually meaningful regions depending on specific geometric characteristics and topological characteristics.

According to the different segmentation goals, mesh segmentation are classified as patch-type segmentation and part-type segmentation. Patch-type segmentation creates disk-like patches which obey certain geometric properties such as planarity, size or convexity. Part-type segmentation is targeted more at partitioning the object defined by the mesh into meaningful components [3]. In order to detect the sharp regions of models, we use patch-part segmentation.

### 70.2.2 Edge Collapse and Mesh Simplification

Edge collapse, first proposed by Hoppe [4], is an optimization algorithm suitable to simplify any two-dimensional manifold mesh. This algorithm iteratively selects the edge with the least error for collapsing, removes all adjacent vertices and faces and re-triangulates the resulting hole. As the algorithm proceeds, the number of the vertices and faces reduces and the model can be simplified.

QEM algorithm, a kind of edge collapse algorithm proposed by Garland in 1997 [5], uses iterative contractions of vertex pairs to simplify models and maintains surface error approximations using quadric matrices. We use the QEM algorithm to simplify the no-sharp regions of models because this algorithm is able to simplify complex models quite rapidly and preserved the primary features of models.

For every model, each vertex is the solution of the intersection of a set of planes, namely the planes of the triangles that meet at that vertex. QEM algorithm

associates a set of planes with each vertex and defines the error of the vertex with respect to this set as the sum of squared distances to its planes:

$$\Delta(v) = \sum_{p \in \text{plane}(v)} (p^T v)^2 = \sum_{p \in \text{plane}(v)} v^T (pp^T)v = v^T \left( \sum_{p \in \text{plane}(v)} K_p \right) v \quad (70.1)$$

where  $p$  represents the plane defined by the equation:

$$ax + by + cz + d = 0 (a^2 + b^2 + c^2 = 1)$$

where  $K_p$  is the fundamental error quadric matrix of the plane  $p$ :

$$K_p = pp^T = \begin{bmatrix} a^2 & ab & ac & ad \\ ab & b^2 & bc & bd \\ ac & bc & c^2 & cd \\ ad & bd & cd & d^2 \end{bmatrix} \quad (70.2)$$

Sum these fundamental quadrics together and represent an entire set of planes by a single matrix  $Q_v$ :

$$Q_v = \sum_{p \in \text{plane}(v)} K_p \quad (70.3)$$

For a given contraction  $(v_1, v_2) \rightarrow \bar{v}$ , the cost of the contraction is defined as  $\Delta(\bar{v})$ :

$$\Delta(\bar{v}) = (\bar{v})^T (Q_{v_1} + Q_{v_2}) \bar{v} \quad (70.4)$$

The error quadric matrix of  $\bar{v}$  is  $Q_{\bar{v}}$ :

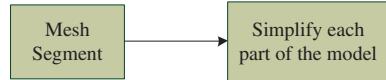
$$Q_{\bar{v}} = Q_{v_1} + Q_{v_2} = \begin{bmatrix} q_{11} & q_{12} & q_{13} & q_{14} \\ q_{12} & q_{22} & q_{23} & q_{24} \\ q_{13} & q_{23} & q_{33} & q_{34} \\ q_{14} & q_{24} & q_{34} & q_{44} \end{bmatrix} \quad (70.5)$$

In order to minimize the computing works during choosing a position for  $\bar{v}$ , we select either  $v_1$  or  $v_2$  depending on which one of these produces the lowest value of  $\Delta(\bar{v})$ .

### 70.3 3D Models Simplification Method With Lossless Sharp Regions

In this section, a novel algorithm is proposed to simplify a model with keeping the local important features of the model, as shown in Fig. 70.1.

**Fig. 70.1** Shows the diagram for this approach



Starting from a complete 3D surface model represented by smooth triangle meshes, the improved watershed segmentation is used to segment the model. Next, simplify each part of the model using QEM simplification.

### 70.3.1 Mesh Segment

Watershed segmentation [6] is a simple and efficient algorithm for 3D model segmentation. However, watershed segmentation tends to cause over segmentation. The paper [7] improved watershed segmentation, using multi-level neighborhood of a point to estimate curvature, which made discrete principal curvature of a point reflect the geometric characteristics of models. Although the improved algorithm solved this problem, the improved algorithm often produces isolated patch. In order to achieve the meaningful segmentation of 3D models, isolated patch should be merged into the neighborhood patch. Thus, we improved watershed segmentation further.

*Curvature computing.* Compute the curvature at each vertex according to the following equation:

$$K_v = \frac{2\pi - \sum_n a_n}{S_{\Sigma}(v)} \quad (70.6)$$

*Initial Labeling.* Find the local minima and assign each a unique label. Next, find each flat area and classify it as a minimum or a plateau.

*Descent.* Loop through plateaus and allow each one to descend until a labeled region is encountered. And then allow all remaining unlabeled vertices to similarly descend and join to labeled regions.

*Region merging.* Merge regions whose watershed depth is below a preset threshold. After merging, every region is a basic patch.

*Basic patch detection.* For each basic patch, detect whether its borders are adjacent to the same basic patch.

*Patch generation.* If the borders of one basic patch are adjacent to the same basic patch, then it will be merged into its adjacent patch.

Information about edges and triangles generations.

### 70.3.2 Simplify Each Part of the Model Dependently

Select one part which is not simplified.

Simplify the part using QEM algorithm depending on the following steps.

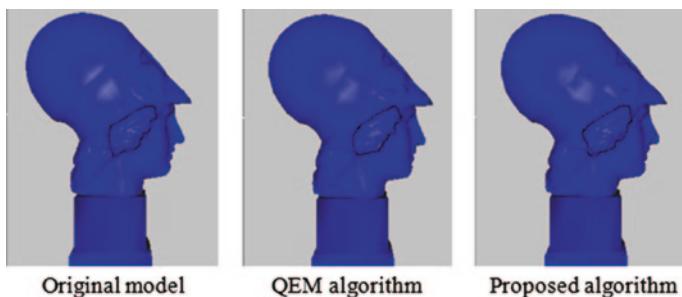
- Step 1: Create the vertex set, edge set and triangle set of the part by reading the model file.
- Step 2: For each vertex, compute its error quadric matrix.
- Step 3: For each edge, compute its collapse cost.
- Step 4: Select an edge with the least QEM collapse cost for collapsing.
- Step 5: Compute the QEM collapse cost of the produced edge and update the edge set.
- Step 6: If simplification ratio is larger than predetermined threshold, end the algorithm, or perform Step 4.

Predetermined threshold is defined as the ratio of the number of the vertices of the simplified model to that of the primitive model.

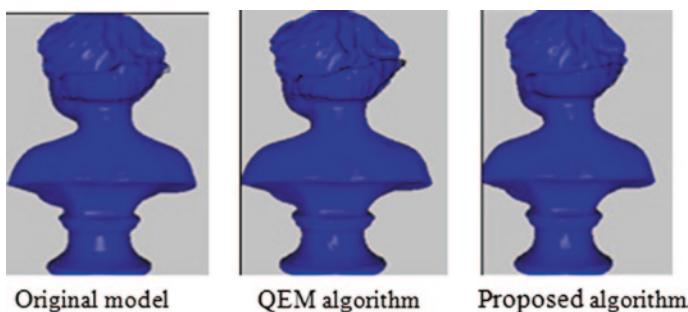
Check whether all the parts are simplified, if yes, then stop the algorithm; otherwise turn to 1.

## 70.4 Experiments

We tested our proposed algorithm using java program in Windows platform and use QEM algorithm as the control group. Examples of results are illustrated in Figs. 70.2 and 70.3.



**Fig. 70.2** Head model



**Fig. 70.3** Body model

In these models, we use the dark coil to mark the local part with the important local features of the model. Experimental results show that the approximations produced by our algorithm maintain higher fidelity to the original model than QEM algorithm.

## 70.5 Conclusion

According to the study of the psychophysics of human cognitive process, human understanding of things primarily concerned with the overall outline of things and then depends on the division that a complex object is divided into a few simple parts, and last focuses on the local features of each part. The paper proposes a novel algorithm for simplifying 3D models, which can remain the local important characteristics. The presented method combines the mesh segmentation algorithm and the simplification algorithm to extract the local visual features while ensuring the high fidelity of the whole mode. Experiments show the proposed algorithm is effectiveness.

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# Chapter 71

## Parallel Optimization for Sparse Matrix–Vector on GPU

Mengjia Yin, Xianbin Xu, Hua Chen, Shuibing He and Jing Hu

**Abstract** Graphics processing units (GPUs) have been used in the general-purpose computation field. Sparse matrix–vector multiplication (SpMV) algorithm is one of the most important scientific computing kernel algorithms. In this paper, we discuss implementing optimizing sparse matrix–vector multiplication on GPUs using CUDA programming model. We used methods and strategy which including mapping thread, merging access, reusing data, and avoiding the branch. The experimental results show that the optimizations strategy to improve SpMV performance.

**Keywords** Sparse matrix–vector multiplication (SpMV) • Compute unified device architecture (CUDA) • Graphics processing unit (GPU) • Performance optimizations strategy (POS)

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## 71.1 Introduction

With the rapid growth of computing complexity and data, general CPU computing power has failed to meet its needs. The rapid development of GPU is greatly exceed the speed of Moore's Law, the development of computing power, memory bandwidth is far exceed CPU. As modern GPUs have become increasingly powerful, inexpensive and relatively easier to program through high level API functions, they are increasingly being used for non-graphic or general-purpose applications (called GPGPU computing).

Sparse matrix–vector multiplication (SpMV) operation is widely used in solving large-scale linear system and solving matrix eigenvalues problems [1], especially in iterative method, it is key steps of influence the arithmetic performance. SpMV is typical of memory bottleneck operations, namely computing/memory is low, ALU seriously unsaturated, it is difficult to achieve the throughput of high floating point operations. SpMV has the nature of parallelism, and use of modern multi-processor platform to improve the performance is one of the feasible direction.

According to the deficiency of the traditional parallel strategies, we present the more efficient performance optimization strategy: mapping thread, merging access, reusing data, avoiding branch, optimization thread block. The experimental results show that these strategies can realize SpMV efficient parallel computing, and effectively improve the performance of the system.

The rest of this paper is organized as follows: Sect. 71.2 introduces related work, SpMV parallel mode is detailed in Sect. 71.3, performance optimization strategy is present in Sects. 71.4, 71.5 contains our results and evaluation, conclusion and future work is shown in Sect. 71.6.

## 71.2 Related Work

The bottleneck problems of memory are those algorithm that each floating point operation needs to multiple access memory, SpMV is a kind of this algorithm [2]. In the past 20 years, there have been a lot of work for the optimization of the SpMV algorithm [3, 4], from the point of view of the memory; optimization is mainly to improve the computational performance [5], which most of the optimization work is focused on generalization system structure similar to CPU [6]. But the optimization technology cannot be directly used in GPU system structure. GPU is massively parallel system; it has multi-stage storage system structure. In order to play the advantages of GPU memory high bandwidth, we need to accord with the characteristics to design different optimization strategies.

In reference [7], Nathan Bell and Michael Garland provide data structures and algorithms for SpMV that are efficiently implemented on CUDA platform for the fine-grained parallel architecture of the GPU. They emphasize memory

bandwidth efficiency and compact storage formats when given the memory-bound nature of SpMV. They also develop methods to exploit several common forms of matrix structure while offering alternatives which accommodate greater irregularity.

In reference [8], with indirect and irregular memory accesses resulting in more memory access per floating point operation, Baskraran proposed optimizations to effectively develop a high-performance SpMV kernel on NVIDIA GPUs. The optimizations include exploiting synchronization-free parallelism, optimized thread mapping based on the affinity toward optimal memory access pattern, optimized off-chip memory access to tolerate the high access latency, exploiting data reuse.

Based on the above, this paper emphasizes its optimization strategy in the process of SpMV algorithm on GPU, the optimization strategy is aimed at the system structure of the GPU, and considers the GPU complex storage management and the mapping optimization between threads.

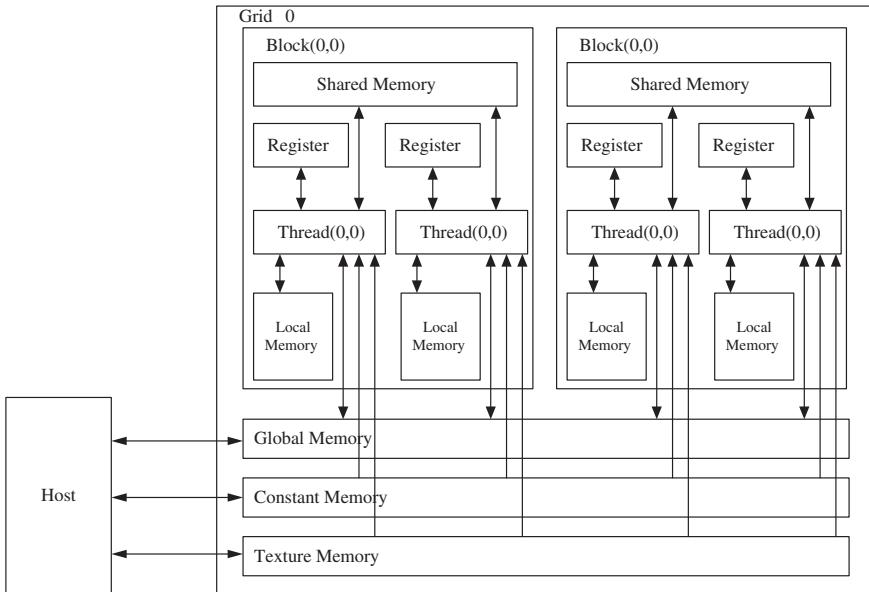
## 71.3 Parallel Acceleration for SpMV Model Based on GPU

### 71.3.1 GPU Programming with CUDA

CUDA is a parallel computing architecture developed by NVIDIA Corporation [3] and allows writing and running general-purpose applications on the NVIDIA GPU's. CUDA uses threads for parallel execution, and GPU allows 1,000 of threads for parallel execution at the same time.

On the GPU, there is a hierarchy of memory architecture to program on it; we present the memories in our implementation: Registers, Shared Memory, Global Memory, Constant Memory, and Texture Memory. In the memory architecture, the fastest memories are the shared memories and registers. The other memories are all located on the GPUs main RAM. The constant memory is favorable when multiple processor cores load the same value from cache. Texture cache has higher latency, but it has a better acceleration ratio for accessing large amount of data and non-aligned accessing. The memory architecture of GPU is described in Fig. 71.1. To gain better performance, we must manage the shared memory, registers, and global memory usage.

The CUDA programming model greatly simplified the difficulty of using the GPU for general-purpose computing, but compared to isomorphic to the systems only included CPU; it is more complicated to program in the heterogeneous system based on the CPU–GPU; the program's performance optimization is even more difficult. Generally affect the performance of CUDA program includes the main three factors: memory access latency, load balance, and global synchronous spending [9]. In different computing platforms, the causes and the corresponding optimization methods of these factors are not same.



**Fig. 71.1** Memory architecture of CUDA

### 71.3.2 Sparse Matrix Format

In scientific computing, SpMV has been proven to be a special important of numerical algorithm [10], it has the characteristics of high intensity calculation, high parallel degree, and simply control, so matrix calculation is very suitable for GPU for parallel computing. How to play the powerful computing ability of GPU in sparse matrix–vector algorithm is need to deal with.

Sparse matrix has several storage formats such as DIA, ELL, COO, CSR, HYB, and PKT. These storage formats are described detailed in [11]. Each format is different in storage requirements, calculation characteristics, access and operation of the matrix element method. Different storage formats are determined by the sparse matrix mode, that is, the distribution of non-zero elements in the coefficient matrix. In this paper, we base our approach on the vector SpMV kernel for CSR sparse matrix and discuss optimization to adapt CSR storage format to suit the GPU architecture.

CSR format is the more popular storage format [11, 12]; it is a line of compressed format which alter storing two-dimensional array of sparse matrix into 3 one-dimensional arrays: A, Col\_Idx, Row\_Ptr. Scan follows the line width for the sparse matrix, and will stored the zero elements in array A; An array of Col\_Idx stored column index of non-zero elements in array A corresponding location in the original matrix; An array of Row\_Ptr stored an index of every row in the first non-zero elements in an array of A Col\_Idx in primitive sparse matrix. For M \* N matrix, the length of Row\_Ptr array is M + 1, the offset of ith row stored in

Row\_Ptr [I], the last Row\_Ptr [M] in sparse matrix stored the total number of non-zero elements. We give an example of  $5 * 4$  sparse matrixes, as shown in Figs. 71.2, 71.3, how to use the CSR storage formats to show the original sparse matrix.

### 71.3.3 Parallel Computing for SpMV Model Based on GPU

The serial algorithm based on the Compression row storage (CSR) format as follows: this algorithm is realized its parallelization in multiple processors, parallelism is realized in outer loop, so the single processors is responsible for computing the row of matrix.

Serial algorithm based on the CSR format:

```
{for i = 0 to rows
{y(i) = 0;
for j = Row_Ptr(i) to (Row_Ptr(i + 1)-1)
{y(i) = y(i) + A(j-1)*x(Col_Idx(j-1));}}}
```

N. Bell and M. Garland proposed two CSR format of SpMV kernel: Scalar-CSR kernel and Vector-CSR kernel [8]. The realization of Scalar-CSR kernel in CUDA is simple and direct: use a thread is responsible for computing one line element in sparse matrix. The performance of the Scalar-CSR is affected by various factors, non-zero elements in each row and its column index is stored, but cannot be accessed at the same time. Vector-CSR overcomes this shortcoming of the Scalar-CSR: using a Warp thread responsible for computing one line element in sparse matrix. The kernel of Vector-CSR continuously accesses to the index and data, so overcome the problem of inefficiency in the Scalar method. In this paper, the realization of the CSR format SpMV kernel is also a reference to Vector SpMV kernel.

Here, the parallelism of the method is as follows: use a Warp thread to responsible for computing non-zero elements in sparse matrix, do not need filling zero elements to

**Fig. 71.2**  $5 * 4$  sparse matrix

0	2	0	4	0
1	2	3	0	0
0	1	0	0	0
0	0	0	1	1

$$A = \boxed{\begin{array}{ccccccc} 2 & 4 & 1 & 2 & 3 & 1 & 1 & 1 \end{array}}$$

$$\text{Col\_Idx} = \boxed{\begin{array}{cccccccc} 1 & 3 & 0 & 1 & 2 & 1 & 3 & 4 \end{array}}$$

$$\text{Row_Ptr} = \boxed{\begin{array}{ccccc} 0 & 2 & 5 & 6 & 8 \end{array}}$$

**Fig. 71.3** CSR storage format of sparse matrix

align, intermediate results put on sharing memory, and then accumulate the intermediate results through reduction summation, finally through thread 0 to get the final results.

Vector SpMV kernel for the CSR sparse matrix:

```
{__global__ void spmv_csr_Kernel(const int num_rows,const int * Row_Ptr, const
    int *Col_Idx, const Float * A, const Float * x, Float* y)
{__shared__ Float vals[];
int thread_id = blockDim.x*blockIdx.x + threadIdx.x;
int Warp_id = thread_id/32;
int lane = thread_id & (32-1);
int row = Warp_id;
    if(row < num_rows)
{int row_start = Row_Ptr[row], row_end = Row_Ptr[row + 1];
    vals [threadIdx.x] = 0;
    for(int j = row_start +lane; j < row_end; j +=32)
        { vals [threadIdx.x] +== data[j] * x[indices[j]];
        if (lane < 16) vals [threadIdx.x] +== vals [threadIdx.x + 16];
if (lane < 8) vals [threadIdx.x] +== sdata[threadIdx.x + 8];
if (lane < 4) vals [threadIdx.x] +== vals [threadIdx.x + 4];
if (lane < 2) vals [threadIdx.x] +== vals [threadIdx.x + 2];
if (lane < 1) vals [threadIdx.x] +== vals [threadIdx.x + 1];
if (lane == 0) y[row] +== vals [threadIdx.x];}}
```

## 71.4 Optimizations for SpMV Model Based on GPU

### 71.4.1 Optimization Method

According to circle, CSR-Vector with a Warp complete computing one line of elements, and in the process of calculation, in order to get the results of output vector, we reduction summation in sharing storage. However, if the number of non-zero elements in the row is less than 32, the performance of the CSR-Vector will drop. When the number of non-zero elements is bigger, often more than 32, it can be get the best computing performance in non-zero elements of matrix each row contained relatively large, often greater than 32. According to the various insufficient of CSR-Vector kernel, based on the proposed all sorts of optimization strategy, here a few of the optimization of the CSR format SpMV: threads mapping, merging access, data reuse, avoiding divergence, optimization thread block.

### 71.4.2 Improve CSR SpMV Optimization Algorithm

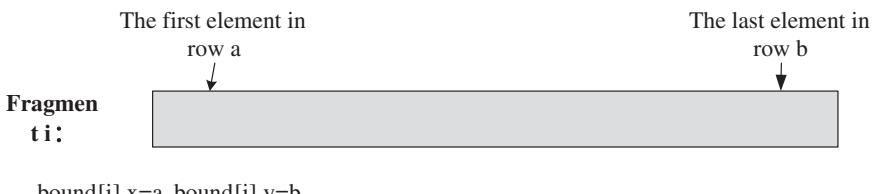
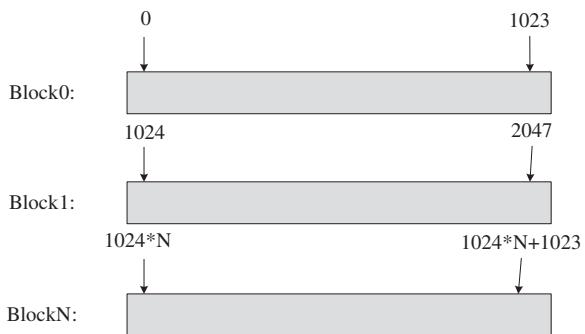
The achievements of kernel first need several threads that responsible for computing an element of the output vector. When the number of non-zero elements that

one line contains is less, or is not multiple of 16, this strategy will cause wasting the thread to calculate the resources. In this paper, we proposed a new calculation method: array A in CSR sparse matrix is divided into certain length fragments, the length of the fragment is an integer multiple of the number of threads in the thread blocks, a thread block calculates element of an array fragment. The intermediate results stored in shared memory, and finally through accumulated calculation the intermediate results to complete the output element y [13]. This method is equally distributed computing tasks, and can effectively improve the operation efficiency.

As there is difference in the number of non-zero elements of sparse matrix each row, CSR SpMV kernel is difficult to the average computing tasks are assigned to each thread and cause computing resources free. To solve this problem, this paper takes the method that each thread block calculates the 1,024 non-zero elements; the last fragment is filled with 0, as shown in Fig. 71.4.

On the base of the CSR data structure, we added a int2 type array Bound, the length of array Bound is the number of array fragments that are divided (the number of thread block). Bound [i] corresponds to thread blocks that index is i, the members of x stored row number where the first element corresponding thread block, the members of y stored row number where tail element. This paper only generates Bound array through a simple judgment on each element value in Row\_Ptr, as shown in Fig. 71.5.

**Fig. 71.4** Each thread block calculates the 1,024 non-zero elements



**Fig. 71.5** Generate bound array

The above process by the two kernel function: the first step calculates the incomplete result and auxiliary vector result\_aid; the second step merged the result\_aid into the result, so obtain the final result.

The first kernel:

1. Calculate the product of 1,024 elements and the corresponding vector elements, saved to the shared memory.
2. According to the boundary row number that Bound recorded, read the value of rpos. Assume the fragment contains 100 lines, then the adjacent 100 Half-Warp thread read. If the number of line is more than Half-Warp number, through the cycle solution.
3. Assuming that this fragment contains 100 lines, so first 100 Half-Warp will products accumulate corresponding single element to the registers. Then, the first and last row that corresponding Half-Warp will accumulate results in a result\_aid, the rest of the corresponding Half-Warp will write the result. The number of line is more than the number of Half-Warp, also used the method of cycle.

The second kernel:

```

1. thread i corresponding Bound[i]
2. if(Bound[i].x == Bound[i-1].y) thread is not work;
else if(Bound[i].x != Bound[i-1].y)
{thread work;
while (Bound[i].y == Bound[i + 1].x) i ++;}

```

## 71.5 Experimental Results

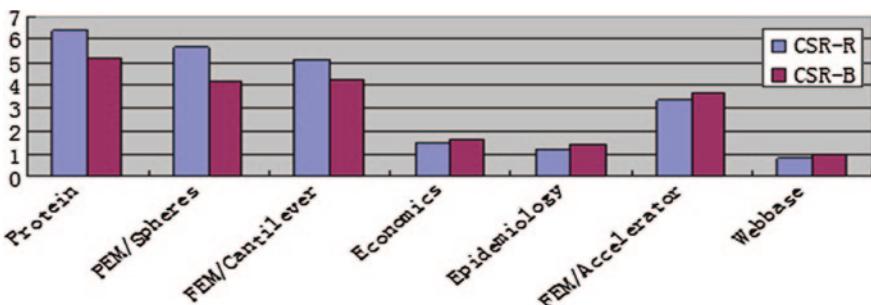
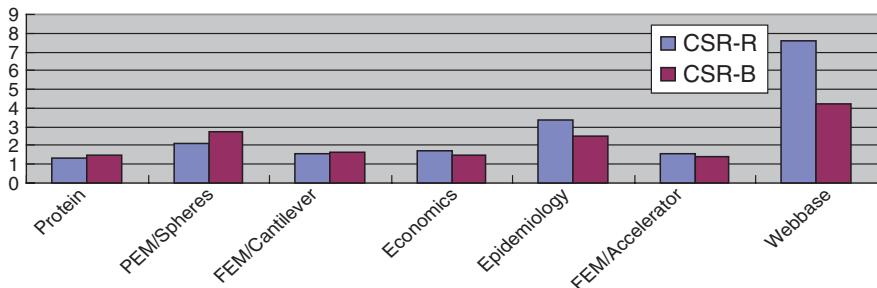
We experimentally evaluated our system using NVIDIA Tesla C1060, connected to Windows 7 system. The development environment is VS2010 IDE. The CUDA kernels were compiled using NVIDIA CUDA Complier (nvcc) to generate the device code that was then launched from the GPU. The host programs were compiled using the C language. We used CUDA used version 4.0 for our experiment. The architectural configurations are presented in Table 71.1.

According to the difference in the SpMV sparse matrix format, we, respectively, marked SpMV as CSR-R-GPU, CSR-B-GPU. CSR-R-GPU is not optimized SpMV kernel. CSR-B-GPU is realized by a new algorithm that proposed in this paper, which is introduced a new data structure contains Bound (Figs. 71.6, 71.7).

Through the analysis, we can get the following conclusion: for CSR-B-GPU kernel, the performance in the matrix Protein, PEM/Spheres, FEM/Cantilever, and FEM/Accelerator is obviously lower than other kernel. But, in Economics, Epidemiology, and Web base matrix, the performance of CSR-B-GPU kernel is higher than other kernel, especially in Web base matrix. When the average number of non-zero elements in each line is little, the performance is higher than other kernel. But when the average number of non-zero elements in each line is more,

**Table 71.1** Test matrix sets

Matrix	Row (column)	The number of non-zero	The number of non-zero each line
Protein	36,417	4,344,765	119.3
PEM/spheres	83,334	6,010,480	72.1
FEM/cantilever	62,451	4,007,383	64.1
Economics	206,500	1,273,389	6.1
Epidemiology	525,825	2,100,225	3.9
FEM/accelerator	121,192	2,624,331	21.6
Web base	1,000,005	3,105,536	3.1

**Fig. 71.6** Computing performance based on CSR SpMV kernel on GPU**Fig. 71.7** Execution time based on CSR SpMV kernel on GPU

its performance is not ideal. One of the reasons is the kernel use many shared memory, so the optimization algorithm also needs to improve

## 71.6 Conclusion

This paper takes memory bottlenecks algorithm SpMV as an example, combines the characteristics of the problem with a special system of the GPU, using thread mapping, merging access, data reuse, avoiding branch and thread optimization,

optimization GPU computing on the sparse matrix storage format CSR. From the experiment, we can see these optimization strategies to be effective, there are still areas for improvement, need to be more refined.

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## Chapter 72

# Research on Adaptability of Human Resource Management in Logistics Enterprise Based on Solow Residual Model

Yi-ming Li, Guo-feng Liu, Leiv Yu and Ning Chen

**Abstract** This paper proposes a novel method to enhance the adaptability of human resource management in logistics enterprise utilizing Solow residual model. After review the formal description of Solow residual model, we give our proposed method in detail. Our method is mainly made up of three parts, which are (1) Part 1: Solow residual model, (2) Part 2: Human Resources Management of Logistics enterprise and (3) Part 3: Evaluation Index. In particular, Part 2 is the most important part in our method, and it consists of Management strategy module, Training process module, Salary allocating system module and Performance evaluating module. Finally, we choose three logistics enterprises as experiment data to show the adaptability of the proposed method.

**Keywords** Human resource management • Logistics enterprise • Solow residual model • Adaptability

### 72.1 Introduction

As is illustrated in Wikipedia, Human resource management (HRM, or simply HR) is the management of an organization's human resources [1, 2, 3]. It is responsible for the attraction, selection, training, assessment, and rewarding of employees, while also overseeing organizational leadership and culture, and ensuring compliance with employment and labor laws [4, 5, 6]. In circumstances where employees desire and are legally authorized to hold a collective bargaining agreement, HR will typically also serve as the company's primary liaison with the employees' representatives [1].

HR is a product of the human relations movement of the early Twentieth century, when researchers began documenting ways of creating business value

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through the strategic management of the workforce [7, 8]. Particularly, for logistics enterprises, effective Human resource management is very important [9, 10]. Hence, in this paper, we focus on enhance the adaptability of human resource management in logistics enterprise utilizing the famous Solow residual model.

The rest of the paper is organized as follows. [Section 72.2](#) introduces overview of the Solow residual model. [Section 72.3](#) presents the method of human resource management in logistics enterprise utilizing Solow residual model. In [Sect. 72.4](#), we conduct experiments to show the adaptability of the proposed method. In [Sect. 72.5](#), we conclude the whole paper.

## 72.2 Solow Residual Model

In this section, we will illustrate the Solow residual model, which has been provided by Solow in 1957 [2, 3]. Solow analyzed a macro-economic model with one production function  $F$ . This situation can be derived from our method by imposing a particular form on  $\Phi$ , that is,  $\Phi(K, L, Y, t) = Y - F(K, L, t)$ . The above assumptions were proposed by Solow, imply production efficiency,  $D = 1$ , hence  $\widehat{D} = 0$ , and then reduce proposition 1 to  $\widehat{T} = \frac{\partial F}{\partial t}/F$ .

Solow divides commodities between a single output and factor inputs. Denoting the latter by a vector  $l$ , the producible output is  $F(l, t) - s$ , where  $F(\cdot)$  is the production function at time  $t$  and  $s$  is slack. Let  $\rho^*$  be the coefficient of resource utilization and  $y$  has components  $F(l, t)$ . The first or product component of material balance is as follows.

$$\left( \sum x_i^0 \right)_l - F(l, t) = \rho^* \cdot 0 = 0 \quad (72.1)$$

Next, the factor components is defined as follows.

$$0 + l = \rho^* l^0 \quad (72.2)$$

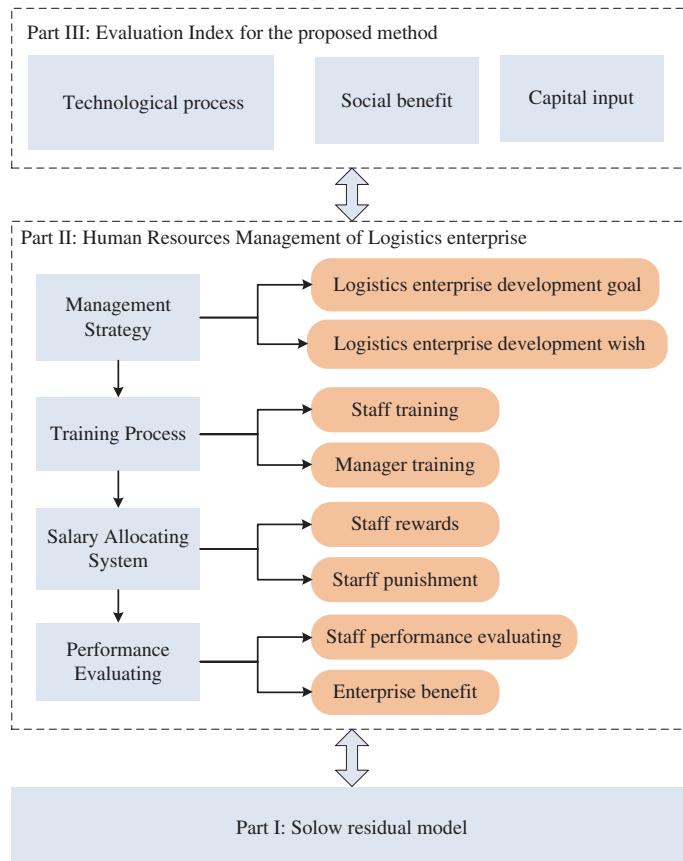
Solow regarded output growth as the result of capital deepening, labor growth, and technological progress. Therefore, technological progress is the residual in the Solow model. The basic equation is as follows.

$$Y = A_t \cdot K(t)^\alpha \cdot L(t)^\beta \quad (72.3)$$

where  $Y$  is the output value, and  $A_t$  is the technological progress.  $K(t)$  and  $L(t)$  represent the input factors of capital and labor respectively. Parameter  $t$  denotes the time, and  $\alpha$  is the output elasticity of capital deepening, and  $\beta$  is the out elasticity of labor growth rate ([Fig. 72.1](#)).

The total differential of Eq. 72.3 is as follows.

$$\frac{dY}{dt} \cdot \frac{1}{Y} = \frac{dA}{dt} \cdot \frac{1}{A} + \alpha \cdot \frac{dK}{dt} \cdot \frac{1}{K} + \beta \cdot \frac{dL}{dt} \cdot \frac{1}{L} \quad (72.4)$$



**Fig. 72.1** Framework of the proposed method

where  $\frac{dY}{dt} \cdot \frac{1}{Y}$  is the growth rate of input, and  $\frac{dA}{dt} \cdot \frac{1}{A}$  is the growth rate of technological progress.  $\frac{dK}{dt} \cdot \frac{1}{K}$  denotes the growth rate of capital input and  $\frac{dL}{dt} \cdot \frac{1}{L}$  represents the growth rate of labor input.

### 72.3 Human Resource Management in Logistics Enterprise Utilizing Solow Residual Model

Based the Solow residual model illustrated in Sect. 72.2, we present a novel method of human resource management in logistics enterprise. The proposed method is made of three parts, such as (1) Solow residual model, (2) Human Resources Management of Logistics enterprise and (3) Evaluation Index for the proposed method.

Part I is used to support the basic functions of human resource management. In part II, we design four main modules to construct human resources management of logistics enterprise, which are (1)Management strategy module, (2) Training process module, (3) Salary allocating system module and (4) Performance evaluating module. To show the adaptability of the proposed method, we use three Evaluation index to conduct experiments.

## 72.4 Experiments

In this section, we choose three logistics enterprises as experiment data to show the adaptability of the proposed method. These three logistics enterprises utilize Solow residual model based human resource management from 2001 to 2010. We conduct three experiments to show the effectiveness of our method. “Contribution of technological process”, “Social benefit” and “Contribution of capital input” are use as metric, and average performance of the three logistics enterprises are shown in Figs. 72.2, 72.3, and 72.4.

From Figs. 72.2, 72.3, and 72.4, we can see that the proposed could effectively promote contribution rate of technological process, capital input and social benefit compared with growth rate from 2001 to 2010. Hence, it proves the adaptability of the proposed method.

## 72.5 Conclusions

In this paper, we present an approach to promote the adaptability of human resource management in logistics enterprise utilizing Solow residual model. The main innovation of this paper method lie in that the whole system is mainly made

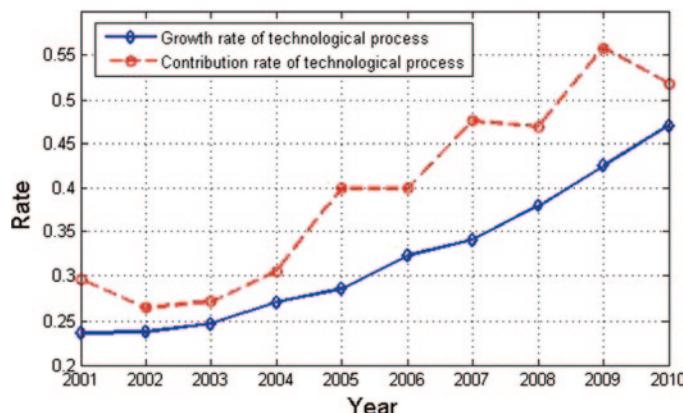


Fig. 72.2 Changing rate of technological process in different years

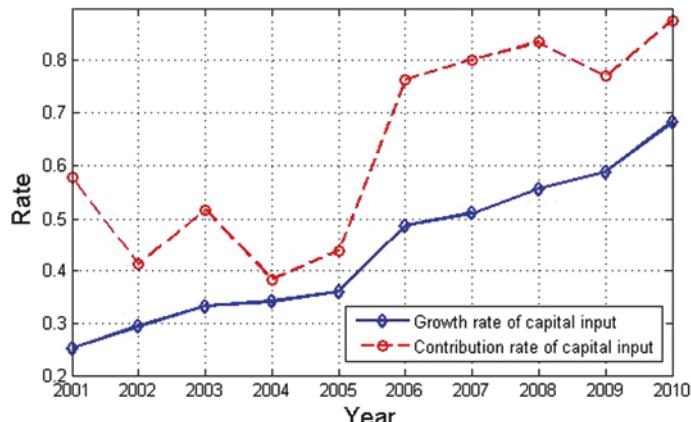


Fig. 72.3 Changing rate of capital input in different years

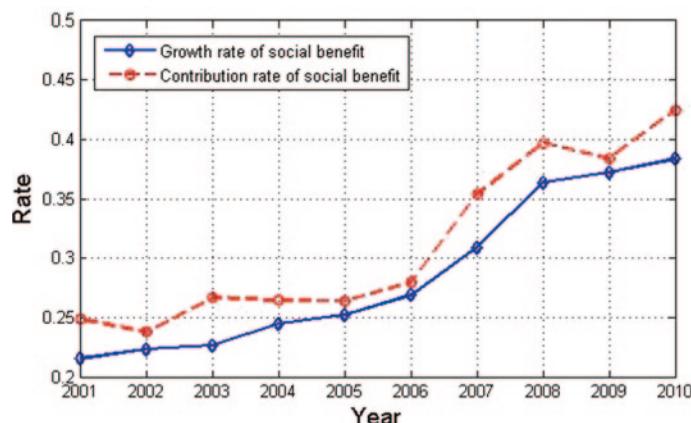


Fig. 72.4 Changing rate of social benefit in different years

up of three parts: (1) Solow residual model, (2) Human Resources Management of Logistics enterprise and (3) Evaluation Index. The effectiveness of our method is verify by experiments conducted on three logistics enterprises.

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# Chapter 73

## Precise Hydrodynamic Numerical Simulation of Sea Area

**Haibin Lv, Li Chen, Jikun Lu and Junsheng Liu**

**Abstract** The tidal current field and tidal energy at sea area around Lianyungang city are studied. Current flows from northeast to southwest direction at maximum flood moment. Because of the terrain effects, current flows to the southeast after Linhong estuary coast. Promontory effect is not obvious around the Xishu headland, and current speed increases. The flood current from the northeast seems stronger during the flood tide, eastard tidal kinetic energy degresses to the southwest, the maximum value is more than 1,100 kW/m; At the east of Xishu headland has a ring of low energy region; At the northwest of marine environmental monitoring station is also an annular energy region; On the headland area (such as the Xilian Island North, Xishu headland, Near East od Lan Mountain), high energy and low energy area coexists.

**Keywords** Tidal current • Tidal energy • Numerical simulation

### 73.1 Introduction

In recent years, marine pollution disaster such as oil spill, land-based pollutant discharging, hazardous chemicals leakage, red tide and Enteromorpha increased significantly. SST, waves and currents are important environmental dynamic factors and decisive factors of pollutant migration and diffusion; therefore, to carry out three-dimensional ocean environmental factors (temperature, current), forecast has important significance on marine safety, disaster prevention and mitigation, marine national defence construction. We are facing a major challenge to build China's

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Marine Science and technology strength, to understand marine environmental law and develop the marine environment forecast ability, to make our country coastal social economy to achieve sustainable development and provide the necessary support and protection of marine environment to national security [1]. Marine numerical prediction system is an embodiment of comprehensive national science and technology strength [2, 3] researched extratropical cyclone gale forecast method at Haizhou Bay [4] studied on the Gulf of Haizhou seiche [5] studied on accretion process of silty beach profile.

This paper presents how to simulate the tidal current field and tidal energy at sea area around Lianyungang city. Observation data and methodology are described in Sect. 73.2; Verification is presented in Sect. 73.3; Numerical simulation analysis is offered in Sect. 73.4. Finally, a conclusion is made in Sect. 73.5.

## 73.2 Data and Methodology

This paper employs the basic principles in dynamics of estuaries, coastal dynamics and physical oceanography. Based on numerical simulation technology, high-resolution hydrodynamic simulation was studied around sea water of Lianyungang city. By collecting historical data, we use numerical simulation to research trend of field dynamic process, combined with the observed data.

### 73.2.1 Measurement

The national marine environment monitoring station of Haizhou Bay in July, 2004, D0401 (E $119^{\circ} 18' 57.3''$ , N $34^{\circ} 48' 1.4''$ ), station during spring tide observation (two tidal periods) flow velocity.

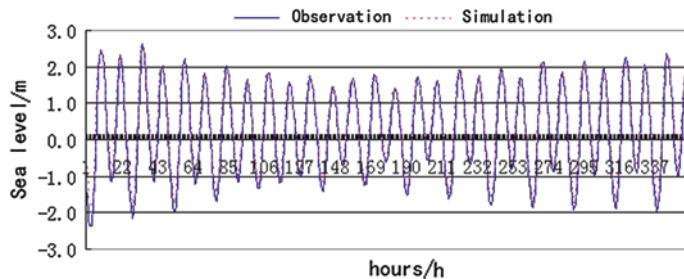
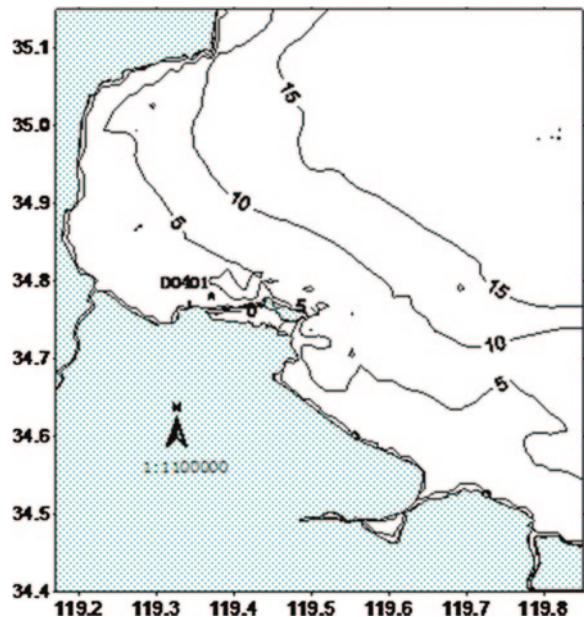
### 73.2.2 Map Collection

“Rizhao port to irrigation estuary”1:120,000, “Lianyungang inner harbor and nearby”1:75,000, “irrigation estuary”1:15,000 (Fig. 73.1).

## 73.3 Verification

With a two-dimensional (2D) hydrodynamic module of Ecomsed, Lianyungang Coastal Waters of 2D flow field was simulated, where open boundary condition for upstream control is flux, downstream water-level control was extrapolated from

**Fig. 73.1** Underwater topography of sea area around Lianyungang city



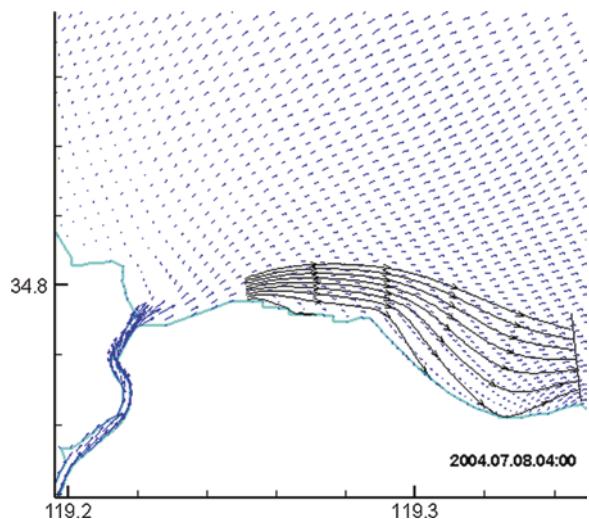
**Fig. 73.2** Comparison between the simulation and the measurement of water level

water level observed by the national marine environment monitoring station from 6.07.2004 to 21.07.2004 and the measured flow velocity of the vertical average value to verify, tidal level for 1.5 cm error, the simulation effect seems good (Fig. 73.2).

### 73.4 Analysis

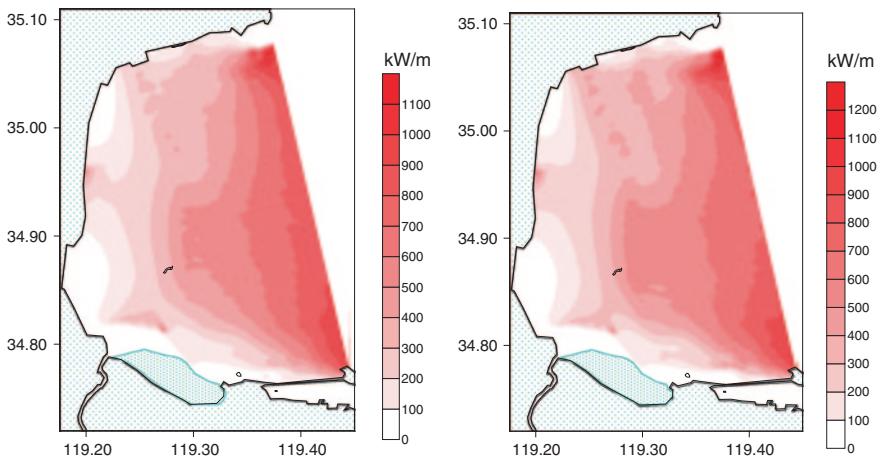
In Fig. 73.3, current flows from northeast to southwest direction at maximum flood moment. Because of the terrain effects, current flows to the southeast after Linhong estuary coast. Promontory effect is not obvious around the Xishu headland, and current speed increases. In the north of embankment, current speed

**Fig. 73.3** Flow field at maximum flood of sea water around Lianyungang city at 8 July 2004



decreases again, the siltation problem may be exacerbated in the next few years. From the streamlines, Linhong river runoff shows jet morphology (simulation flow flux upstream is  $800 \text{ m}^3/\text{s}$ ). Energy dissipates due to the coastal stream effect, soon, coastal stream flows eastard after Xishu headland.

In Fig. 73.4, the flood stream from the northeast seems strong during the flood tide, Eastard tidal kinetic energy degresses to the southwest, the maximum value is more than  $1,100 \text{ kW/m}$ ; At the east of Xishu headland has a ring of low energy



**Fig. 73.4** Tidal kinetic energy field at flood tide of sea water around Lianyungang city from 9:00 to 16:00 at 8 July 2004(left); tidal kinetic energy field at flood tide from 4:00 to 9:00 at 8 July 2004 (right)

region; At the northwest of marine environmental monitoring station is also an annular energy region; On the headland area (such as the Xilian Island North, Xishu headland, Near East of Lan Mountain), high energy and low energy area coexists. Xishu headland effect can touch the north of Linhong river, forming a strip energy region; in the south of Linhong river and the west of Xishu headland, tidal energy is abnormally low, which for the sediment silting provides weak power environment, it is also one of the reasons the waters become shallow. West Bay waters tidal energy is weak, in the middle there is a low energy region. This may be associated with peripheral special coastal morphology.

### 73.5 Conclusion

We simulated the tidal current field and tidal energy at sea area around Lianyungang city. Current flows from northeast to southwest direction at maximum flood moment. Because of the terrain effects, current flows to the southeast after Linhong estuary coast. Promontory effect is not obvious around the Xishu headland, and current speed increases. The flood stream from the northeast seems strong during the flood tide, Eastard tidal kinetic energy degresses to the southwest, the maximum value is more than 1,100 kW/m; At the east of Xishu headland has a ring of low energy region; At the northwest of marine environmental monitoring station is also an annular energy region; On the headland area (such as the Xilian Island North, Xishu headland, Near East od Lan Mountain), high energy and low energy area coexists.

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# Chapter 74

## Parametric Modeling Based on KBE of CATIA

Gui-yu Zhou and Guan-jun Liu

**Abstract** In the phase of multidisciplinary design optimization of UAV, according to the changes of the design parameters, structure scheme and the shape of the airframe need to be continuously adjusted. The parametric modeling can avoid the disadvantages of 3D modeling, such as long time consuming, low efficient, and poor interaction, and it will be the important method of UAV of multidisciplinary design optimization. A 3D model of a UAV airframe by using the parametric modeling in CATIA software was constructed, which was the base of design and analysis of UAV.

**Keywords** Parametric model • Airframe • Knowledge-based engineering • CATIA

### 74.1 Introduction

The airframe of UAV, consisted the wing, tail, landing gear, and engine, is also the platform to assemble all kinds of task devices and systems. The load on the wing, tail, landing gear, and engine is transferred to the aircraft body by adaptors, and thus achieve a balance [1]. The modeling of the aircraft airframe needs to be updated quickly to satisfy requirements of different parts on space. Using the traditional 3D modeling, the model modifies slowly, interact badly; while using the parametric modeling, the model can modify quickly and expediently. Therefore, it is very important to conduct the parametric optimization design and parametric modeling. This paper studies the realization of the parametric modeling of UAV airframe based on knowledge-based engineering using the CATIA software.

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## 74.2 Parametric Technology and Knowledge-Based Engineering

Parametric technology is an important field of modern engineering design methods. The parameters predefined graphic geometric constraint set, specify a set of size as a parameter so that the geometric constraints associated with the set, and all associated type into the application, and then use human-computer interaction through the dialog box to modify the parameters of size, and ultimately by the program according to the expression of these parameters the order of implementation to achieve the modification of the design results [2, 3]. Parametric technology can greatly improve the efficiency of the model changes, improve design flexibility, and shorten product development cycle, reflect the high value. In the future of engineering design, parametric technology will play an increasingly important role.

Knowledge-based engineering is an artificial intelligence development in knowledge and information processing. It uses symbol manipulation techniques based on description of the specific areas of knowledge, and this knowledge is prepared on the basis of reasoning knowledge of the application. Core discipline of knowledge-based engineering is relevant knowledge; design standards and specifications, principals of selection of design parameters, and design history information are embedded into the design software, thus achieving an intelligent product design through logic and reasoning [4].

The basic idea of knowledge-based engineering is to seek and record the knowledge of different engineering designs and parts product configuration based on the experience and knowledge in product design and development process, and to add artificial intelligence (knowledge base, knowledge of rules, and logic reasoning, etc.) to this knowledge. Combining knowledge engineering, parametric design, and the theory of feature-based modeling will be able to make up for deficiencies in the traditional parametric design, enabling the product design more flexible, efficient, and intelligent [5, 6].

## 74.3 Knowledge-Based Engineering of CATIA

KNOWLEDGE ADVISOR is a CATIA product, which allows users to embed knowledge within design and leverage it to assist in engineering decisions, in order to reduce errors or automate design for maximum productivity.

In the CATIA software, the parameters are generally divided into two categories:

System parameters (internal parameters): parameters represent the internal properties defined by documents.

User parameters: parameters defined by the designer to add the node in the characteristics of tree parameters (Parameters). User parameters and system

parameters are complementary and inseparable; designers can achieve a perfect combination of system parameters and user parameters by constraints, formulas, and rules.

In the top-down modeling approach, the parametric model is essentially built the parametric model; parametric model is conducted by the association or assembly of the location parameters. The user parameters of part are divided into two categories: location parameters and feature parameter.

The location parameters are established in the overall assembly, and the feature parameters are established in constructing the parts. It is convenient to manage, modify, and improve efficiency. The parametric model is established through constraints, formulas, and rules.

## 74.4 UAV Airframe Parametric Modeling

### 74.4.1 Development Environment

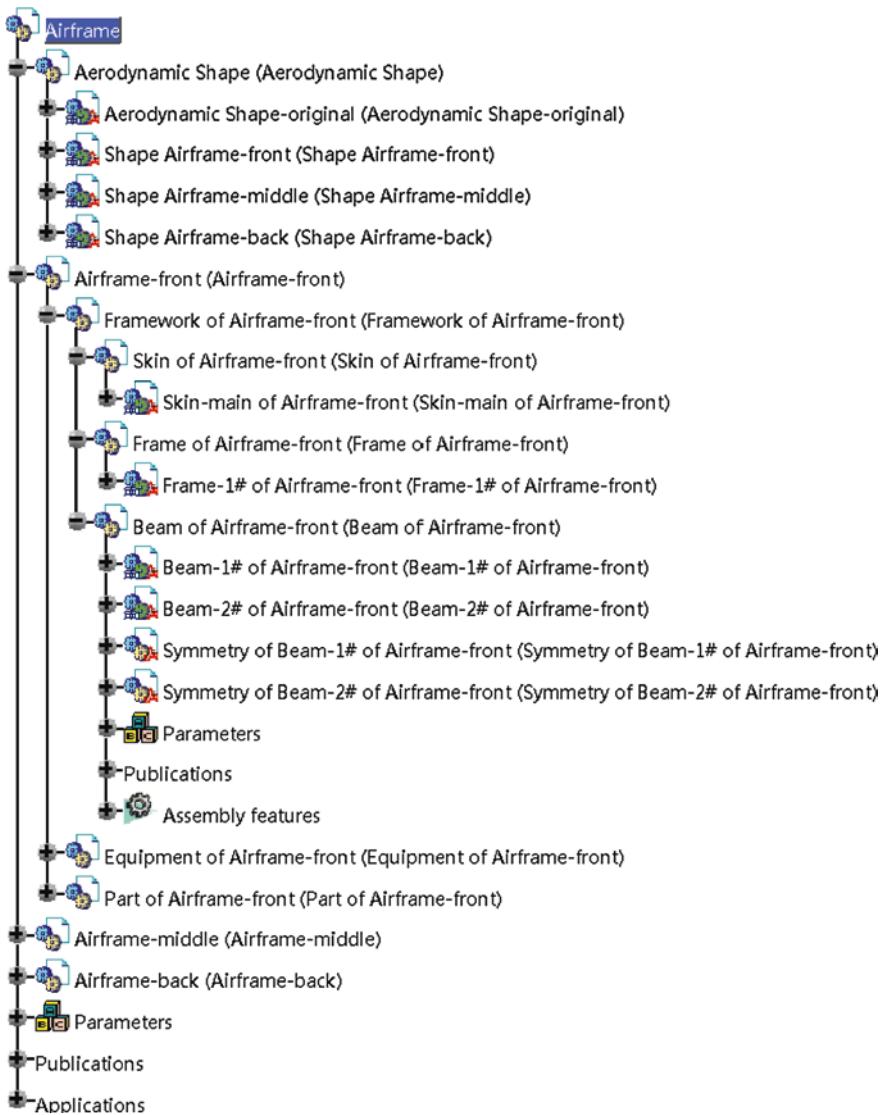
This work is based on the CATIA V5R19 as the studying platform, uses ASD (Assembly Design), PDG (Part Design), GSD (Generative Shape Design,) and KWA (Knowledge Advisor) to conduct the parametric modeling.

### 74.4.2 Design Idea

The airframe, a semi-monocoque shell structure, is mainly composed of skin, frame, and truss components. This work uses the top-down modeling approach: firstly, a structural tree based on assembly relation to the parts was established; then, necessary parameters were constructed; the parametric model through constraints, formula, and rules was established; finally, parametric model satisfaction of requirements was checked. If it satisfies the requirements, the parametric modeling is finished; otherwise, the model will be modified until the model meets the requirements. The body structured of the model tree shown in Fig. 74.1.

### 74.4.3 Realization of the Parametric Model

For complex assemblies, the relative installation positions and assembly shapes of components are related to each other. If the overall design parameters are adjusted, or the shape or position of certain components are changed, the relevant components may need to be modified. In the top-down design, all components in the product can be directly updated.



**Fig. 74.1** The model tree

In the top-down design, components are designed in the assembly environment. The modification of parameters in and between components can be done by the using the interact parameters between different components. The top-down design approach agrees with the product design process and thinking process of designers. It is convenient to facilitate the synergy of multiple subsystems, shorten production cycles, improve product quality, and design efficiency.

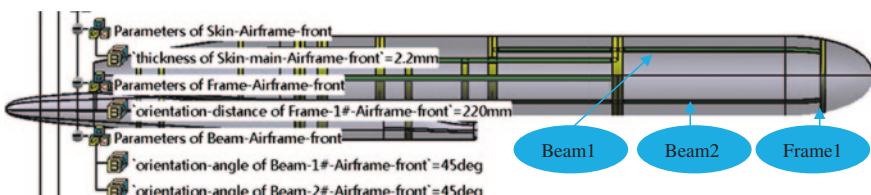


**Fig. 74.2** The airframe model

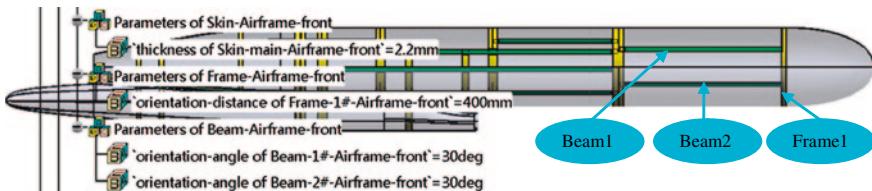
In the top-down design, component design can be switched from assembly workbench to the component workbench; the skeleton parts are constructed in the product module, then, the reference parameters (point, line, surface, and control variables) are published. At the same time, under the control of the main skeleton, subassembly skeletons are constructed. In detailed design, only the associated release element is selected to avoid too much reference. In the associated design, only child relationship (no parent relationship) is generated for noncritical elements. Thus, no system crashes will be caused during conducting the large assembly. At the same time, spatial analysis functions in the DMU can be used to check the rationality of the design.

Finally, according to the overall UAV design, the UAV parametric model is established using the parametric modeling approach. The UAV parametric model is shown in Fig. 74.2.

If parameters were modified, the model would be updated. For example, when the parameter ‘orientation-distance of Frame-1#-Airframe-front’ = 220 mm, the parameter ‘orientation-angle of Beam-1#-Airframe-front’ = 45 °, and the parameter ‘orientation-angle of Beam-2#-Airframe-front’ = 45 °; Fig. 74.3 shows the model.



**Fig. 74.3** The airframe model of parameter 1



**Fig. 74.4** The airframe model of parameter 2

When the parameter ‘orientation-distance of Frame-1#-Airframe-front’ = 400 mm, the parameter ‘orientation-angle of Beam-1#-Airframe-front’ = 30 °, and the parameter ‘orientation-angle of Beam-2#-Airframe-front’ = 30 °; Fig. 74.4 shows the model.

## 74.5 Conclusion

The development and wide application of parametric modeling technology based on knowledge-based engineering improves the design and manufacture of UAV and speeds up the overall developing process of modern UAV. Using the 3D parametric design method based on knowledge-based engineering of CATIA, the UAV parametric model is established, and the model can be updated easily according to different design requirements. This proves the effectiveness of the parametric modeling method using knowledge-based engineering of CATIA.

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# Chapter 75

## Solutions for Discrete Toda Equation with Homotopy Analysis Method

Xiu Rong Chen and Jia Shang Yu

**Abstract** In this letter, we apply the homotopy analysis method (HAM) to solving the differential-difference equations, and the approximate solution for the model was obtained. HAM contains the auxiliary parameter  $h$ , which provides us with a convenient way to adjust and control convergence region and rate of solution series. The results show that the method is feasible for the discrete Toda equation studies

**Keywords** Differential-difference equations • Homotopy analysis method • Discrete Toda equation

### 75.1 Introduction

The nonlinear differential-difference equations (DDEs) play an important role in modeling complicated physical phenomena. However, it is usually difficult to solve them either theoretically or numerically. Up to now, many powerful methods for constructing exact solutions are proposed, such as tanh-function method [1], Jacobi elliptic function expansion method [2], Backlund transformation [3], Darboux transformation [4] and so on.

Homotopy analysis method (HAM), firstly proposed by Liao [5], is a powerful analytic method for nonlinear problems. The HAM contains a certain auxiliary parameter  $h$ , which provides us with a simple way to adjust and control the convergence region and rate of convergence of the series solution and has been successfully employed to solve explicit analytic solutions for many types of nonlinear problems [6, 7]. However, HAM is a powerful and easy-to-use analytic tool to solve systems of DDEs. Here, we generalized the method to discrete Toda Equation [8, 9].

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## 75.2 The Solution by HAM

Consider the nonlinear discrete Toda equation [10]

$$\begin{cases} \frac{du_n(t)}{dt} = u_n(t)(u_{n-1} - u_{n+1} + v_n - v_{n+1}) \\ \frac{dv_n(t)}{dt} = v_n(t)(u_{n-1} - u_n) \end{cases} \quad (75.1)$$

with initial conditions

$$\begin{cases} u_n(0) = -k\lambda \cot h(kd) + k\lambda \tan h(kdn + c) \\ v_n(0) = k\lambda \cot h(kd) - k\lambda \tan h(kdn + c) \end{cases} \quad (75.2)$$

whose bell wave type solution can be written as

$$\begin{cases} u_n(t) = -k\lambda \cot h(kd) + k\lambda \tan h(kdn + k\lambda t + c) \\ v_n(t) = k\lambda \cot h(kd) - k\lambda \tan h(kdn + k\lambda t + c) \end{cases} \quad (75.3)$$

where  $\lambda$  is amplitude,  $k$ ,  $c$  and  $d$  are real constants. Due to the governing Eq. (75.1), we choose

$$L[\varphi_n(t, p)] = \frac{\partial \varphi_n(t, p)}{\partial t} \quad (75.4)$$

As our auxiliary operator, where  $p \in [0, 1]$  is an embedding parameter. Note that the linear operator  $L$  has the property

$$L[C_1] = 0, \quad L[C_2] = 0 \quad (75.5)$$

where  $C_1$  and  $C_2$  are integral constants. Furthermore, due to (75.1), we define non-linear operators

$$N_1[\phi_n(t, p)] = \frac{\partial \phi_n}{\partial t} - \phi_n(\phi_{n-1} - \phi_{n+1} + \varphi_n - \varphi_{n+1}) \quad (75.6)$$

$$N_2[\phi_n(t, p)] = \frac{\partial \varphi_n}{\partial t} - \varphi_n(\phi_{n-1} - \phi_n) \quad (75.7)$$

Then, introducing a nonzero auxiliary  $h$ , we construct the zero-order deformation equations

$$(1 - p)L[\phi_n(t, p) - u_{n,0}(t)] = hpN_1[\phi_n(t, p)] \quad (75.8)$$

$$(1 - p)L[\varphi_n(t, p) - v_{n,0}(t)] = hpN_2[\varphi_n(t, p)] \quad (75.9)$$

$$\phi_n(0, p) = u_{n,0}(t), \quad \varphi_n(0, p) = v_{n,0}(t) \quad (75.10)$$

Obviously, when  $p = 0$  and  $p = 1$ , we have

$$\phi_n(t, 0) = u_{n,0}(t) = u_n(0), \quad \varphi_n(t, 0) = v_{n,0}(t) = v_n(0) \quad (75.11)$$

$$\phi_n(t; 1) = u_n(t), \quad \varphi_n(t; 1) = v_n(t) \quad (75.12)$$

Therefore, as  $P$  increases from 0 to 1,  $\phi_n(t, p)$  and  $\varphi_n(t, p)$  vary or deform from the initial  $u_{n,0}(t)$  and  $v_{n,0}(t)$  to the exact solution  $u_n(t)$  and  $v_n(t)$  governed by (75.4). This is the basic idea of the homotopy, and this kind of variation is called deformations in topology. Expanding  $\phi_n(t; p)$  and  $\varphi_n(t, p)$  in Taylor series with respect to  $p$  one has

$$\phi_n(t, p) = u_{n,0}(t) + \sum_{k=1}^{\infty} u_{n,k}(t) p^k, \quad \varphi_n(t, p) = v_{n,0}(t) + \sum_{k=1}^{\infty} v_{n,k}(t) p^k \quad (75.13)$$

where

$$u_{n,k}(t) = \frac{1}{k!} \frac{\partial^k \phi_n(t, p)}{\partial p^k} \Big|_{p=0}, \quad v_{n,k}(t) = \frac{1}{k!} \frac{\partial^k \varphi_n(t, p)}{\partial p^k} \Big|_{p=0} \quad (75.14)$$

We emphasize that the zero-order deformation equations contain an auxiliary parameter  $h$ , whose value we have great freedom to choose. Assume that  $h$  is so properly chosen that above two series are convergent at  $p = 1$ , and then, due to (75.13), we have that

$$u_n(t) = u_{n,0}(t) + \sum_{k=1}^{\infty} u_{n,k}(t), \quad v_n(t) = v_{n,0}(t) + \sum_{k=1}^{\infty} v_{n,k}(t) \quad (75.15)$$

Differentiating the zero-order deformation Eq. (75.8)  $m$  times with respect to and then dividing them by  $m!$  and finally setting  $p = 0$ , we have the  $m$ th-order deformation equation

$$L[u_{n,m}(t) - \chi_m u_{n,m-1}(t)] = h R_1[u_{n,m-1}(t)] \quad (75.16)$$

$$L[v_{n,m}(t) - \chi_m v_{n,m-1}(t)] = h R_2[v_{n,m-1}(t)] \quad (75.17)$$

With the initial conditions ( $m \geq 1$ )

$$u_{n,m}(0) = 0, v_{n,m}(0) = 0 \quad (75.18)$$

where

$$R_1[u_{n,m-1}(t)] = \frac{du_{n,m-1}}{dt} - \sum_{j=1}^{m-1} (u_{n-1,j} - u_{n+1,j} + v_{n,j} - v_{n+1,j}) u_{n,m-1-j} \quad (75.19)$$

$$R_2[v_{n,m-1}(t)] = \frac{dv_{n,m-1}}{dt} - \sum_{j=1}^{m-1} (u_{n-1,j} - u_{n,j}) v_{n,m-1-j} \quad (75.20)$$

$$\chi_{n,m} = \begin{cases} 1 & m > 1 \\ 0 & m \leq 1 \end{cases} \quad (75.21)$$

The  $m$ th-order deformation Eqs. (75.16) and (75.17) is linear and thus can be easily solved, especially by means of symbolic computation software Maple, Mathematica and so on. We now successively obtain

$$\frac{du_{n,1}}{dt} = h\left[\frac{du_{n,0}}{dt} - u_{n,0}(u_{n-1,0} - u_{n+1,0} + v_{n,0} - v_{n+1,0})\right] \quad (75.22)$$

$$\frac{dv_{n,1}}{dt} = h\left[\frac{dv_{n,0}}{dt} - v_{n,0}(u_{n-1,0} - u_{n,0})\right] \quad (75.23)$$

$$\begin{aligned} \frac{du_{n,2}}{dt} - \frac{du_{n,1}}{dt} = & h\left[\frac{du_{n,1}}{dt} - u_{n,1}(u_{n-1,0} - u_{n+1,0} + v_{n,0} - v_{n+1,0})\right. \\ & \left. - u_{n,0}(u_{n-1,1} - u_{n+1,1} + v_{n,1} - v_{n+1,1})\right] \end{aligned} \quad (75.24)$$

$$\frac{dv_{n,2}}{dt} - \frac{dv_{n,1}}{dt} = h\left[\frac{dv_{n,1}}{dt} - v_{n,1}(u_{n-1,0} - u_{n,0}) - v_{n,0}(u_{n-1,1} - u_{n,1})\right] \quad (75.25)$$

All the linear equations above can be easily solved, and we get all the solutions as follows:

$$u_{n,0}(t) = -a + k\lambda \tan h(kdn + c) \quad (75.26)$$

$$v_{n,0}(t) = a - k\lambda \tan h(kdn + c) \quad (75.27)$$

$$\begin{aligned} u_{n,1}(t) = & h(-a + k\lambda \tan h(kdn + c))[1 - tk\lambda(\tan h(kd(n-1) + c) \\ & - \tan h(kd(n+) + c))] \end{aligned} \quad (75.28)$$

$$\begin{aligned} v_{n,1}(t) = & h(a - k\lambda \tan h(kdn + c))[1 - tk\lambda(\tan h(kd(n-1) + c) \\ & - \tan h(kd(n+) + c))] \end{aligned} \quad (75.29)$$

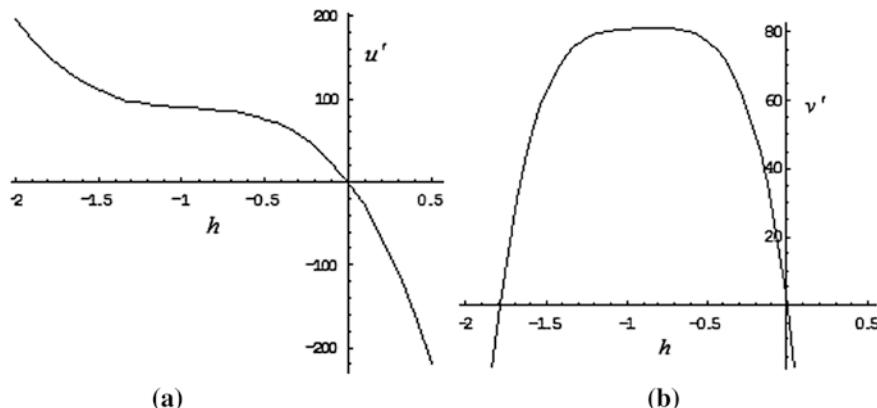
etc. Where  $a = k\lambda \cot h(kd)$ ; therefore, the expression solution Eq. (75.15) can be written in a more accurate form:

$$u_{n,m}(t) = u_{n,0}(t) + u_{n,1}(t) + u_{n,2}(t) + \dots \quad (75.30)$$

$$v_{n,m}(t) = v_{n,0}(t) + v_{n,1}(t) + v_{n,2}(t) + \dots \quad (75.31)$$

### 75.3 Results and Analysis

It has been proved that, as long as a series solution given by the homotopy analysis method converges, it must be one of exact solutions. So, it is important to ensure that the solution series Eqs. (75.30) and (75.31) are convergent. Note that the



**Fig. 75.1**  $h$ -curve for the 5th-order approximation solution for  $n = 10$  and  $t = 0.05$  when  $d = 0.2, c = 1.5, a = 2, k = 1$ . **a**  $u'(0.05)$ . **b**  $v'(0.05)$

solution series Eqs. (75.30) and (75.31) contain the auxiliary parameter  $h$ , which provides us with a simple way to adjust and control the convergence of the solution series. In general, by means of the so-called  $h$ -curves, that is,, a curve of  $h$ . As suggested by Liao [5], the valid region of  $h$  is a horizontal line segment. Thus, the valid region of  $h$  in this case is  $-1.2 < h < -0.8$ , as shown in Fig. 75.1. For example, when  $h = -1$ , our analytic solution converges.

## 75.4 Conclusions

In this paper, we have applied HAM to obtain the approximate analytic solution of the discrete Toda equation. This study shows that the HAM is applicable to this equation. HAM is an effective and simple method for solving nonlinear differential-difference equations. This proposed method problems and solitary wave problems. So, the HAM has great flexibility and potential for complicated nonlinear problems.

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# Chapter 76

## Modeling for Criminal Case with Large Message Traffic

Jialin Lou, Jiaxin Zhao and Yang Song

**Abstract** In order to solve the criminal case involved with large message traffic, an evaluate model and semantic analysis are used in this paper. By using analytical hierarchy process (AHP) method, information branching and iteration, the model can give the suspicious index of each person. Also, a semantic analyze model based on vector space is set up to empower the former model. For illustration, a certain criminal case is utilized to prove the feasibility of the model. The model has both great extensibility and very low complexity, thus not only it can be directly applied to huge network case, but also by trivial modifying, it can also be applied into the biology and medical field.

**Keywords** Criminal case • Iteration • AHP • Semantic analysis • Vector space

### 76.1 Introduction

With the message the crafty outlaws communicate, the criminal gangs in large scope can produce the network-like database which is not easy to investigate. There is a methodology for converting terrorist networks from undirected graphs to simplified directed graphs (or digraphs) and mapping the flow of influence in them [1, 2]. One practical way to use semantic analysis is to establish an associate constraint network, a constraint programming-based algorithm, and the problem of generating the cross-lingual concept space [3]. This paper, a methodology to solve criminal cases with large database of message traffic, is developed by using the tree structure, analytical hierarchy process (AHP), and semantic analysis.

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## 76.2 Main Model

### 76.2.1 Metrics

Assume that the amount of people is  $n$ , and the identity of some of them is known. The weight matrix is  $\mathbf{W}_p = [ w_{p1} \ w_{p2} \ \cdots \ w_{pn} ]$ , where

$$w_{pi} = \begin{cases} 1, & \text{conspirator;} \\ 0.5, & \text{unknown;} \\ 0, & \text{non - conspirator} \end{cases} \quad (i = 1, 2, \dots, n) \quad (76.1)$$

Assume that message traffic can be classified into  $T$  topics.

*Concept Frequency* Here, concept means word or phrase with actual meaning. High frequency use of it can lead to the dubiety of the codes. We use Automap, a text mining tool developed by CASOS, to obtain concept frequency [4].

Let  $Y$  be the number of the concept of all the topics. Defined  $x_{ij}$  ( $i = 1, 2, \dots, T$ ;  $j = 1, 2, \dots, Y$ ) and  $X_j$  ( $j = 1, 2, \dots, Y$ ) to be the given concept's frequency of the  $i$ th topic and of all the topics, and its weight can be defined as  $w_j$ . Hence, the weight of topics considered with concept frequency is

$$w_{ti1} = \frac{\sum_{j=1}^Y x_{ij} w_j}{\sum_{j=1}^Y X_j w_j} \quad (i = 1, 2, \dots, T) \quad (76.2)$$

Hence, the matrix under this circumstance is

$$\mathbf{W}_{t1} = [ w_{t11} \ w_{t21} \ \cdots \ w_{tT1} ].$$

*Known Information* Suppose there are  $T_1$  suspicious topics and  $T_2$  are not.

$$w_{ti2} = \begin{cases} \frac{1}{2T_1} \text{topic is suspicious} \\ \frac{1}{2T_2} \text{topic is not suspicious} \end{cases} \quad (i = 1, 2, \dots, T) \quad (76.3)$$

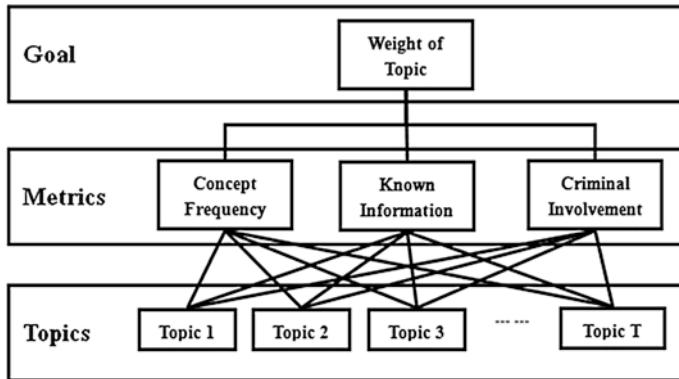
Similarly, the matrix is  $\mathbf{W}_{t2} = [ w_{t12} \ w_{t22} \ \cdots \ w_{tT2} ]$ .

*Criminal Involvement* Message traffic can be simplified to a matrix  $\mathbf{M}$ , whose first column refers to the talker and the second one to the listener. The third is the topic number. By going through the first two columns to add up people's weight, the CI can be obtained.

$$w_{ti3} = \frac{CI_i}{\sum_{i=1}^{15} CI_i} \quad (i = 1, 2, \dots, T) \quad (76.4)$$

And this time, the weight matrix is  $\mathbf{W}_{t3} = [ w_{t13} \ w_{t23} \ \cdots \ w_{tT3} ]$ .

*Determine Weights by AHP Method* To determine the weights of each metric, the AHP method is applied to set up the layer structure and the conjugated-comparative matrix  $\mathbf{A}$  [5] (Fig. 76.1).



**Fig. 76.1** Layer structure by AHP

$$\mathbf{A} = \begin{bmatrix} 1 & 1/3 & 3/5 \\ 3 & 1 & 9/5 \\ 5/3 & 5/9 & 1 \end{bmatrix} \quad (76.5)$$

By using the summation method and consistency check, the weight vector is

$$\mathbf{W}_t = 0.1765\mathbf{W}_{t1} + 0.5294\mathbf{W}_{t2} + 0.2941\mathbf{W}_{t3} \quad (76.6)$$

### 76.2.2 Information Branching

By using arrows and nodes, message traffic can be simplified into tree structures. Figure 76.2 shows a simple example, which can be described as

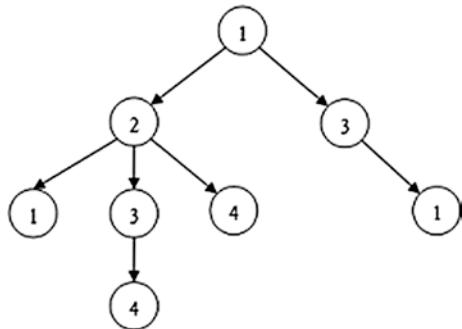
$$\mathbf{I}_{ex} = \begin{bmatrix} 1 & 2 & 1 & 0 \\ 1 & 2 & 3 & 4 \\ 1 & 2 & 4 & 0 \\ 1 & 3 & 1 & 0 \end{bmatrix} \quad (76.7)$$

The weight can be defined by length of it. Hence, the weight of this example is  $3/13$ ,  $4/13$ ,  $3/13$ , and  $3/13$ .

Consider the transfer efficiency and the leader's position, the weight of position should be taken into consideration. Assume that the transfer efficiency coefficient is 50 %. The weight of position can be measured by the depth of the node  $j$ ,

$$w_{position} = \left(\frac{1}{2}\right)^{j-1} \quad (76.8)$$

**Fig. 76.2** The example of tree structure



### 76.2.3 Suspicious Index

The dimension of union information branching matrix  $\mathbf{I}$  can be measured by  $n_r = \sum_{i=1}^T n_{ir}$  ( $i = 1, 2, \dots, T$ ) and  $n_c = \max\{n_{ic}\}$  ( $i = 1, 2, \dots, T$ ). By going through all elements in  $\mathbf{I}$ , we can get one's talker's and listener's *SI*.

$$SI = \sum w_{\text{partner}} w_{\text{topic}} w_{\text{branch}} w_{\text{position}} \quad (76.9)$$

We use the parameter  $\alpha$  to combine the speakers' and listeners' *SI*. According to our simulation experiment, we decide the best value of it is 0.8.

$$SI = \alpha SI_{\text{speaker}} + (1 - \alpha) SI_{\text{listener}} \quad (0 < \alpha < 1) \quad (76.10)$$

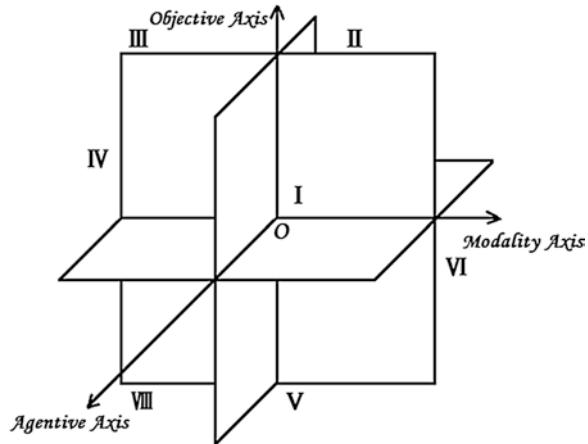
### 76.2.4 Iteration

Given that the unknown-identity people share the same weight, the result can be not that accuracy. The idea of iteration is to use the *SI* we get to determine the weight of the person whose identity is unknown to us. If the  $i$ th person's identity is unknown, we use the expression to iterate.

$$w_{pi} = \frac{\exp(SI_i) - \exp(SI_{\min})}{\exp(SI_{\max}) - \exp(SI_{\min})} \quad (76.11)$$

Since the weight of people is determined by their *SI*, the *SI* would have a limitation. After finite times of iteration, the *SI* would converge to its limitation, which helps to reveal the outlaws.

**Fig. 76.3** The 3D-space of semantic analysis



## 76.3 Semantic Analysis

### 76.3.1 Background

Semantic analysis is an useful tool that helps to improve the capability of coding and deducing information [6]. Combining this method with vector space, we can analyze the polarity of information. Since a complete sentence at least contain three elements: agentive, modality, and objective [7], we can set up a three-dimension space as Figs. 76.3, 76.4 shows.

Agentive indicates the agent described by the verb. We can define a parameter  $a_0 (a_0 > 0)$  to tell the known-identity people from unknown-identity ones.

$$\begin{cases} a > a_0, \text{non - consipartor} \\ -a_0 < a < a, \text{unknown} \\ a > a_0, \text{consipartor} \end{cases} \quad (76.12)$$

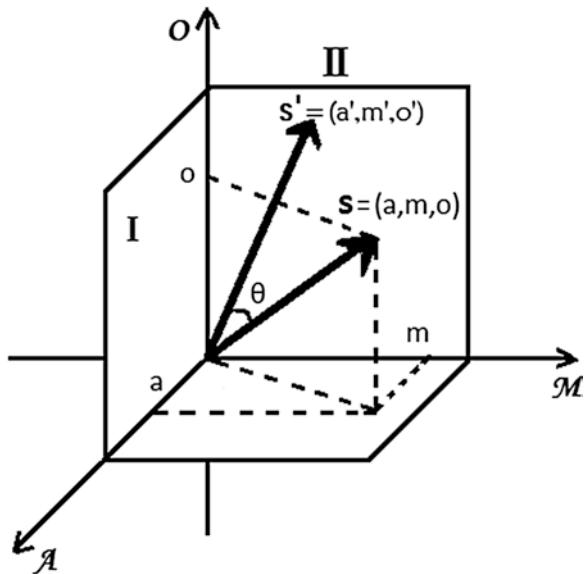
Modality is a mood that represents an act or state (not as a fact but) as contingent or possible. We define its sign by the attitude it contains.

$$\begin{cases} m > 0, \text{positive} \\ m = 0, \text{irrespective} \\ m < 0, \text{negative} \end{cases} \quad (76.13)$$

Objective is used to identify the direct object of a finite verb or preposition and for various other purposes. We define its sign by the correlation of the conspiracy.

$$\begin{cases} o > 0, \text{uncorrelated} \\ o < 0, \text{correlated} \end{cases} \quad (76.14)$$

**Fig. 76.4** The schematic diagram



### 76.3.2 Algorithm

Based on the vector 3D-space, we can use a vector to describe the sentences. The octant can be divided into 4 sets. And define  $\varphi_1$  as the initial polarity degree.

$$\varphi_1 = \begin{cases} 10^{1.2}, & \text{in I; least suspicious} \\ 10^{0.5}, & \text{in II, IV, or V; little suspicious} \\ 10^{-0.5}, & \text{in III, VI, or VIII; suspicious} \\ 10^{-1.2}, & \text{in VII; most suspicious} \end{cases} \quad (76.15)$$

Assume that  $s'$  is the reference sentence in the same set of the given sentence. We normalized the twice correlation degree to obtain  $\varphi$ .

$$\varphi = 0.5 \lg \varphi_2 = 0.5 \lg \varphi_1 \frac{|s \cdot s'|}{|s'|} = 0.5 \lg \varphi_1 |s| \cos \theta, \quad \varphi \in (-1, 1) \quad (76.16)$$

Let  $\xi$  be the correction coefficient, which is the mean of the polarity degrees. Therefore, we can re-rank the  $SI$  to make our result more accurately.

$$SI^* = SI(1 - \xi) = SI(1 - \bar{\varphi}) \quad (76.17)$$

**Table 76.1** The simulation result of the criminal case

Criminal	Undetermined			Innocent		
	Rank from 1 to 10	Rank from 11 to 20	Rank from 21 to 30	Rank from 31 to 40	Rank from 41 to 50	Rank from 51 to 60
7-Elsie*	28-Dwight	82-Reini	22-Eric	26-Marian	11-Francis	58-Lao
18-Jean*	60-Lars	35-Shelley	38-Beth	44-Patricia	42-Katherine	72-Andra
21-Alex*	46-Louis	41-Donald	9-Malcolm	47-Christina	4-Gretchen	70-Hark
43-Paul*	1-Kristina	19-Kristine	32-Gretchen	6-Patrick	23-Wesley	71-Cory
49-Harvey*	20-Crystal	31-Neal	15-Julia	8-Hazel	51-Dayi	59-Darol
54-Ulf*	30-Stephanie	25-Claire	37-Elsie	13-Marion	5-Karen	55-Olina
57-Yao*	45-Lois	17-Neal	29-Wayne	69-Han	66-Melia	76-Cole
81-Seenii	34-Jerome	73-Carina	40-Douglas	12-Sandy	77-Gerry	62-Mai
33-Kim	16-Jerome	14-Beth	50-William	24-Franklin	79-Phille	53-Chara
33-Sherri	27-Marcia	10-Delores	36-Priscilla	39-Erica	80-Fanti	52-Vind

## 76.4 Application

There is a criminal case about a conspiracy taking place to embezzle funds from the company and use internet fraud to steal funds from credit cards of people who do business with the company. The case has 83 people, 400 links, over 21,000 words of message traffic, 15 topics (3 suspicious ones), 7 known conspirators (\*), and 8 known non-conspirators (#). The result can be seen in the Table 76.1.

To test the robustness of our model, we change some conditions, namely change Topic 1 into a conspiracy one and change 0-Chris into a conspirator. By simply adjusting some initial parameter, we do the similar simulation. The result changes slightly, but 0-Chris's rank rises from 74 to 8, and 32-Grethen's rank also rises, for she not only talks to 0-Chris, but also gets involved in Topic 1. In conclusion, the model can give the desirable answer, even with the change of initial conditions.

## 76.5 Conclusion

By using probability and tree structure, we simplify the network to analyze the case. With the help of AHP method and iteration, model is empowered. Semantic analysis based on the vector space helps to evaluate the correlation degree among message, thus to empower the model. Due to the appropriate assumption and reasonable simplification, the time complexity of algorithm is  $O(n^2)$ , which leads to the ability to apply to even tens of thousands of messages.

As for the other similar network in different field, we can adjust the model to meet the need. For instance, in the biology cell-network, the structure is similar to our case. Therefore, the model can find the infected or diseased cells in a bionetwork where there are various kinds of image or chemical data for the nodes indicating infection probabilities and already identified some infected nodes.

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# Chapter 77

## Structure Modeling of Schatz Linkage

Jingfang Liu, Xiao'ou Huang, Yueqing Yu and Zhen Huang

**Abstract** Schatz linkage has been applied as a main component in a mixed machine “Turbula.” To further understand this mechanism, the structure analysis and modeling of the Schatz linkage in “Turbula” is given. From the analysis and modeling, a novel type of Schatz linkage is designed and the parameter conditions are modified, which can be regarded as a variant of Schatz mechanism. It can further extend the key linkage selection of mixed machines.

**Keywords** Structure modeling • Screw theory • Schatz mechanism

### 77.1 Introduction

Schatz linkage is an over constrained single-loop linkage proposed by Schatz [1], which is one of a few classical mechanisms that have been applied to industry. Schatz linkage is the main component of the mixing tool named as “Turbula,” and its movement supports the mixing operation and work function of “Turbula.”

Schatz linkage is a 6R loop, and its joint axes are distributed with special conditions expressed as  $a_{12} = a_{56} = 0$ ,  $a_{23} = a_{34} = a_{45} = a$ ,  $a_{61} = \sqrt{3}a$ ,  $\alpha_{12} = \alpha_{23} = \alpha_{34} = \alpha_{45} = \alpha_{56} = \alpha_{61} = \frac{\pi}{2}$ ,

$R_i = 0$  ( $i = 2, \dots, 5$ ),  $R_1 = -R_6 = R$ .

It is well known that the structure analysis for a classic single loop is very difficult due to the special geometric distribution of the joint axes. This paper theoretically analyzes its structure based on D-H parameters and screw theory, and a variant mechanism is obtained as well.

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## 77.2 Structure Expression and Modeling of Schatz Mechanism

As shown in Fig. 77.1, a fixed coordinate system  $A\text{-}XYZ$  is built, where  $x$ -axis is along  $FA$ ,  $z$ -axis is coincident with the axis of joint 1 and  $y$ -axis can be determined by the right-hand rule.

$x_1\text{-}x_6$ , respectively, express the directions of all link, and  $z_1\text{-}z_6$  express the axes of all joints. In the initial configuration, the moving coordinate system  $o\text{-}xyz$  is the superposition of a local coordinate system  $o_1\text{-}x_1y_1z_1$ . After the coordinate system has been transformed, the origin  $o$  will move to points  $B, C$  in turn, and  $z$ -axis will be correspondingly coincident with  $z_2$ - and  $z_3$ -axes. In addition, after some other transformations, the origin  $o$  will move to points  $F, E, D$  in turn, and  $z$ -axis will be correspondingly coincident with  $z_6$ -,  $z_5$ - and  $z_4$ -axes. By virtue of D-H parameters and homogeneous transforms of coordinate system  $o\text{-}xyz$ , the homogeneous coordinate of all points can be expressed as

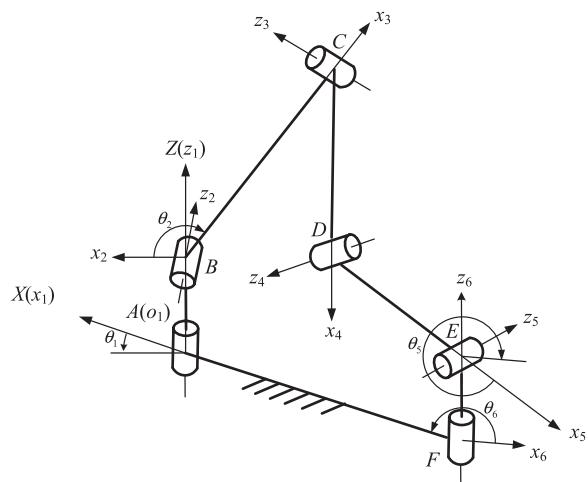
$$\begin{aligned} P_{Hi} &= \begin{bmatrix} P_i & 1 \end{bmatrix}^T = T_i P_{HA} \quad (i = B, C, D, E, F) \\ S_{Hj} &= \begin{bmatrix} S_i & 0 \end{bmatrix}^T = T_j S_{H1} \quad (j = 2, 4, 5, 6) \end{aligned} \quad (77.1)$$

where

$$P_{HA} = (0 \ 0 \ 0 \ 1)^T, \quad S_{H1} = (1 \ 0 \ 0 \ 0)^T,$$

$P_{Hi} \in R_{4 \times 1}$  — the homogeneous coordinates of point  $i$ ,  
 $P_i \in R_{1 \times 3}$  — the coordinates of point  $i$ ,

**Fig. 77.1** Sketch of Schatz mechanism



$T_i \in R_{4 \times 4}$  — the homogeneous transform matrix when origin  $o$  moves to point  $i$  from initial location,

$T_j \in R_{4 \times 4}$  — the homogeneous transform matrix when  $z$ -axis moves to  $z_j$ -axis from initial location,

$S_{Hj} \in R_{4 \times 1}$  — the homogeneous direction vector of  $j$ -axis,

$S_j \in R_{1 \times 3}$  — the direction vector of  $j$ -axis.

The associated homogeneous transform matrices  $T_i$  and  $T_j$  are denoted as Table 77.1.

**Table 77.1** Homogeneous transform matrix  $T_i$  and  $T_j$

i	$T_i$	j	$T_j$
B	Trans(z, R)	2	Rot(z, $\theta_1$ ) Rot(x, $\pi/2$ )
C	TB Rot(z, $\theta_1$ ) Rot(x, $\pi/2$ ) Rot(z, $\theta_2$ ) Trans(x, a)	3	T2 Rot(z, $\theta_2$ ) Rot(x, $\pi/2$ )
F	Trans(x, -a)	6	Rot(x, 0)
E	TF Trans(z, R)	5	T6 Rot(z, $-\theta_6$ ) Rot(x, $-\pi/2$ )
D	TE Rot(z, $-\theta_6$ ) Rot(x, $-\pi/2$ ) Rot(z, $-\theta_5$ ) Trans(x, -a)	4	T5 Rot(z, $-\theta_5$ ) Rot(x, $-\pi/2$ )

According to Eq. (77.1) and Table 77.1, the coordinates of the points and axes in A-XYZ can be obtained as

$$\begin{aligned} P_B &= \begin{pmatrix} 0 & 0 & R \end{pmatrix}, \quad P_C = \begin{pmatrix} ac\theta_1 c\theta_2 & as\theta_1 c\theta_2 & as\theta_2 + R \end{pmatrix}, \\ P_D &= \begin{pmatrix} -ac\theta_6 c\theta_5 - \sqrt{3}a & as\theta_6 c\theta_5 & -as\theta_5 + R \end{pmatrix}, \\ P_E &= \begin{pmatrix} -\sqrt{3}a & 0 & R \end{pmatrix}, \quad P_F = \begin{pmatrix} -\sqrt{3}a & 0 & 0 \end{pmatrix}, \\ S_1 &= \begin{pmatrix} 0 & 0 & 1 \end{pmatrix}, \quad S_2 = \begin{pmatrix} s\theta_1 & -c\theta_1 & 0 \end{pmatrix}, \quad S_3 = \begin{pmatrix} c\theta_1 s\theta_2 & s\theta_1 s\theta_2 & -c\theta_2 \end{pmatrix}, \\ S_4 &= \begin{pmatrix} c\theta_6 s\theta_5 & -s\theta_6 s\theta_5 & -c\theta_5 \end{pmatrix}, \quad S_5 = \begin{pmatrix} s\theta_6 & c\theta_6 & 0 \end{pmatrix}, \quad S_6 = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix} \end{aligned} \quad (77.2)$$

where “ $s$  and  $c$ ” are short for “sin and cos.”

Since in A-XYZ, the kinematic screw system of Schatz mechanism can be expressed as

$$\hat{\$} = (\$1 \ \$2 \ \$3 \ \$4 \ \$5 \ \$6)^T \quad (77.3)$$

Substituting Eqs. (77.2–77.3), we get

$$\hat{\$} = \left[ \begin{array}{l} S_1; 0 \\ S_2; AB \times S_2 \\ S_3; AC \times S_3 \\ S_4; AD \times S_4 \\ S_5; AE \times S_5 \\ S_6; AF \times S_6 \end{array} \right] = \left[ \begin{array}{cccccc} 0 & 0 & 1; & 0 & 0 & 0 \\ s\theta_1 & -c\theta_1 & 0; & Rc\theta_1 & Rs\theta_1 & 0 \\ c\theta_1 s\theta_2 & s\theta_1 s\theta_2 & -c\theta_2; & -as\theta_1 - Rs\theta_1 s\theta_2 & ac\theta_1 + Rc\theta_1 s\theta_2 & 0 \\ c\theta_6 s\theta_5 & -s\theta_6 s\theta_5 & -c\theta_5; & -as\theta_6 + Rs\theta_6 s\theta_5 & -ac\theta_6 + Rc\theta_6 s\theta_5 + \sqrt{3}as\theta_6 c\theta_5 & \sqrt{3}as\theta_6 s\theta_5 \\ s\theta_6 & c\theta_6 & 0; & -Rc\theta_6 & Rs\theta_6 & -\sqrt{3}ac\theta_6 \\ 0 & 0 & 1; & 0 & \sqrt{3}a & 0 \end{array} \right] \quad (77.4)$$

Then,

$$\det(\hat{\$}) = 3a^3(s\theta_5 s\theta_1 c\theta_1 - s\theta_2 s\theta_6 c\theta_6) \quad (77.5)$$

In addition,  $|CD| = a_{34} = a$ ,  $CD \perp S_3$ ,  $CD \perp S_4$ ,  $S_3 \perp S_4$ . Suppose that  $\sin\theta_1 = \delta_1$ ,  $\cos\theta_1 = \eta_1$ ;  $\sin\theta_2 = \delta_2$ ,  $\cos\theta_2 = \eta_2$ ;  $\sin\theta_5 = \delta_5$ ,  $\cos\theta_5 = \eta_5$ ;  $\sin\theta_6 = \delta_6$ ,  $\cos\theta_6 = \eta_6$ .  $\delta_1$  and  $\eta_1$  are regarded as known variables, so the following equation group can be established, and  $\delta_2$ ,  $\eta_2$ ,  $\delta_5$ ,  $\eta_5$ ,  $\delta_6$ ,  $\eta_6$  will be solved.

$$\begin{aligned} |CD|^2 &= |P_D - P_C|^2 = (-a\eta_5\eta_6 - \sqrt{3}a - a\eta_2\eta_1)^2 + (a\delta_6\eta_5 - a\eta_2\delta_1)^2 + (-a\delta_5 - a\delta_2)^2 = a^2 \\ CD \cdot S_3 &= (-a\eta_5\eta_6 - \sqrt{3}a - a\eta_2\eta_1)\delta_2\eta_1 + (a\delta_6\eta_5 - a\eta_2\delta_1)\delta_2\delta_1 + (-a\delta_5 - a\delta_2)\eta_1 = 0 \\ CD \cdot S_4 &= (-a\delta_6\delta_5 - \sqrt{3}a - a\delta_2\eta_1)\delta_5\eta_6 + (a\delta_6\delta_5 - a\delta_2\delta_1)(-\delta_5\delta_6) + (-a\delta_5 - a\delta_2)(-\eta_5) = 0 \\ S_3 \cdot S_4 &= \delta_2\delta_5\eta_6\eta_1 - \delta_2\delta_5\delta_6\delta_1 + \eta_5\eta_1 = 0 \\ \delta_2^2 + \eta_2^2 &= 1, \quad \delta_5^2 + \eta_5^2 = 1, \quad \delta_6^2 + \eta_6^2 = 1 \end{aligned} \quad (77.6)$$

Four groups of solutions will be obtained as

$$\begin{aligned} \delta_{21} &= \frac{\sqrt{1+3\delta_1^2}}{2}, & \eta_{21} &= -\frac{\sqrt{3}\eta_1}{2} \\ \delta_{51} &= -\frac{1}{\sqrt{1+3\delta_1^2}}, & \eta_{51} &= \frac{\sqrt{3}\delta_1}{\sqrt{1+3\delta_1^2}} \\ \delta_{61} &= \frac{\eta_1}{\sqrt{1+3\delta_1^2}}, & \eta_{61} &= -\frac{2\delta_1}{\sqrt{1+3\delta_1^2}} \end{aligned} \quad (77.7)$$

$$\begin{aligned} \delta_{22} &= -\frac{\sqrt{1+3\delta_1^2}}{2}, & \eta_{22} &= -\frac{\sqrt{3}\eta_1}{2} \\ \delta_{52} &= \frac{1}{\sqrt{1+3\delta_1^2}}, & \eta_{52} &= -\frac{\sqrt{3}\delta_1}{\sqrt{1+3\delta_1^2}} \\ \delta_{62} &= -\frac{\eta_1}{\sqrt{1+3\delta_1^2}}, & \eta_{62} &= \frac{2\delta_1}{\sqrt{1+3\delta_1^2}} \end{aligned} \quad (77.8)$$

$$\begin{aligned} \delta_{23} &= \frac{\sqrt{1+3\delta_1^2}}{2}, & \eta_{23} &= -\frac{\sqrt{3}\eta_1}{2} \\ \delta_{53} &= -\frac{1}{\sqrt{1+3\delta_1^2}}, & \eta_{53} &= -\frac{\sqrt{3}\delta_1}{\sqrt{1+3\delta_1^2}} \\ \delta_{63} &= -\frac{\eta_1}{\sqrt{1+3\delta_1^2}}, & \eta_{63} &= \frac{2\delta_1}{\sqrt{1+3\delta_1^2}} \end{aligned} \quad (77.9)$$

$$\begin{aligned} \delta_{24} &= -\frac{\sqrt{1+3\delta_1^2}}{2}, & \eta_{24} &= -\frac{\sqrt{3}\eta_1}{2} \\ \delta_{54} &= \frac{1}{\sqrt{1+3\delta_1^2}}, & \eta_{54} &= \frac{\sqrt{3}\delta_1}{\sqrt{1+3\delta_1^2}} \\ \delta_{64} &= \frac{\eta_1}{\sqrt{1+3\delta_1^2}}, & \eta_{64} &= -\frac{2\delta_1}{\sqrt{1+3\delta_1^2}} \end{aligned} \quad (77.10)$$

If we substitute Eqs. (77.7–77.10) to Eq. (77.5), they all satisfy

$$\det(\hat{\$}) = 0 \quad (77.11)$$

which shows that for the four cases denoted by Eqs. (77.7–77.10), the order of the Schatz mechanism is always less than 6. Based on the Modified G-K Criterion, the Schatz mechanism can move in all four cases.

### 77.3 Mechanism Analysis and Structure Modeling

The four types of mechanisms corresponding to Eqs. (77.7–77.10) are denoted by M1–M4.

For the two types M1 and M2, Eq. (77.12) can be obtained by substituting Eqs. (77.7–77.8) to Eq. (77.2).

$$\frac{S_3 \times S_4}{|S_3 \times S_4|} = \frac{CD}{|CD|} \quad (77.12)$$

which denotes that M1 and M2 both satisfy  $\alpha_{34} = \pi/2$ .

For the other two types M3 and M4, Eq. (77.13) will be obtained by substituting Eqs. (77.9–77.10) to Eq. (77.2).

$$\frac{S_3 \times S_4}{|S_3 \times S_4|} = -\frac{CD}{|CD|} \quad (77.13)$$

which shows  $\alpha_{34} = 3\pi/2$ .

Now, let us give the computation progress for Eqs. (77.12) and (77.13).

For any mechanism  $M_i$ , suppose that  $L_{1i} = \frac{S_3 \times S_4}{|S_3 \times S_4|} = (L_{1i}^x \ L_{1i}^y \ L_{1i}^z)$ ,  $L_{2i} = \frac{CD}{|CD|} = (L_{2i}^x \ L_{2i}^y \ L_{2i}^z)$ .

For M1–M4, there exists  $|CD| = a_{34} = a$ ,  $CD \perp S_3$ ,  $CD \perp S_4$ ,  $S_3 \perp S_4$  by Eq. (77.2), we have

$$S_3 \times S_4 = \begin{vmatrix} i & j & k \\ c\theta_1 s\theta_2 & s\theta_1 s\theta_2 & -c\theta_2 \\ c\theta_6 s\theta_5 & -s\theta_6 s\theta_5 & -c\theta_5 \end{vmatrix} = \begin{pmatrix} -s\theta_1 s\theta_2 c\theta_5 - c\theta_2 s\theta_5 s\theta_6 & -c\theta_2 s\theta_5 c\theta_6 + c\theta_1 s\theta_2 c\theta_5 \\ -c\theta_1 s\theta_2 s\theta_5 s\theta_6 - s\theta_1 s\theta_2 s\theta_5 c\theta_6 \end{pmatrix}$$

$$|S_3 \times S_4| = |S_3| \cdot |S_4| = \sqrt{(c\theta_1 s\theta_2)^2 + (s\theta_1 s\theta_2)^2 + (-c\theta_2)^2} \cdot \sqrt{(c\theta_6 s\theta_5)^2 + (-s\theta_6 s\theta_5)^2 + (-c\theta_5)^2} = 1$$

$$L_{1i} = \begin{pmatrix} -s\theta_1 s\theta_2 c\theta_5 - c\theta_2 s\theta_5 s\theta_6 & -c\theta_2 s\theta_5 c\theta_6 + c\theta_1 s\theta_2 c\theta_5 & -c\theta_1 s\theta_2 s\theta_5 s\theta_6 - s\theta_1 s\theta_2 s\theta_5 c\theta_6 \end{pmatrix} \quad (77.14)$$

$$L_{2i} = \frac{CD}{|CD|} = \frac{P_D - P_C}{a} = \begin{pmatrix} -c\theta_5 c\theta_6 - \sqrt{3} - c\theta_1 c\theta_2 & c\theta_5 s\theta_6 - s\theta_1 c\theta_2 & -s\theta_5 - s\theta_2 \end{pmatrix} \quad (77.15)$$

For simplify the analysis, we assume that  $k = \sqrt{1 + 3\delta_1^2}$ .

1. For mechanism M1, substituting  $\sin\theta_1 = \delta_1$ ,  $\cos\theta_1 = \eta_1$ ,  $\sin\theta_2 = \delta_{21}$ ,  $\cos\theta_2 = \eta_{21}$ ,  $\sin\theta_5 = \delta_{51}$ ,  $\cos\theta_5 = \eta_{51}$ ,  $\sin\theta_6 = \delta_{61}$ ,  $\cos\theta_6 = \eta_{61}$ , Eqs. (77.7–77.14) and (77.15), we have

$$L_{11} = \left( -\frac{\sqrt{3}\delta_1^2}{2} - \frac{\sqrt{3}\eta_1^2}{2k^2}, \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2}, \frac{\eta_1^2}{2k} - \frac{\delta_1^2}{k} \right)$$

$$L_{21} = \left( \frac{\sqrt{3}\delta_1^2}{2} - \sqrt{3} + \frac{\sqrt{3}\eta_1^2}{2}, \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2}, \frac{1}{k} - \frac{k}{2} \right)$$

Thus,

$$L_{21}^x - L_{11}^x = \frac{\sqrt{3}}{2k^2} (4\delta_1^2 + k^2\eta_1^2 - 2k^2 + k^2\delta_1^2 + \eta_1^2) = \frac{\sqrt{3}}{2k^2} (4\delta_1^2 - k^2 + \eta_1^2) = 0$$

$$L_{21}^y - L_{11}^y = \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2} - \frac{\sqrt{3}\delta_1\eta_1}{k^2} - \frac{\sqrt{3}\delta_1\eta_1}{2} = 0$$

$$L_{21}^z - L_{11}^z = \frac{1}{2k} (2 - k^2 - \eta_1^2 + 2\delta_1^2) = 0$$

So for M1 mechanism,  $L_{11} = L_{21}$ , that is,  $\frac{S_3 \times S_4}{|S_3 \times S_4|} = \frac{CD}{|CD|}$ .

2. For mechanism M2, substituting  $\sin\theta_1 = \delta_1$ ,  $\cos\theta_1 = \eta_1$ ,  $\sin\theta_2 = \delta_{22}$ ,  $\cos\theta_2 = \eta_{22}$ ,  $\sin\theta_5 = \delta_{52}$ ,  $\cos\theta_5 = \eta_{52}$ ,  $\sin\theta_6 = \delta_{62}$ ,  $\cos\theta_6 = \eta_{62}$  and Eqs. (77.8–77.14) and (77.15), we have

$$\begin{aligned} L_{12} &= \left( -\frac{\sqrt{3}\delta_1^2}{2} - \frac{\sqrt{3}\eta_1^2}{2k^2}, \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2}, -\frac{\eta_1^2}{2k} + \frac{\delta_1^2}{k} \right) \\ L_{22} &= \left( \frac{\sqrt{3}\delta_1^2}{2} - \sqrt{3} + \frac{\sqrt{3}\eta_1^2}{2}, \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2}, -\frac{1}{k} + \frac{k}{2} \right) \end{aligned}$$

So  $L_{22}^x - L_{12}^x = L_{21}^x - L_{11}^x = 0$ ,  $L_{22}^y - L_{12}^y = L_{21}^y - L_{11}^y = 0$ ,  $L_{22}^z - L_{12}^z = -(L_{21}^z - L_{11}^z) = 0$ .

So for M1 mechanism,  $L_{11} = L_{21}$ , that is,  $\frac{S_3 \times S_4}{|S_3 \times S_4|} = \frac{CD}{|CD|}$ .

3. For mechanism M3, substituting  $\sin\theta_1 = \delta_1$ ,  $\cos\theta_1 = \eta_1$ ,  $\sin\theta_2 = \delta_{23}$ ,  $\cos\theta_2 = \eta_{23}$ ,  $\sin\theta_5 = \delta_{53}$ ,  $\cos\theta_5 = \eta_{53}$ ,  $\sin\theta_6 = \delta_{63}$ ,  $\cos\theta_6 = \eta_{63}$  and Eq. (77.9) to Eq. (77.14) and (77.15), we have

$$\begin{aligned} L_{13} &= \left( \frac{\sqrt{3}\delta_1^2}{2} + \frac{\sqrt{3}\eta_1^2}{2k^2}, -\frac{\sqrt{3}\delta_1\eta_1}{k^2} - \frac{\sqrt{3}\delta_1\eta_1}{2}, -\frac{\eta_1^2}{2k} + \frac{\delta_1^2}{k} \right) \\ L_{23} &= \left( \frac{\sqrt{3}\delta_1^2}{2} - \sqrt{3} + \frac{\sqrt{3}\eta_1^2}{2}, -\frac{\sqrt{3}\delta_1\eta_1}{k^2} - \frac{\sqrt{3}\delta_1\eta_1}{2}, \frac{1}{k} - \frac{k}{2} \right) \end{aligned}$$

This shows

$$L_{23}^x + L_{13}^x = L_{21}^x - L_{11}^x = 0, L_{23}^y + L_{13}^y = L_{21}^y - L_{11}^y = 0, L_{23}^z + L_{13}^z = L_{21}^z - L_{11}^z = 0$$

For mechanism M3,  $L_{13} = -L_{23}$ , that is,  $\frac{S_3 \times S_4}{|S_3 \times S_4|} = -\frac{CD}{|CD|}$ .

4. For mechanism M4, substituting  $\sin\theta_1 = \delta_1$ ,  $\cos\theta_1 = \eta_1$ ,  $\sin\theta_2 = \delta_{24}$ ,  $\cos\theta_2 = \eta_{24}$ ,  $\sin\theta_5 = \delta_{54}$ ,  $\cos\theta_5 = \eta_{54}$ ,  $\sin\theta_6 = \delta_{64}$ ,  $\cos\theta_6 = \eta_{64}$  and Eqs. (77.9–77.14) and (77.15), we have

$$L_{14} = \left( \frac{\sqrt{3}\delta_1^2}{2} + \frac{\sqrt{3}\eta_1^2}{2k^2}, -\frac{\sqrt{3}\delta_1\eta_1}{k^2} - \frac{\sqrt{3}\delta_1\eta_1}{2}, \frac{\eta_1^2}{2k} - \frac{\delta_1^2}{k} \right)$$

$$L_{24} = \left( \frac{\sqrt{3}\delta_1^2}{2} - \sqrt{3} + \frac{\sqrt{3}\eta_1^2}{2}, \frac{\sqrt{3}\delta_1\eta_1}{k^2} + \frac{\sqrt{3}\delta_1\eta_1}{2}, -\frac{1}{k} + \frac{k}{2} \right)$$

This shows

$$L_{24}^x + L_{14}^x = L_{21}^x - L_{11}^x = 0, L_{24}^y + L_{14}^y = L_{21}^y - L_{11}^y = 0, L_{24}^z + L_{14}^z = -(L_{21}^z - L_{11}^z) = 0$$

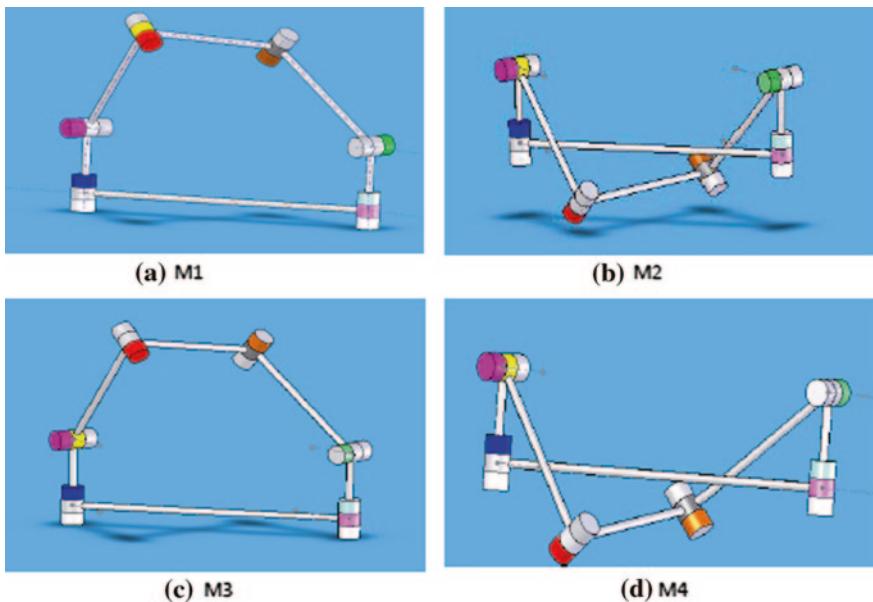
For mechanism M4,  $L_{14} = -L_{24}$ , that is,  $\frac{S_3 \times S_4}{|S_3 \times S_4|} = -\frac{CD}{|CD|}$ .

Four types of mechanism can be modeled. To simply compare their structure properties,  $\theta_2$ ,  $\theta_5$ ,  $\theta_6$  computed from Eqs. (77.7–77.10) are shown in Table 77.2 where we assume  $\theta_1 = 135^\circ$ , and corresponding mechanism models are shown in Fig. 77.2.

For two groups, respectively, comprised of M1 and M3, M2 and M4, the difference between two mechanisms is the directions of some axes. Based on screw theory, if two screws satisfy  $\$1 = \lambda \$2$ ,  $\$1$  and  $\$2$  are the same screw [2, 3]. Therefore, M1 and M3 are the same mechanism denoted as Schatz I mechanism; M2 and M4 are also the same mechanism denoted as Schatz II mechanism. In fact,

**Table 77.2** Rotational angles of four types ( $\theta_1 = 135^\circ$ )

	$\theta_1$	$\theta_2$	$\theta_5$	$\theta_6$
M1	$135^\circ$	$52.2388^\circ$	$-39.2315^\circ$	$-153.4349^\circ$
M2	$135^\circ$	$-52.2388^\circ$	$140.7685^\circ$	$26.5651^\circ$
M3	$135^\circ$	$-52.2388^\circ$	$39.2315^\circ$	$-153.4349^\circ$
M4	$135^\circ$	$52.2388^\circ$	$-140.7685^\circ$	$26.5651^\circ$



**Fig. 77.2** Structure modeling when  $\theta_1 = 135^\circ$

former study always focuses on the Schatz I mechanism [4, 5] and little attention is attracted to Schatz II mechanism.

No matter  $\alpha_{34}$  is  $\pi/2$  or  $3\pi/2$ , the mechanism property will not be altered. In other words, the parameter condition of Schatz mechanism can be revised as

$$\begin{aligned} a_{12} &= a_{56} = 0, \quad a_{23} = a_{34} = a_{45} = a, \quad a_{61} = \sqrt{3}a \\ \alpha_{i,j} &= \frac{k_{i,j}\pi}{2}, \quad R_i = 0 \quad (i = 2, \dots, 5), \quad R_1 = -R_6 = R \end{aligned} \quad (77.16)$$

## 77.4 Summary

This paper analyzed the structure property of Schatz linkage based on screw theory and D-H parameters, and according to the analysis, corresponding mechanism is modeled. It is concluded that a novel type of Schatz linkage is existent and the parameter conditions are modified, which can be regarded as a variant of Schatz mechanism. To some extent, the variant mechanism provides a certain reference value for linkage selection of mixed machines.

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# Chapter 78

## (k, n) Threshold Secret Sharing Scheme Based on N-Dimensional Cube

Guangming Yang, Hainan Yu, Zhenhua Tan, Shuang Li and Xiang shuai Yan

**Abstract** Secret sharing is a key technology to protect the security of key. This paper advances a novel (k, n) threshold secret sharing scheme to secure the secret. S is the secret that should be shared by n participants and the encrypted secret S' is on the geometric center of a cube. In the distribution stage, all shares were distributed to participants by dealer on surfaces of the cube and each participant received a share. In the reconstruction stage, at least k authorized participants could reconstruct the cube to learn the secret. Compared to classical secret sharing schemes, this paper is as good as in space complexity, channel efficiency, and communication efficiency. Rivest Shamir and Adleman (RSA) encryption and the communication between point to point secure the scheme.

**Keywords:** Threshold • Secret sharing • N-dimensional cube • RSA

### 78.1 Introduction

In the process of exploring the security of the key, a pair of contraction always exists: great damage will be suffered if there is lack of backups of the key, and on the contrary, overloaded backups lead to high probability of leak. Secret sharing provides a way to protect the security of the key. The idea is that the secret would be distributed to n participants and each participant receives a share. At least k authorized participants cooperate to reconstruct the secret, while k – 1 participants cannot learn anything about the secret. The idea is called (k, n) threshold secret sharing scheme.

(k, n) threshold secret sharing scheme is first put forward by Shamir [1] in 1979. This scheme constructs a polynomial of degree  $k - 1$  in Galois field, GF(p) (p is a big prime number). During the reconstruction of the secret, the Lagrange interpolation formula is used. Blakley [2] regards the secret as a point in a k-dimensional

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space;  $n k - 1$  dimensional curved surfaces including the point are called shares. Shamir's and Blakely's schemes need to build private channels between the dealer and each participant and this increases the channel cost. Secret sharing scheme with partial broadcast channels put forward by Rei [3] decreases the channel cost. Secret sharing with public reconstruction proposed by Amos [4, 5] decreases the channel cost; however, to guarantee the communication security, private channels should be simulated on the public channels. Actually, threshold scheme in use often involves a weight problem; thus, advanced threshold schemes are often proposed for different demand [6, 7]. Besides, people have proposed several schemes in which shadows can be used more than once [8, 9].

The rest of this paper is organized as follows: In Sect. 2, it provides the preliminaries. In Sect. 3, it advances a novel  $(k, n)$  threshold secret sharing scheme based on  $n$ -dimensional cube including the distribution stage and the reconstruction stage. In Sect. 4, it simulates and analyzes the scheme and then compares it to Shamir's and Rei's schemes, respectively. Finally, it summarizes.

## 78.2 Preliminaries

**Axiom 1** Three points not in the same straight line determine a plane.

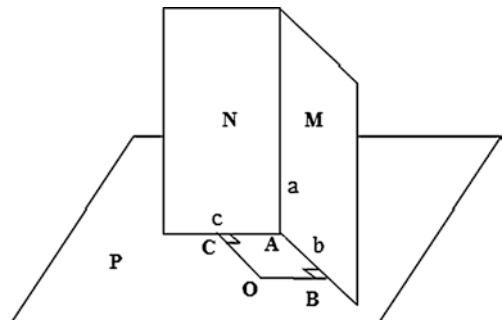
**Theorem 1** The intersecting lines of three mutually perpendicular planes are mutually perpendicular.

*Proof.* As is shown in Fig. 78.1, plane  $M \perp N \perp P$ ,  $M \cap N = a$ ,  $M \cap P = b$ ,  $N \cap P = c$ .

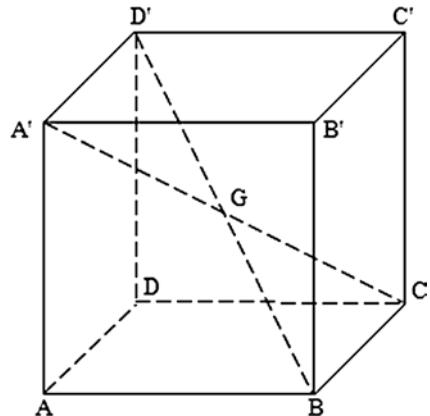
Selecting a random point  $O$  in plane  $P$  to make  $OB \perp b$  at point  $B$ ,  $OC \perp c$  at point  $C$ .

$$\begin{aligned} & M \perp P, N \perp P, M \cap P = b, N \cap P = c \\ \Rightarrow & OB \perp \text{plane } M, OC \perp \text{plane } N \\ \Rightarrow & OB \perp a, OC \perp a \\ \Rightarrow & a \perp \text{plane } P \\ \Rightarrow & a \perp b, a \perp c \end{aligned}$$

**Fig. 78.1** Three mutually perpendicular planes



**Fig. 78.2** A cube with geometric center G



$P \perp N$ , b is in plane P, c is in plane N

$\Rightarrow b \perp c$

$a \perp b, a \perp c, b \perp c$

$\Rightarrow a \perp b \perp c$

In Fig. 78.2, when three mutually perpendicular planes connected to vertex A are known, it is easy to calculate the intersecting lines AA', AB, AD. Given the cube's side length, a cube is easily determined. G is the geometric center whose coordinate can be obtained easily by vertexes A, A', B, and D.

There are eight vertexes in the cube, A ( $x_1, y_1, z_1$ ), B ( $x_2, y_2, z_2$ ), C ( $x_3, y_3, z_3$ ), D ( $x_4, y_4, z_4$ ), A' ( $x_5, y_5, z_5$ ), B' ( $x_6, y_6, z_6$ ), C' ( $x_7, y_7, z_7$ ), D' ( $x_8, y_8, z_8$ ), and G ( $x_0, y_0, z_0$ ) is the geometric center and can be obtained by (Eq. 78.1).

$$\begin{cases} x_0 = (x_1 + x_4)/2 \\ y_0 = (y_1 + y_2)/2 \\ z_0 = (z_1 + z_5)/2 \end{cases} \quad (78.1)$$

In this paper, the secret is on the geometric center of the cube. Reconstructing the cube is to learn the secret. Equation. (78.1) would be applied in the secret reconstruction stage.

### 78.3 Algorithm Description

In this section, a novel (k, n) threshold secret sharing scheme is put forward based on three-dimensional cube including the distribution stage and the reconstruction stage, as is shown in Fig. 78.3.

Assuming that D is the trusted dealer who distributes shares to participants and  $P_{i,j}$  is the  $i$ th participant on the  $j$ th surface of the cube, where  $i = 1, 2, \dots, n$  is the

**(k,n) Threshold Secret Sharing Scheme Based on N-dimensional Cube**

**Distribution stage:**

**Input:** the encrypted secret  $S'$  which is on cube's center  $G(S', d, h)$ .

$S_{ij} (x_i, y_i, z_i)$  representing a share is a point on one of the cube's surfaces.

$P_{ij}$  is the i-th participant on the j-th surface of the cube.

**Reconstruction stage:**

k participants from at least three planes adjacent to each other demand to learn the secret.

$P_{ij}$  is the team leader who will reconstruct the plane by three-order determinant, i is the minimum serial number of the participants in the same plane.

The manager whose serial number is the minimum among the team leaders will reconstruct the secret  $S$  and inform it to all team leaders.

**Fig. 78.3** The secret sharing scheme based on geometric graphics

serial number of the participant  $P_{ij}$  and  $j = 1,2,3,4,5,6$  presents the cube's upper surface, bottom surface, front surface, rear surface, left surface, and right surface, respectively.  $S$  is the secret which should be shared by n participants.  $S_{ij} (x_i, y_i, z_i)$  ( $i = 1,2\dots n$ ;  $j = 1,2,3,4,5,6$ ) is the share which is distributed to participant  $P_{ij}$ . To secure  $S$ , this paper uses RSA to encrypt  $S$  and the encrypted secret is  $S'$ .

### 78.3.1 Secret Distribution

As is described above, the secret  $S$  is on the geometric center of the cube. The encrypted secret  $S'$ , therefore, should be mapped into the three-dimensional coordinates.  $G(S', d, h)$  is the geometric center,  $S'$  is the encrypted secret,  $d$  is part of private key( $d, N$ ) in RSA encryption algorithm, and  $h$  is from a random number set.

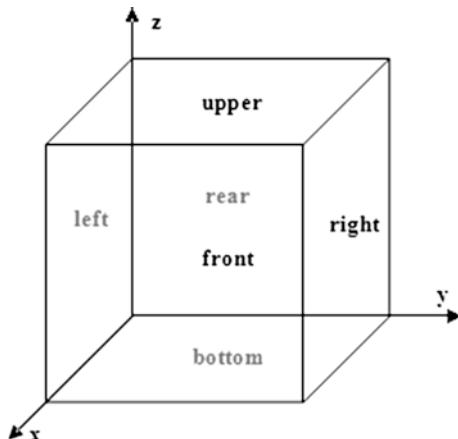
Assuming that axes x, y, and z are in parallel with the three adjacent edges of the cube, respectively, as is shown in Fig. 78.4.

When the participants of the upper surface aim to obtain the plane they stay in, they only need to know vertical coordinates. Similarly, once the participants from front and right surface know their own abscissa and ordinate, the plane equations can be obtained, respectively. In this way, at least three participants could reconstruct the cube to obtain the secret. To improve the security, the cube should be rotated a certain angle in practice, as is shown in Fig. 78.5.

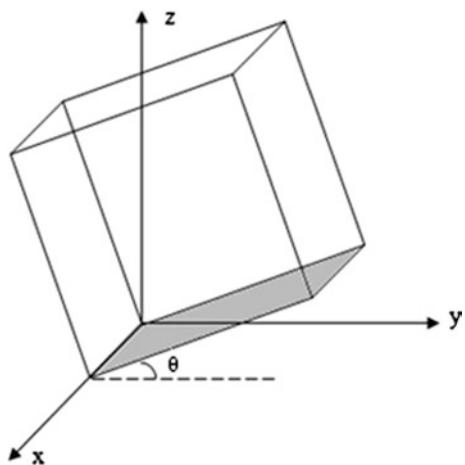
In Fig. 78.5, the abscissa, ordinate, and vertical coordinates of each plane are restricted in a fixed range. The dealer D randomly distributes coordinate  $S_{ij} (x_i, y_i, z_i)$  to  $P_{ij}$  in an allowed range, where  $i = 1,2\dots n$  is the serial number of the participant and  $j = 1,2,3,4,5,6$  presents the cube's upper surface, bottom surface, front surface, rear surface, left surface, and right surface.

As is shown in Fig. 78.6, in the floor plan of the front surface, the abscissa is  $S' + r/2$ , the range of the ordinate is  $[y_1 - r * \sin\theta, y_1 + r * \cos\theta]$ , and the range of the vertical coordinate is  $[z_5 - r * \cos\theta, z_5 + r * \sin\theta]$ .

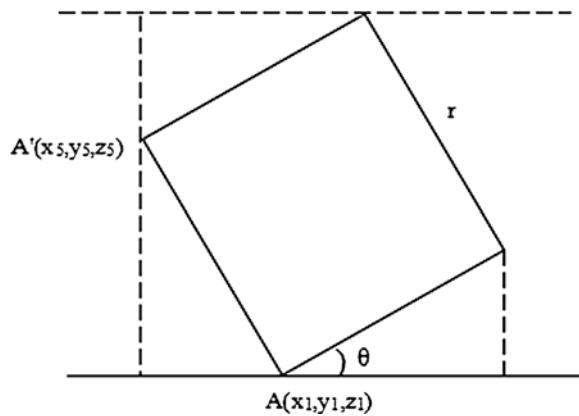
**Fig. 78.4** A cube whose three adjacent edges are axis



**Fig. 78.5** The angle between the cube and xoy plane is  $\theta$



**Fig. 78.6** The floor plan of the front surface



D selects r from a random number set as side length of the cube and publicizes it to all participants in the distribution phase.

### 78.3.2 Secret Reconstruction

Reconstructing the cube is to learn the secret. The operations are as follows.

Step 1: k authorized participants are from three planes adjacent to each other.

The three planes can be selected from {upper, bottom}, {front, rear}, and {left, right}, respectively.

Step 2: At least three authorized participants in each plane can obtain the plane and the computing task is executed by the minimum serial number of the participant called team leader. For example, P<sub>1,1</sub>, P<sub>2,1</sub>, and P<sub>3,1</sub> demand to calculate the upper surface and P<sub>1,1</sub> will be the team leader. The shares they contribute are S<sub>1,1</sub> (x<sub>1</sub>,y<sub>1</sub>,z<sub>1</sub>), S<sub>2,1</sub> (x<sub>2</sub>,y<sub>2</sub>,z<sub>2</sub>), and S<sub>3,1</sub> (x<sub>3</sub>,y<sub>3</sub>,z<sub>3</sub>) and the upper surface can be obtained by three-order determinant shown in Eq. (78.2).

$$\begin{vmatrix} x - x_1 & y - y_1 & z - z_1 \\ x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ x_3 - x_1 & y_3 - y_1 & z_3 - z_1 \end{vmatrix} = 0 \quad (78.2)$$

Step 3: The three team leaders communicate to each other, and the reconstruction task of the cube is executed by the minimum number of the team leader called manager.

Step 4: Manager calculates the geometric center, obtains the encrypted secret S' and private key, and then gets the secret S through RSA decryption.

Step 5: Manager informs S to team leaders. Then, team leaders pass it to all the participants who contribute to reconstruct the secret S.

## 78.4 Simulation and Analysis

In this section, this paper simulates the secret sharing scheme including distribution stage and reconstruction stage, analyzes the performance, and compares it to Shamir's and Rei's schemes, respectively. Finally, it analyzes the feasibility and security of the scheme.

To measure the performance of the scheme, some parameters should be defined.

Space complexity: this parameter measures the memory that participants use to store secret shares.

Channel efficiency: this parameter defines the total number of the channels between the dealer and participants, participants to each other.

Communication efficiency: this parameter defines the ratio that secret shares account for all messages sent by the dealer.

**Table 78.1** Performance comparison among schemes

Performance parameters	Shamir	Rei	This paper
Space complexity	$O(n)$	$O(n)$	$O(n)$
Channel efficiency	$O(n^2)$	$O(\log n)$	$O(n^2)$
Communication efficiency	$1/n$	$1/O(\log n)$	$1/n$

By simulation, the scheme in this paper presents good performance. The performance comparison among schemes is shown in Table 78.1.

The scheme in this paper is feasible. The mathematical principles are simple, besides, the extensibility of the scheme is excellent; thus, it is convenient to add and delete participants. When it comes to the security, this paper also performs well. Firstly, the RSA encryption is secure enough currently, and breaking RSA is difficult to achieve. Secondly, the point to point channels secure our scheme. These two advantages ensure the security of the scheme. To improve the security of our scheme,  $n$  shares could be distributed on the surfaces of a  $n$ -dimensional cube, and thus,  $k$  becomes larger, namely more participants need to cooperate to learn the secret  $S$ .

## 78.5 Conclusion

This paper advances a novel (k, n) threshold secret sharing scheme based on n-dimensional cube. In the scheme, the secret is on the geometric center of a cube and all shares are distributed on the surfaces of the cube. Reconstructing the secret does not rely on a combiner. By simulation, this scheme is feasible and secure. However, a number of issues still remain, such as how to identify the participants and how to resist fraud from the participants.

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**Part IX**

**Physical Education and Applications**

# **Chapter 79**

## **Design and Production of Objects 3D Animation Base on Flash Technology**

**Ya Chen**

**Abstract** The dissertation aims to introduce the procedures of producing simulative object 3D model bases on Adobe Flash 8.0 that specializes in producing two-dimensional vector images. Flash animation consists of frames, according to this characteristic, I found out a new way to achieve my goal. Rotated the selected object at the same central point took photos every 30° then import these photos in Adobe Flash 8.0. Achieved the interaction between computer and man be ActionScript statement and some buttons. As a result, the animation which is produced in these above-mentioned ways can reach high quality display but upload very quickly.

**Keywords** Adobe flash 8.0 • Object three-dimension • Design • Produce

### **79.1 Foreword**

By the development of the computer network technology, the number of software specializes in three-dimension increases at amazing speed. Nevertheless, there are often so many problem in many of them can lead to loading difficulties and image quality decline, such as, too large number of data and slow speed of transmission. Adobe Flash 8.0 is expert in editing vector graphics and creating interactive animations. It can produce smaller files; meanwhile, it adopts streaming media technology to run files in order to play and download animations at the same time. What is more, ActionScript, which is contained in Adobe Flash 8.0, has powerful interactive ability. To make a conclusion, though Adobe Flash 8.0 is good at produce two-dimension, it is rarely enough to achieve three-dimension on its own. As a consequence, here will introduce another simple but useful way to assist Adobe Flash 8.0 with the achievement of three-dimension. That is photographing technology.

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**Fig. 79.1** Four angle photos of ceramic horse

## 79.2 Design Scheme for Producing Objects Three-dimensional Animations

### 79.2.1 Application Development Tool

#### 79.2.1.1 Hardware

*Digital Camera:* Digital camera is used for taking photos for objects. We would better adopt high-performance digital camera which is equipped with focusing function and high pixels, so that we can reduce the difficulties while taking photos. As a result, we can attain clearer photos.

*Tripod:* Tripod is used to fix the digital camera to make it easier to adjust camera angle, so that it can stay at the best working state.

*Rotating Disk with Angle Scale:* Rotating disk with angle scale is used to change the angle of objects to help the camera gain all kinds angles of the object at the same nodal point.

*Ceramic Horse:* This time we choose ceramic horse as three-dimensional simulated object. Ceramic horse is suitable because each angle of it can demonstrate different state. And, this feature is convenient for recognizing that whether the object three-dimensional display is similar to the definite object's original shape or not. Figure 79.1 is four angle photos of ceramic horse.

#### 79.2.1.2 Software

*Adobe Flash 8.0:* Adobe Flash 8.0 is used to combine object three-dimensional models and achieve interactive communication between computers and people as well.

*Photoshop 8.0:* Photoshop 8.0 is specialized in processing images. As we all know, no matter which angle we take photos for the object, it is impossible to eliminate the background in photos. However, we can take advantage of powerful cutout function to eliminate the redundant part except the object. The photo can be used to compose object three-dimensional models when it just leaves object part alone.

### **79.2.2 Material Preparation**

Flash animation consists of stack frames. According to the principle how Flash animation form, as long as input photos of different angles one by one, it is able to form object three-dimensional model. In view of this, we could say the more delicate the object is divided up in accordance with definite angle, the more vivid the three-dimensional model can be. But, sometimes if we take too many photos for the object, it will increase pressure on network speed as well as shooting demand. For this reason, we need to pay more attention on controlling the amount of photo when taking them. Establish a space rectangular coordinate system could contribute to provide a standard for us to judge the specific amount. Above all, take the geometric center of the selected object as origin, regard the central axis of the object as the axis of bank and select a horizontal plane which is perpendicular to the axis of bank with the origin within. Secondly, with the central axis as standard, divide the coordinate system into 12 equal divisions, in other words, take photos for the selected object every  $30^\circ$ . Since a circle has  $360^\circ$ , according to division,  $360 \div 30 = 12$ , so we just need to take 12 photos for the object totally. Therefore, the three-dimensional model will render the appearance of the object more completely when it spins around on the horizontal plane.

### **79.2.3 Three-dimensional Model Composition**

- Step 1 : Eliminate the background in the 12 photos that were mentioned before.
- Step 2 : Import the processed 12 photos in Adobe Flash 8.0 to make a movie clip.
- Step 3 : In the scene, control the movie clip playback by ActionScript and some buttons to revolve the model backwards and forwards. [1].

## **79.3 Details of Three-dimensional Production Process**

### **79.3.1 Photography and Edit**

#### **79.3.1.1 Photography**

To make the three-dimensional animation looks more vivid, it is necessary to focus on the same focus among of the 12 angles when photographing, or it may

lead to the phenomenon of misplacement. To avoid the above-mentioned problem, we have to lay emphasis on the details of every step.

- Step 1 : Fix the digital camera on the tripod.
- Step 2 : Fix the craft ceramic horse on the rotating disk with angle scale then put it in place in front of the camera lens.
- Step 3 : Go on adjusting the camera until both the nodal point of the shot and the axis rotation of the tripod are on the same line exactly.
- Step 4 : Revolve the rotating disk with angle scale clockwise.
- Step 5 : Take photos for the craft ceramic horse every  $30^\circ$  and then get 12 photos totally.

### **79.3.1.2 Eliminate the Background of the Photos**

After photographing, we can cutout the photos in Photoshop 8.0. Name the photos “taocima1; taocima2; taocima3...” in turns and save them as JPEG image format.

### **79.3.2 Import 12 photos into Adobe Flash 8.0**

- Step 1 : Open Adobe Flash 8.0. Set the stage to  $779 \times 430$  pixels and the background color to white.
- Step 2 : Set up a new movie clip element and name its layer1 “Maputo”.
- Step 3 : Import processed 12 photos into the stage in turns so that they can generate frame animation immediately: The first frame to the twelfth frame in the frame grid will generate key frame automatically.
- Step 4 : Add a new layer named “mas” on layer “Maputo” and add “stop ()” statement in the first frame of the layer “mas” so as to stop playing the three-dimensional animation at the first frame. Name the file “bysz” then save it.

### **79.3.3 Achieve the Interactive Communication Features between Computer and Men in 3D Animation**

The purpose of achieving interactive communication features is to gain silhouettes information of the object 3D model. Edit the “leftward” and “rightward” button by ActionScript statement, so that the buttons can respond to cursor mouse clicking. When click the “leftward” button, the screen displays previous frame of the 3D model. Click the “leftward” button consecutively; the three-dimensional model will spin around forward. Likewise, click the “rightward” button once, the next frame will be displayed. Consecutive clicking can revolve the model backward. The following is the introduction of the steps to revolve the 3D model forward and backward.

Step 1 : Open File “bysz,” name the Layer1 that is in the scene1 “taocima.” Then, drag movie clip in the scene1 and input “mc” in the dialog box “instance name” in the option “property panel.” Create a new layer on layer “taocima” and name it “button.” After that, create two button elements and name them “leftton” and “rightton.”

Step 2 : Drag button “leftton” and button “rightton” in layer “button” of scene1 and set their instance name to “left” and “right.” Create a new layer named “maaction” on layer “button.” Input button “leftton” and button “rightton” event handlers in the first frame of layer “maaction.”

### 1. Button “leftton” event handler:

```
left.onRelease = function () { // When button “left” feel the user click it, execute this
    program
    if (mc._currentframe == 1) { // If current frame stays at the first frame
        mc.gotoAndStop (mc._totalframes); // Then let the object 3D model MC skip to the last
        frame and over
    } else { // or
        mc.prevFrame (); // Object 3D model MC to be a backward step
    }
};
```

### 2. Button “rightton” event handler

Inputting button “right” event handler in the first frame of layer “maaction” in scene1 is equal to inputting another program below button “left” event handler:

```
right.onRelease = function () { // When button “right” feel the user click it, execute this
    program
    if (mc._currentframe == mc._totalframes) { // If current frame stays at the last
        frame
        mc.gotoAndStop (1); // Then let the object 3D model MC skip to the
        first frame and over
    } else { // or
        mc.nextFrame (); // Object 3D model MC to be a forward step
    }
};
}; [2, 3]
```

## 79.4 Test and Analysis

Put up the object three-dimensional animation on the Internet and test, we will find that the images display quickly, and picture quality is undistorted. Click the buttons; we can observe the object three-dimensional model from all angles. Achieve lifelike effect; partly meet the target to demonstrate Flash analog technology. But, there are still some shortcomings here and there. For example, the animation shakes a bit when the three-dimensional rotate. As mentioned above, the nodal point of the 12 photos should be fixed in the same location, but both inaccurate

shooting angle and changing the nodal point of the camera lens by accident will destroy this requirement. And, it is unable to align the central point among of the 12 photos, in order that the images cannot be jointed completely.

## 79.5 Conclusion

Compared with other methods, Adobe Flash 8.0 and digital camera provide us with a simpler way to achieve three-dimensional modeling. It is easier to satisfy our requirement of hardware but avoid involving on any large-scale equipment if we select digital camera as assistive tool. Similarly, choose Adobe Flash 8.0 as the situation of producing object three-dimensional model can simplify the steps of creating a three-dimensional model instead of the complex three-dimensional modeling. Mastering some simple script actions can be available to achieve the interactive communication between computer and man in producing three-dimensional animation. However, photographing is not as simple as usual. We need to ensure maintaining consistent the nodal point in the 12 photos from beginning to end. For this purpose, it is necessary to fix the camera on the tripod rather than hold it in hand. Otherwise, when the image focus deviates from the fixed location, the effect of the three-dimensional animation would fall short of a requirement or promise. In other words, throughout the whole procedure, we need to take the photographing step seriously not only because of its big amount of hard work but also the accurate requirements.

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# **Chapter 80**

## **Social Adaptability Cultivation of College Students in Gymnastic Teaching**

**Zun Li**

**Abstract** To provide reference for the effective methods to conduct and reform gymnastic classes in high-learning institutions, this paper employs such approaches as literature review, expert consultation, and logical analysis to research the social adaptability cultivation of college students in gymnastic teaching of Chinese high-learning institutions. Results showed that social adaptability is one of the specific representations of the overall curricular target of sports and health. Educators and employers pay more and more attention to the social adaptability of college students. As an important part of physical education classes in Chinese high-learning institutions, gymnastics plays a positive role in cultivating the social adaptability of college students with its unique sports form and value.

**Keywords:** Gymnastic teaching • College student • Social adaptability • Ability cultivation • China

### **80.1 Introduction**

WHO defines health as the physical health, psychological health, good social adaptability, and moral health. Good social adaptability is an indispensable part of health. Social adaptability cultivation of college students is the demand of modern society as well as the trend for educational reform and talent cultivation. In order to cultivate talents for the new century, high-learning institutions should regard it as an important task to cultivate the social adaptability of college students. Social adaptability refers to the ability of individuals to adjust their behavioral habits or attitudes in order to adapt to the social living environment [1]. It includes the ability of social communication, the ability of

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psychological endurance, and the ability of behavioral constraint, confidence, competition awareness, cooperation awareness, and will quality and innovation awareness. In social life, individual growth cannot be separated from the social environment, which is highly selective of individual adaptability. Individual adaptability is the important factor to determine individual accomplishments and the comprehensive ability to guarantee individual successes amid the social wave laden with competition and challenge. As an important part of physical education in high-learning institutions, gymnastics has unique and irreplaceable functions in cultivating the social adaptability of college students. In this sense, it is of great theoretical and practical significance to research the social adaptability cultivation of college students in gymnastic teaching.

## **80.2 Uniqueness in the Social Adaptability of College Students Determined by the Teaching Content and Target of Gymnastic Teaching**

Gymnastic classes have rich contents and diverse forms. Ranging from the basic formation drills and the bare-handed practices to various practices on apparatuses, technical movements, jumps and leaps, rhythmic gymnastics, practical gymnastics and aerobics, gymnastic practices in diverse forms exert different influences on the physical and psychological development of students. Due to the fact that gymnastic teaching contents, especially those of bar movements, involve certain difficulties and risks, successful gymnastic classes can help students overcome their different phobias and cultivate their various abilities. Gymnastic classes involve a complex teaching process, with the purpose to cultivate students' strong and healthy physiques and brave and perseverant will qualities, as well as the awareness of cooperation and competition and the spirit to withstand hardships and setbacks to improve their social adaptability.

The teaching content and target for gymnastic classes determine the cultivation orientation of the social adaptability of students. For example, formation drills and bare-handed gymnastic practices can help students learn to obey orders in the social environment; difficult and beautiful technical movements and rhythmic gymnastics can help students cultivate confidence and courage and improve their abilities in beauty appreciation and innovation; wide application of protection and help in gymnastic classes can help students cultivate abilities in team work and social communication. In one word, gymnastic classes can help students learn how to be social beings, how to secure social survival, and how to cultivate good social adaptability. These abilities are of unique importance in real society. The teaching content and target of gymnastic classes determine the uniqueness of the social adaptability of students, as is indicated that the guiding ideology determines the practicing morphology.

## **80.3 Analysis of the Reasons why Gymnastic Classes can Promote the Social Adaptability of College Students**

### ***80.3.1 Supply of Room for Social Communication***

Modern society is one of frequent social communications, demanding people of establishing social connections with others in various places. Harmonious interpersonal relationship has the function of psychological health care, providing people with support and satisfying their various psychological demands of sense of belonging, sense of security, self-respect, and confidence. A marked feature of gymnastic classes is protection and help [2]. Most gymnastic movements of high degree of difficulty and risk are performed with mutual protection and help. As a result, after having gymnastic classes, students can form the awareness of protection and help. In real life, when others meet difficulty and need help, they will give their helping hands. It is natural that the social communication and interaction will be promoted. Gymnastic classes play a unique and irreplaceable role in cultivating students' ability in social communication.

### ***80.3.2 Creation of Scenes for Social Roles***

After the gymnastic teaching reforms, the degree of difficulty for gymnastic movements has been lowered. But, college students still have difficulty to perform gymnastic movements. Consequently, the necessary security device and unique teaching method of protection and help are usually employed in gymnastic classes. In the relationship between protection and help, usually, a line is drawn, and a role exchange is made between primary and secondary protectors. They work together to complete the task with each performing his or her own duties. Thus, important scenes are provided for students to exchange roles. Entertaining and amusing games are usually employed as auxiliary measures to help students practice difficulty elements in gymnastic teaching. Students play different roles in the games, experiencing the duty, task, skill, and psychology of different roles. Game rules also set a limit on students' free will, making them learn to cooperate with others, adjust their behavior, and understand the game rules to finally adapt to the game environment.

### ***80.3.3 Cultivation of the Ability to Withstand Setbacks***

Psychologists define setbacks as psychological conflicts one experience when one's needs cannot be satisfied. The ability to withstand setbacks is an important aspect of social adaptability. Pains and tears and happiness and annoyance coexist

in gymnastic training. Success and failure as well as praise and criticism walk hand in hand in gymnastic competitions. In the sports arena, competitors are hailed as heroes because of their successes. Nobody can be the all-time winner. Success and failure are hard to predict. Sooner or later, students will experience failure attacks in competitions. For students, how to withstand the hardship of failure and convert failure into success is a process of psychological adjustment as well as one of social adaptability improvement.

#### ***80.3.4 Cultivation of the Psychology to Follow Orders***

Various school sports group activities, games, and competitions have their own unique rules and demands. The special “rule effect” makes students gradually learn to observe the discipline, respect the judge, restrain themselves, compete fairly, obey regulations of sports morality, and compete or cooperate with others under the rule constraints in sports activities [3]. These unique restraints make students subconsciously form the will to follow orders and equip themselves with a peaceful mind in competitions stimulated by external environments to win the final success.

### **80.4 Means to Cultivate the Social Adaptability of Students in Gymnastic Teaching**

#### ***80.4.1 Importance Attached to the Cultivation of Students' Confidence***

The ever-quicken tempo of modern life brings individuals various opportunities and challenges. Without strong confidence, individuals cannot meet the opportunities and challenges from life and work, making it hard for them to realize their dreams [4]. Gymnastic teaching follows the principle of gradual improvement as well as the principle of teaching students according to their practical situations. Complex movements are made easier, and easy contents are taught before difficult ones to cater to the demands of different difficulty elements and learning individuals. In the overall learning process, students get more opportunities of success, and they are full of confidence. In gymnastic teaching, teachers should try their best to provide students with conditions and opportunities for success to cultivate their confidence. For those students who can perform graceful elements of high degree of difficulty, they should be praised by others and recognized by teachers. When students complete the basic learning task and want to develop elements of high degree of difficulty, they are supposed to overcome certain difficulties and perform the task. Students can taste the happiness of success when they finally win prize from others with their unique and unrivaled performance. Such happiness of

success can be gradually accumulated and deposited to finally convert to confidence which can promote the simultaneous improvement in students' comprehensive qualities and social adaptabilities.

#### ***80.4.2 Importance Attached to the Cultivation of Students' Team Work Awareness***

Due to the fact that most modern college students are single children, together with the bad social and family influence, many college students lack the team work spirit and the ability of mutual care as well as the awareness of mutual cooperation in their education process, which directly affects the class conduction of teachers. The difficulty and risk involved in gymnastic teaching make teachers generally adopt the teaching method of protection and help. Students are required to teach and help each other to successfully complete the learning task. Due to various inherent factors, students have different learning skills. Students are required to guide each other, learn from each other, learn from strong points of others to offset their weaknesses, and complement each other's strength during or after classes, so that they can make mutual progress. In terms of practices on special apparatuses, only when there are protectors standing beside the apparatuses, students are allowed to practice; during competitions, off-court guidance can help team members recognize their own shortcomings; in group events, team members are supposed to well cooperate with each other to improve their competitive strength to win the final success. It can be seen that the characteristic protection and help involved in gymnastics are helpful to cultivate students' cooperation awareness and team work spirit. Students can learn to get well along with others after they understand the importance of team work. Future society needs workers with team work spirit. The success of whatever great cause cannot be separated from team work. In this sense, cultivation of the team work spirit for college students is the demand of social development. In gymnastic teaching process, students can find out their own strong and weak points and decide upon the means to enhance their strong points and correct their weak points. The process is a process for students to constantly form self-awareness and reform themselves by means of self-recognition. It is also a process for people to form and develop their individuality and realize their socialization through gymnastic training.

#### ***80.4.3 Reinforcement of the Cultivation of Students' will Qualities***

Strong will qualities are important conditions to overcome difficulties and perform activities, including independence, decisiveness, persistence, and self-discipline. According to the basic traits of will and the basic characteristics of students' will

qualities, teachers should reasonably and scientifically arrange certain difficulties and barriers in their teaching and direct them against the training of students' will qualities to highlight the gap between the present level and the development level of students and guide the development of students' will along the right path. Students are made to complete tasks with their persistent efforts to cultivate their strong will qualities [5]. For example, present gymnastic teaching in high-learning institutions can attempt to introduce cadent gymnastics, aerobics, modern dance, gymnastics on apparatuses, and routines of different apparatus combination to moderately heighten the teaching difficulty. When students are confronted with difficulties or frustrations in gymnastic classes, teachers should offer timely and needy help and encourage students to overcome difficulties and complete the learning task to help them gain experiences of success, boost confidence in learning, and overcoming difficulties and be persistent in their efforts; so that their will can be polished.

#### ***80.4.4 Reinforcement of the Cultivation of Students' Innovation Awareness***

Modern age is an age with the coexistence of opportunities and challenges. More and more people have recognized the importance of innovation. Innovative abilities have also been regarded as basic abilities of modern talents. Cultivation of the innovation awareness of college students is an important task of present higher education. Gymnastic teachers should devise reasonable activities and scenes to stimulate students' creative thinking in their gymnastic classes. In gymnastic teaching, teachers should require students to devise new technical combinations and performances. They should also employ the instructive teaching method to draw more students to discussion. Teachers should guide students in assessing the knowledge and skill they have already acquired according to their own physical condition and knowledge store and discussing the reasonableness and application of the movement to generate the best performance. Thus, month by month, day by day, the creative thinking of college students can be effectively developed and their innovation awareness can be cultivated.

### **80.5 Conclusion**

Such awareness and behavior can be transformed into the daily life, learning and working of students as hardship endurance, social communication and cooperation, mutual protection, and help as well as rule observation formed in gymnastic activities. It is contributive to cultivating the social adaptability of college students. Good social adaptability is the learning and career foundation for college students. Cultivation of the social adaptability of college students should run through the

whole education process. Gymnastic teaching staff should find out various methods to cultivate the social adaptability of college students in a long-term process. Teaching practice proves that adopting diverse and focused teaching measures and centering on the development of students to make them willingly engage in training and actively participate in practice in gymnastic classes can help students achieve a balanced development in each skill and improve their social adaptability and competitive strength, so that they can be successful in social competitions.

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# Chapter 81

## Research on Aerobic Computer Music Production

Zun Li

**Abstract** To change the traditional aerobic music production means and render the production of aerobic music convenient, quick and effective and make the production of aerobic music well represent the thoughts of the producers, and to provide reference for the music production of other sports where skills are demanded, and difficulties are found in beauty expression. A music revolution is generated with the development of computer hardware and software and computer-assisted music production. Meanwhile, aerobic computer music production is also made easier. With the help of such research methods as literature review, comparative analysis, interview, and logic analysis, the hardware environment, and steps and methods for aerobic computer music production are introduced in this paper.

**Keywords** Aerobics • Computer music • Production • Sports group where skills are demanded, and difficulties are found in beauty expression

### 81.1 Introduction

The so-called computer music refers to digital music produced and processed with the help of various software and multimedia output equipment like the keyboard and the microphone. It goes without saying that the computer should play a central role in the production. Along with the development of computer hardware and software and the application of the computer in music production, a music revolution is generated [1]. The unrivaled computer flexibility and software applicability, especially the popularization of home computers and the intellectualization and simplification of software access, enhance the technology for music production and lower the threshold for professional music production. Assisted by the computer, the music sense of the competitor can be quickly into

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the artistic sense, and breakthroughs can be made in the instrument play to realize the spectacular sound effect that can only be generated by the band. A bridge can be built between the artistic creativity and the music production of the individual competitor with the middle link of playing instruments undertaken by the computer [2]. In this sense, it is a worthy topic to study how to make use of the great power of computers in music production to make aerobic music. It is of important practical significance to change the traditional aerobic music production means and render the production of aerobic music convenient, quick and effective and make the production of aerobic music well represent the thoughts of the producers [3]. Meanwhile, it can provide reference for the music production of other sports where skills are demanded, and difficulties are found in beauty expression.

The production of computer music mainly includes the MIDI production in the earlier stage and the audio processing in the later stage. MIDI production in the earlier stage is rather difficult and hardly accessible for ordinary people, for it demands a lot of music expertise, while the audio processing in the later stage is comparatively easy for ordinary people, for it demands the use of software to edit and process the existing music material. This paper is limited to discussing how to make aerobic music by means of the audio processing in the later stage on the computer.

## 81.2 Research Methods

### 81.2.1 Literature Review

Books and documents related to the making of computer music and materials related to aerobics are checked to master skills and acquire knowledge relevant to the hardware of computer music making and understand relevant requirements on aerobic music production.

### 81.2.2 Experimentation

As the head coach for Sichuan Aerobic Team having participated in the 7th National Universities' Games, the thesis writer makes use of the computer to make music for the mixed pair and individual and finds that music plays a crucial role in securing the success of the mixed pair and individual in the 7th National Universities' Games. On the other hand, in the process of offering students aerobic lessons, the thesis writer has always been using the computer to edit and make music for mass aerobics. Students have warmly welcomed the music be it in terms of the sound

effect or music novelty. Consequently, the thesis writer has accumulated many skills and methods about using the computer to make aerobic music.

### **81.3 Demands Raised by the System Environment of the Aerobic Computer Music Production**

#### ***81.3.1 Hardware Environment***

Ordinary home computers better than Pentium II plus ordinary disk-carving machines can complete the task of making aerobic music. Due to the closest relation between the quality of the sound card and that of the finished product, professional sound cards are preferred in the making of aerobic music. Here, the thesis writer would like to recommend MAYA sound card or Sound Blaster Live, for they are simple, practical, and cost-effective. It is suggested that monitor speakers should be used, so that final music products will not lose the fidelity when played in whatever music equipment.

#### ***81.3.2 Software Environment***

Lots of software can be employed to edit computer audios. Taking into consideration such factors as the editing function of the software, the power of the action command, the convenience and speed of the operation, and the accessibility of the software, the thesis writer chooses Sound Forge 5 and Vegas Audio 2 of the Sonic Foundry Company for editing mono-track audios and combining multi-track audios, respectively. Due to the fact that both of the products are made by the same company, they share similarities in the interface, command, and operation. The two can coordinate and cooperate with each other to offer a complete set of software for making computer music.

### **81.4 Steps and Methods of Aerobic Music Production**

#### ***81.4.1 Music Analysis***

Music analysis is the first and foremost step in the complete music production process. Producers center on a given music theme to designate the music style, melody, track number, and rhythm for their routines according to existing aerobic routines or their own music understandings or inspirations. Meanwhile, they

select necessary files from their music collections to figure out the demands of the mutual link and coordination between each file to fix the music framework.

#### ***81.4.2 Acquisition of Music Materials***

Music materials for later audio processing must be of the \*. Wave layout to make the processing possible. So, it is necessary to turn music files selected for the music analysis into files of \*. Wave layout or to get the required music materials by means of sound recording. There are two cases for the sound recording. One is to record the voice and sound of the speaker by means of the microphone; the other is to record the music in the tape or gramophone by means of the audio line and save them in the \*. Wave layout operation can be performed through either the inherent recording program of Windows or the embedded recording program of Sound Forge5. As for the transformation of music layout, the practical tool of Extract Audio from CD in Sound Forge5 can help to change CD music tracks into wave files of \*. Wave layout or change Mp3 into wave files of \*. Wave layout.

#### ***81.4.3 Mono-Track Editing of Digital Audios***

Mono-track denotes that only one wave is seen and edited in the audio editing window. The wave can be of single or double channels. Mono-track editing means to process in various forms of the gathered music materials in Sound Forge5. Different regular editing commands in edit are mainly employed to separate and combine the audio events to change the music length, reduce the music space, or transform the music sequence according to the practical needs. Simple audio processing is chiefly done by the Process menu, which mainly includes the following eight submenus, namely amplify, pitch shift, equalizer, fade in, fade out, tempo, backwards, reverb, delay, echo, flanger. The collected or recorded audios are often inconsistent in sound volume. The submenu of amplify can amplify or reduce the sound volume to achieve a general balance in the sound volume of audios. The submenu of pitch shift can heighten or lower the standard pitch of audio files. The submenu of equalizer can adjust the volume of each Hz in audio files. For example, the low Hz can be highlighted, while the high Hz can be dimmed, or different curves can be drawn according to the band to change or transform the music style. The submenu of fade in is generally used to capture the beginning of audio fragments. A short period of time is set to increasingly amplify the sound volume from low to high, creating a sense of gradually entering something. The submenu of fade out is just in opposite to that of fade in. It is used to capture the ending of the audio fragments. In many cases, the captured audio fragments do not lie in the ending of the music paragraph or sentence. If the music comes to an abrupt end when the music is still of the high sound volume, people may feel awkward. It is

precisely where fade out is needed. The submenu of tempo can generally adjust the music in the range of 100 % fast or slow, but the music may not please the ear if it is adjusted in too large a range. The most useful function of the submenu of tempo is to accurately limit a piece of music to a set time. For example, if a piece of music lasting for 18.8 s is needed, while the edited music lasts for 20.1 s. It is where the function is precisely needed. The submenu of backwards can play the audio files backwards, creating the unique and unusual music. Music effect refers to reverberation and delay. As for the creation of such sound effects as reverberation and ensemble, acoustic effect in the menu of effects can be employed. Moreover, the external effect slug in the DirectX menu can be used to satisfy the demand in creating more complex sound effect. Before the processing of various effects is done to all the audio events, an operation of Snap to Zero should be done to the various chosen zones. Otherwise, blasts can be heard in the beginning or ending of the music, and the role effect of the music is consequently affected.

#### ***81.4.4 Multi-Track Combining of Digital Audios***

Multi-track combination mainly means to progress the various independent wave files of \*. Wave layout in the earlier stage of mono-track editing into the sorting and adjusting in the later stage with the help of the multi-track combination software of Vegas Audio2 to finally produce an independent audio file. The multi-track combination can simultaneously process audio events of more than one track and make each track temporally overlapped. Multi-track combination mainly means to progress the various independent wave files of \*. The operation of multi-track combination is mainly performed in the multi-track editing zone. Sound track is duplicated, moved, inserted, or deleted to adjust the position and relation of each sound track according to the earlier music framework. Moreover, the personality panel and envelope operation of each sound track can be used to adjust the sound volume, tone, and effect of each sound track. After all the adjustment work is done, multi-track mix down can be used to mix and combine the wave in each track into a stereo wave file and adjust the final sound effect through the level meter. The mixed and combined products can be outputted as WAV files of independent and standard layout or compressed files in the layout of WMA, MP3, ASF, and REAL. If the producer is satisfied with the mixed and combined finished product, then, a music product is almost made. On the other hand, the mixed and combined stereo wave files can be put into Sound Forge5 again for further revision to obtain ideal sound effect.

#### ***81.4.5 Master Tape Processing***

Master tape processing is the last as well as the most important step in the generation of finished music products. Such methods as equalization, compression, and

limitation can be employed to improve the sound effect to a large extent and establish a proper transition in the sound volume and tone between the neighboring two pieces of music, so that the final sound effect can be grasped in general. Master tape processing is done through the menu of Effects/Wave Hammer in Sound Forge5. The menu includes two important functions. One is the compressor, and the other is maximized.

#### ***81.4.6 Product Release***

Finished music products should be released according to the final playback device. They can be released in the form of CD or tape. CD recording can be done either through the inherent program of the recorder or the recording program of Sound Forge5. The recorded audio files can be in the layout of MP3, Wave, or CD. In CD recording, it must be confirmed that the recorded audio files should be in the stereo standard files of 16 Bit, 44, 100 Hz. Otherwise, some mistakes will appear in the recording process, which may lead to the failure of recording. If the finished music products are released as music tapes, the interface of line out can be employed to output the sound into recording; thus, the whole music production is completed.

### **81.5 Summary**

Aerobic computer music production heralds the new beginning of aerobic music production. Compared with the traditional aerobic music production, aerobic computer music production is more economical, convenient, rapid, and flexible with its comparatively low demand of hardware equipment, powerful function and rich command of computer audio editing software, convenient and rapid operation and easy accessibility. It is not necessary for producers to acquire much music theoretical knowledge. They can well express their own music philosophies and realize desired music effect through editing, polishing, and combining the existing music materials. In the practical production process, the computer hardware is the basis, with the audio processing software being just the tool and the effect plug-in units being the embroidery, to make richer and more powerful music. Good originality and conception as well as the awareness and appreciation of music are the key to aerobic computer music production. Adept operation will make producers yield twice the result with half the effort. And, accumulative practical experience and solid theoretical knowledge will make the production more professional. This paper is limited to introducing the general methods of making aerobic music and producers need constant experiment, accumulation and improvement, so that they can generate good music products.

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## Chapter 82

# Kinematics Analysis on Discus Throwing Technique Based on Computer Calculation

Jing Fei Chen, Ying Liu, Xiao Feng Xu and Lei Wang

**Abstract** By using the computer three-dimensional kinematics research method, computational analysis of the kinematic characteristics of discus athletes in throwing technical aspects in training and competition is carried on to identify the strengths and weaknesses of the discus athletes in athletic ability, providing reference for the guidance of coaches' scientific selection and reasonable arrangements for sports training to improve specific sports results.

**Keywords:** Computer • Discus technique • Computational analysis

### 82.1 Introduction

The discus movement is originated in human's practical activities in overcoming and transforming nature for a long time [1, 2]; to some degree, it is originated from human's natural throwing motion [3, 4]. Since the beginning of the twenty first century, along with the continuous development of the modern athletics, discus throwing technique is also improving, and discus throwing is a typical speed and power project in track and field techniques [5, 6, 7]. It not only requires athletes to have good explosive ability, but also requires fast rotation speed and shooting speed [8, 9, 10]. Correct analysis on discus technique, technical characteristics, and shortcomings of the athlete can provide a theoretical basis for their future competition [11, 12].

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## 82.2 The Study Objects and Research Methods

### 82.2.1 The Study Objects

Take the female athletes' 22 times sports techniques in training and competition as the study objects. Table 82.1 shows the results.

### 82.2.2 Mathematical Statistics

Make use of the computer statistical analysis software to analyze and calculate the acquired data in 22 times throwing. Fig. 82.1

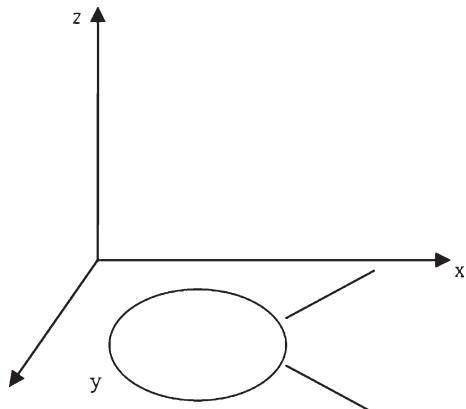
Phase classification and marking code:

R ↑—right foot off the ground time;      ↓ → R ↑ preparation phase  
 L ↑—left foot off the ground time;      R ↑ → L ↑ beginning of rotation

**Table 82.1** Results table in training and competition of female discus athletes (unit: m)

Times	Competition	Training
1	57.84	64.18
2	61.42	59.79
3	59.25	65.06
4	62.39	63.84
5	63.46	64.59
6	61.73	64.93
7	59.67	62.89
8	58.32	63.51
9	60.17	65.29
10	62.56	64.88
11	61.62	62.76

**Fig. 82.1** Coordinates of discus throwing direction



$R \downarrow$ —right foot landing time;  
 $L \downarrow$ —left foot off the ground time;  
 $\downarrow$ —pre-swing ending time;  
 $\uparrow$ —discus shooting time

$L \uparrow \rightarrow R \downarrow$  flight phase  
 $R \downarrow \rightarrow L \downarrow$  transition phase  
 $L \downarrow \rightarrow \uparrow$  final putting force phase

## 82.3 Results and Discussions

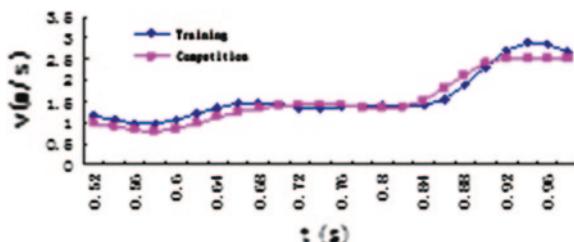
### 82.3.1 The Kinematic Characteristics of Body Center of Gravity in Throwing Process

From Table 82.2 and Fig. 82.2, it can be seen that on the moment of the right foot off the ground, the body center of gravity speed is in a sharp rise, in the pre-swing ending time, and the body center of gravity speed is 0.18 m/s, but the body center of gravity up to 0.98 m/s when the right foot off the ground, the increase of the speed is 0.80 m/s, so that the body center of gravity obtains a certain speed [13]. This is because the body gradually moves to the left rear. In the preparation phase, the general trend of body center of gravity speed is rising, during the training, the body center of gravity speed increase from 0.22 m/s to 1.19 m/s, while in the competition, the speed of body center of gravity increases 0.75 m/s. The increase value of body center of gravity in training is bigger than it in competition, so Song Aimin starts faster in training phase. Speed curve in competition has a peak value in 0.39s and then reduces, while the speed curve in training has a peak value when the right foot off the ground. The speed of Song Aimin's gravity center ups and downs in the preparation phase, and the speed of gravity center increases relatively stable in training comparing to competition [1].

**Table 82.2** Speed changes of Song Aimin's gravity center (unit: m/s)

	$\downarrow$	$R \uparrow$	$L \uparrow$	$R \downarrow$	$L \downarrow$	$\uparrow$
Training	0.22	1.19	2.69	2.36	2.59	1.01
Competition	0.23	0.98	2.51	1.95	2.61	1.36
Average	0.18	0.98	2.72	2.32	2.62	1.29
Deviation	0.06	0.12	0.13	0.21	0.17	0.14

**Fig. 82.2** Speed changes of body center of gravity in preparation phase

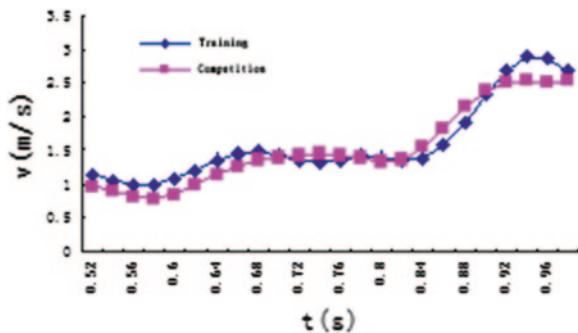


$R\uparrow \rightarrow L\uparrow$  is the beginning of rotation phase, and the main purpose of this phase is to enable the body to get some pre-acceleration. Body center of gravity is gradually shifted from the left leg to the right leg. On the right foot off the ground moment, the right foot actively swings in large radius, and the left foot in this moment has a pedal action in the throwing direction, which shows in this phase, body center of gravity gets a maximum acceleration to prepare for flight phase. It can be seen from Figs. 82.2, 82.3 and 82.4 that the trajectory in training and competition is almost the same, the change value in training is 1.5 m/s, while in competition is 1.53 m/s, so the speed change has no greater difference.

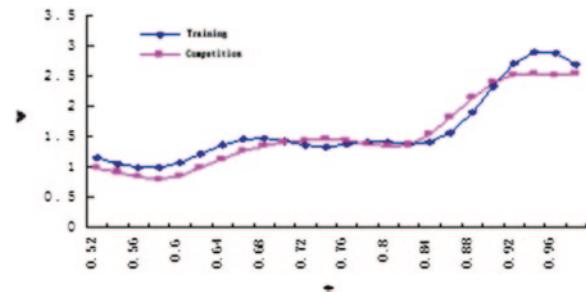
$L\uparrow \rightarrow R\downarrow$  is flight phase. Table 82.2 shows that the body is in a flight phase, on the left foot off the ground moment, the speed of body center of gravity is  $2.72 \pm 0.13$  (m/s), in the right foot landing time, the speed of body center of gravity is  $2.32 \pm 0.21$  (m/s), so the speed reduces 0.4 m/s, but remains at the original speed. That is to say, during a shorter time, body with the speed of energy can change the speed of a link of the body, but as a whole, it is basically remain unchanged. This is because the body is in a positive turn state through the right leg buckle rotation, which is in line with the movement principle [2].

Speed of body center of gravity is slightly decreased when the right foot landing, the main reason is that on the right foot landing moment, the right leg support reaction force on the body is braking. From Table 82.2, the speed of body center of gravity in the right foot landing time is  $2.32 \pm 0.21$  (m/s), and in the left foot

**Fig. 82.3** Speed change of body center of gravity in rotation phase



**Fig. 82.4** Speed change of body center of gravity in flight phase



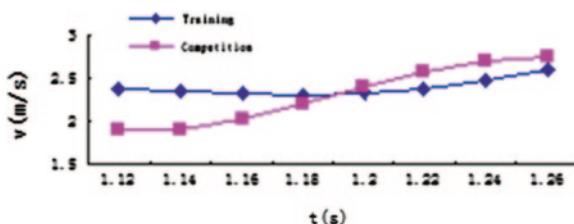
landing instant, the speed is  $2.62 \pm 0.17$  (m/s), so the speed of body center of gravity is increased. This shows Song Aimin's left leg swings closer to the right leg, reducing the turning radius of the lower legs and increasing rotation speed of lower limb in order to discuss to stay behind the body to form good results surpassing the equipment.

From Fig. 82.5, it can be seen the training curve rises smoothly, while competition curves have a maximum value in 1.24s, combining with "the characteristics of the human body-equipment system in the process of throwing," it shows that body center of gravity transition to the left axis faster and right leg support time is shorter in competition than in training, and there is no better support of the right side and upper body lifted earlier, while in training, body speed increases stably and forms a good result beyond the equipment.

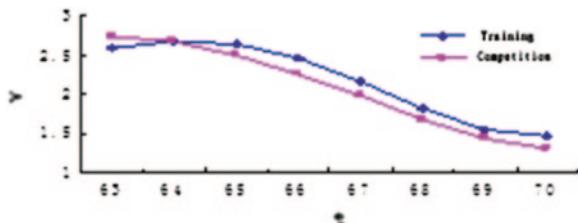
In the final phase, the right leg should mainly turn and pedal to promote the hip to the throwing direction. Upper body is still far to stay in the body to form "full bow" posture, with the rotation of the hip, speed of body center of gravity sharply declines, which is because the strong support of the left side of the body and right arm swing whipping produce the reaction force to stop the trend of forward. Reaction in lower limbs quickly passes to the upper limbs and finally to the lower extremities, and the discus is threw.

In this phase, the more decrease of the speed of body center of gravity, the more fully the energy transfers, the better and the effect of the final force. The speed of the body center of gravity has a certain influence on the results, and the relationship is closer ( $r = 0.465$ ),  $P < 0.05$  [3]. From speed change of the body center of gravity, it can be learned that in training, Song Aimin's center of gravity reduces 1.59 m/s, while in competition, it reduces 1.25 m/s relatively in line with the technical principles, range of motion in training is large. However, from Figs. 82.5 and 82.6, it can be clearly seen that the two curves as a whole are gradually declining, and it is not difficult to find the training curve is firstly increased and then decreased. Mainly, in the process of rotation, center of gravity supported by the right leg is moved to the left support, the center of gravity forward, the speed increases, the left leg land, so the body has a brake; therefore, speed of the body center of gravity should be the firstly increased and then reduced. In the training, the distance of the final force increases, enhancing the effect of the force, while the competition curve trajectory is a steady decline, which shows the body center of gravity homeopathic forward, it does not form good left side support, and the force is not sufficient.

**Fig. 82.5** Speed change of body center of gravity in transitional phase



**Fig. 82.6** Speed change of body center of gravity in final putting force phase



## 82.4 Conclusions and Recommendations

### 82.4.1 Conclusions

In the beginning of rotating phase, the upper body has forward movements, and the right leg positively kicks, swings and turn buckle, left leg kicks hold up in throwing direction, so that the human body obtains the support reaction force and gains a certain speed. During the flight phase, the effect of swinging and turning buckle of right leg is better, and left leg swings positively, lower limbs beyond the upper limbs, forming surpassing equipment effect. In transitional phase, upper body transfers faster forward and horizontally, and the shoulder and hip angle reduces, the turning leading by the ankle, knee, and hip turns into the acceleration rotation leading by the shoulder axis. In the last force phase, the force moves from the right side axis to the left side axis; in the transition to the left axis, the left support is poor. Upper body lifts early and shortens the working distance, the state surpassing the equipment is damaged, and the right foot after landing rotates negatively. The left support is poor, and the work distance of the last force is shorter.

### 82.4.2 Recommendations

An effective way to improve the competitive ability of female discus thrower is to rely on their special technical advantages and make up the shortcomings such as the core athletic ability and body shape to improve overall athletic ability. The future training should take some necessary practices and improve the technical shortcomings, such as do some exercises to feel the left side support, experience the technique of putting forth strength by the left side to improve the shortcomings like the right foot turn positively after landing, the left support is poor, and final work distance is shorter.

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# Chapter 83

## Analysis on Smashing Motion in Badminton

Rui Jiang and Zhaonian Wang

**Abstract** In this paper, through the infrared monitoring of long-range system of the infrared high-speed camera QUALISYS-MCU500, we make a biomechanics analysis on badminton athletes' smashing motion and draw when badminton player is smashing the ball by hand vigorously, how to effectively strengthen the batting strength to stabilize their center of gravity and to maintain balance throughout the body. This plays a crucial role in China's badminton athletes to regulate their spiking action.

**Keywords** Badminton player • Smash • Arm • Mechanical analysis

### 83.1 Introduction

This paper is using the infrared high-speed camera to take the entire process of the badminton athletes on the field smashing the ball, and the QUALISYS-MCU500 type of high-speed video image motion capture video camera is mainly used. This set of equipment is made up by the Motion Capture Unit, target, the camera, and the corresponding software component, see Fig. 83.1. The infrared high-speed camera's working principle is as follows: put the target infrared radiation environment and the camera catches the reflected light; at this time, the computer system can detect the target corresponding numerical. Therefore, the equipment can obtain the accurate 3D movement of complex sports information [1].

### 83.2 Experimental Steps

Step1: Put the camera as required below in the badminton court:

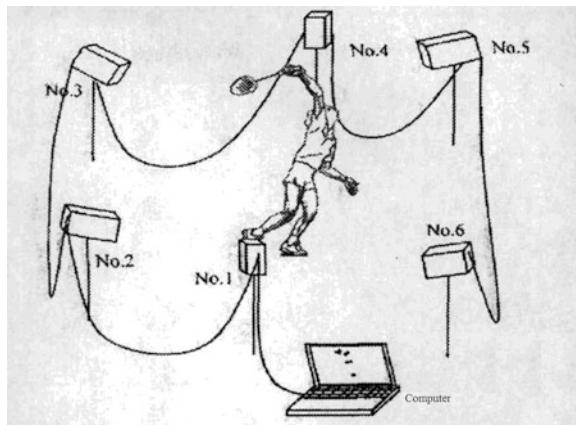
1. Distance: the distance between the high-speed cameras is 15 m, with each camera from goal 10 m far.

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**Fig. 83.1** QUALISYS-MCU500 testing schematic diagram

2. Height: each camera body height is 1.5 m.

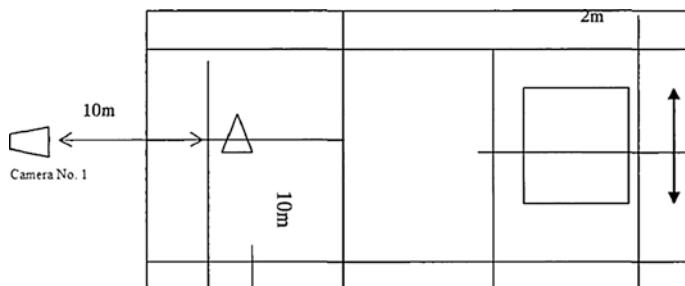
3. Angle between adjacent cameras: the camera angle is 45 degrees.

Step2: Athletes spiking action test

Badminton players affixing mark in arm can produce the reflection of the object, so that the badminton players can try to take some tries; then, in the test, badminton players try to complete the qualified smashed ball; each of the movements has to achieve the fundamental requirement, and the action is taken down by the camera completely [2], Figure 83.2.

Step3: Data collection

The whole process is shot down and then sent to signal conditioning, in which signal pressure is under processing, and then transmit data to the data acquisition card; data acquisition card will signal the/number (A/D) and convert into the computer; through program operation and treatment, pressure data will be eventually displayed on the screen, Figure 83.3



**Fig. 83.2** Test site schemes

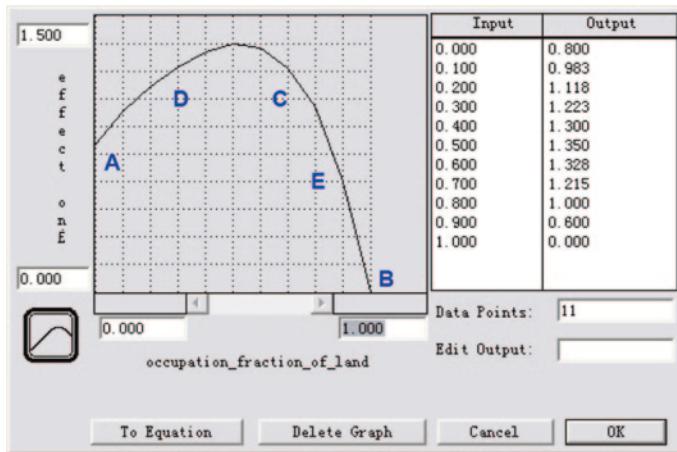


Fig. 83.3 QUALISYS software interface

### 83.3 Badminton Arm Movement Analysis Based on the Dynamics

When the badminton player's forehand smashes the ball, before hitting, the right foot is slightly before the left foot, and the body slightly bends forward and bends knees, the focus falls on the right foot, ready to takeoff. The rear of the body right after the jump, upper right back into the anti-bow, his right arm right elevation, shoulder and try to pull. During the shots, forearm quickly lifts out into the forearm, wrist from behind and then quickly under the direction of the ball. After smashing, the knees buffer, the right foot on the right side, the center of gravity before the right foot, left foot on the left before, and rapidly restore [3].

The right arm is set to the midpoint of the mark as a whole, so we assume there is a coordinate, and the midpoint of the arm is the origin of coordinates; then, we apply the kinetic analysis and QUALISYS to draw three-dimensional coordinates of the arm, as is shown in the figure below: Figs. 83.4, 83.5.

Among them, the establishment of the coordinate system is as the following, which can be seen in Fig. 83.6:

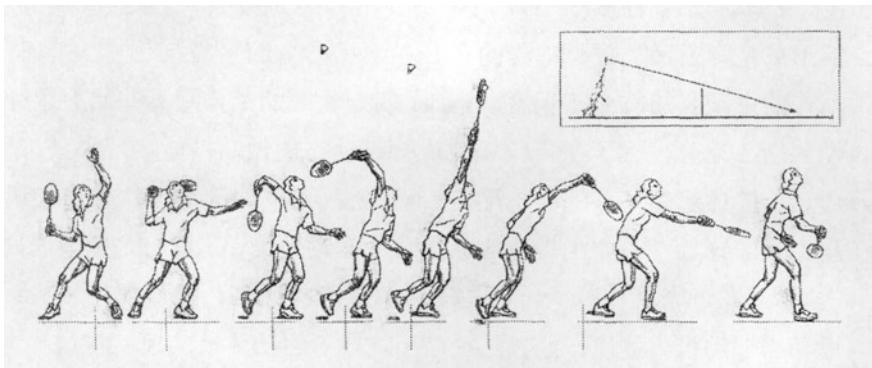
$$\text{Arm X} = (\text{forearm X} + \text{reararm X})/2$$

$$\text{Arm Y} = (\text{forearm Y} + \text{reararm Y})/2$$

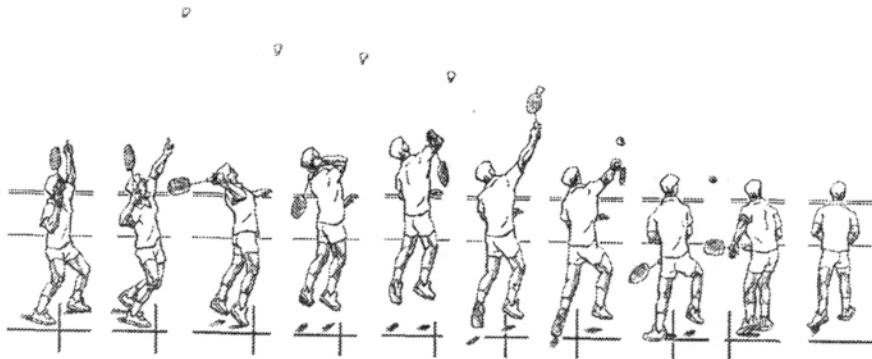
$$\text{Arm Z} = (\text{forearm Z} + \text{reararm Z})/2$$

The coordinate system,  $Oj, Xj, Yj, Zj$  ( $j = 0, \dots, 3$ ) in the standard smash the arm is straight up with each parallel to another. When the arm is straight up when spiking, athletes smash in fact is the dynamics problem. Through Kane dynamics, we can derive Eq. [4]:

$$F^{(r)} + F^{*(r)} = 0 (r = 1, 2, 3, \dots, 7) \quad (83.1)$$



**Fig. 83.4** Simple diagram of smashes on the ground ball



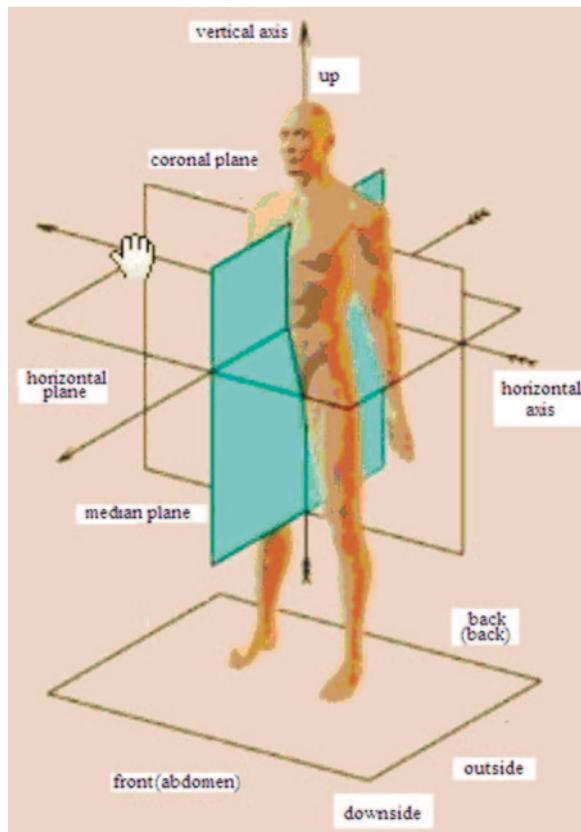
**Fig. 83.5** Simple diagram of smashes when taking off

$$q\&_r = q \& (u_r, q_r) = 0 \quad (r = 1, 2, 3, \dots, 7) \quad (83.2)$$

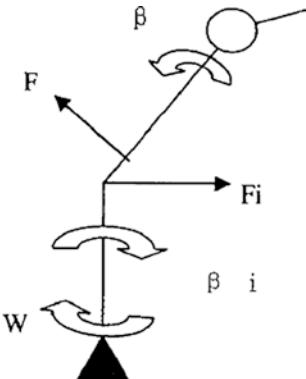
And then according to law and Newton's third momentum theorem, when the athletes spiking, we make a force analysis of the stress of the arm. Among them, the law of conservation of momentum is used in this paper and is conformed to the research content conditions. Because the law of conservation of momentum is stipulated in the following points: system not affected by external force or the external force is zero. System under external force is not zero, but much smaller than system internal force. System of external force is not zero force, but in a direction of component to zero, the total momentum remained the same—point momentum conservation. So when athletes shot ball, although not affected by force 0, compared with the internal system, this can be ignored. Figure 83.6.

According to the formula  $p = m_1v_1 = m_2v_2$ , when athletes make a smash action, first accelerating arm swing to get some momentum. Then, according to the transmission principle, the momentum generated is passed to the racket, so the racket is on a very large initial velocity. Stress analysis is shown in Figs. 83.6, 83.7.

**Fig. 83.6** The establishment of the coordinate system



**Fig. 83.7** Stress on the arm when shot



Then, again through the dynamics theory, we conclude that the stress on the arm when spiking:

$$Mt = \Delta \sum Ii\omega i = (I_1 + I_2)\omega_0 \quad (83.3)$$

Then,

$$\begin{aligned} Q &= Q_0 \\ I_1\omega &> I_2\omega_0 \\ w &= \frac{(I_1+I_2)\omega_0}{I_2}\omega_0 + \frac{I_1\omega_0}{I_2} \end{aligned} \quad (83.4)$$

$$\therefore I\omega_0 = 0$$

$$\therefore Q = I_2\omega \quad (83.5)$$

Then, according to the law of conservation of energy, we further draw:

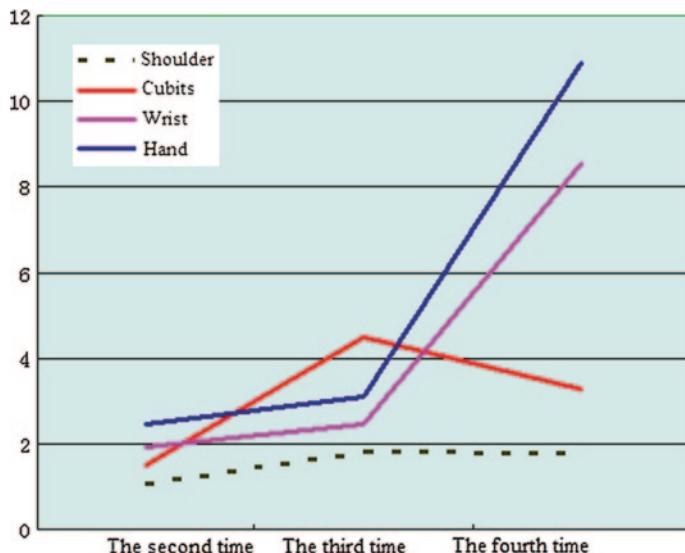
$$\begin{aligned} Q &= Q_0 \\ Q_o &= (I_1 + I_2)\omega_0 \\ w &= \frac{(I_1+I_2)\omega_0}{I_2}\omega_0 + \frac{I_1\omega_0}{I_2} \end{aligned} \quad (83.6)$$

Through the formula, we can easily draw  $\omega > \omega_0$  and  $I_1\omega > I_2\omega_0$ .

Through the above formula deduction, we can get the instantaneous velocity of the upper extremity during the ball smashes on the ground and during the takeoff. Figure 83.8

Through the above two figures, we can safely draw the conclusion that when the athletes are in the spike, what instantaneous speed each arm joints can reach [5]. Table 83.1

Through interview by experts, it is drawn when the athletes are in the shots; survey results of the arm holding the racket in badminton movement's effect are given in Table 83.2



**Fig. 83.8** Instantaneous velocity of each part of the upper arm (m/s)

**Table 83.1** Instantaneous velocity of each part of the upper arm (m/s)

Name	The second time	The third time	The fourth time
Shoulder	1.05 ± 0.4	1.78 ± 0.8	1.76 ± 0.7
Cubits	1.5 ± 0.64	4.5 ± 2.5	3.26 ± 1.5
Wrist	1.94 ± 1.2	2.45 ± 1.5	8.56 ± 1.7
Hand	2.45 ± 1.4	3.1 ± 1.87	10.9 ± 2.5

**Table 83.2** Survey results of the arm holding the racket in badminton movement's effect

	Sample	Increase hitting power	Balance	Beautiful movements	Improve hitting	Improve accuracy
Number	10	10	10	7	10	10
Percentage %		100	100	70	100	100

## 83.4 Conclusion

With the help of the QUALISYS-MCU500 camera, this article records the athletes' action of ball smashes and then reuses movement mechanics theory and the law of conservation of energy to analyze arm in spiking. We can get the stress of the upper arm in each part and the corresponding instantaneous speed. Through this, we can regulate the athletes' spiking action standards.

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# Chapter 84

## Model Analysis of Cognitive Training in Sports Activities

Linbao Zhang

**Abstract** In order to shape behavior, we need to make transition through the cognitive subsystem by accumulation, adaptation and fully absorbing the information to carry out the operation and improvement. Aware of these aspects, we will witness the cognitive students in physical education activities of non-personal. Given the real possibility, we make our preliminary study on the reflection of the psychological and behavioral aspects of college freshman and sophomore students, the practice of physical exercise, and how the introduction of the global impact of improved cognitive goals among other goals, during the training under the influence of a specially designed program makes their attitude changed. The premise of the background is considered to assume that the experience gained from the references and the training process.

**Keywords** Cognitive • Training • Movement • Sports

### 84.1 Introduction

At the beginning of this paper, the premise is assumed that through the explicit introduction of the cognitive objectives, students of physical education courses to join the movement and emotional goals, then the efficiency of the student training process increases [1, 2].

In modern sports, in addition to power and speed of the competition, there is also the comparison of the endurance, and athletes' anaerobic ability is one of the key elements to win the competition. At current, many sports scientists and coaches widely believe that the adaptability of the athletes and performance testing are very important factors in athletes' designed training plan in the project of the athlete's progress analysis. Anaerobic ability is considered that athletes' working ability when the muscles do not provide enough oxygen for the body. Generally speaking, in an anaerobic state and a short time period, athletes have shown the explosive force

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that is the maximum speed and power meaning the speed of finishing the work. In basketball games, a successful performance mainly dependent on several fitness adaptability part (for example, speed, agility and vertical leap). The movement is in essence anaerobic properties, and these components must be repeated, with the lowest reduce competition for the performance. Currently, there is no particular test that can be used as a measure of basketball player anaerobic power acceptance standards.

## **84.2 Study Design**

The composition of the study design is for the students' sports activities in the cognitive, emotional, psychological and movement mode of operation [3]. The effect of the implementation of the project and the training methods were assessed. We focus on the knowledge the students have obtained in the training of secondary questionnaire. Assessment of study cognition: the level of the experimental and control groups, in particular, knowledge, and the number of questionnaires answered in the evaluation design. We explain the recorded datas by Table, processing program and statistics. We make the graphical presentation of the key indicators of the research phenomenon.

### **84.2.1 Theme**

In the survey, we selected 88 students from the university freshman and sophomore years. In order to verify, informing the students know that this training course, which occurred in a qualitative leap from the experimental group randomly selected 30 students to a group of randomly selected control group with another group of 29 students were compared.

### **84.2.2 Research Methods**

This paper uses literature, observation, survey methodology (dialog, questionnaires, etc.), methods of experimental teaching, statistical and mathematical methods, and the graphical method [4].

### **84.2.3 Research Objectives**

The purpose of this study is to study all aspects of the scientific organization of students of physical education courses, and lessons learned, and at the same time taking into account the feelings of awareness and training components, and they will take what kind of practice to improve the process [5].

#### **84.2.4 Research Goals**

Completion of the importance of relevant education, cognitive and affective objectives of the introduction and the use of specialized information; design a training program, making the introduction and use of cognitive objectives and other objectives and the practical application; to eliminate the negative attitude of the sports, in education use of cognitive and affective objectives; assessment of the experimental results.

### **84.3 Research Contents**

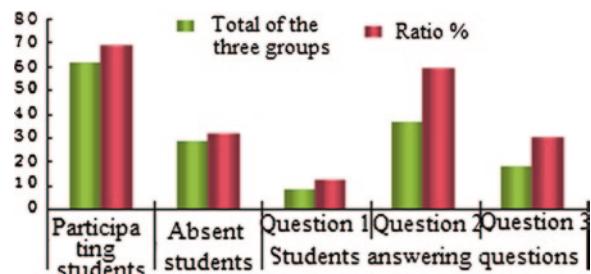
Developing solutions to achieve sports as the main goal, to produce effective change (cognitive, emotional, sports). New training programs and cognitive objectives through intervention techniques include physical games: basketball education in the 2-year period in each class, not only provide verbal knowledge, in writing or through the physical media education; language, sports, written information, video and other manipulation of the factors known as the independent variables, the modified coefficients are referred to as the dependent variable. In our example, the cognitive and emotional lessons, the objectives of the program, as the independent variable of the experiment; answer as a result, the performance results in the knowledge of the interventions are the dependent variable [5].

Ensure that the cognitive goals and the need to verify all the important cognitive variables (insight and logic) cannot be separated. Even if it is a restrictive manner, we should allow the ability to modify the students' responses to stimuli and in accordance with their necessities and update the information transmitted (for example, update the information received, you can do: sports lessons, sporting events and in everyday life leisure activities). On the structure of each person's three questions: one, action sports activities, structure; sports games; sports history data of general and specialized public knowledge. Data provided by the history of our sport, to educate their esthetic awareness and physical exercise, the need of self-knowledge, emotional competition, and the desire to know. To assess their knowledge, a group of 89 students, 61 of them rated their physical education and sports knowledge. The survey results are shown in Table 84.1 and Fig. 84.1.

**Table 84.1** Evaluation of performance of the freshmen's knowledge about sporting

Group	Years	Total number of students	Participating students	Absent students	Students answering questions		
					Question 1	Question 2	Question 3
Total of the three groups	1	89	61	28	7	36	18
Ratio %			68.54	31.46	11.48	59.02	29.50

**Fig. 84.1** Evaluation of performance of the freshmen's knowledge about sporting



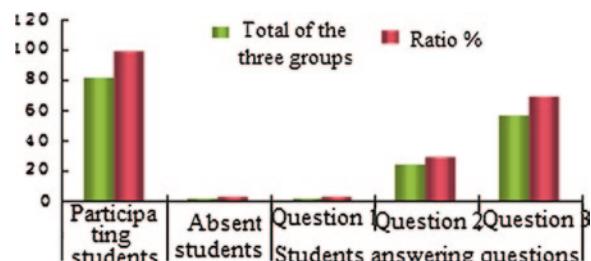
I am a college freshman record test results. When they entered the sophomore stage, monitoring and training for 2 years, and then test again. With the results achieved in the first year, compared to results, 89 students were admitted, five people were lost a year, or move to other universities. 84 students were left in the second year [6]. In the knowledge test, 82 students, this means that more than the annual profit and loss rates are 97.61 and 27.16 %. Test students' knowledge gained in the second year, the investigation as shown in Table 84.2 and Fig. 84.2.

From Tables 84.1, 84.2, it can be observed that the level of knowledge gained in the 2-year training process to improve, such as improved significantly in the proportion accounted for the second year of higher training students. In order to sustain this argument, we studied a sample of students: 30 students participated in physical education and sport lessons learned set of experiments; the control group of 29 students enrolled in physical education and sport lessons learned education.

**Table 84.2** Evaluation of performance of the sophomore's knowledge about sporting

Group	Years	Total number of students	Participating students	Absent students	Students answering questions		
					Question 1	Question 2	Question 3
Total of the three groups	2	84	82	2	2	24	56
Ratio %		1	97.61	2.39	2.43	29.27	68.30

**Fig. 84.2** Evaluation of performance of the sophomore's knowledge about sporting



We use the same approach to the control group of students from another teacher training. First, at least in theory, all the students seem to university life and physical education activities into the same knowledge base and level of training. Although students were informed at the beginning of day, date, test location, the experimental group was 80 and 20 % of absence. But in the case of the control group, the situation is different, 55.17 and 44.83 % in the absence of investigation are shown in Table 84.3 and Fig. 84.3.

We use the same approach for the second year of sports knowledge education survey, and the comparative analysis shows.

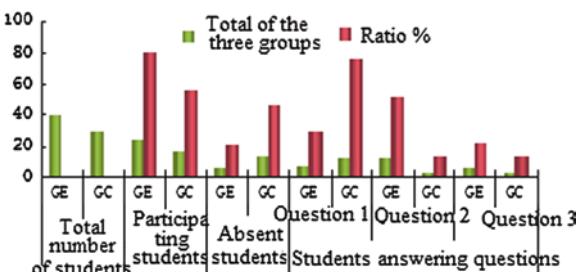
According to the survey data, the experimental group of students usually has independent information and training programs, under these conditions, a second-year students, GE accounting for 93.54 % and exceeding 50 % of the total assessment Fig. 84.4 and Table 84.4.

Linear sprint is an appropriate field test for the measurement of a basketball player's anaerobic adaptability. But later, we will have to increase the sample size. Because of the widespread application of basketball coach, linear sprint as a basketball player anaerobic measurement is quite attractive. And the test is more efficient and practical when several players are running the same test. Linear sprint and vertical leap tests are acceptable field tests to measure a basketball player's specific anaerobic power, though APJT and WAnT measure lower anaerobic ability. The difference is because the lower

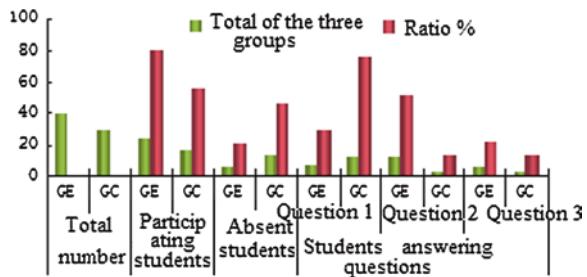
**Table 84.3** Freshmen's evaluation of their sports knowledge and education questionnaire

Group	Years	Total number of students	Partici-Absent		Students answering questions						
			GE	GC	Question 1	Question 2	Question 3				
Total of the three groups	1	39	29	24	16	6	13	7	12	12	5
Ratio %			80		55.2	20	44.8	29.2	75	50	12.5
					20.8			20.8		12.5	

**Fig. 84.3** Freshmen's evaluation of their sports knowledge and education



**Fig. 84.4** Sophomore's evaluation of their sports knowledge and education questionnaire



**Table 84.4** Sophomore's evaluation of their sports knowledge and education questionnaire (including the exercise GE and control GC)

Group	Years	Total number				Participating students		Absent students		Students answering questions					
		of students								Question 1			Question 2		
		GE	GC	GE	GC	GE	GC	GE	GC	GE	GC	GE	GC	GE	GC
Total of the three groups		39	26	29	13	2	13	2	5	6	6	21	2		
Ratio %				93.5	50	6.5	50	6.9	38.5	20.7	46.2	72.4	15.5		

limbs ability is produced simultaneously or successively. And when the upper limbs muscle is active or passive, they will have better performance impact [7].

The fatigue index between WAnT and linear sprint doesn't have any relationship; this may be due to the fact that the two test movements are caused by different rules. WAnT is a separate movement for 30 s. But sprint also has the same three phases as WAnT, but there are 2 min to rest. Therefore, FIWanT is to measure a single sports fatigue index, and FILD is to test the recovery probability. If we conduct multiple, discontinuous WAnT test in this study, perhaps the two sports fatigue index will be more similar.

## 84.4 Research Results Analysis

Based on this hypothesis, we stressed the emotional and cognitive goals of moving targets are undeniable, and to provide teachers in the training process, the possibility of the implementation, thus becoming the awareness-raising work.

There are often emotional contrasts; there is a cognitive, and on the basis of border between them is subtle but important, as pure emotion between functions of

combination is impossible. Its main purpose is the basis of research achievements of the transformation from subject to help young teachers work of the object in the student on own initiative their training and development.

In the past, the training for the premise process is cognitive and emotional mechanism factors of their knowledge. The important thing is the particularity of their achievements, this change them, in a model (in this case in the special training plan) of existence, in other words, is involved in the study group characteristics.

## 84.5 Conclusion

Through this model, the investigation and the analysis, we believe that if we establish and adapt to the teaching strategy (and cognitive goal of a new work plan), we will improve training quality and positive actions and spontaneous to trigger to sports and leisure activities. At the same time, positive suggestions experiment is completed by the cognitive and emotional, psychological means and moving targets and validation of the assumption, in other words, by implementing the expected results. But it will be necessary to adhere to certain conditions are met, in order to achieve the P.E. in cognitive goal that with the movement of the strategy, we will visit the students, in the realization of the target of the cognitive and emotional; their achievement motive level is clear, with the purpose of accurate, and only by increasing physical education activity, to make it a way of the process of training to identify the hypothesis.

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# Chapter 85

## Model Analysis of the Impact on Physical Fitness of Taichiquan

Yajing Li

**Abstract** This paper first described the existing several types of Taichiquan and then analyzed the health effects of Taichiquan on the cultivation of the human body. Finally, through the automatic identification system of the Qualisys infrared light point, the paper made a mechanical analysis of the human upper body movement, looking for changes in law, which will play a crucial role for the carry forward of Taichiquan.

**Keywords** Tai chi • Tai chi culture • Qualisys • Kinetic analysis

### 85.1 Introduction

Taichiquan is a traditional martial arts project and has a long history in China, now developed into a sport, a fitness program, and favorite sports for the public [1]. Tai chi chuan is called Tai chi, covering spread from the I Ching yin and yang, movement of the reason, empty or full growth and decline of the machine.

China's Tai chi chuan has Chen style, Yang style, Sun style, Wu style, Wu style and Wudang, Zhao Bao, and other variety of genres. Among them, Chen style, Yang style, Sun style, Wu style, Wu style are the five schools of Chinese Tai chi chuan.

Chen style Taichiquan is ever-changing and invincible, although the movement trend is multiterminal outside from the virtual with open style. To be full open, not only hands, hearts of ideas along with open; to closure, not only the hands to the foot together, hearts and the idea with both together. A move of a potential, where the self with the want to move charmed under who want to move on from the collar of God to go where up and down action in the central and God coordinate, where the desire to move up and down the auxiliary ancestral connected both inside and outside, before and after the phase required, the actual situation of the

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**Fig. 85.1** Chen style tai chi

opening and closing totally together, and the force will naturally rapid and clever. Chen Taichiquan standard movements are as follows: Fig. 85.1

Yang style tai chi is very beautiful; its frame stretches zhongzheng, action and simple and smooth, soft AIDS, in one take, like the lake on light spirit calm both. Its methods are concise, by the general public's favorite, and are also the most popular. Young's action requires the emerging of Taichiquan along Yangtze River with its words pouring out [2]. The action is complete, but the next action's beginning is sequential. The method also needs one take. The movements are as follows: Fig. 85.2.

Accord with tai chi theory of Yin and Yang, Wu style Taichiquan mainly includes the following aspects: GongJia compact, quiet nature, recruit potential



**Fig. 85.2** Yang style tai chi



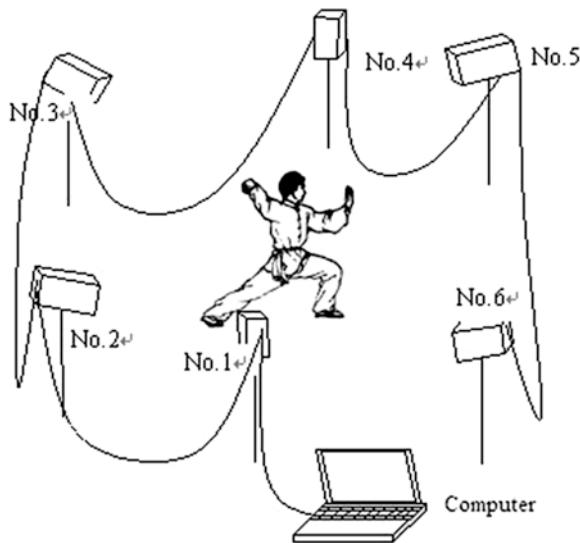
Fig. 85.3 Sun-style Taichiquan

strictly, exquisite soft continuous. Wu style Taichiquan, according to the comprehension and exercising, is in tight quan type small compact, set physical, self-defense, cultivate one's morality as a whole, and more suitable for uniting the literati of Tai chi chuan, and future generations called Wu style tai chi. Practice with the change of the requirement to control the movement of appearance emphasizes walk and not uncover strength inside the appearance, in order to reach the people and not hurt the magic of the state. Wu style Taichiquan melts with the Confucian culture, and Taoist traditional Chinese medicine health care, health care, martial arts physical at an organic whole have increased longevity, illnesses and health, beauty educational model body effect. Often, Wu style practice Taichiquan can effectively "ease the mental stress, remove physical disease," to treatment, and chronic fatigue syndrome has remarkable effect [3]. All Wu style tai chi in spirit, the solid frame and easy and comfortable, posture dignified, the momentum of the move STH, open, compact have exquisite. Sun-style Taichiquan characteristic is a go, stretch round live, action quick, a change of direction as close to connect with, so it is also called "live close step Taichiquan," is the three sent swords, creating Sun-style tai chi Fig. 85.3.

## 85.2 The Qualisys Infrared Light Automatic Identification System

This trial uses infrared light Qualisys automatic identification system collection of tai chi of athletes' action; its main use is the Qualisys—MCU 500 type of high-speed video image motion capture video camera. This set of equipment is composed by the Motion Capture Unit, target, and the camera has the computer and the corresponding software component. Specifically, see Fig. 85.1. The infrared high-speed camera work principle is: the goal of infrared radiation on environment, and the camera to the target of reflected light; at this time, the computer

**Fig. 85.4** Qualisys testing system test site schemes



system can detect the target corresponding numerical. Therefore, the equipment can obtain the accurate complex 3D-movement of sports information [1] and then select Taichiquan quan for dynamic analysis Fig. 85.4.

### 85.3 The Experiment Process

Step 1: put the camera as required below besides Tai chi chuan athletes [4]:

- (1) Camera distance: the distance between the high-speed cameras is 15 m, each camera from goal 10 m far.
- (2) Camera height: each camera body height is 1.5 m.
- (3) Camera angle between the adjacent: the camera angle between adjacent and 45°.

Step 2: athletes of Taichiquan movement test.

In the upper body, Taichiquan athletes can produce the reflection of the markers, and then in the test, to complete the qualified Taichiquan athletes each act, each test the movements to achieve the fundamental requirement just calculate, through, and the action taken by the camera Taichiquan completely recorded before [2].

Step 3: Data collection

The whole process of Taichiquan was recorded using cameras, and then signal conditioning was carried out followed by transmission of data to the data acquisition card, which in turn will signal the number (A/D) to the computer, and the computer program operation and treatment will eventually display the data on the screen.

Step 4: Qualisys index selection, as is shown in Table 85.1:

**Table 85.1** Qualisys index selection

Name	Description
Sacral vertical height	Sacral vertical ground levels
Sacral level speed	Sacral level speed
Torso angle	Angle of torso vertical and the ground
Thoracic curvature	Thoracic sagittal alignment projection curvature
Lumbar curvature	Lumbar sagittal alignment projection curvature

## 85.4 Taichiquan Movement Analysis

This paper chooses X-axis for the human body shoulder the positive direction left for the right shoulder to the left shoulder for, and the Y-axis for the vertical direction, then we can get the following formula [5]:

$$L_1 = (x_2 - x_1)i + (y_2 - y_1)j + (z_2 - z_1)k$$

$$L_1 = \begin{bmatrix} x_2 - x_1 \\ y_2 - y_1 \\ z_2 - z_1 \end{bmatrix} \quad (85.1)$$

$$L_3 = (x_4 - x_3)i + (y_4 - y_3)j + (z_4 - z_3)k$$

$$L_3 = \begin{bmatrix} x_4 - x_3 \\ y_4 - y_3 \\ z_4 - z_3 \end{bmatrix} \quad (85.2)$$

Shoulder midpoint, hip midpoint

(1) According to mechanical relationship, we can get the following formula: The human body is the human body sagittal of x-axis and human body vertical-Axis vector product after pointing,  $L_2 = L_1 \times L_3$ .

$$L_2 = L_1 L_3 = \begin{bmatrix} 0 & -z_3 & y_3 \\ z_3 & 0 & -x_3 \\ y_3 & x_3 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} = \begin{bmatrix} z_3 y_1 + y_3 z_1 \\ z_3 x_1 - x_3 z_1 \\ x_3 y_1 - y_3 x_1 \end{bmatrix} = \begin{bmatrix} x_2 \\ y_2 \\ z_2 \end{bmatrix} \quad (85.3)$$

(2) Based on the xyz-axes of the human upper body, we can determine the plane equation [6]:

X-axis is the normal vector of the plane equation:

$$X_3 + y_3 y + z_3 z + D = 0 \quad (85.4)$$

Y-axis of the plane equation:

$$x_1x + y_1y + z_1z + D = 0 \quad (85.5)$$

Z-axis vector of the plane equation:

$$x_2x + y_2y + z_2z + D = 0 \quad (85.6)$$

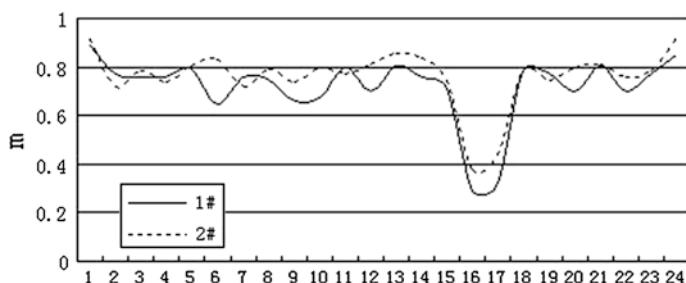
D contained in the above equation is used to determine the coefficient of the plane location, and generally is 0.5–1.

### (3) Analysis of test results

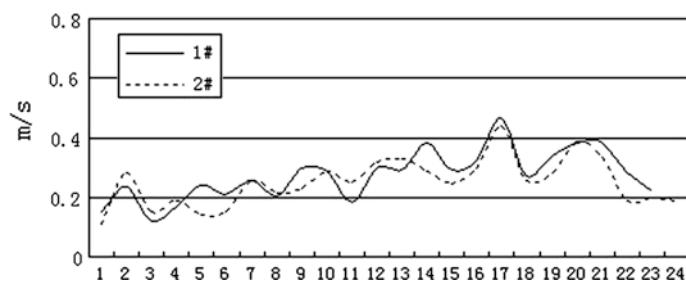
Athletes in the tai chi used to fill the gap of the word to describe again the state of the sacrum up and down, and the paper uses Qualisys test system to get test results as follows: Figs. 85.5, 85.6, 85.7, 85.8, 85.9.

Then for athletes in the tai chi on the degree of tilt of the upper extremity to make the data analysis:

Finally, we improve the performance of the athletes' lumbar and thoracic spine in the tai chi. And the curvature changes is shown as below:



**Fig. 85.5** Sacral ups and downs movements



**Fig. 85.6** Sacrum ups and downs with its movements

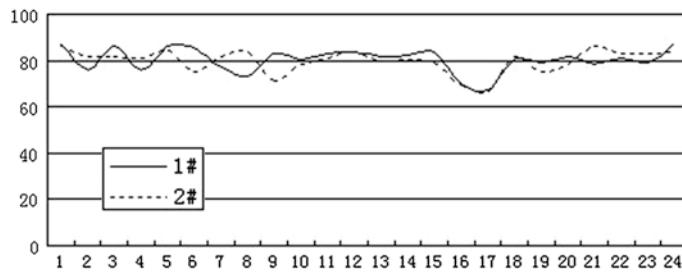


Fig. 85.7 Upper limb inclination changes

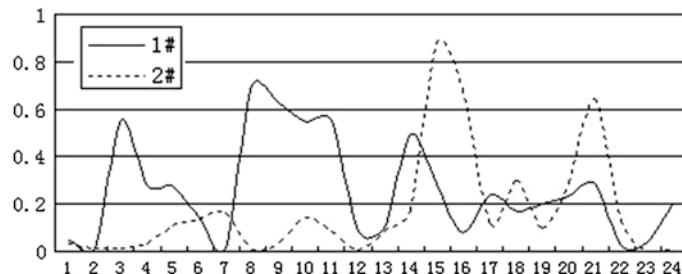


Fig. 85.8 Changes of the lumbar curvature

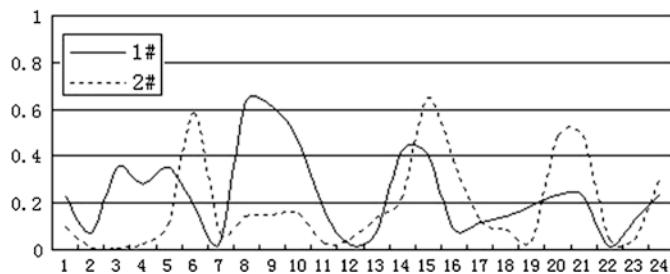


Fig. 85.9 Changes of the thoracic curvature

## 85.5 Conclusion

Through Qualisys test systems, this paper analyzes the sacrum of tai chi athletes, trunk, vertebral, thoracic, and lumbar spine related changes in the data. From the data, it is very obviously good for health care functions in human physical effect by exercise Taichi.

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# **Chapter 86**

## **Survey of the Job Market for College Students Majoring in Sports Performance**

**Yan Wang**

**Abstract** Sports performance belongs to the literary nature of art, including artistic gymnastics, aerobics, models, martial arts and other categories. At present, more and more colleges and universities are beginning to learn sports performance, which is training performing arts class social talents to serve the community. In order to adapt to the needs and development of the state and society, sports performance professional needs of the community and employment market, we did a lot of research on marketing and marketing management mode for some provinces. Through the use of computer technology survey data, statistical processing and analysis, we get to know the professional job market of sports performance and prospects, and the development of professional and social needs of the countermeasures for sports performance.

**Keywords** Sports performances • Job market • Investigation reports • Countermeasures

### **86.1 Introduction**

At present, sports performance belongs to a new development in recent years and is highly advocated setting up by the state education department [1, 2]. Physical education, art education, dance education, performing arts, performance and fitness, dance are their main professional directions. The creation of sports performance professional schools of our country at this stage have reached 23, the Sports School and with some of the normal school and comprehensive school [3]. The professional curriculum of the college sports events is shown in Table 86.1.

Currently, the number of schools offering sports performance is continuously increasing, and the annual intake of students, graduate students each year have exceeded several hundred people. But sports performance in the field of

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**Table 86.1** College sports performance courses

	Comprehensive school	Normal school	Sports school
Main courses	Introduction to art, literary accomplishment, sports, dance, art, performing basic theory, physical education, practical education, social investigation, basic music theory.	Exercise physiology, performance (aerobics, dance sports) basic theory and literary training, introduction to art, sports aesthetics, sports psychology, sports management, group calisthenics director and public art gymnastics.	Basic music theory, introduction to art, ballet basic training, day and presentation of dance drama, special theory and art practice, exercise physiology, sports anatomy and sports psychology.

professional talent is still extremely scarce, such as performing design, layout and organization. At the beginning of this paper, the premise is assumed that through the explicit introduction of the cognitive objectives, students of physical education courses will join the movement and emotional goals, and then the efficiency of the student training process increases [4].

In modern sports, in addition to power and speed of the competition, there is also the comparison with the endurance, and athletes' anaerobic ability is one of the key elements to win the competition. Currently, many sports scientists and coaches widely believe that the adaptability of the athletes and performance testing are very important factors in athletes' designed training plan in the project of the athlete's progress analysis. Anaerobic ability is considered as athletes' working ability when the muscles do not provide enough oxygen for the body. Generally speaking, in an anaerobic state and a short time period, athletes have shown the explosive force, which is the maximum speed and power meaning the speed of finishing the work. In basketball games, a successful performance is mainly dependent on several fitness adaptability parts (e.g., speed, agility and vertical leap). In essence, the movement is an anaerobic property, and these components must be repeated, with the lowest reduced competition for the performance. Currently, there is no particular test that can be used as a measure of anaerobic power acceptance standards for basketball player. To this end, the sports performance professional job market and a clear understanding of sports performance professional direction of employment and demand market contribute to the education department or college in a timely manner to adjust the specialty structure, which conforms to the needs of the times and development [5].

## 86.2 Research Methods

The composition of the study design is for the students' sports activities in the cognitive, emotional, psychological and movement mode of operation [3]. The effect of the implementation of the project and the training methods was assessed.

We focus on the knowledge the students have obtained in the training of secondary questionnaire. Assessment of study cognition includes the level of the experimental and control groups, in particular knowledge, and the number of questionnaires answered in the evaluation design. Table, processing and statistics are used to explain the recorded data. We make the graphical presentation of the key indicators of the research phenomenon [6].

First, the literature data collection, and marketing and other theoretical approaches, was done using monographs, related magazines and university employment site information to gather information.

Second, the data were collected through the questionnaire survey. In view of part of the creation of sports performance professional learning as well as the cities of entertainment, clubs engage in relevant professional teachers, students, experts and managers to conduct an investigation.

Third, sports performance professional experts or senior managers were contacted one-on-one interviews by telephone and online form.

In the second approach, we distributed 500 questionnaires and there were 469 copies to recover, with the recovery rate of 93.8 %. Third interviews with 20 senior experts on sports performance professional and the job market are very understanding.

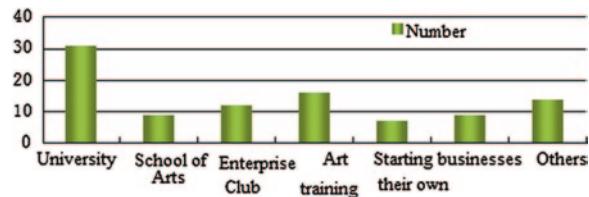
The questionnaire includes professional name, professional direction, the whereabouts of graduates, the school professional development-targeted programs, sports performance training objectives, professional evaluation of sports performance, professional specializing in practice the course content, province sports performance professionals demand and the training recommendations. Expert interviews include reasonable professional courses offered on college sports events, professional personnel training objectives and market-oriented, personnel training, sports performance graduates with quality and analysis of the status of the professional job market.

### **86.3 Analysis of the Job Market Demands of Sports Performance**

With the rapid development of material civilization, people gradually turn to the pursuit of spiritual civilization and the constant pursuit of the health and survival of harmony. Sports performance professional trained personnel should meet the current needs of social development [7]. Sports performance professional job market is also continuously improving the development of the times, mature, and the creation of professional schools and enrollment numbers are growing, for example professional employment in a college sports events.

Table 86.1 and Fig. 86.1 show the highest proportion of sports performance professional graduates entering the school, followed by the health club. In the field of enterprise, the art of dance training is also a sports performance professional employment direction [8]. Therefore, sports performance majors on diverse

**Fig. 86.1** Comparison of the sports performance employment of a college



selection of employment. According to the 2008 Social Blue Book in professional sports performance analysis, in terms of quality or quantity, we need a lot of sports performance in the field of professional talent. And the demand of the club is the largest. The survey results are shown in Table 86.2.

Through the investigation and analysis, each club at least demands an average of six fitness instructor, the country's existing health club for more than 600 million, and then the nation's sports performance professionals required more than 360,000. Efficient training of the professional students is not enough only club in this industry needs, Fig. 86.2.

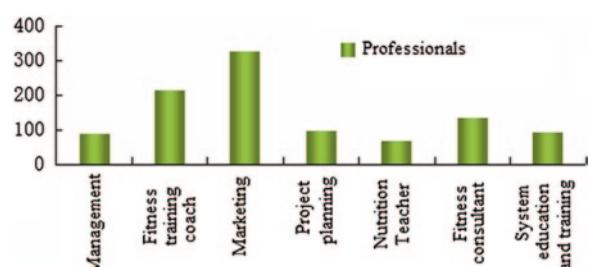
Then, we made the investigation and analysis of entertainment sites in some major cities. The survey results are shown in Table 86.3, Fig. 86.3.

From Table 86.3, we know that dance performances, art scheduled for the higher proportion of entertainment establishments needs. But this industry talent flows; in particular, there is a difference between the outstanding problems of the qualifications and performance capabilities. This also shows that China's education is not in accordance with the practical training mode, the education of students, the theory and practice [9, 10]. The survey found that performing casino and sports performance professional talent is still a serious shortage of both parties, which also limits the part of the student's field of employment, Table 86.4.

**Table 86.2** Sports performance employment of a college

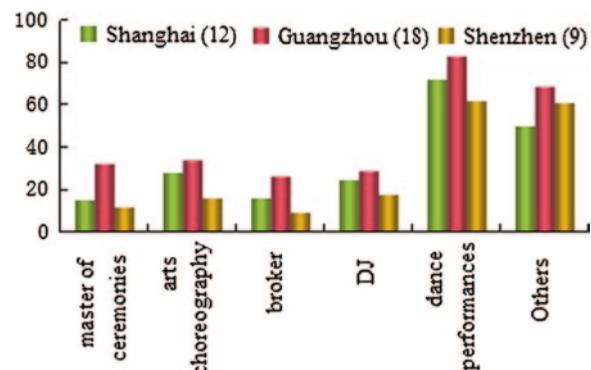
	University	School of arts	Enterprise Club	Art training	Starting their own businesses	Others
Number	31	9	12	16	7	14
Percentage	31.6	9.18	12.24	16.32	7.14	14.28

**Fig. 86.2** Some clubs' demand for sports performance professionals



**Table 86.3** Some clubs' demand for sports performance professionals

Range	Management	Fitness training coach	Marketing	Project planning
Professionals	88	214	325	98
Range	Nutrition teacher	Fitness consultant	System education and training	Total needs
Professionals	69	136	92	1,022

**Fig. 86.3** Entertainments' demand for sports performance professionals**Table 86.4** Entertainments' demand for sports performance professionals

	Master of ceremonies	Arts choreography	Broker	DJ	Dance performances	Others	Total demand
Shanghai (12)	15	28	16	24	72	50	205
Guangzhou (18)	32	34	26	29	83	68	272
Shenzhen (9)	12	16	9	18	62	61	178

## 86.4 The Development and Analysis Countermeasures of Sports Performance Employment

First, sports performance professionals should meet the needs of the community development orientation. They should be market-oriented and professional restructuring, personnel training, specialization and diversification of development.

### 86.4.1 Cultured in Targeting Analysis

Colleges and universities should determine the training objectives, namely the culture of professional sports performance characteristics of talent. Combination

of school status, resources and advantages, market research analysis and forecasting development trends can determine professional orientation and training goals.

#### ***86.4.2 Positioning Analysis of Social Needs***

According to market trends, we can determine the employment market demand, the mode of education improvement and curriculum. We should increase sports performance majors in social practice in order to adapt to the needs of the community. Meanwhile, we must continue to improve the performance of university sports professionals training strategy. Society, the market needs in a professional fill in the blank filled, tit for tat, look for other ways such as training strategy adjustment, and increase competitiveness. At the same time, we need talents of all skill application, and students' practical ability to target the training strategy [11].

- (1) Establish the students' training base and social practice. This can enhance the students' ability through training, increasing employment chips.
- (2) Establish a self-assessment system to enhance students' comprehensive quality. Evaluation system includes personal characteristics, learning ability, work ability and teamwork ability.

Finally, we recommend starting job counseling and training. Selective guidance based on sports performance professional students' personal characteristics, combined with its own characteristics and needs of the community-targeted career plans, also improves their understanding of themselves and society to improve their own abilities and qualities.

### **86.5 Conclusion**

Currently, sports performance is in the stage of slow development, and the demand for talents of the society in this respect is very huge. But the college personnel training goals and practical needs of the community are out of line with the phenomenon. To this end, universities should intensify the investigation and analysis of sports performance professional job market, to establish the diversity of professional training direction, social needs, market segmentation, targeted improvement of training objectives and curriculum. To meet the needs of society, combination of professional skills and knowledge enhances professional practice culture and students' skills ability. At the same time, optimizing the outstanding courses focuses on training its own characteristics of education to enhance professional knowledge and general education; sports performance students' knowledge and skills of structural adjustment should be in accordance with enterprise units. The students should be cultured to have a positive mental attitude to realize professional values and their value of life.

**Acknowledgments** This research was supported by the Twelve-Five-Year Educational Planning Fund Program of Hunan Province, with the number XJK011BTM011 and the name Research on the Construction of training system on the employment force of Performance (sports) Professional students.

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# **Chapter 87**

## **Formation Mechanism of Taichiquan Culture Based on Space Panel Measurement Analysis**

**Dongsheng Lv**

**Abstract** This paper describes Taichiquan culture to form a panel econometric model of the mechanism space on the basis of space effect. This paper selected China Taichiquan popular cities for data sampling, measured by the panel analysis, suggesting that Taichiquan culture during the formation had a strong continuity, and showed a significant effect on the time dimension and space dimension. We analyzed the results from different dimensions to understand the formation mechanism of Taichiquan.

**Keywords** Taichiquan culture • Formation mechanism • Space panel measurement

### **87.1 Introduction**

In our daily life, we are inseparable from culture everywhere, the concept of culture, due to the broadness, resulting in the word that we can not accurately define the culture, but we are pressing ahead with efforts, we can go from many angles analysis [1]. Taichiquan culture with other cultures in China are the same, they all belong to the community some kind of phenomenon is the culture created by the Chinese people in the long-term social experience.

Taichiquan is a traditional martial arts project, has a long history in China, has now developed into a sport, a fitness program and become a crowd favourite [2, 3]. Taichiquan Chuan is called Taichiquan, covers the yin and yang in Yi Jing and is movement of the reason, empty or full, growth and decline of the machine [4]. As sport, letting nature take round live sports such as the ring of gratuitous, ad infinitum, endless, spectacular and unpredictable, so people call it Taichiquan [5].

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China's Taichiquan mainly has Chen, Yang, Sun, and Wu style, and Wu Dang, Zhao Bao and other variety of genres. Among them, Chen style, Yang style, Sun style, Wu style of the five schools of Chinese Taichiquan Chuan [6].

Taichiquan culture is by no means the shelves of the dry practice a set of boxing. Taichiquan has its rich cultural connotations. Connotation of cultural Taichiquan changes such as yin and yang, light and agile moves, up and down and walk away, internal and external consistency, the actual situation transformation is not our intention force, and has no power at all and so on. Taichiquan culture connotation relies on the awareness and understanding of science to practice Taichiquan to enlightenment, realized the effort. From “proficiency” and “gradual enlightenment to understand the powerful” by “understand the strength and the terraces and the gods”, practitioners of the “proficiency” are very important.

## 87.2 The Taichiquan Culture Formation Process

Taichiquan formation culture process includes the following aspects [7]: (1) Taichiquan intangible cultural development; (2) The shaping of the cultural development; (3) Taichiquan cultural development maturity; (4) Taichiquan development and prosperity; (5) the period of diversification of the Taichiquan cultural development.

Developed for thousands of years, Taichiquan now is throughout the five continents of the world. Taichiquan Chuan from the Qing Dynasty popular in the capital of the Imperial Palace is the most aristocratic origins of the martial arts. Taichiquan really began to compose from the 1963 National Sports Bureau to simplify the 24-style Taichiquan and popularizing the beginning. Taichiquan is ever-changing and invincible, although the action trend is many-fold, outside the virtual, not real, open, or four words. Drill from head to toe, internal organs, meridians muscles, the outer skin, flesh, hair, and limbs; everywhere is connected as one, broken but not open, hit the ghost while playing the instead of chaos to gas urge the deformation. To pull full open, not only hands, hearts of ideas along with open; to closure, not only the hands to the foot together, hearts and the idea with both together. A move of a potential, where the self with the want to move charmed under who want to move on from the collar of God to go where up and down action in the central and God coordinate, where the desire to move up and down the auxiliary ancestral connected both inside and outside, before and after the phase required, the actual situation of the opening and closing totally stretch. Taichiquan is very rich in culture.

We analyze the formation process of Taichiquan from the following geographical areas in China; the main object of study of this article is Zhejiang Taichiquan enthusiasts or athletes. We make the analysis of the whole Taichiquan culture propagation [8] (Figs. 87.1, 87.2, 87.3 and 87.4).

From the end of the twentieth century to the beginning of twenty-first century, Zhejiang province of Taichiquan chuan culture through the great change,

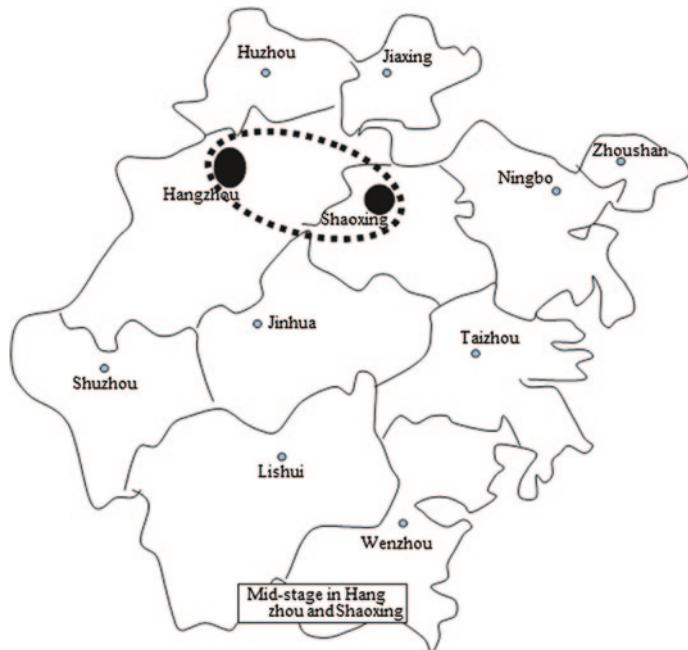


Fig. 87.1 Location of Taichiquan culture establishment

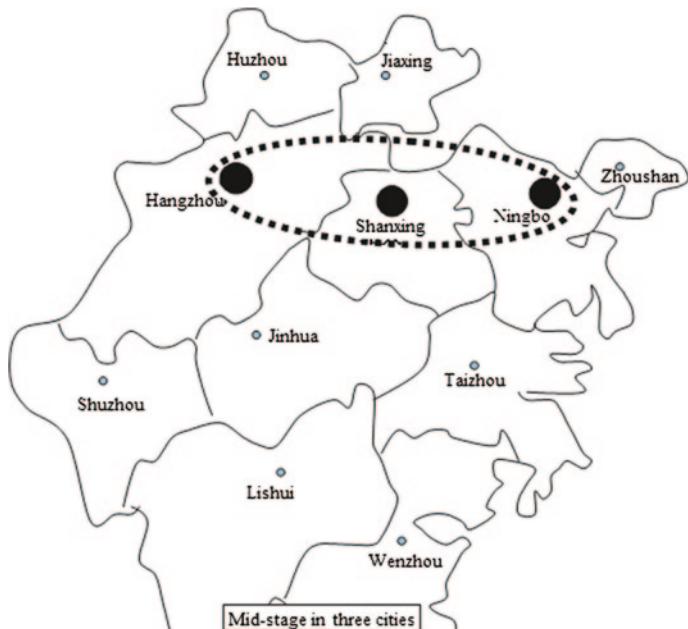


Fig. 87.2 Location of Taichiquan maturity periods

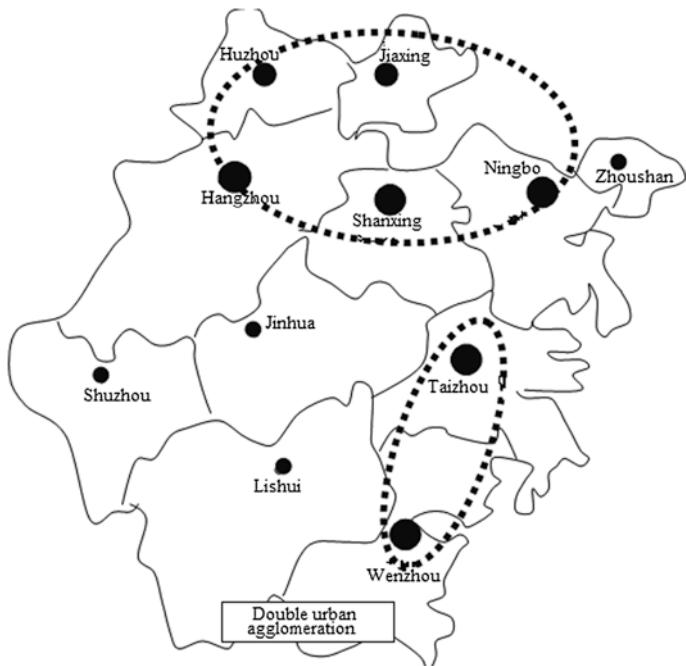


Fig. 87.3 Locations of Taichiquan culture prosperity period

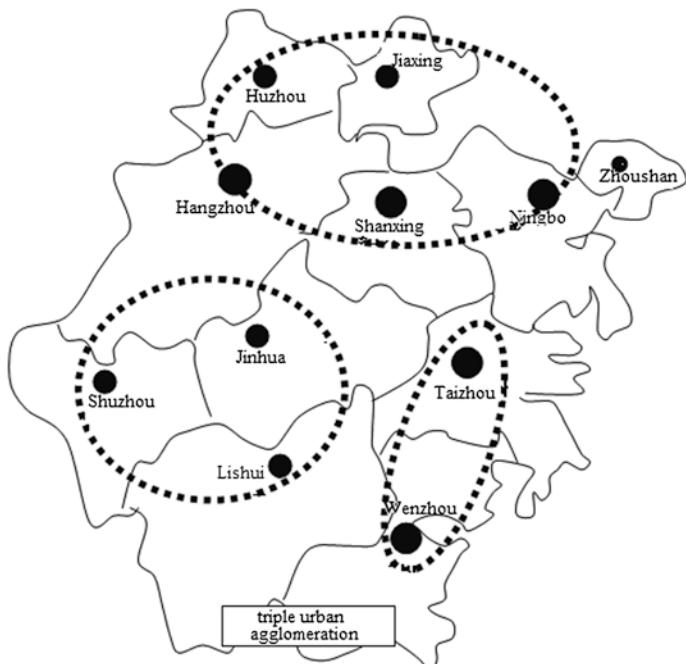


Fig. 87.4 Locations of Taichiquan culture diversification

according to not complete count, Zhejiang province of Taichiquan chuan activists, including enthusiasts and athletes, a total of 62,000 people, 9.35 % of the population, among them, Hangzhou's most Taichiquan fans, followed by Ningbo [9]. Gradually, the state, and the Shaoxing, Jiaxing, Taizhou this three also have become have Taichiquan fans of big cities.

The author in Zhejiang province from the formation of the culture of the Taichiquan as an example, through the analysis and research, summed up the formation mechanism of the Taichiquan culture, as is shown in the figure below (Fig. 87.5).

From the graph, we can find that the formation of the culture of Taichiquan not only with personal factors and social factors. And the same situation factors can also restrict the development of the Taichiquan culture.

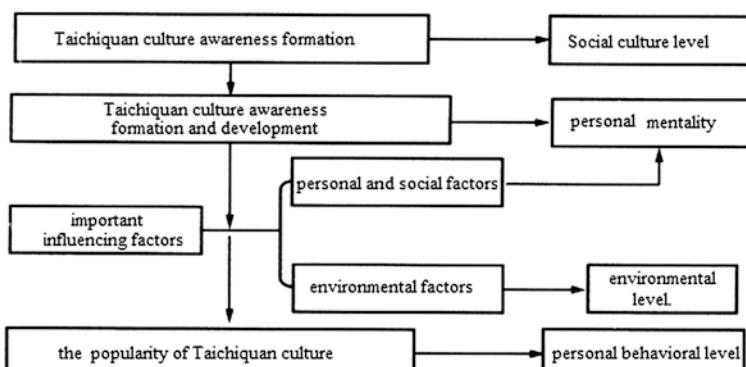
### 87.3 Taichiquan Culture Formation Mechanism Space Panel Measurement Analysis

First is the choice of variables. This article uses Taichiquan culture entropy coefficient LQ judge the sport gathered Taichiquan degree (SERV). We use the formula  $LQ = (E_{ij}/E_i)/(E_{kj}/E_k)$  and then work out Taichiquan culture entropy coefficient, the higher the value, the sport of Taichiquan gathered the higher level; conversely, the value of the smaller, Taichiquan chuan the sport gathered the less degree.

Next is the Taichiquan culture space panel measurement analysis [10]:

Individual  $I = 1, 2, \dots, N$ ,  $N = 15$ ; Time  $t = 1, 2, \dots, T$ ,  $T = 5$ ; And then the space weight matrix  $Y = \{y_1, y_2, y_3, \dots, y_m\}$  resolve for diagonal matrix, next is the measuring model [11]:

$$y = p(I_T * W_N)y + X\beta + \varepsilon \quad (87.1)$$



**Fig. 87.5** Taichiquan culture formation mechanism

$$y' = X\beta + \varepsilon \quad (87.2)$$

$$\varepsilon = \lambda(I_T * W_N)\alpha + \mu \quad (87.3)$$

$$y'' = p(I_T * W_N)y + X\beta + \varepsilon + \delta + \nu \quad (87.4)$$

This paper uses samples of the 15 cities of Zhejiang province, with the time from 2007 to 2011, a total of five years. By using the above formula, we put each parameter into formula, and the data statistics are as follows: (Tables 87.1, 87.2, 87.3).

From the above chart of the results, we can see that our country of Taichiquan culture development has obvious space correlation, and displays a strong continuity and performance to the time dimension and the spatial dimension significantly.

**Table 87.1** Moran I exponent value of the Taichiquan culture of 15 cities in Zhejiang

Years	Moran I	Moran I expectations	Standard deviation	Normal statistics	Probability p value
2007	0.256	-0.035	0.108	2.703	0.005
2008	0.249	-0.028	0.112	2.629	0.015
2009	0.231	-0.030	0.114	2.405	0.025
2010	0.215	-0.024	0.107	2.576	0.015
2011	0.210	-0.029	0.116	2.129	0.020

**Table 87.2** Correlation inspection

Method of inspection	Sample	Check value	Critical value	Probability value
LMerror	308	21.75	17.547	0
LMsar	308	24.35	7.548	0
Lratios	308	54.68	6.635	0
Moran	308	5.79	1.967	0
Walds	308	1047.95	6.635	0

**Table 87.3** Taichiquan culture weight matrix data table

Model	Variable	Non-fixed effect	Fixed effect	Time effect	Space effect
Space panel data model	Constant	4.292	0	0	0
	LnTFP	0.441	-0.347	0.441	-0.135
	LnCOST	1.032	0.124	0.878	-0.366
	LnSCALE	-0.552	0.152	0.487	0.060
	LnKNO	0.165	0.242	0.157	0.054
	LnGOV	0.575	0.922	0.175	0.213
	Rbar	0.514	0.912	0.546	0.278
	Sigma^2	0.102	0.019	0.111	0.882
	Log	-85.54	173.67	102.52	100.94

## 87.4 Conclusion

Taichiquan is a sport that has obvious quality effect on the human body. It has the function of health care. This paper made an analysis of the measurement again, from which we can draw at present the Taichiquan culture development speed. Therefore, our country's Taichiquan culture forming process is reasonable and healthy, and we want to make persistent efforts, continue to spread Taichiquan culture to make the world feel Taichiquan is a sport that can bring people happiness.

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# Chapter 88

## Physiological Responses of College Male Basketball Athletes' Sport-Specific Aerobic Interval Training

Jialing Liu

**Abstract** At present, basketball in the community has been getting more and more attention, and there are more and more college basketball games. Therefore, how to enhance the physical fitness of basketball players and basketball skills has gained the widespread concern of the community. This paper made a comparison test on the university's male basketball athletes in this article from a specific sport aerobic gap training starting from the maximum running speed, vertical jump height, agility and repeated sprint ability of several projects to test the physiological responses of male basketball players, which will lay a good foundation to strengthen training, learn from each other, and to avoid issues such as errors in the game of basketball, basketball player to be sport-specific training to strengthen the physical endurance of its special qualities, so that they can fight fatigue, maintain a long focus, and play to their competitive level in basketball races.

**Keywords** Aerobic • Interval training • Comparative analysis • Repeated sprint ability

### 88.1 Introduction

Basketball is a high intensity, lasted longer and more intermittent sport [1]. In the daily lives of people in society now, basketball is also the same as a mass movement carried out, especially as one of the events of the international society has been of particular concern, basketball requires not only technique needs of athletes to rapid, repeated movement, this is necessary a special skill for basketball players [2]. Aerobic exercise can greatly improve the body's functional

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status, enhance the ability of the body resistance, had been in academia get consensus, at present the aerobic exercise is became popular in the world because it has high value of exercise itself, aerobic setting-up exercise as one of the kind of exercise form, because have the rich content and a variety of forms and favoured by the majority of teenagers love. In order to research the aerobic exercise (based on the aerobic setting-up exercise, for example) to the youth and the influence of the physical body, the author of instruction took aerobic setting-up exercise of the students of a half a teaching experiment, combined with the aerobic exercise in the test by classmates setting-up exercise has effect, and through the determination of test students body shape and physical composition, physical function and the sports quality etc., many index changes to explore aerobic exercise is aerobic exercise to the health of the teenagers setting-up exercise and physical beauty of the coupling effect, the purpose is to understand how aerobic exercise the influence of the constitution of teenagers and the teaching of college sports work and extracurricular sports guidance for the corresponding instruction, at the same time also can be formulated to provide young sports prescription related basis. In the face of such high-tech, with strong antagonistic events, how to make a basketball player to maintain a high state, give full play to our strengths, which need to test the physiological situation of basketball players, so this article from the aerobic intermittent training perspective of university male basketball player to test research, comparative analysis of test data in order to study the physiological responses of university male basketball athletes sport-specific aerobic interval training, in order to effectively grasp the athlete's physical condition, which in the game weaknesses, advantages, strengthen training in peacetime [3, 4], to overcome its weaknesses and enhance basketball skills, enhance their physical play to their competitive level in the game of basketball [5, 6].

## 88.2 Research Methods

This paper made experimental tests, quantitative and qualitative analysis [7]. We select male basketball player in college to take these tests, the average age is  $16.5 \pm 2.5$  years old; average height is  $1.78 \pm 0.2$  m; the average weight of  $62.5 \pm 14.3$  kg. And we selected basketball player and has a basketball game one to two years experience and regularly participate in a basketball game between the two schools.

This test study took six weeks, and was held during the college basketball season, two physical benchmark tests (laboratory and field) during the six weeks before the training intervention, physiological test period followed after the intervention. The two previous interventions during the test are used to detect the reliability of the testing methods. Physiological testing before and after the intervention around the occurrence of seven days, and would involve three different physiological test section, each test will need 24–48 h of recovery time.

In this paper, we mainly focus on male basketball players, some of the projects test. We start the test part and will involve carrying out a number of physiological tasks to assess the maximum running speed, the maximum vertical jump height, agility and repeated sprint ability.

The maximum running speed formula is as follows [8]:

$$V_{\max}(\text{km.h}^{-1}) = V + V_{\text{step}} \times (R_{\text{com}} - R_{\text{total}/2})/R_{\text{total}} \quad (88.1)$$

The vertical jump height formula is as follows [9]:

$$H_{\text{jumpheight}} = 0.5 * g(t/2)^2 \quad (88.2)$$

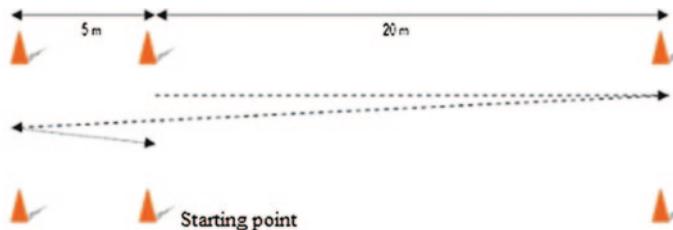
During the testing and evaluation standards for each task before 10 min special basketball warm-up exercises, which include jogging, distance running, sprinting and high jump and other projects. There will be five minutes of dynamic warm-up exercises and static stretching. Interspersed with a series of special energy recovery system in the process of conducting physiological tests, in order to avoid the boring and fatigue energy system to the performance of athletes in the next test. The fatigue is calculated as follows [10]:

$$F\% = (T_{\max} - T_{\min})/T_{\min} \times 100 \% \quad (88.3)$$

The test sequences are [11]: The maximum running speed; the maximum vertical jump; agility; repeated sprint ability. In addition to the repeated sprint ability, the three tests for each assessment should be implemented, and the average of two tests will be tested, and used in data analysis. In order to ensure the reliability of data, a practice trials before each test is permitted.

### 88.3 Test Experiment

Aerobic interval training for specific sports for athletes is a circular path in accordance with Fig. 88.1, testing, athletes are often in a basketball game, back and forth on the court is about 190 times, is about 5500 m. Basketball is not only a



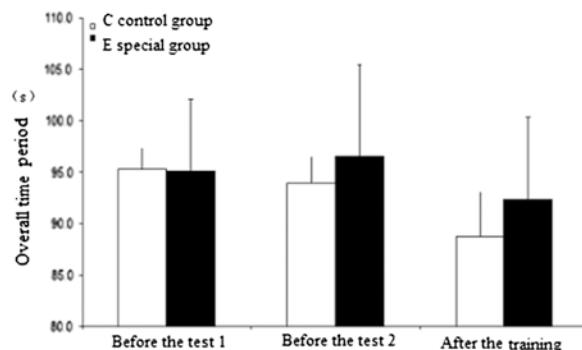
**Fig. 88.1** Circular test path dotted line

high strength, high compressive strength, high confrontation lasted longer a sport. Aerobic interval training basketball players to endurance exercise, which not only allows endurance athletes to reach peak value, and enhance its confrontational, a longer period of time the insistence of the game. Range of duration of aerobic interval training is usually more than 3–5 min, you can make the combination can be used intermittently to run and transform both ways, and enhance athletic fun at the same time, also makes the game to adapt to the fluctuations of the intensity of exercise.

Figure 88.2 shows that in the previous Test 1, C control group sprint time is longer than the E special group, but in the first Test 2 as well as aerobic interval training athletes sprint time of C control group is obviously less than E special group, indicating that aerobic interval training in specific sports of basketball players is effective for improving the speed. But to basic training on the basis of training for basketball players to strengthen the specific special sports training can enhance the speed and patience, but also to achieve the organic integration of the capacity advantages [12].

According to Table 88.1 and Fig. 88.3, it is very intuitive that the average of E special group's vertical jump height and agility is greater than all participants, while the C-control group is less than the mean of all participants. As for the 5, 10, and 20 m running speed, E special group is less than the mean of all participants, and C control group is greater than the mean of all participants. It also reflects

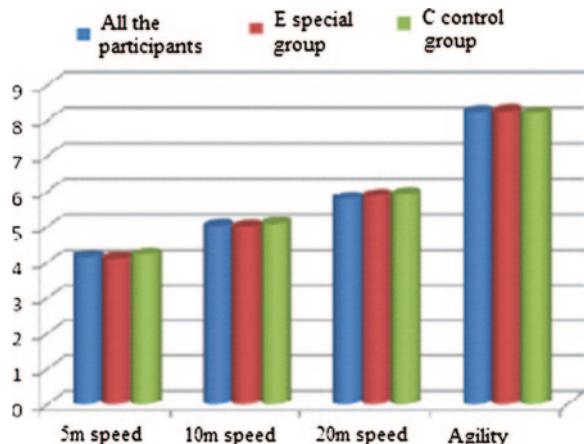
**Fig. 88.2** The overall time period of sprint of the two groups before and after the test



**Table 88.1** Baseline test data of athletes completing the test

Tests	All the participants (N = 20)	E special group (N = 12)	C control group (N = 8)
5 m speed	$4.16 \pm 0.25$	$4.11 \pm 0.26$	$4.23 \pm 0.24$
10 m speed	$5.02 \pm 0.26$	$5.00 \pm 0.27$	$5.08 \pm 0.27$
20 m speed	$5.89 \pm 0.27$	$5.87 \pm 0.30$	$5.92 \pm 0.28$
Vertical jump	$42.3 \pm 7.5$	$42.7 \pm 9.3$	$41.6 \pm 4.3$
Agility	$8.23 \pm 0.47$	$8.26 \pm 0.57$	$8.19 \pm 0.34$
Overall time	$95.49 \pm 6.87$	$96.52 \pm 8.84$	$93.94 \pm 2.52$

**Fig. 88.3** Comparative analysis of project data of each tester group



the aerobic interval training basketball players to strengthen specific movement can enhance the speed and strength of athletes hanging jump and agility is usually a basic skills training, to maintain the agility and vertical jump advantage of the premise, enhance the speed and strength training in basketball players.

#### 88.4 Result Analysis

This paper's testing and analysis data show that the basketball athletes' sport-specific aerobic interval training reflected the physiological characteristics such as special endurance from the circular test path and test data analysis. In fact, the basketball player's special patience ring compared to the typical basketball training in the high jump and sprint, it can be reduced related to the performance of power [13]. With the prevalence of basketball as well as the intensity of the basketball game and gradually intensified, basketball players to continue to strengthen their own aerobic interval training, in order to grasp the basketball skills at the same time to enhance their speed and endurance, continue to carry out anti-pressure training, so that you can continue to enhance the body's physical basketball player, and fully in the game to play to their tolerance and stress resistance, increase speed and will occupy the dominant position in the game.

Through the above data show that, through the aerobic setting-up exercise of the weight and exercise students than the bust reference group can significantly change, with significant difference, that is human bone and muscle of the growing degree of the aerobic exercise can get through increased. And through the many scholars' research we can find a variety of diseases and the formation of the development and abdominal fat have close ties, And the test data from the show, undertake oxygen moves having the students after waist-hip ratio has decreased

significantly compared before exercise of the trend, and with exceptional significant difference. Through the half a year of aerobic setting-up exercise of exercise, the exercise of the waist circumference, and students after hip changes obviously, at present the most can better reflect the abdominal fat accumulation degree of a practical index namely waist-hip ratio (WHR), thus aerobic exercise can significantly change the student body.

Through the aerobic exercise can effectively consumption of excess body fat, the human body fat content can significantly reduce, muscle strength obviously increase, fat content decrease apparently, lean body mass was significantly increase, so the human body density improve obviously effect, test subject classmates body also is extremely strong and handsome, through the observation of the change in the composition of the classmates body we can obviously feel aerobic exercise brings change. The data from the test that through aerobic setting-up exercise after exercising students various parts of the body of the sebum degrees thickness can be observed reference group compared to have decreased significantly trend, waist abdomen is adipose content for outstanding students consumption function, particularly evident. Body fat in through the aerobic aerobics training effectively after decomposition, to increase fat as a way of energy to the purpose of reducing fat, and through the aerobic exercise the setting-up exercise course of teenagers of the body form students gradually to the strong and handsome figure direction.

Through the above data shows, six months after aerobic setting-up exercise course students after exercise, its vital capacity are improved to varying degrees (), the largest students ability to increase oxygen therapy efficacy. In the movement under the condition of the little strength, 1–2 h of aerobic setting-up exercise of exercise, the students ability to increase lung ventilation effect significantly, obviously increase the vital capacity, breathing the function of the system is also significantly improve abnormal. Respiratory function can also through the long time aerobic exercise to exercise the effect, to exercise the purpose of lung function [14].

Athletes admitted to the university should implement a comprehensive management, research and training athletes to develop the particularity of an effective management system, according to the special nature of the result of years of training, may be appropriately extended to learn a fixed number of year, you can take a more flexible teaching and assessment methods to relax the range of elective courses. In the use of the coach, the school should create a comfortable environment for coaches and provide the necessary conditions. Schools should pay attention to the characteristics of competitive sports, follow the laws of competitive sports, taking fully into account the particularity of exercise training, a special management training instructor and coach in school leadership, the division of labor system; not the coach's training methods, training methods and training process be too much intervention. Athletes should be chosen from multi-channel and multi-faceted. From the high technical level of the professional league selection of athletes, from high school selection, and select potential athletes from the testing of athletes younger.

## 88.5 Conclusion

Through specific sports training for basketball athletes, their speed, endurance or strength compressive strength and agility will be fully strengthened. Training for basketball athletes can strength training on the premise of speed, endurance and agility. And strengthening cardio interval training of the basketball players can strengthen the athletes' self-recovery features and advantages, thus they can achieve outstanding results in basketball competitions.

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# **Chapter 89**

## **Coupling Model Analysis of the Psychological Dynamic in Sport**

**Qing Wang and Niankun Zhang**

**Abstract** In this modern society, competition is very fierce, and there will inevitably be subject to pressure from all sides. The increased psychological pressure is gradually becoming a serious social problem. The current sports' cutting into perspective also lack of relevant research results of the psychological dynamic. This paper is mainly combined with sports characteristics and those influencing factors of the psychological dynamic to apply the coupling concept, establishing the sport psychological dynamic coupling models. It also research on sports mechanics, psychology and other knowledge for the psychological dynamic changes and impacts, mitigation of pressure to study the coupling model based on the unique perspective of innovation, giving people some guidance on their psychological dynamics.

**Keywords** Sports • Psychological dynamics • Psychological pressure • Coupling model

### **89.1 Introduction**

Psychological pressure has become a topic of concern to the community in the period of rapid development and rapid social transformation of modern society, and the psychological problems are faced by the public have evolved a very real problem of the social, but rarely to combine sports to analyze the psychological dynamic of change. The sports team is a special social group. It is the combination of certain social relations collective joint activities is the basic unit of social competitive sports organizations. To complete the training and competition task entrusted by the sports

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organizations, to meet the members of a variety of social needs, such as security, ownership, communication, self-esteem and achievement needs [1]. In addition, sports team also has a social function cannot be ignored. Sports team members are young children, they are at learning, interaction and personality the best period of their long-term living, learning, training in teams, in addition to master specific sport, their world view, outlook on life the formation of value sand aesthetics, ideals, ethics, basic life skills and social norms of behavior, learning, etc., are closely linked within the team environment by the coaches, team culture, the psychological atmosphere of group pension and other aspects of impact. With the acceleration of social integration and economic globalization, what kind of coupling is in the psychological dynamic of the sport? From the unique and innovative perspective, we make cross-integration and comparison tests on coupling the concept of multi-disciplinary sports and psychology, and build a psychological dynamic coupling model to carry out effectively guide people in sport, health, psychological changes, and actively release negative emotions and psychological dynamics, and ease the psychological pressure [2].

## 89.2 The Conceptual Model

In sports, the body's heart beat and blood flow is cyclical and between the existence of the gap. When the body is in motion, the person's blood goes through external resistance vessels to provide energy to the body peripheral tissue activities. When the normal state, blood flow in the psychological dynamics, human movement and heart beat have the coupling relationship.

Sports science and psychology, sports psychology is the system of interaction and impact of research on people's movement in the psychological dynamic coupling phenomenon has very important practical significance. The physiological mechanism of sports psychology use sport and the psychological dynamic simulation, clear mutual coupling between the standard and criteria, to predict the dynamics and volatility of the psychological pressure. We built this through psychological factors through the heart and blood vessels of the sports related data analysis, and the establishment of the coupling model [3]:

$$q_{in}(t) = a(1 + m\tau)e^{mt} + b(1 - m\tau)e^{-mt} - \frac{\lambda}{R + Z_c} \quad (89.1)$$

Factors affect the athletes' psychological dynamic, athletic ability in sport conceptual model of the following aspects: First is the psychological momentum model. From changes in the cause and effect analysis of motivation, control, optimism, energy and synchronized view of the power of cognitive psychology toward a moving target [4]. Cause or effect of the difference between these models, the psychological momentum to admit defeats, the performance changes. The nature of the task is also an important consideration. Namely the psychological dynamic is likely to lead to a high level of awakening, which may contribute to the awakening of performance at a high level task [5].

The model of an incident or series of events, leading to the performance of athletes are different, subjective norm, athletes began to generate power, trigger change in cognitive, emotional and physical changes, which in turn affect the behavior of the players, the performance and the final result of an event. The change in momentum led to corresponding changes in cognition, but not persistent.

In summary, this paper, the psychological dynamic model for the dynamic characteristics of athletes' psychological analysis that athletes can be effective and comprehensive analysis to consider from the perspective of qualitative and quantitative binding assay, fully teamwork used in which, to common analysis of the performance of athletes in the game, better analysis of the psychological dynamics, psychological momentum and momentum, and cognitive, emotional, etc.

When people are in sports, the power output by the heart mainly the dynamic power and potential power, usually the state, the potential power is much larger than the dynamic power, while the energy supply during exercise, blood flow rate provided by the organization fluctuations in the whole psychology of the people have quite the impact of sports, we have to the optimization of the psychological dynamic coupling analysis.

### 89.3 The Coupling Analysis

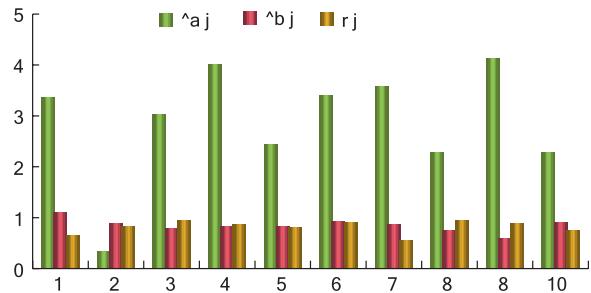
Under the motion study of people's psychological dynamic coupling relations, we need a prerequisite which is a separate but associated with heart and blood vessels, arterial model fitting, while during the fitting to the actual situation of the people fit body input impedance curve, which is the most critical step for the model fitting. Blood flow and the input impedance is not only the arterial bed of its own characteristics and volatility feedback. In coupling model analysis, we need to carry out the analysis of dispersion and concentration of the two parameter model fitting, so as to more comprehensive comparative analysis.

The psychological dynamic coupling data in Table 89.1 and Fig. 89.1 show that  ${}^a j$  coupling data was much larger than  ${}^b j$  and  $r j$  value in addition to the second

**Table 89.1** Psychological dynamic coupling data table

j	${}^a j$	${}^b j$	$r j$
1	3.37	1.097	0.639
2	0.32	0.879	0.836
3	3.02	0.777	0.921
4	3.99	0.83	0.843
5	2.43	0.836	0.793
6	3.39	0.913	0.897
7	3.58	0.849	0.533
8	2.27	0.739	0.938
9	4.13	0.593	0.873
10	2.27	0.893	0.756

**Fig. 89.1** Psychological dynamic coupling model parameter proportion



set of data  $\hat{a}_j$  is significantly less than  $\hat{b}_j$  and  $r_j$ , while  $\hat{a}_j$  is the minimum value of all data. Relatively speaking, the value of  $\hat{b}_j$  and  $r_j$  are relatively flat and they are in the relationship between fluctuations. Sport, the energy provided by the blood flow is mainly used for aortic other in the main artery of the contraction and expansion of consumption needs, but the blood during exercise after peripheral vascular resistance, the external body tissues is essentially no direct impact. This can show the psychological dynamic changes in the sport main concern in  $\hat{a}_j$  numerical changes,  $\hat{b}_j$  and  $r_j$  can be used as two auxiliary parameters to control.

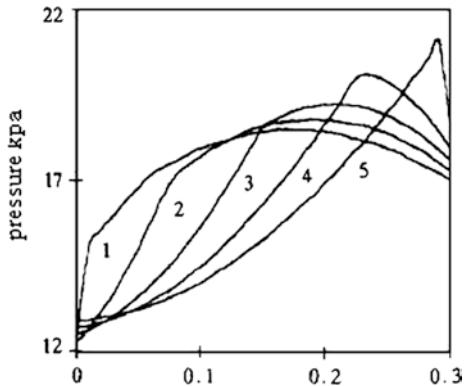
Through the coupling model analysis, combined with the kinematics and the psychology literature, we get the model of the triangular flow wave of sports and athletes with physical and psychological, and its coupling to the formula as follows, as time increases, the movement of athletes' psychological dynamic changes are shown in the figure below [6, 7].

$$q_{in}(t) = \begin{cases} \frac{2SV}{T_S T_P} t & (0 \leq t < T_P) \\ \frac{2SV}{T_S(T_P - T_s)} (t - T_s)(T_P \leq t < T_s) \\ 0 & (T_s \leq t < T) \end{cases} \quad (89.2)$$

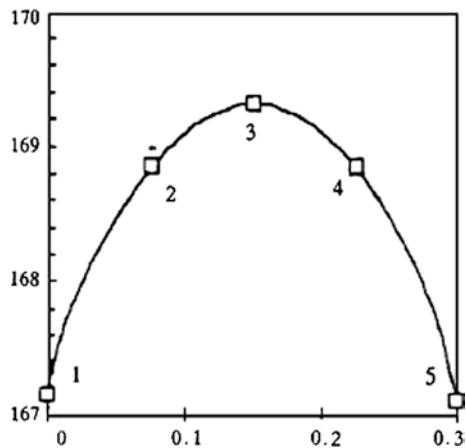
From our comparison of chart by the coupling curve in Fig. 89.2, we know that five data presented curve there is a difference in basis points is the same, but first the pressure of the first curve, but when up to a certain stage, the corresponding pressure value on the horizontal line data in ascending order according to the order of 1–5. And 1–4 increase is relatively flat; 5 at the beginning is slow, but after a sharp increase it has the formation of a maximum point.

This also reflects in the process of sports, the body of motor function caused by the heart, blood flow to the arteries, resulting in a pulsating flow, and includes not only the steady flow oscillating flow [8]. Often mobile sucked the blood of energy delivery to the blood vessels of the external resistance, so that you can make the external surrounding body tissue, such as access to energy and nutrition; but it also needs to be the case of oscillating flow analysis, it is mainly used to the aorta and other organizations to release and storage, This makes the psychological dynamic

**Fig. 89.2** Coupler curve comparison chart pressure



**Fig. 89.3** Psychological dynamic curve



changes remained relatively stable, you can also maintain its continuity, so as to better carry out the analysis of sports under the psychological dynamic coupling relations.

Figure 89.3 shows that when people are in the process of doing sports, the psychological dynamic curve is first low and then increased to the highest point, and then under the bottoming out. Combined with Fig. 89.2, the first curve is the beginning of the high starting point, and then tends to smooth the development relative to the psychological dynamic changes in the lowest position; and 2, 3, 4 three curves in Fig. 89.2 is basically the rate of increase substantially the same, and therefore corresponds to Fig. 89.3, the third curve is the position value at the highest point, while the 2 and 4 in the position corresponding to the highest point of the left and right, 25 in Fig. 89.2 is an increase of the relative maximum in Fig. 89.3 is located in the lowest position, which shows the course of the campaign, the psychological dynamic changes also have a maximum value, corresponding to fluctuate within a certain range. Appropriate to decompression

in the sport, and often concerned about the psychological dynamics change, to maintain the psychological changes within certain reasonable limits, and anything cannot go too far. Therefore, in sport people should reasonably control psychological significantly change and in this way they can maintain a good and healthy mentality.

## 89.4 Conclusion

The aim of sports is to promote human health, and it is also a reasonable and effective way to promote a person's mental health. When people in sports they put great importance to accelerate the psychological dynamic and the emphasis is also increasingly concerned about. This paper discusses the construction of sport psychological dynamic coupling model, and verifies the actual reliability of the psychological changes in the coupled model fitting movement, so not only can be more perfect model, but also can strengthen people's the ability to predict and explain the application of psychological changes in the exercise.

For the coupling model sports, the human heart, blood flow and pulse affect the role of the psychological dynamic of the people, and they are the basis to establish the coupling relations and sense of optimizing the coupled model, which is in line with the reality of the body's physiological the actual situation. It allows people to have a better understanding of the sport, and to know how they affect the psychological dynamic, what kind of relationship, how to undertake more effective physical exercise in order to better maintain a more healthy and a good mental state, but also helps people effectively improve and promote their physical activity, and their physical and psychological qualities.

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# Chapter 90

## Measurement Model of Competition Ability of Basketball Elite Athletes

Pu Jian Wang

**Abstract** Basketball now is the world's top sport, and the basketball skills continue to develop. In order to make analysis on innovative basketball elite athletes' competition ability, we make research during the race to optimize the position measurement. Through the observation of a few teams, questionnaire survey, and the use of model calculations, the results of the competition are taken for data processing, comparative analysis, and we come up with different azimuth measuring method, and also get the position and movement measurement of basketball players' competition ability.

**Keywords** Competition ability • Optimal orientation • Measurement model • Basketballs

### 90.1 Introduction

At present, basketball develops rapidly in the global development. It is a kind of fast changing collection of several sports to confront the movement [1]. During the race, basketball players attack and defense around the ball by fierce plane and direction compete force, and thus create the rapid movement and velocity transformation between the offensive and defensive position [2, 3]. Currently, many sports scientists and coaches widely believe that the adaptability of the athletes and performance testing are very important factors in athletes' designed training plan in the project of the athletes' progress analysis [4, 5]. Anaerobic ability is considered as athletes' working ability when the muscles do not provide enough oxygen for the body. Generally speaking, in an anaerobic state and a short time period, athletes have shown the explosive force which is the maximum speed and power meaning the speed of finishing the work. In basketball games, a successful

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performance mainly depends on several fitness adaptability parameters (e.g., speed, agility, and vertical leap) [6].

But in the process of basketball games, conversion and different physical conditions and basketball skills basketball player, and gradually formed a basketball player on the basketball court, the division of tasks and show the movement position of offensive and defensive to form a basketball position. According to the technology and tasks, the formation of forward, center, and guard in different positions on the basketball court. This is known as the basketball players' ability to position the placeholder technology, which also formed to assess the content of an athlete's ability to be recognized as a system of indicators to assess the players' game ability [7]. To this end, the azimuthal variation of this paper, basketball player on the basketball court, and the entire basketball team in the game reflect the optimal orientation of the maximum capacity of modeling and measurements and provide theoretical research methods which provide future guidance of basketball teaching.

## 90.2 Orientation of Structural Features of the Competition Ability of Basketball Elite Athletes

During the competition, the movement area and the surrounding athletes in basketball are always changing, and the athletes use the orientation of strategy, technology, techniques, tactical coordination to conquer others. With the process, the players are also changing their orientation and flexibility [8]. It can be used as a favorable basketball combination for the athletes' orientation process. A combination of the orientation of this structure as the hub of the basketball during the game plays an important role.

The structural features of basketball for the different orientation mainly includes the following three characteristics: structural orientation features, the orientation conditions, and location quick conversation.

### (1) Structural features of orientation technology

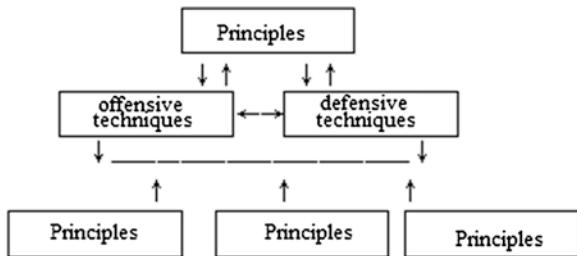
Its structural position is in Fig. 90.1.

Figure 90.1 shows that the orientation technology under the rules limiting the basketball player is a combination of technologies based on defensive skills and offensive skills of their own development or use of the azimuth position of the basketball court at any time. Position is constantly changing: with the selection and location technology development, there will be a constant change in position as well as in the definition of the optimal orientation. The best position to determine the need to continue after the three-dimensional calculations and the athletic field staff position is to take a fuzzy calculation method.

### (2) The use of the orientation of the technical conditions

Basketball player use of orientation characteristics and behavior of field conditions, the need to collaborate with other team members meet every athlete orientation technology there is a certain position responsibilities. Therefore, the basketball

**Fig. 90.1** Orientation technology chart



player can make good use of orientation conditions: external factors, conditions of time, space conditions, and behavior conditions.

### (3) Orientation technology transformation logic

The interconversion of the offense and defense technology is based on the performance of movement combinations according to the position of changing the playing field, orientation, and use, which depends not only on the quality of the individual athlete movement and orientation action, but also needs the action combination.

## 90.3 The Position Technology to Measure the Model Design

Based on the position technology as well as conversion change to establish the model [9]:

- (1) The azimuth of the total target a: optimal orientation technology formula;
- (2) Criteria b1: Option 1, Option 2, Option 3.
- (3) Program c1: score, error rate.

Establish the position measurement to judge the model matrix; the best position measurement is according to the formula of the hierarchy model. Judgment matrix data are shown in Table 90.1.

According to the above calculation, the actual results of the competition and the athlete position area defined research. Orientation of research based on expert opinion obtained data is as follows (Fig. 90.2).

**Table 90.1** Basketball position measurement matrix data table

b1	c1	c2	.....	cn
c1	2	2		2/3
c2	2	2		2/3
c3	4	4		1

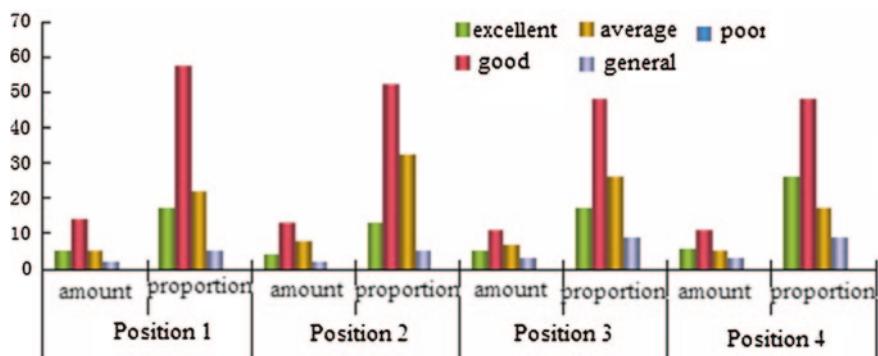
On the basis of the judged calculations and observations test, we sort out the results and the weight value. Obtained  $c_1 = 0.0231$ ,  $c_r = 0.032 < 0.1$ , to meet the consistency of the level matrix technology law. This optimal position is calculated as follows (Table 90.2):

Optimized position = [score + 0.231 \* assists + 1.32 \* rebounds + steals \* 0.23 + 0.42 \* free throws]

## 90.4 The Optimal Orientation Measurement Model Calculations

We focus on technology for the measurement model, the use of the competitions of the substantive analysis of the use of the calculation shows that, by the 12 teams game data analysis shows that, in the center position, the striker and the defender of the measurement and calculation data is shown in Table 90.3 (Fig. 90.3).

According to the chart, the measurement results show that orientation of the striker team obviously shows the important position in the team during the game; the striker has an important role in the offensive and defensive transition.

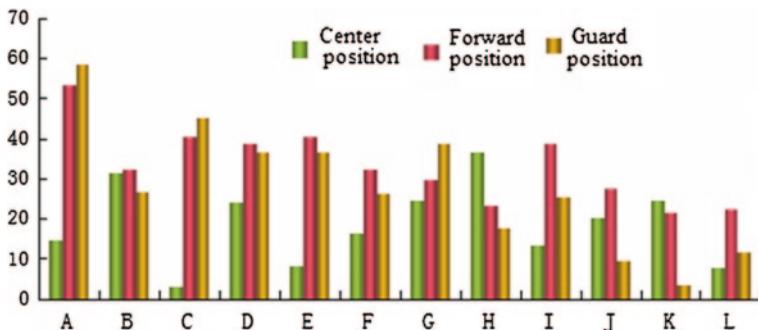


**Fig. 90.2** Basketball player orientation defined region comparison chart

**Table 90.2** Basketball player orientation defined area

**Table 90.3** 12 teams competition orientation measurements

Team	Center	Forward	Guard	Position efficiency	Rankings	Game rankings
A	14.75	53.35	58.63	126.73	1	1
B	31.43	32.32	26.53	90.28	4	2
C	3.24	40.42	45.26	88.92	5	3
D	24.24	38.53	36.53	99.3	2	4
E	8.23	40.42	36.74	85.39	6	5
F	16.56	32.45	26.34	75.35	9	6
G	24.42	29.53	38.64	92.59	3	7
H	36.53	23.42	17.53	77.48	7	8
I	13.42	38.52	25.45	77.39	8	9
J	20.42	27.42	9.53	57.37	10	10
K	24.53	21.42	3.53	49.48	11	11
L	7.64	22.43	11.65	41.72	12	12
Total	225.41	400.23	336.36			

**Fig. 90.3** 12 teams competition azimuth data comparison chart

The orientation of technology needs a fast and excellent jumping ability [10]. They attack in the game when striker position region is in the external assistance and help guard the ball while creating a counter-attack opportunity. In addition, the strikers at the position and the team inside work closely with another outside shooting breakthrough. Defense at the same time with interference blocks the attack of hostile players to create the attack and the defense and so on.

## 90.5 Relationship Between Optimized Orientation and Position Responsibility

Basketball competition is increasingly intensive, and physical players are more larger in the strength against each other. If the position is the tool how to improve the advanced performance of individual ability in technique, which

is not consistent with the requirements of a strong team. However, we should pay attention on the field of different directions, such as offensive skills and the orientation scope [11]. Orientation offensive post is under pressure, while the players are forcing the peripheral position effectively, which can expand to a combination of tactical orientation in order to balance the ability of the teams as a whole structure [12].

(1) Basketball players' offensive position and responsibility spatial relations

The entire basketball, ball position and the environmental conditions of space limitations the performance of the attack on the relationship between the orientation of space-time for space and the orientation of the objective existence of the sport of basketball game with the fastest speed, standing position, fought back and tactical cooperation.

(2) Basketball players' defense position and responsibility spatial relations

With the speeding up of the pace of life, the increase of the pressure of social competition, people spend less time in sports, especially female college students who are faced with weaker physique, pressure, poor psychological bearing ability, and poor sleeping quality and so on, which lead to present trend of gradual decline of female university students' physical quality. The more students are fit, the more they are willing to learn. Physical education is a key factor of the students' physical qualities, health and learning, so we should strengthen the college sports education, and the state and society should increase college sports career support and investment to improve the quality of the education of college sports [13]. According to the current situation of sports, we discuss the influence of short-term training plan for female university students' physical qualities from the angle of sports in order to find a way to improve female college students' physical fitness.

## 90.6 Conclusion

With the rapid development of basketball, there is the need for the athletes' capacity sports arena in the position to fine measurement and calculation. We obtain the optimal orientation of the playing field and increase the team game scoring rate in the game. Calculation of the optimal azimuth data, optimization of the basketball training programs and team tactical style, the timely detection of adverse risks of the team, and adjustment of the position of players to play in the game will give excellent results. At the same time, we use this method to calculate the optimal position, which can effectively record the position of different players of different teams in the game. The position accounts for the ratio of horizontal comparative analysis, which is reasonable to summarize and provides a reasonable and constructive advice for basketball players.

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# **Part X**

## **Project Management and Applications**

# Chapter 91

## Research on Tourism Industry Based on SWTO Analysis

Qiufen Zhang and Wuqi Jiang

**Abstract** Tourism is a large-scale and emerging industry with broad prospects. As the only municipality in the central and western regions, the economic center of upper reaches of the Yangtze River, the western economic growth poles, and the tourist center of the upstream region of the Yangtze River and Sichuan, Guizhou, Yunnan, and even the Southwest, Chongqing breaks the bottleneck of the development of tourism, and strengthen the tourism coordination function, which is essential for the development of tourism in Chongqing. This paper makes a Chongqing tourism industry development SWTO analysis from development advantages, weaknesses, opportunities, challenges and other factors. It also makes constraints analysis to identify the main constraints of Chongqing's tourism industry development, including tourism management system, the regional tourist traffic, tourism, image and marketing, and regional tourism linkage to come up with Chongqing tourism industry development bottleneck breakthrough strategies and bottlenecks breakthrough development strategy.

**Keywords** Tourism industry • Development status • Chongqing city • SWTO analysis

### 91.1 Introduction

SWOT strategic analysis has been widely used planning methods of marketing. SW is the internal strengths and weaknesses of a particular industry or sector; OT refers to a particular industry or sector of the external environment opportunities and threats [1]. Through comprehensive analysis of SWOT elements, we

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can make evaluation of development strategies, to achieve the purpose of selecting a suitable strategy. Therefore, this method is a system engineering approach throughout the system theory point of view, especially in the highly competitive and rapidly changing era of market economy; the analysis method is effective and indispensable [2, 3]. The only municipality of Chongqing in the central and western regions, the upper reaches of the Yangtze River economic center of western economic growth poles, as Sichuan, Guizhou, Yunnan, and even the Southwest and the upper reaches of the Yangtze River region's tourism center. In recent years, Chongqing tourism resources have been effectively developed. The survey found that the development of Chongqing tourism resources, with many advantages and market opportunities, there are also a number of adverse factors [4, 5].

## 91.2 The Tourism Reform Changes

At present, China's Hainan Province, Hangzhou, Guiyang City, and under the jurisdiction of Hainan, Haikou, Sanya, Qionghai, Wenchang City, Ding'an and Chengmai County, and Lingshui Li Autonomous County belong to the Tourism Development Committee Tourism which is the administrative department upgraded by the government agencies directly under the Government sector, and is the vanguard of China's tourism administrative reform into the fourth stage. This has provided valuable experience for China to promote tourism reform [6].

### (1) Industrial base relying on a strong base and expected high growth

These areas of the whole process of development of tourism industry basically formed a "eat, live, line, travel, shopping and entertainment," which are the six tourism elements of mutual supporting industrial system and industrial chain. The tourism industry is constantly enriching the formation of tourism, vacation and had balances of the travel pattern of special tourism competitiveness will increase markedly in the domestic and international tourism market. Thus, tourism has become a pillar industry that lead to the development of tertiary industry [7]: First, the number of tourist has a sustained and rapid growth; Second, the scale of the tourism industry is growing; Third, tourism destination building with remarkable results, characteristics of tourism products rich in content; the construction of tourist facilities are maturing, reception conditions are fundamentally changed; Fourth international reputation to rise gradually, to optimize the structure of tourist; Fifth, the gradual deepening of tourism management to further standardize the market order.

### (2) Relying on the full attention of senior leadership and leadership

These regional leadership attaches great importance to the tourism industry sustained and rapid development under the premise, emancipate the mind, the reform and opening up, change the mode of development, in particular 41 document in accordance with the national development "in accordance with the co-ordination, to form a joint force requirements, and innovative institutional mechanisms,

promote tourism management system" requirements to strengthen the tourism sector-led local economic development status.

### (3) Relying on the relevant departments for their support

These areas offices strengthen the awareness of active service, often many times to the tourism sector, research guidance, in the addendum to the requirements of the case, to strengthen the guidance of the travel management system, targeted combination of travel management functions corresponding expansion, the effective integration of the tourism administrative resources for the tourism sector to improve coordination and service levels to create a favourable policy environment and working conditions.

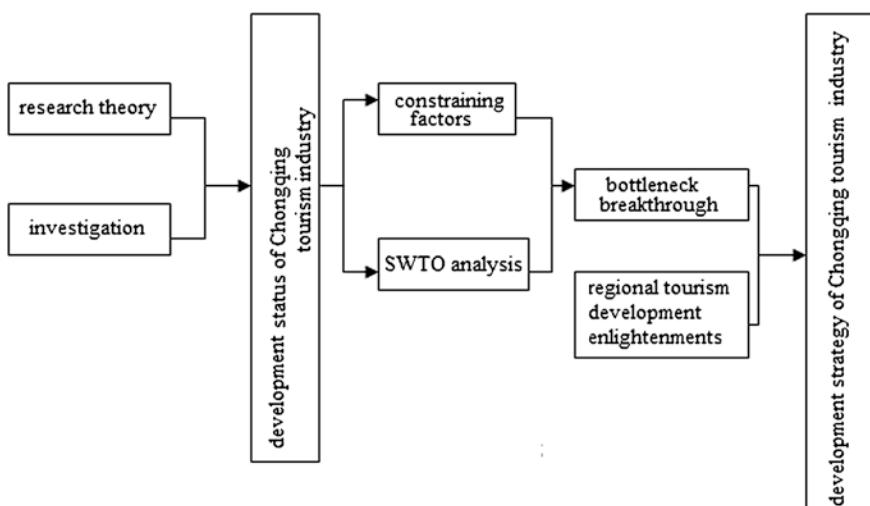
## 91.3 Analysis Model of the Tourism Industry in Chongqing

### (1) Research system analysis

This paper makes the overview and summary of research theory and field research on the development of tourism industry in Chongqing truth. And then by analyzing the constraints and using SWTO analysis techniques to analyze Chongqing tourism development bottlenecks, and proposes a breakthrough strategy. In addition, tourism development combined with some other revelation to come to Chongqing, the development of specific measures in the tourism industry. Research system framework is shown in Fig. 91.1.

### (2) Research methods

In this paper, we use the following research methods [8]:



**Fig. 91.1** Chongqing tourism development framework

Fieldwork method: conduct field investigations in the main tourist attractions in Chongqing Municipality to collect first-hand information and analysis.

Survey method: the research basis points are Chongqing's tourism image and tourism brands, master tourists Chongqing tourism image and tourism brand awareness which is very important. The survey included a survey of oral interviews, field survey, online survey, and its purpose is to obtain a valid sample. The research has a certain objectivity and operational.

Documentary research: through literature collection and retrieval, we get access to a wealth of literature, selected by screening after more mature theoretical and practical results of this research material and theoretical basis.

Comparative analysis: through Chongqing and other tourist cities in the Comparative Study of Tourism Development, we summed up the successful experience of its tourism development.

### (3) Statistics

We find the literature and field surveys, and we get the level of development of Chongqing's tourism industry in the country, as is shown in Table 91.1.

Chongqing tourism industry tourist foreign exchange income growth rate [9].

$$r_j = \frac{Y_1 - Y_2}{Y_0}, (j = 1, 2, 3 \dots n) \quad (91.1)$$

**Table 91.1** Horizontal comparison of Chongqing city tourists number and foreign exchange earnings

Years	Indicators	Tourist reception/billion	Tourism foreign exchange earnings/billion U.S. dollars
2002	National ranking	18	16
	Western ranking	5	4
	Proportion in the national total	1.14 %	1.18 %
	Proportion in the national first	3.02 %	4.28 %
	Proportion in the western total	33.85 %	52.00 %
2003	National ranking	20	17
	Western ranking	6	6
	Proportion in the national total	0.26 %	0.65 %
	Proportion in the national first	2.00 %	2.65 %
	Proportion in the western total	23.45 %	33.29 %
2004	National ranking	21	17
	Western ranking	6	6
	Proportion in the national total	0.40 %	0.79 %
	Proportion in the national first	2.78 %	3.77 %
	Proportion in the western total	36.95 %	48.05 %
2005	National ranking	21	18
	Western ranking	6	6
	Proportion in the national total	0.44	0.90 %
	Proportion in the national first	2.76 %	4.09 %
	Proportion in the western total	34.86 %	50.00 %

Chongqing tourism industry tourist foreign exchange income growth rate [10].

$$R_j = \frac{Z_1 - Z_2}{Z_0}, (j = 1, 2, 3 \dots n) \quad (91.2)$$

Chongqing tourism industry share in the foreign exchange after standardization is [11].

$$Y_j = \frac{Y_0 \times Z_0}{Z_0} \quad (91.3)$$

We can see from the graph that since the past Chongqing tourism achieved from small to large, from weak to strong gradually shift among them, 2005 years of Chongqing tourism reception tourist arrivals number 500,000 people break mark, up to 520,000 people, and the tourism income exceeding RMB 30 billion, for 9.8 % of GDP. Tourism has become the fastest growing, Chongqing of the most dynamic emerging industry and one of the new economic growth point. However, because it is in inland, development of the low starting point, put in more bills, planning development level is not high; resource advantage has not been effectively into economic advantage, the Chongqing tourism economic development level compared with the national, still in middle level. This can be seen from the entry tourism reception people and tourist foreign exchange income. Chongqing tourism in national and in the west of status was low.

## 91.4 SWTO Analysis on Chongqing Tourism Industry

### (1) Development model

The regional tourism industry development of the basic mode has two options: one is the destination type development mode, and the second is channel type development model. Destination type development mode (1) has three key factors: namely shocking tourist attractions, leading the core competitive ability, the efficiency industry value chain. Channel type development model (2) also needs to have three key factors: namely relevance tourist attractions, followed the core competitive ability, the efficiency of the value chain. From the Chongqing tourism planning study of the core ideas reflect look, Chongqing tourism industrialization road only choose “channel type development model”, which is a sensible strategy choice.

### (2) Strategic goals

In the western development strategy, the tourism industry is a priority, the foundation of the development of industry. Chongqing guards the Yangtze River has three gorges, known as the southwest of the town of reputation, in the development of western history background, the industrialization of tourism goal is attainable. Chongqing tourism industry development overall objective is: implanting tourism city gathered function and diffusion function, Chongqing city will be built into “they moved eastward expansion, south west led north to” relying on the city; Foster the development of the tourism industry mechanism and growth

advantage, to be within their jurisdiction areas in Chongqing construction of western tourism into three channel (northwest, southwest along,); one The construction of regional tourism industry's cascade to structure, Chongqing China construction development concept into clear level four tourism system (three gorges, the city of Chongqing Wujiang river/Qianjiang, specific area, scenic spots scattered); Make tourism industry value chain, Chongqing tourism industry will build a high elastic operation mechanism, high market response, high degree of input-output ratio, high GDP contribution rate of "four high" industry.

### (3) Framework for action

The main axis of the Yangtze River uses the cyberspace development strategy of "taste, growth, nurturing" the very core capabilities of the city of Chongqing, Fuling, Wanzhou, Qianjiang, Pengshui travel, build cascade tourist system, Chongqing tourism industry of laid along the axis of growth pole; support in some small cities developed into a tourism relying on node city felled the development of tourist areas, the relative concentration of group #. Convenience and other factors based on the geographical coherence, and tourism activities linked closely, transport links, select the Yangtze River riparian zone to the main axis, along the railway line, along the highway for the two axis, to the region's main transit along the national highway for three level axis, full use of various modes of transportation, and ultimately there is the formation of a network-axis system.

First, build relying on the city, and vigorously develop the theme of tourism and leisure and sports tourism products; strengthen Chongqing city tour at the same time, as soon as possible to build large enough, Fuling, Wanzhou, Qianjiang, Wushan city tourism circle, the formation of two-way tourist economy, and the ability to radiate.

Second, cultivate a new growing point of the tourism focus; vigorously develop the experience of travel of the holiday back to nature and folk customs. Strengthen surrounded by mountains, Jinyun Mountain National Scenic Area, the Dazu Rock Carvings tourist area and the Yangtze River Three Gorges line combination to form a world-class tourism product system.

Third, promote by focusing on points and lines, vigorously developing the theme of participatory tourism products. Focus on building the Three Gorges of the Yangtze River—Daning River Small Three Gorges—Wujiang River Gallery—mountain town along the river tourism product.

Forth, focus on transportation routes, comprehensively promoting the tourist areas along the Yangtze River, the main railway line and highway travel product portfolio strategy, linked together to form tourist routes, practical tourism products onto the scale, intensive development and opening up the forefront of the market. Further strengthen the decision-making, planning and management, tourism practitioners, as well as society as a whole tourism industry development awareness, improve the regulatory function of the tourism industry development, promote public participation and international cooperation, to take preventive measures to better manage the tourism industry development process to ensure that tourism is gradually moving in the harmonious development of the values of direction for the sustainable development of Chongqing Municipality.

#### (4) Operation platform

Implementing tourism industrialization strategy is a long-term arduous process, the process must adhere to the “strategic, government coordination, enterprise play, resource sharing” approach to development. Adhere to the “strategic”, it is on guidelines must be in the tourism industry construction as the center, take the tourism resources development and tourism product promotion for basic points, the implementation of international and domestic tourism and strategy, brand article strategy and intensive scale operation strategy, strengthen the tourism industry association effect; Adhere to the “government coordination”, it is in the management system, and set up a government under the leadership of the administrative agencies for the industry of the implementation of the management layer management mode, organizational guarantee from Chongqing tourism industrialization development; Adhere to the “enterprise play”, it is established in the implementation of the tourism enterprise the dominant position of industrialization strategy, this is the market economy condition tourism industry development the objective need to realize is the inevitable result of the modern enterprise system; Adhere to the “resource sharing”, it is fully understand the relevance of the tourism industry, through the resources of the link, construction of tourism industry value chain, and to cultivate “four high” tourism industry.

## 91.5 Conclusion

Through the SWTO analysis method, this paper makes an analysis of the tourism industry in Chongqing, and also solves the bottleneck problem of the development of tourism industry and puts forward some reasonable strategic measures to strengthen the construction of tourism management system. Therefore, we must do the work in six aspects: first, implement the administrative organization tourism, and perfect the management network; second, carry out the national promulgated by the relevant ministries and tourism management regulations series, combined with the practical implementation of Chongqing, continuously consolidate perfect, make it play a bigger role; third, further develop the standardization management range, in continue to strengthen to “travel agency, tourist hotel, tourism transportation, tourism scenic spot” etc. special tourism industry management at the same time, but must strengthen to the “tourism education, travel shopping, tourist information, postal telecommunications, finance and insurance, cultural relic protection and urban construction planning” generalized the travel industry management; forth, do well the service of the competent administrative department of tourism, improve management, and further improve the industry management authority; Fifth, establish tourism industry development strategic coordination commission, realize the inter-departmental strategic management; Sixth, establish tourism industry development strategy management expert consultation system, and construct the tourism industry knowledge management of “strategy pool”.

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# Chapter 92

## Landscape Ecological Planning Management and Ecological Regulation in Small Towns

Xin Zheng

**Abstract** The climate in northern China is cold, and there is relatively discrete distribution of small towns. Because of the climate in the north region, the ecological environment of the small towns is different from that of the south. In response to our national policy, to drive local economic and development strategy requires the development of small towns; owing to the cold climate in the northern small towns, landscape ecological planning and management and eco-regulation are very important. In this paper, the overall planning and management are based on landscape ecology principles, other technology and small towns' landscape ecosystem to build the index system of urban landscape spatial pattern. This paper undergoes the analysis of the northern areas of urban ecological planning from a quantitative and qualitative point of view in order to make the establishment of small town's landscape ecological control system and policies to meet the cold regions of northern small town landscape ecological planning requirements and promote the economic development of small towns.

**Keywords** Northern region • Small town landscape • Ecological planning and management • Ecological regulation

### 92.1 Introduction

The rapid development of modern urbanization and deteriorating ecological environment and small town issues improve human ecological and environmental protection awareness [1, 2]. There are plains, plateau and basin topography in northern China, which is rich in natural resources. In these areas, the acceleration and the development and utilization of resources caused the continuous deterioration of the surrounding ecological environment in the cold climate conditions;

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the small towns of the northern region ecology have been seriously damaged in these cold northern regions. Thus, we should make the progressive development of small town landscape ecological planning, planning and management of ecological environment and ecological regulation which is very important [3].

## 92.2 The Ecological Planning Theory and Management Methods

Landscape ecology practice of urban landscape ecology is also an important means to manage the landscape; it is the concentrated expression of the scientific value of the landscape architecture. All landscape elements, such as factories, farms, housing, roads and other design and planning, can be seen as key points. By a comprehensive study of the entire urban landscape system, we could achieve the overall optimal effect [4].

First of all, it is based on the principle of giving priority to ecological environment, the principles of diversity, principles of sustainable development, overall planning and design principles, and according to local conditions of public participation in design and planning. The general landscape ecological processes in the planning area includes the following aspects: the characteristics and human behavior, activities of landscape surrounding natural environmental, the investigation, analysis and synthesis of landscape ecological condition and program planning analysis.

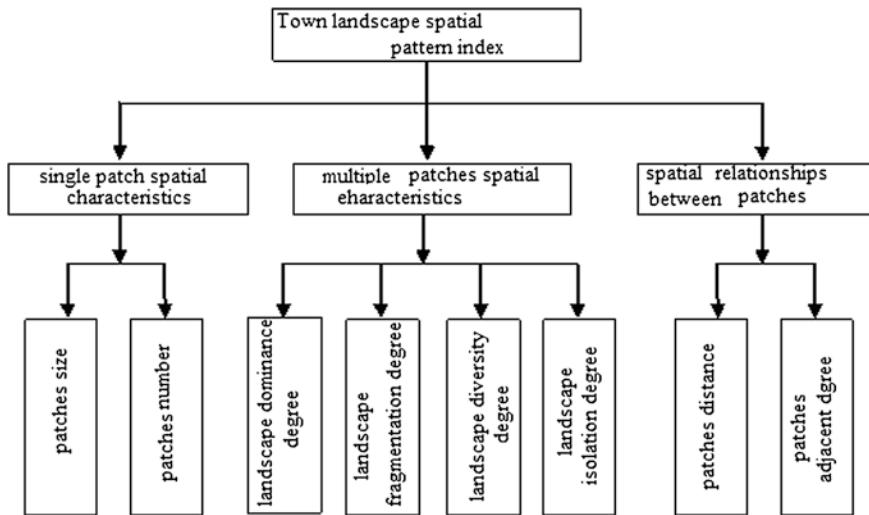
Secondly, it should be in accordance with the planning, scope and objectives of landscape ecological surveys, according to the findings of landscape spatial pattern analysis. Landscape ecological functions are divided in accordance with the completion of the cities and towns across the landscape ecological planning design.

Finally, there should be the entire urban landscape ecological planning and management, with general administrative departments of local governments to develop the corresponding administrative regulations and measures to constrain the construction projects of urban transformation, to ensure that the project is in accordance with the law.

## 92.3 Landscape Ecological Planning and Design of Small Towns in Cold Northern Areas

According to the characteristics of climate in the north and the pattern of small towns, we obtain simple quantitative indicators of small towns' structure and space configuration as shown in Fig. 92.1.

The index system is integrated into the urban landscape planning and other documents to establish the small town landscape spatial pattern of the northern cold regions, including single patch spatial characteristics, multiple patches spatial



**Fig. 92.1** Small town landscape spatial pattern index system

characteristics and spatial relationships between patches. Indicators of these factors with the quantitative point of view can reflect the status of urban landscape and also is an important measure of the quality of urban landscape.

Single patch spatial characteristics can be used to measure patch size and number, regional species composition, biological storage of nutrients and the size of the patch in a direct correlation effects. Multiple patches spatial characteristics include the landscape dominance, the degree of fragmentation, and landscape diversity and landscape separation of four parts.

The landscape diversity index is the number of elements of the landscape, and each factor accounting for the change to be reflected. Element's landscape diversity index is zero; factor greater than two and the various elements of equal type accounting for the diversity of the landscape are the highest; when accounting for differences in increases in various elements, landscape diversity will decline. Diversity index formula is given as follows:  $H$ ,  $i$ ,  $m$  and  $P_i$ , respectively, mean the landscape diversity index, the proportion of landscape area, the number of elements of the type and the landscape element types [5].

$$H = \sum_{i=1}^m p_i \times \ln p_i \quad (92.1)$$

Landscape dominance index means that several landscape elements account for the main control of the extent of diversity that relative to the maximum deviation from the scope of the degree. Dominance then corresponds to the deviation from the greater; it means that certain types of relative landscape elements have advantages; dominance index is smaller, the deviation from the small proportion

of each type of landscape elements is no obvious difference; if the advantages of zero, that is, various types accounting for equalization does not exist a comparative advantage. Dominance index,  $n$  is the number of patches of the type of landscape elements; patch  $ij$  area ( $\text{m}^2$ ) is represented by  $a_{ij}$ ;  $A$  is the total area of the landscape ( $\text{m}^2$ ) [4].

$$P_i = \sum_{i=1}^m a_{ij}/A \times 100 \% \quad (92.2)$$

Under the influence of the human and natural environment, from big to small, patch types has certain quantitative and qualitative change. That is to say, the degree of fragmentation of the landscape is from simple to difficult to be changed. There still has more to do with the feedback artificial activity behavior for landscape planning, which ranges between zero and one. When the fragmentation does not exist, we compare it to zero, while complete fragmentation is compared with 1. Landscape fragmentation includes  $C$ ,  $\Sigma N_i$  for the patch type and all landscape elements [5].

$$C = \sum N_i/A \quad (92.3)$$

In different patches of individual space in some landscape types, there are some discrete phenomenon (or gathered), which is the landscape isolation index. The patch is more dispersed, and then, the greater the distance between patches, the greater the separation. Separation index of the landscape elements of type  $i$  is represented by  $N_i$ ;  $D_i$  is the type of landscape element  $i$  from the index,  $D_i = 0.5 \times (n/A) 0.5$ .  $S_i$  is the area index of landscape type I;  $S_i = A_i/A$  in which the area of landscape type  $i$  is represented by  $A_i$  [6].

$$N_i = D_i/D_i \quad (92.4)$$

A variety of landscape element types in the real space distance is adjacent and may be indicated adjacent to the patch index. I-th class patch and the length of the distance of the  $j$ -th class patch intersection is represented by  $n_{ij}$ ;  $N_j$  means the total length of the  $j$ -th patch edge [7].

$$Fn = n_{1j}/N_j \quad (92.5)$$

Investigation and analysis details of the ecological environment of the small town landscape of the northern cold regions and survey data are presented in Table 92.1.

By the relevant elements of the spatial pattern of the selected landscape space in the index system and through the investigation of the 2003, 2007 and 2011 years, we get the past 3 years in all types of landscape indicators change, and the findings are in Table 92.2.

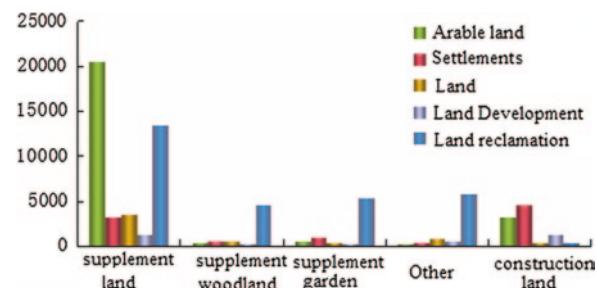
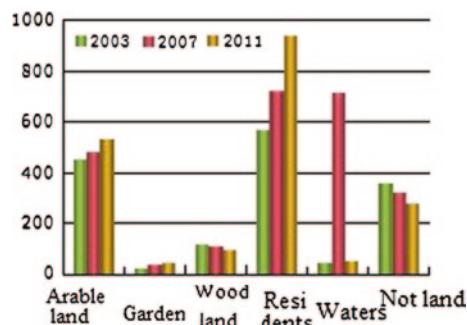
The chart shows the pattern of factors for the various elements of the landscape of small towns in northern cold regions of space in a more obvious status, which shows that the small towns begun to focus on planning in recent years (Figs. 92.2, 92.3, 92.4, 92.5, 92.6).

**Table 92.1** Land development and consolidation potential survey of small towns in the cold northern areas (unit: 10,000 ha)

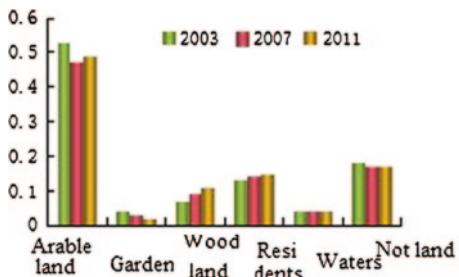
Name	Supplement agricultural land use potential					
	Supplement land	Supplement woodland	Supplement garden	Other	Subtotal	Land for construction
Arable land	20434.32	324.53	532.43	235.53	21526.81	3244.3
Settlements	3256.46	536.53	894.53	425.79	5113.31	4536.1
Land	3533.64	578.64	357.54	784.22	5254.04	435.3
Land development	1246.34	238.13	245.15	453.76	2183.38	1246.1
Land reclamation	13355.3	4646.2	5357.3	5734.2	29093	424.2
Total	41826.06	6324.03	7386.95	7633.5	63170.54	9886

**Table 92.2** Annual data survey of the various types of landscape spatial pattern

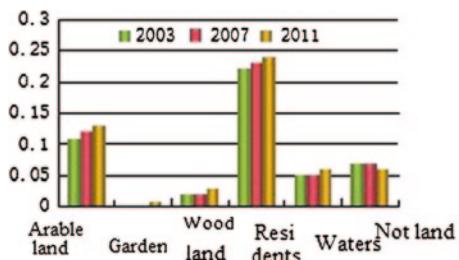
Types of landscape	Various types of landscape patch degree			Various types of landscape dominance degree			Various types of landscape fragmentation degree			Various types of landscape isolation degree		
	2003	2007	2011	2003	2007	2011	2003	2007	2011	2003	2007	2011
Arable land	453	483	531	0.53	0.47	0.49	0.11	0.12	0.13	0.31	0.36	0.39
Garden	26	38	46	0.04	0.03	0.02	0.00	0.00	0.01	1.14	1.12	1.30
Woodland	114	108	95	0.07	0.09	0.11	0.02	0.02	0.03	0.99	0.87	0.64
Residents	571	720	938	0.13	0.14	0.15	0.22	0.23	0.24	1.26	1.31	1.42
Waters	43	715	53	0.04	0.04	0.04	0.05	0.05	0.06	0.34	0.34	0.34
Not land	361	320	276	0.18	0.17	0.17	0.07	0.07	0.06	1.13	1.02	1.25

**Fig. 92.2** Land developments and consolidation potential comparison chart of small towns in the cold northern areas**Fig. 92.3** Various types of landscape patch degree

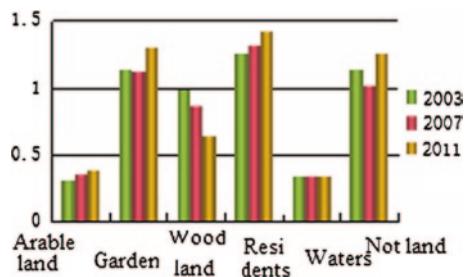
**Fig. 92.4** Various types of landscape dominance degree



**Fig. 92.5** Various types of landscape fragmentation degree



**Fig. 92.6** Various types of landscape isolation degree



## 92.4 Small Town Landscape Ecological Planning Management and Ecological Regulation

In order to encourage the sound development of the landscape ecology of the small towns of the northern cold regions, and to encourage the measures for the administration of space governance, the small town landscape ecological planning and management must follow the following principles:

1. The type of industry and structured governance combining, that is, the use of small town industry driven by the construction project, promote the overall economic development of small towns.
2. Guidance and prescriptive governance combining, that is, the development of small urban enterprises, investment, ecological reform guidance; prescriptive

- governance approach to river development and protection, heavy pollution and low band.
3. Sustainable development and emergency management combining, that is, following the guidelines of the strategy of sustainable development requirements and to take special handling of small towns landscape ecosystem governance.
  4. The centralization of power and public participation combining to cross-management.

At the same time, the use of the basic requirements of the ecology, according to the ecological system is efficient, optimized, harmonious goals to strengthen the awareness of the ecological planning and design, ecology and environmental protection box management and knowledge. In harmony with nature, the coordinated development of eco-control means to regulate the landscape ecology of the northern cold regions:

1. Establish a rational distribution of small town landscape ecology;
2. Construct small towns across the landscape system of ecological monitoring network, to ensure the safety of the ecological environment;
3. Promote awareness of the ecological and environmental protection;
4. Gradually develop the tourism ecosystem;
5. Take the relevant policies and comprehensive management of the danger zone of the northern cold regions;
6. Build a system of eco-environmental impact assessment system and ecological restoration.

At present, rapid expansion process of cold north small town and city has completely changed the original landscape ecological characteristics; it not only affects the water, gas, but more importantly it has impact on the soil, biological, geological and human activity. According to the results of ecological impact assessment, project development may cause the regional ecological environment quality declining; therefore, development project on the ecological environment must be the necessary compensation, namely the collection of ecological compensation fee, charge a deposit, it is used widely in the world economic approach. It should be actively promoted, “who pollutes, who pays”, “who manages, who gains” active management pattern, the ecological protection and environmental management as an industry to develop, promote enterprises on ecological environment protection enthusiasm and even engaged in ecological protection and pollution of the environment of professional enterprises.

Landscape ecology applied in the ecological regulation and control in the construction of small towns and gradually formed a kind of new town construction idea and train of thoughts; it not only adhere to the natural ecological holism—and human influence is one of the important factors to be considered—but also emphasize the importance of man-land relationship, from the overall coordination of people and the environment, social economy and resources environment and achieve small town landscape protection utilization and sustainable development.

## 92.5 Conclusion

Landscape ecological planning of small towns in northern cold regions need to adhere the philosophy of the natural ecology and focus on human factors and coordinate the relationship between people, machines, environmental and natural resources from the entire landscape ecological environment in order to build a harmonious society.

**Acknowledgments** The search was supported by the Eleventh Five-Year Science and Technology program of Department of Education in Jilin Province with the number 405 [2009] and was named The research on the ecological planning and design of small towns' landscape in the northern cold region.

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## Chapter 93

# Ecology Environmental Design of Cold City Waterfront Landscape Based on Regional Ecological Priority

Xin Zheng

**Abstract** This paper is on the basis of landscape ecology design literature, combined with the climatic characteristics of the cold city to analyze the cold city waterfront landscape ecological state of the environment. According to the design principles of landscape ecology and environmental, combined with the qualitative and quantitative perspective, this paper builds a planning and design evaluation system of winter city waterfront landscape. Finally, through the use of expert weighting method and the spatial analysis of GIS technique, the author assesses the ecological environment of the cold city landscape, then lays emphasis on the design countermeasures of ecological environment in cold city waterfront landscape.

**Keywords** Regional ecological priority • Weighting method • GIS overlay technique • Cold region waterfront landscape • Ecology environmental design

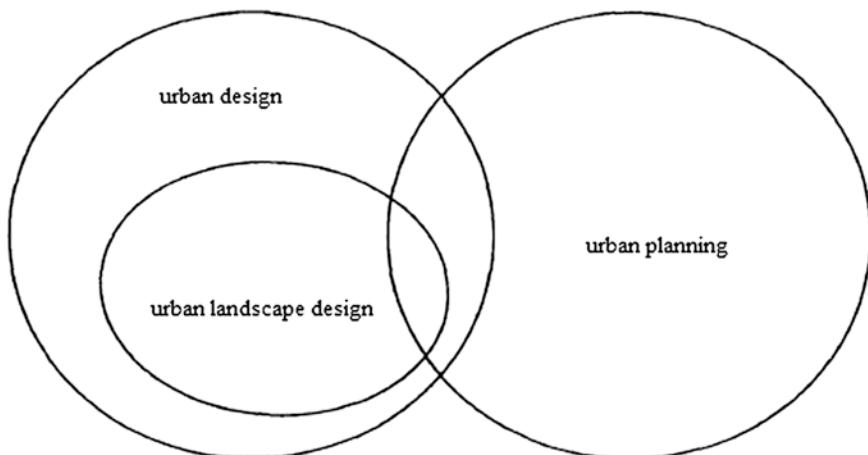
### 93.1 Introduction

Urban waterfront is the most affluent areas of the environment and culture of a city, which represents the city special section of the environment and the vitality of public open space, with a special unique urban landscape and with the hydrophilic ecological environment in the city and open green spaces, and it is important element of the carrier of urban civilization and the ecological environment. However, due to the rapid economic development of urbanization, the urban industrial scale is expanding [1, 2]. With people's rising awareness of environmental protection and the pursuit of safety and health standard of living, we begin to attach importance to the city of the living environment and ecological conditions,

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**Fig. 93.1** The relationship between urban waterfront landscape and urban design and planning

the pursuit of the hydrophilic, high-grade urban landscape. This requires that the urban waterfront according to the ecological characteristics of the environment, history and culture of the urban areas, in accordance with the market mechanism of action of the city's normal requirements of economic development, law and urban re-planning of the urban waterfront design, making the urban modernization features and highlights, which requires higher requirements for the design of landscape ecological environment in urban waterfront [3, 4].

At present, China's urban waterfront, especially the eco-environmental planning in the cold city's waterfront landscape design, is at the preliminary stage. As the temperature climate of the cities, urban culture, level of development, urban residents life habits and a variety of reasons, urban design and planning of the waterfront, regional ecological environment construction compared with the southern China region has a very large difference [5]. Figure. 93.1. shows the relationship between urban waterfront landscape and urban design and planning. Therefore, it provides a basis and reference for the ecological environment of the cold city waterfront landscape design.

## 93.2 The State of Cold City Waterfront Landscape Ecological Environment

The growing social needs and economic development have contributed to the rapid construction of the urban waterfront landscape planning. However, the rapid construction has also led to the urban waterfront landscape ecological and environmental problems [6].

1. Result in fragmentation and failure of the ecological environment of the urban waterfront landscape.

Revetment in the urban riparian flood prevention against vertical concrete way leads to the fragmentation and loss of the landscape and waterfront district. Concrete revetment not only is blocking the river outside the city waterfront land, material, water and energy to be interchanged, but also causes the destruction of the environment for the survival of some animals and climate migration area, leading the structure of the region's biodiversity destruction and reduce the regulatory function of the ecological environment of the region.

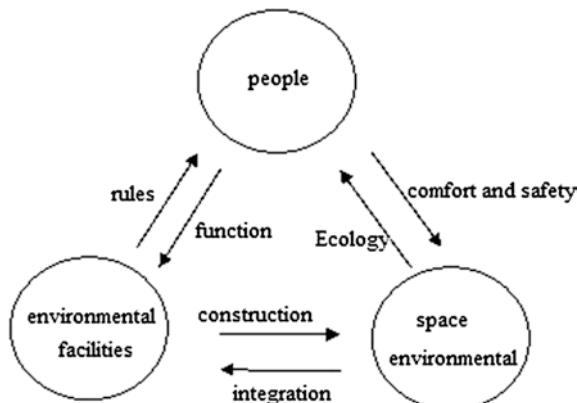
2. Lead to the ecological environment of the urban waterfront landscape scale disorders, and reduce the hydrophilic nature of the ecological zones.

Planning and design of urban roads, buildings, etc., make the overall city image to improve. But due to the expansion of the scope of construction, making the distance of the waterfront area from the residents of the regional to the greater, resulting in a number of residents difficult to hydrophilic, the overall result in residents hydrophilic reduced. Riparian perimeter security facilities and green reach, so nobody cares about the waterfront under the special climatic conditions, leading to the extreme waste of natural landscape resources, is not conducive to the sustainable development requirements of a city's demand for energy saving. The relationships between people, environmental facilities, and environmental space are shown in Fig. 93.2.

3. Urban waterfront landscape ecological environment pollution is serious.

In urban construction and development process, residents' every day garbage basically all emit into the surrounding the cities such as rivers and lakes area. And these water resources as well as urban residents of the life in the water, if in riverside landscape ecological city environment planning and design and construction process of sewage and garbage is not perfect abandoned system, will be serious pollution of water resources city [7].

**Fig. 93.2** Relationships between people, environmental facilities, and environmental space



### **93.3 Cold City Waterfront Landscape Ecological Environment Design Principles Based on Regional Ecological Priority**

From the urban waterfront landscape ecological planning of the present situation, combining modern cold city for landscape ecological needs, it should fully display own superiority, avoid the waste of resources construction, population distribution and density and the environmental pollution caused by excessive, fully resources optimization allocation, the ecological environment around to make use of resources, and realize the effective combination of the individual far outweigh the value of individual utility. In the ecological environment design, we need to adhere to the following principles [8]. First, urban ecological system maintenance and improvement are made as the basic premise. Second, the combined with city life environment is made, as a whole, interdependence and common development. Third, a regional ecological priority of the standard is established. In urban areas within the scope of the ecological resources for first starting point, will the city ecological elements use and contact, in the protection and improvement of give priority to the ecological resources and environment, and on the basis of evaluating again for the city landscape planning of influence, to effectively avoid landscape planning for the destruction of the behavior nature to take corresponding measures to make the negative factors to lowest.

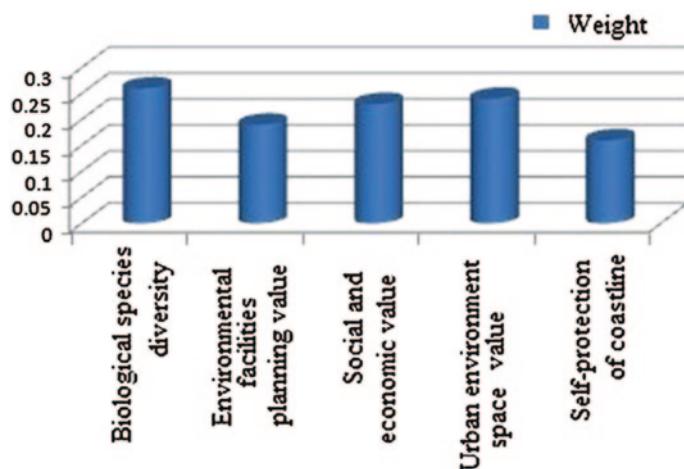
### **93.4 Cold City Waterfront Landscape Ecological Environment Design Based on the Regional Ecological Priority**

Analysis results are given in Table 93.1 [9].

For the evaluation factors, we set five component lists. According to each factor important degree grade by experts, the most important points for 5, and the least important for 0, combined with the GIS spatial analysis of landscape planning stacking technique impact factor are united. We conclude that the comprehensive evaluation of landscape planning and value in 1.3–3.5 scope change, and desirable corresponding grade scores range, urban environmental protection request and city development, and the combination of urban landscape planning to jointly determine the key. Cold city waterfront landscape ecological environment planning and design, and evaluation factors weight are shown in Fig. 93.3.

**Table 93.1** Evaluation factors analysis of cold city waterfront landscape ecological environment planning and design

Landscape planning and design evaluation factors	Weighing	Judgment standard
Biological species diversity	0.26	Species category, quantity and ecological system's ability to maintain stability
Environmental facilities planning value	0.19	Entertainment and esthetic value
Social and economic value	0.23	Social economic activities for the support and carry out the landscape ability strength
Urban environment space value	0.24	Maintenance of the urban ecology, protection and improvement ability
Self-protection of coastline	0.16	Disadvantages and decontamination purification function

**Fig. 93.3** Evaluation factors weights of cold city waterfront landscape ecological environment planning and design

### 93.5 Conclusion

The image of a city in the cold region is mainly reflected in the city's waterfront landscape environment, which fully embodies the characteristics of a city. But cold city's waterfront landscape design is relative to other first-line developed areas of the city late start, combined with the actual situation of the various cities, and there is no direct reference template for the design of the landscape ecological environment, which is a big challenge for the city's waterfront landscape design in cold regions, but also bring more opportunities and create more room for development. In the course of accelerating urbanization, we have to pay more attention

to the ecological landscape of urban waterfront design, and cold climatic characteristics of effective. We should play its favorable advantages instead of negative changes to make the ecological environment of urban waterfront landscape value.

**Acknowledgments** This paper is one of the achievements of the Eleven-Five Science and Technology project of the Education Department of Jilin Province, with the name research on ecological planning and design on the landscape of small towns in northern cold region, with the number 405 [2009] of Jilin education and science Program words.

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## Chapter 94

# Research on Relations Between Investment and Consumption Model and Transaction Costs

Zhumei Luo

**Abstract** This paper studies several different investment and consumption models, such as investment to the wealth within the scope of the growing model, uncertain investment time range as well as investment and consumption models in the decision-making and the effectiveness of logarithmic functions. It also analyzes several models of investment and the relationship between the characteristics and transaction costs and the model equations. Through comparative analysis, we create a new transaction, which is proportional to the investment and consumption problem of numerical algorithms, and have the establishment of transaction costs and investment and consumption, financial management approach, and puts forward the corresponding investment financial management system.

**Keywords** Investment and consumption model • Transaction costs • Financial management

### 94.1 Introduction

With the continued downturn in the economic development of society and consumption growth, the investment industry is overheating. Return on investment and consumption with transaction costs disproportionate growth, which allows investors to keep thinking about the nature of the distribution of wealth between consumption and cost of investment [1, 2]. Therefore, a lot of investment and consumption model and mathematical model is established; the purpose is to solve the dynamic control of the investment and consumption way, the cost of trading profit [3, 4]. At present, investment and consumption model is based on the traditional

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utility function model of investment and consumption, including the growing model of wealth within the scope of the investment in time to determine the scope of investment of time uncertainty and decision-making and utility of logarithmic functions, investment and consumption model [5].

## 94.2 The Status Quo of Investment and Consumption Model

### 94.2.1 The Wealth Growing Model Within the Investment Time

The model assumes that the probability of a complete range to a function defined in a sheet Lang movement. The investment risk painting is divided into consumption risk and risk-free consumer price ranges, and lists circulating differential equation [6]:

$$P_i(t) = p_i \cdot \exp\left(\int_0^t (b_i(s) - \frac{1}{2} \sum_{j=1}^m \sigma_{ij}^2(s))ds + \sum_{j=1}^m \sigma_{ij}(s)dw_j(s)\right) \quad (94.1)$$

The equation means the initial investment and consumption transaction costs  $X > 0$ , when the process of investment and consumption transactions satisfy  $X(t) > 0$ , then by one of the best investment and consumption transactions, portfolio transaction costs, financial posture model. So the function parameter plant can repeat the operation as a strategy of investment and consumption.

Through game analysis theory, an investor's investment as a game, the games on both sides want to get the effectiveness of the transaction costs to maximize profits through investment scope to determine the time component investment, and consumption model relations calculate the growth in transaction costs to meet the market price of units of measurement and quantitative analysis of a numerical probability.

### 94.2.2 The Time Uncertain Investment Range Investment Wealth Model

We create a continuous differential function model Lebei measure growth, and it is defined as that the probability space is still a one-dimensional movement, but the function of exercise time interval is uncertain. The function equation is [7] as follows:

$$\pi(t) := (\pi_1(t), \dots, \pi_m(t)), t \in [0, T] \quad (94.2)$$

In the equation,  $\pi_i(t) = \frac{\varphi(t) \bullet P_i t}{X(t)}$

In the fixed investment and consumption process A and B, these combinations can be formed since the integration of funding a collection of portfolio collection of A ( $x$ ).

Investors can make the transaction when the cost of trading in the meantime a transaction cost strategy will be transaction costs trading of both feasible and transaction costs for investment and consumption model equation [8]:

$$V(x) = \sup_{x \in A(0,x)} E \left[ \int_0^\infty U(X_{\tau \wedge T}^{\pi,x}) dF_t \right] = \sup_{x \in A(0,x)} E \left[ \int_0^T U(X_u^{\pi,x}) dF_u + U(X_u^{\pi,x}) \right] \quad (94.3)$$

Function is given the uncertain time frame to form a concave function that can be assumed to function as a smooth function, the dynamic model of investment and consumption planning principle to simplify the function, available indefinite period of time to invest in consumer transaction costs wealth model HJB equation condition is as follows:

$$\pi_t^* = -\sigma(t)^{-1} \theta(t) \frac{V_x(t,x)}{V_{xx}(t,x)x} \quad (94.4)$$

#### **94.2.3 The Investment and Consumption Model of Logarithmic Function Decision-Making and Effectiveness**

Based on the first two investments and consumption models, we can derive the terminal transaction costs to the growth model utility function:

$$V(t,x) = P(t) + q(t) \ln x \quad (94.5)$$

Combination of parameters in the equation can be simplified. Optimal investment strategy of the model function equation function is as follows:

$$-rI(\xi_i) + I(\xi_i)\xi_i(\theta'\theta - r) + \frac{1}{2}\xi_i^2\theta'\theta I(\xi_i) + I(\xi_i)\xi_i \frac{v'(t)}{v(t)} \quad (94.6)$$

In the equation, there is no specific investment and consumption model to calculate the specific expression; it can be omitted the value of the equations.

### **94.3 The Numerical Algorithms of Transaction Costs Proportion of Investment and Consumption**

Although the above model equations can be investment and consumption model calculations, but for the first-order nonlinear partial differential equations is generally difficult to calculate an accurate equations. To this end, a new calculation of the proportion of transaction costs, investment and consumption model and numerical algorithm. First of all, there is the new model. Investment and

consumption model based on transaction costs, defined as  $B(t)$ , is standard on the range of the cost of one-dimensional Brownian motion equation:

$$dP(t) = r P(t)dt \quad (94.7)$$

$P(t)$  represents the cost price for the transaction process.

$$dS(t) = \mu S(t)dt + \sigma S(t)dB(t) \quad (94.8)$$

In the equation,  $\mu$  is the expected rate of return of investment,  $\sigma$  is the volatility of investment effectiveness, where  $\mu, \sigma$  is the planting, and  $\mu > r, \sigma > 0$ .

Its numerical algorithm is H. Liu algorithms and will soon the transaction costs range interface problem is transformed to a numerical method as follows:

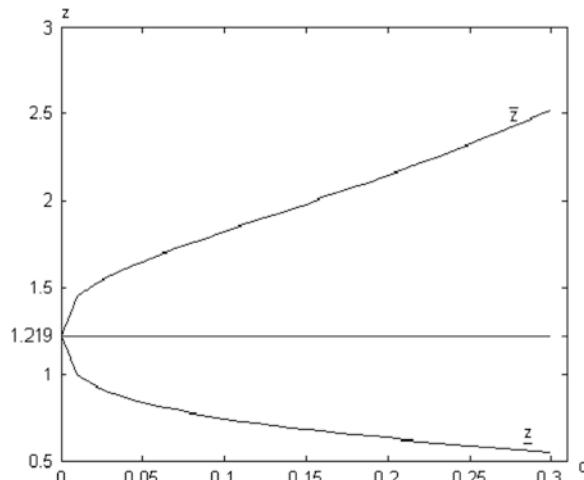
1. Determine the parameter values;
2. Select the colonization, and then use Newton's differential equation solver, to meet the conditions of equation;
3. The use of the equation loop operation, if set up is returned to the model function equation;
4. If the defined parameter interval tends to 0, then the calculation of the end of the output calculation.

First, we select the model parameter values  $\sigma = 0.32$ ,  $\mu = 0.07$ ,  $\rho = 0.02$ ,  $r = 0.03$ ; the transaction rate of  $\alpha$ :  $0 \leq \alpha \leq 0.2$ ,  $\beta = 0.02$ , and then, the calculation results are shown in Fig. 94.1.

When the parameters change, changes in investment and consumption model are shown in Table 94.1 and Fig. 94.2.

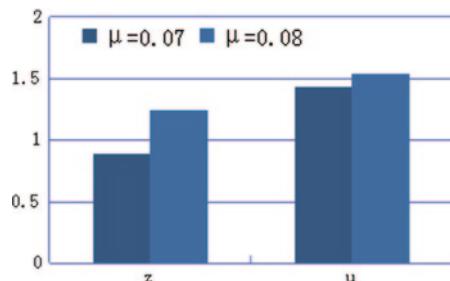
From the table, we know that investment and consumption model results obtained when the transaction costs' expected rate of return  $\mu$  becomes larger and larger, the investors' risk increased.

**Fig. 94.1** Investment and consumption model calculations schematic



**Table 94.1** Investment and consumption model parameters and data sheets

	$z$	$u$
$\mu = 0.07$	0.8897	1.4267
$\mu = 0.08$	1.2372	1.5367

**Fig. 94.2** Investment and consumption model parameters change comparison chart**Table 94.2** The volatility of investment and consumption model parameter data

	$z$	$u$
$\sigma = 0.22$	1.5387	1.5285
$\sigma = 0.32$	0.8342	1.2357

Second, change investment and consumption volatility, changes in the parameter data are in Table 94.2 and Fig. 94.3.

From the table, we know that when the volatility  $\sigma$  increases, the investment risk increases, investors in risky assets are smaller; otherwise, it increases.

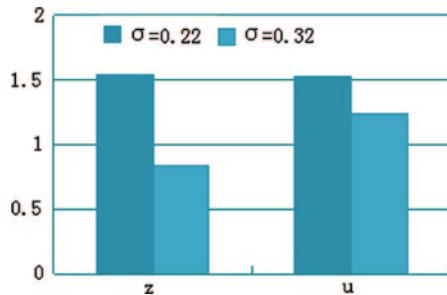
#### 94.4 Financial Management Practices of Investment and Consumption and the Risk of Transaction Costs

Investment and consumption model calculated that the situation shows that there is a big risk between investment and consumption with transaction costs; we must need a rational, scientific approach to financial management, effective cost management and accounting investment.

1. The establishment of strict investment in consumer and business financial management processes

We must establish programs and strategies of scientific investment and consumption; investment and consumption group set up the corresponding transaction costs to the total charge. And investment program and project objectives, planning, according to the needs and validation work of the project the level of risk provisions in the investment business. Investment group should be according to the specific circumstances of changing the investment transaction costs and the instruction process, and continuous feedback dynamics and financial dynamics of the investment projects.

**Fig. 94.3** Investment and consumption model volatility parameters change comparison chart



2. Investment consumer groups need to carry out investment projects in the feasibility study report writing tasks, including a feasibility study on the feasibility of the project objectives and project income. Macro and micro environmental survey analysis, namely the investigation of the development trends of the social environment and internal management, and cultural development.

### 3. Complete investment in financial management systems

In order to meet the completion of the investment business receipts and objectives, well-developed financial statements record the system and continuously recorded to reflect the long-term investment value of transaction costs and short-term books.

### 4. The financial evaluation of investment projects management system

We should use venture capital consumer items to make a rational, scientific risk assessment, making the effective rate of investment increases, reducing invalid adventure. Meanwhile, the project financial management system to the stage of investigation and comprehensive analysis and appraisal, the use of the theory of profit and loss analysis, probability analysis, financial management and analysis methods for the project to measure and decision-making.

### 5. Investment risk mechanisms and financial accounting, reward and punishment mechanism

We should make full use of comprehensive theoretical knowledge as well as corporate financial management reform and innovation of consumer transaction costs on project investment, the establishment of scientific investment and consumption model and system, to speed up investment resources for the cost of regression and rational utilization.

## 94.5 Conclusion

In order to meet the reasonable use of the investment and consumption with transaction costs, through the establishment of several investment and consumption model equation relationship between transaction costs, we make investment analysis from the different investment and consumption model. The interval between the decision-making in the uncertain investment range model of transaction costs, and determine the cost of transactions for investment and consumption time

interval changes, while establishing the numerical algorithm to calculate the formula for the transaction costs of investment and consumption models, and studied the different parameters investment and consumption, changes in risk. Finally, according to a number of issues related to investment and consumption model and transaction costs, we come up with some financial and investment financial management approaches and recommendations.

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# **Chapter 95**

## **Development Strategy of Tourism Industry Based on Innovation Mechanism**

**Yanling Xiao**

**Abstract** With the improvement of income level, tourism has become one of the normal requirements; this requires us to need to understand the needs of the public, development and innovation of tourism industry development strategy. The paper from multiple angles discusses how to establish the innovation mechanism of the tourism industry development strategy, and it will closely combine cultural entrepreneurship and our tourism industry, finally the paper uses APH method to analyze and evaluate the results of this mode of travel, hope it can provide some reference to the development of our country's tourism industry.

**Keywords** Tourism industry • Entrepreneurial mechanism • Development strategy • APH

### **95.1 Introduction**

As income level rise, tourism has become one of the common needs, people can travel to see things and landscapes that never seen before in their lifetime, in order to satisfy their own life needs and increase their knowledge [1]. From the beauty of nature which can make people feel comfortable so that a lot of trouble will disappear like smoke. Therefore, China's tourism industry has also ushered in its own space for development; establishing a new mechanism of the tourism industry development strategy becomes imminent. But we have to take into account that the current tourism industry dilemma, people's require become more and more high, and the tourism industry's impact on the environment is also very serious, how to balance the two situations, and make better develop in tourist industry is a big problem, traditional tourism industry is no longer in line with China's sustainable development strategy, a new novel

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which not only good for the tourism income, but also can reduce environment pollution load from the development strategy of tourism industry is in urgent need of our creation [2]. This paper is based on this situation, which explains the present situation of the tourism industry from my experience and based on a novel strategy, whereby the tourism industry development aspects elaborate [3, 4].

## 95.2 China's Tourism Industry at Present Situation

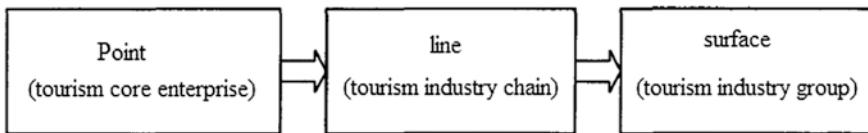
Our country is rich in tourism resources, and there is a lot of tourist attraction, which also has many kinds [5]. The following is some of the basic situations of our country's tourism industry Table 95.1.

China's tourism industry pattern can be divided into three categories; the first category of industry is the industry of transportation, travel, accommodation and catering and tourist attractions. The second type of tourism industry refers to tourist attractions, scenic spots souvenirs, bank insurance, retail, entertainment and leisure activities, tickets and other personal services. Third type of tourism industry is a major ancillary services, such as public services, publishing and printing, food and fuel travel infrastructure. China's tourism industry is also from point to line, and then a line to surface process. Look at Fig. 95.1.

However, one of the prominent problems generated in China's current tourism industry is, the emission of the carbon dioxide. According to statistics, China's tourism industry manufacturing carbon dioxide emissions accounted for the global tourism industry about 5 % of emissions. It is expected that China's

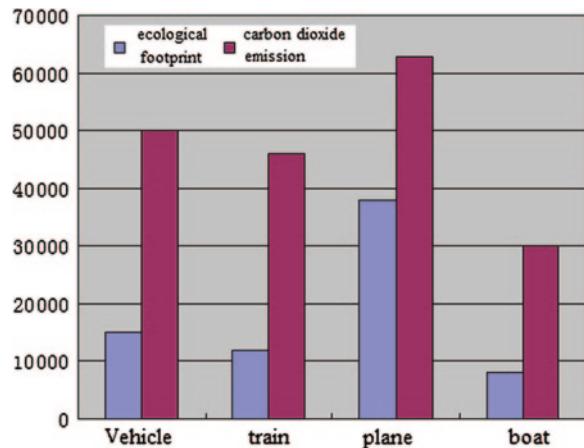
**Table 95.1** The current situation of tourism industry in China

Project	Coastal cities	Northern cities	Southern cities	The country total ratio %
Travel Agency	459	85	73	58.64
Star Hotel	297	63	68	50.17
A scenic spot	16	10	8	49.73
The number of inbound tourism	$94.57 \times 10^4$	$22.43 \times 10^4$	$19.437 \times 10^4$	54.73
Foreign exchange income of Tourism	$89247 \times 10^4$	$9000 \times 10^4$	$8737 \times 10^4$	56.37
Number of domestic tourists	$6500 \times 10^4$	$1680 \times 10^4$	$930 \times 10^4$	40.75
Domestic tourism income	$64782 \times 10^4$	$15420 \times 10^4$	$8700 \times 10^4$	48.55



**Fig. 95.1** The formation process of tourism industry

**Fig. 95.2** The ecological footprint and the carbon dioxide emissions



tourism industry will have 2.5 % growth rate of carbon dioxide emissions every year by 2035, especially in some vegetation, which belongs to man-made damage to tourist attractions. Therefore, it is very necessary to maintain the ecological environment, and the coordination of the relationship between nature and society and to build a balanced, harmonious, low carbon new development model of tourism industry [6]. In this paper, we use the formula to judge our country's tourism industry eco safety coefficient without any consideration of the ecological footprint. Through considering the ecological footprint of energy consumption only produced by the automobile, aircraft and ships and other vehicles, we get the following Fig. 95.2.

**Table 95.2** The value of the ecological safety criteria for the classification

Ecological security types	Security	Security threats	Security unsafe	Serious unsafe
GESC	$GESC \geq 1$	$0.75 \leq GESC \leq 1$	$0.5 \leq GESC \leq 0.75$	$0 \leq GESC \leq 0.5$
SESC	$SESC \geq 1$	$0.95 \leq SESC \leq 1$	$0.9 \leq SESC \leq 0.95$	$0 \leq SESC \leq 0.9$

In modern transportation, although the aircraft speed brings us a great convenience, in all the statistics of traffic tools, the plane produces large amount of carbon dioxide. So, this is what we need to control. Table 95.2.

### 95.3 The Development Strategy of Tourism Industry Innovation System

Due to the people's need, the tourist attractions are increasingly demanded, the way that people will enjoy their lifestyles also had a big change. If it is still in the past tourism development mode, people will not accept, coupled with the tourism industry to the environment brought huge negative effect. It is very important to appear a method based on the innovation mechanism of tourism business development strategy, which is the use of creative culture and tourism industries combined method to realize a kind of new tourism industry development strategy. This approach not only changed the traditional way, but also can give people new tourism environment, in order to meet the real needs of people and the mechanism innovation fundamentally solves the environmental pollution caused by the conflict, and mechanism innovation of this kind is exactly our country needed now. The cultural and tourism industries combined mode.

The cultural and tourism industries combined mode is based on creating a culture of creativity, and then bring the creative cultural tourism, promote the cultural creative tourism. However, it needs government construction support system, to ensure that the tourism industry and cultural creative enterprise integration and development, by building the legal laws and regulations, using various means and form to strengthen the management of ecotourism, to make Chinese ecological tourism healthy and sustainable development, and strive to achieve tourism development and environmental protection, and the win-win goal between human and the nature harmonious. But for this new mechanism, we first need to promote the conception, and then to construct the production, establish the market, and at the same time, talent training is indispensable for this kind of tourism and cultural creativity. In order to make better the implementation of the sustainable development of tourism resources, China must increase the protection of tourism resources in research and personnel training. To reach the target, firstly, our country should encourage more students to apply to the specialty school of tourism; secondly, having a good planning on post-graduate courses so that these people can get better education to promote China's tourism industry and cultural creative fusion development. For implement this strategy, you must follow the below steps Figs. 95.3 and 95.4.

Finally, taking a city tourism industry as an example, in the city's tourism industry, we carry out the development strategy of combining creative culture and tourism industry, analysis how much economic benefit this new mechanism bring to this city. The paper selects method is called APH method and Grainger causality test.

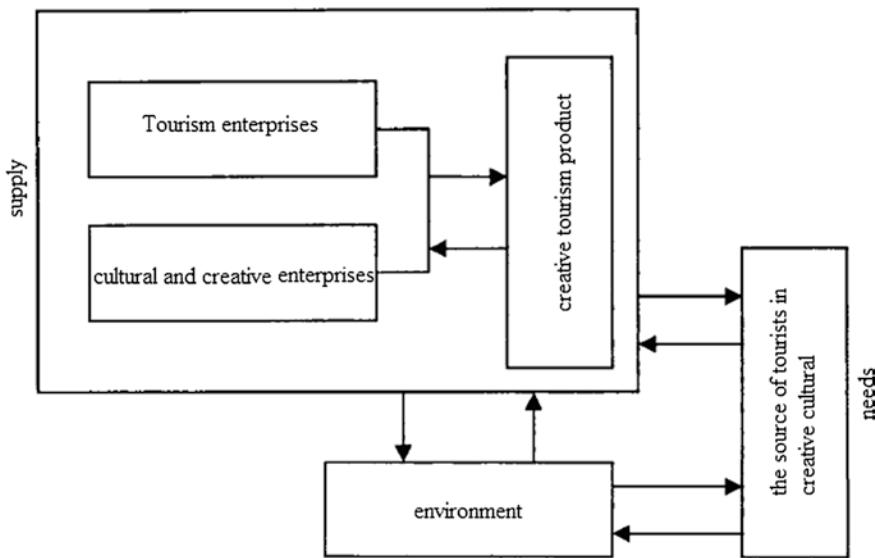


Fig. 95.3 Cultural and tourism industries combined model

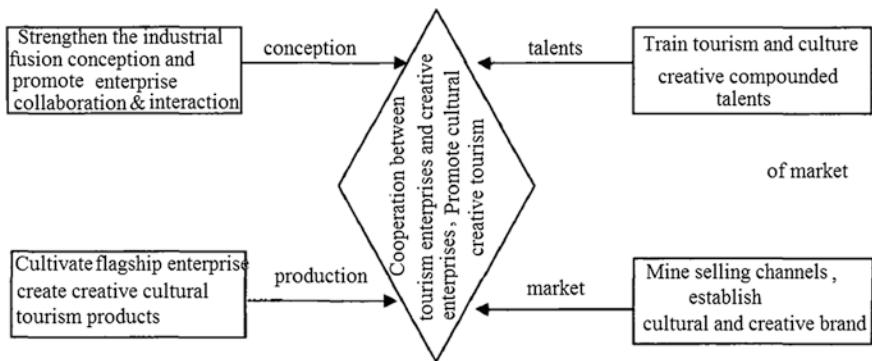


Fig. 95.4 The strategy implementation way

First step is the establishment of mathematical model, then, we must construct a matrix according to these factors [7, 8]:

$$R = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ r_{31} & r_{32} & r_{33} & r_{34} \\ r_{41} & r_{42} & r_{43} & r_{44} \end{bmatrix} \quad (95.1)$$

$$R = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \quad (95.2)$$

Next step is the hierarchical ranking [9]:

$$A_1 : a_1 b_{11} + a_2 b_{12} + \dots + a_m b_{1m}$$

$$A_2 : a_1 b_{21} + a_2 b_{22} + \dots + a_m b_{2m}$$

...

$$A_n : a_1 b_{n1} + a_2 b_{n2} + \dots + a_m b_{nm}$$

(95.3)

	$A_1, A_2, \dots, A_m$ $a_1, a_2, \dots, a_m$	Hierarchy ordering
$B_1$	$b_{11} b_{12} b_{1m}$	$\sum_{j=1}^m a_j b_{1j} = b_1$
$B_2$	$b_{21} b_{22} b_{2m}$	$\sum_{j=1}^m a_j b_{2j} = b_2$
...	.....	.....
$B_n$	$b_{n1} b_{n2} b_{nm}$	$\sum_{j=1}^m a_j b_{nj} = b_n$

According to this table, we use APH method to get the results, which display in the following table.

X1, Y1 are X, Y first-order differential sequence, X2, Y2 are X, Y two order difference sequence. C is a constant, n represents the trend and direction, and the meaning of P is order number. The value of X1 did not change significantly, but the Y1 values are kept swinging, so we need to use Grainger test to testing, analysis of its specific trajectory. The value of X1 after the T values of the results is 2.687485, apparently greater than 1 %, but less than the other two numerical critical values, so the figure shows that cultural and tourist industries combined model is very stable under any environment, and it can be basically very effective. The value of Y1 is obviously not 10 %, its 2.61479, which shows the wave series. The following X2, Y2 are not listed any more, which has been very clearly. Next is the use of Grainger test to test on X1 and X2. We make X as tourism

**Table 95.3** The results of APH method

Variable	(c, n, p)	ADF	1 %	Critical value 5 %	10 %
X	(c, n, 0)	1.555682	-4.29821	-3.54782	-21485
Y	(0, 0, 0)	10.86547	-4.29821	-3.54782	-3.21485
X1	(c, n, 0)	-2.45875	-2.65872	-1.95835	-1.62574
Y1	(0, 0, 0)	1.875695	-4.33258	-3.57426	-3.22658
X2	(0, 0, 0)	-9.35585	-2.68746	-1.95874	-1.62485
Y2	(0, 0, 0)	-2.65422	-2.57821	-1.95874	-1.62485
e	(0, 0, 0)	-2.47826	-2.64785	-1.97463	-1.62166

**Table 95.4** The test result

Hypothesis	P	F	P	Result
X<= Y	1	5.584456	0.015854	Accept
X<= Y	1	0.587412	0.427952	Reject
X<= Y	2	2.748562	0.058422	Accept
X<= Y	2	3.725496	0.035585	Accept
X<= Y	3	3.854863	0.047263	Accept
X<= Y	3	2.841724	0.023585	Accept
X<= Y	4	2.025871	0.012536	Accept
X<= Y	4	3.331472	0.015277	Accept

revenues, Y shows the city's all income and make  $Y = 35874.78 + 22.84569X$  and  $A = 0.856745$ ,  $B = 2.025836$ , and the test results are as follows Table 95.3.

From the table, we found only second is rejected, it shows that it is a promising development strategy to combine creative culture and tourism, and it is necessary for us to carry out the plan Table 95.4.

## 95.4 Conclusion

In this paper, considering the current tourism industry dilemma, on one hand, people's requirement becomes more and more, on the other hand, the tourism industry has big impact on the environment, how to balance the two situations to develop tourist industry is a big problem. This paper puts forward the creative culture and tourism industry integration innovation mechanism development strategy, and uses APH method and Grainger method to analyze whether this kind of new development strategy in the implementation process can be implemented. Only a very small part, due to a local tourist attraction of its own characteristics, cannot be very good for tourism industry, other data which are described based on the innovation mechanism of the strategy of tourism industry development has a good operability.

**Acknowledgments** This paper belongs to the strategical achievements of the Research Center for Guangdong-Hongkong-Macao enterprises transferation, the key construction Research Base of eleventh five Humanities and Social Sciences for Universities of Guangxi, with the Project number [2007] 20. It concludes more than the following specific project: the scientific research project of Wuzhou University with the name The Strategy Research on How to Develop Low Carbon Tourism for Guangxi and the Project ID [2011] 50.

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# Chapter 96

## Geographical Profile Establishment Based on ANFIS and Fuzzy Matter-Element Analysis

Lijun Cheng, Haiyan Zhao, Jiahua Tian and Yilei Kou

**Abstract** Firstly, the researchers compile the ANFIS's fuzzy systematic procedure into the MATLAB software and input the times of criminals of its completely criminal category who belong to the studied city; subsequently, it can produce the list of possible happened criminal regions of all kinds of crimes in each city. Moreover, the researchers compile the subtractive clustering initialization fuzzy deducing ANFIS model into the MATLAB software and input the data of serial crimes and the potential criminal regions got from the above procedure into this software, then it can produce the possible happened regions of the criminal rate of the definitely criminals. Therefore, it is necessary to do the checking in the regions where there are high criminal rates.

**Keywords** Adaptive network-based fuzzy inference system (ANFIS) • Fuzzy matter-element analysis • Commensurability

### 96.1 Introduction

Because crime is a very complicated system, the fuzzy words in the case will cause the result that it is impossible to predict crime by using the accurate and irreconcilable model [1]. Therefore, in recent years, the scholars in various countries focus their attentions on the study of complicated system of self-learning and parameter's obscure system's self-regulating. By applying the neural network's self-learning function into the obscure systematic model, the researchers can construct the ANFIS, and its notable character is that this type of system based on the data's modeling model, which can construct systematic obscure degree of membership functions as well as the fuzzy principle by using the vast

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known data's studies [2]. So, it is most important to master the system of the huge data and the complicated character's huge specimen. Usually, the geography and the humanity's character in one zone will determine the number and type of this district. Because there is no obvious function's relation existed between the districts and crimes, the only possible way is to do the data mining by analyzing vast kinds of criminal date and criminal districts, then it can obtain the inner connection between all kinds of crimes and districts. In this paper, the researchers adopt the Scheme of ANFIS to do the automatic data mining of the huge criminal data's bank, to construct the obscure and regularly deducing system, which can be used in the judgment of continuous and similar kind of crimes and districts [3, 4].

## 96.2 T-S (Takagi-Sugeno) Fuzzy Model

The former part of T-S (Takagi-Sugeno) Fuzzy Model's fuzzy rule is the fuzzy form, and the latter part is its common value or lineable equation, its fuzzy rules are as follows:

$$R^i : \text{if } x_1 \text{ is } A_{i1}, x_2 \text{ is } A_{i2}, \dots, x_n \text{ is } A_{in}, \text{ then } y_i = c_{i0} + c_{i1}x_1 + c_{i2}x_2 + \dots + c_{in}x_n \quad (96.1)$$

In this case,  $i = 1, 2, \dots, l$ .  $l$  represents the totality of the rules,  $x_i$  ( $i = 1, 2, \dots, n$ ) represents variable,  $A_{ik}$  ( $i = 1, 2, \dots, n$ ) represents the inputting fuzzy language figure, and  $c_{ik}$  ( $k = 1, 2, \dots, n$ ) represents the concluding parameter.  $y_i$  is the number  $i$ 's regular output.

Supposing the researchers have got a given inputting vector  $(x_1, x_2, \dots, x_n)$ , then according to the above-mentioned rules, it can get the weighted average of  $y_i$ ; furthermore, it can get inputting figure  $y$ .

$$y = \frac{\sum_{i=1}^l w_i y_i}{\sum_{i=1}^l w_i} = \frac{\sum_{i=1}^l w_i (c_{i0} + c_{i1}x_1 + c_{i2}x_2 + \dots + c_{in}x_n)}{\sum_{i=1}^l w_i} = \frac{\left[ \sum_{k=0}^n \sum_{i=1}^l w_i c_{ik} x_k \right]}{\sum_{i=1}^l w_i} \quad (96.2)$$

In this equation,  $x_0 = 1$ ,  $w_i$  is the number  $i$ 's *f-then*'s regularly weight number.

$$w_i = \prod_{k=1}^n \mu_{A_{ik}}(x_k), i = 1, 2, \dots, n \quad (96.3)$$

$\mu_{A_{ik}}(x_k)$  is the element  $k$ 's degree of membership in fuzzy collection  $A_{ik}$ .

Systematic Structure of ANFIS

The systematic structure of ANFIS can be divided into 5 levels; each panel point in the same level has the similar functions.

The first level is the input level.

The second level is the fuzzy level, that is to dim the input data.

$$A_{ik}(x_k) = \mu_{A_{ik}}(x_k), i = 1, 2, \dots, l k = 1, 2, \dots, n \quad (96.4)$$

$A_{ik}(x_k)$  is the number  $i$ 's panel point of the subordinate function.  $A_{ik}$  is number  $i$ 's language variable of element  $k$ .

The third level is to obtain the degree of rule's intensity, that is, to obtain each input message's multiplicated product of degree of membership.

$$w_i = \prod_{k=1}^n \mu_{A_{ik}}(x_k), i = 1, 2, \dots, n k = 1, 2, \dots, n \quad (96.5)$$

The fourth level is to get the specific value between the number  $i$ 's rule  $w_i$  and the sum figure of the entire rule  $w$ .

$$\bar{w}_i = \frac{w_i}{\sum_{i=1}^l w_i} \quad (96.6)$$

Each of the fifth level's panel point is the self-adaptive panel point, number  $i$ 's output is  $out_i = \bar{w}_i y_i$ , and  $y_i$  is the conclusion of number  $i$ 's rule.

The sixth level is the output level.

$$y = \sum_{i=1}^l \bar{w}_i y_i = \frac{\sum_{i=1}^l w_i y_i}{\sum_{i=1}^l w_i} i = 1, 2, \dots, l \quad (96.7)$$

### 96.3 The Systematic Algorithm of ANFIS

**Subtraction Cluster:** The subtraction cluster is a quick calculation of one-pass to evaluate the number of clusters and the central location of clusters in one date's group. So, the evaluations we got by using this Scheme can be applied into recognizing the Scheme adopted in the model and initializing the fuzzy clusters based on the repeated optimizing procedure [5].

This paper can get the initializing vague deducing system by applying subtraction cluster, then, by inputting the output figures to do the furtherer systematic optimizing, therefore, the researchers can get the reasonable fuzzy deducing system. The subtraction cluster Scheme can be realized by transferring function sub-clust through MATLAB [6, 7].

**The systematic algorithm of ANFIS:** To do the regulation of the function's degree of membership's parameter by using counter propagation Scheme, which following the rules of descending the negative gradient of the error functions [8].

Let us define the error function to be  $E = \frac{1}{2} (y - t)^2$

The fuzzy subordinate function in the collection adopts Gauss function.

$$A_{ik}(x_k) = \exp \left[ -\frac{(x_k - a_{ik})^2}{\sigma_{ik}^2} \right] \quad (96.8)$$

Let us define  $v_i$  to be parameter vector of the model,  $v_i = [a_i, \sigma_i, c_i]^T$

$$v_i(k+1) = v(k) + \eta \Delta v_i = v(k) - \eta \frac{\partial E_n}{\partial v_i} \quad (96.9)$$

Here,  $\eta$  is the learning efficiency.

$$\begin{aligned} \sigma_i(k+1) &= \sigma_i(k) - \eta \frac{\partial E_n}{\partial \sigma_i} \\ &= \sigma_i(k) - \frac{2\eta}{\sigma_i^3} (y - t) (c_i - y) \bar{w} \sum_{i=1}^n (x_k - a_i)^2 \end{aligned} \quad (96.10)$$

## 96.4 Analysis of the Series Criminals' Cases in Dallas

This paper uses the criminal data in Dallas to count and catalog thousands of figures so that to deal with the data, to check the figures and to test it.

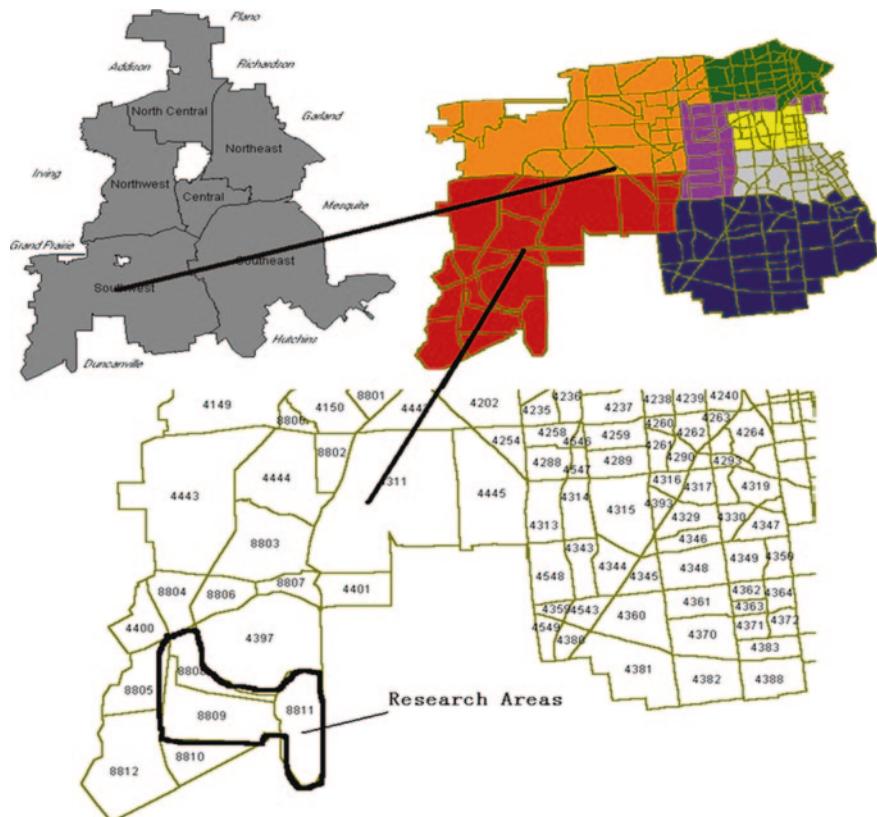
Now, the researchers have got all of the criminal figures of the districts in Dallas, ranging from 92 to 07 years. Taking the criminal figures of the three districts 8808, 8809, 8811, which is divided by the Dallas police station from 92 to 07, for example, according to the following table, it is known that the studying districts locate in the West-South corner's black frame in Dallas' South part marked by red color [9] (Fig. 96.1).

The following Table 96.1 shows the all kinds of crimes of the three districts (8808, 8809, 8811) ranging from 05 to 07 years.

To classify all of the criminal date, and let us take it as the neural network training's sample data. Then, to draw a safety coefficient picture of completely districts in Dallas according to the criminal figures statistics in this domain, this picture can play a predicted alarming role.

It can be regarded as safety if the crime is less than one case each day. It can be regarded as middle level if the crime is limited in the domain 3–5 cases. If the crime overpasses three, it can be regarded as danger.

Putting the given sample figures into ANFIS's fuzzy system, let us check by using the figures of 2009, it can get the tested error TextRMse = 0.0683, it is clear that the ANFIS's fuzzy system connects logical thought and linguistic expressing ability with the ability of self-study, it mixes the advantages of neural network and vague theory, respectively, and at the same time, it also makes up the disadvantages of them. Because the ANFIS's fuzzy system's model has high qualification to the training data and the checking data, if the data contains high noises, it may



**Fig. 96.1** The criminal figures of the districts in Dallas

**Table 96.1** The all kinds of crimes of the three districts

	8808	05	06	07	8809	05	06	07	8811	05	06	07
Murder	0	0	0	0	Murder	0	0	0	Murder	0	0	1
Rape	0	0	0	0	Rape	0	0	0	Rape	5	6	5
Business robbery	0	0	0	0	Business robbery	1	0	0	Business robbery	4	3	1
Individual robbery	0	2	1	1	Individual robbery	0	0	0	Individual robbery	4	3	8
Aggravated assault	1	1	3	3	Aggravated assault	0	0	1	Aggravated assault	13	20	20
Business burglary	3	3	2	2	Business burglary	0	0	5	Business burglary	13	15	13

occur the phenomenon that the systematic structure's parameter could not match with the training data, and it also exists the situation that the training step number to be over fitting. In this paper, it can get highly correct rate if it sets the training

step number within 30–40. It is feasible and effective to predict the places where may happen the similar crimes next time by using the ANFIS's fuzzy system.

Therefore, after the researchers got a new crime, it can deduce the district's serial number of the similar crime which may happen next time, and the serial number may be very large and may occur in the situation that it is not a kind of serial crimes, so the researchers must do the further selection of given places by using the Fuzzy Matter-element Analysis Scheme.

## 96.5 Fuzzy Matter-Element Analysis Scheme

Fuzzy Matter-element Analysis: Matter element has three essential factors which including object, character and magnitude. If the magnitude factor has fuzzy character, this can be called as Fuzzy Matter element

$$\text{fuzzy matter} = \begin{bmatrix} & & \text{object} \\ & \text{character} & \text{vague} & \text{magnitude} \end{bmatrix} \quad (96.11)$$

Here,  $M$  represents object, and  $C$  represents the object's character,  $\mu(x)$  represents the degree of membership of object  $C$ 's character which relative to magnitude  $x$ .

Therefore, it can express the  $n$  dimension's complex fuzzy matter element of the numbers of  $m$ 's relative object as follows:

$$R = \begin{bmatrix} M_1 & M_2 & \cdots & M_m \\ C_1 & \mu(x_{11}) & \mu(x_{21}) & \cdots & \mu(x_{m1}) \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & \mu(x_{1n}) & \mu(x_{2n}) & \cdots & \mu(x_{mn}) \end{bmatrix} \quad (96.12)$$

According to the same theory, it can construct the  $n$  dimension's complex vague matter-element matrix of the numbers of  $m$ 's standard object. If the equation adopts  $R_w$  to represent each object's all characters' weighting complex matter element, and taking  $w_i$  ( $i = 1, 2, \dots, n$ ) to represent each object's the number  $i$ 's characteristic weighting, it can get

$$R_w = \begin{bmatrix} C_1 & C_2 & \cdots & C_n \\ w_i & w_1 & w_2 & \cdots & w_n \end{bmatrix} \quad (96.13)$$

By the same Scheme, it can obtain the double-deck weighting complex matter element:

$$R_w = \begin{bmatrix} C_1 & C_2 & \cdots & C_n \\ w_i & w_1 & w_2 & \cdots & w_n \\ C_{11}C_{12}\cdots C_{1p} & C_{21}C_{22}\cdots C_{2p} & \cdots & C_{n1}C_{n2}\cdots C_{np} \\ w_{ik} & w_{11}w_{12}\cdots w_{1p} & w_{21}w_{22}\cdots w_{2p} & \cdots & w_{n1}w_{n2}\cdots w_{np} \end{bmatrix} \quad (96.14)$$

### Steps of Fuzzy Matter-element Analysis

The main steps of Fuzzy Matter-element Analysis are as follows:

1. Constructing complex matter-element's matrix.
  2. Transferring complex matter-element's matrix into membership degree's matrix. This transfer should introduce the priority principle, the concrete rules take such model: the greater the better, then the transferring formula to be
- $$\mu_{ji} = \frac{X_{ji}}{\max X_{ji}} \quad (j = 1, 2, \dots, n; i = 1, 2, \dots, n) \quad (96.15)$$
3. Transferring the degree of membership's matrix into correlation coefficient matrix. Obviously, this step takes the degree of membership  $\mu_{ji}$  as correlation coefficient  $\zeta_{ji}$ , then it forms corresponding correlation coefficient's matrix.
  4. Obtaining the degree of association's vector. In the correlation coefficient matrix, each object has its number  $n$ 's correlation coefficient, and a certain object's centralized value of all of the correlation coefficient is the degree of association. It takes  $K_j$  to express the number  $j$ 's object's the degree of association. Number  $M$ 's object's the degree of association constitutes the vector of the degree of association.  $R_w$  has been used to represent the weighting complex matter element of each object's all kinds of evaluation indicators. Taking  $R_k$  to represent the degree of association's complex fuzzy matter element (vector of the degree of association) constituted by number  $m$ 's degree of association. Adopting the Scheme of the weighted arithmetic average to dispose + these data, it can get  $R_k = R_k \times R_\zeta$ , ' $\times$ ' is the mark of the operator.
  5. Disposing of the degree of association. The paper adopts the disposing Scheme of the sorting of the degree of association to deal with the gotten degree of association; that is, after obtaining the degree of association, it needs to make the comparison in order to get most required results.

By using fuzzy matter-element analysis Scheme to analyze the characteristic of objects of the serial crimes and doing the further place's selection which is predicted by neural network, the purpose of it is to select highly the degree of association's places, and these places proved to be the potential serial crimes' highly happened places.

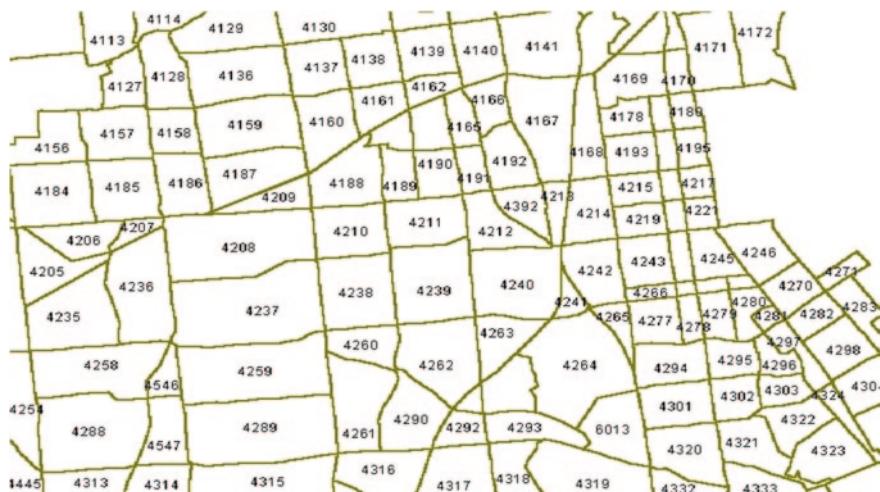
## 96.6 Analysis of the Series Criminals' Cases in Dallas

Now, let us testify the series criminals' cases in Dallas once again which occurred in the Scheme one, let us transfer the crime's address into the serial number specified by the local police's network in Dallas. Thus, we can obtain the Table 96.2 as follows:

Constructing the ANFIS's operating Scheme by using the tool case of MATLAB's neural network, meanwhile, taking advantage of subclust functions by applying MATLAB to realize subtraction cluster. Let us construct the storage

**Table 96.2** The crime's address into the serial number specified

Address	Mark	Corresponding serial number
W Jefferson Blvd, Dallas, TX	S1	4138
Cockrell Hill Rd, Dallas, TX 75212	S2	4089
S Oak Cliff Blvd, Dallas, TX 75208	S3	4236
Perimeter Rd, Dallas, TX 75212	S4	4086
Arcadia Park, Dallas, TX	S5	4129

**Fig. 96.2** The ANFIS's operating scheme by using the tool case of MATLAB's neural network**Table 96.3** The relation of degree of association

The serial address number	Degree of association	The serial address number	Degree of association
4113	0.01865	4206	0.03512
4129	0.15699	4209	0.25416
4130	0.12698	4210	0.03845
4158	0.03476	4237	0.0344
4160	0.01628	4260	0.01451
4186	0.22154	4414	0.0312

matrixes of places in Dallas and the criminal types. Then, the executer inputs the criminal addresses, its happening time and its criminal types into the neural network, and then ANFIS will provide the place's serial numbers of such similar cases when happen next time Fig. 96.2.

By applying this case's data, then finally, we can get the possible 12 places marked by 4113, 4129, 4130, 4158, 4160, 4186, 4206, 4209, 4210, 4237, 4260, 4414.

Subsequently, the researchers analyze the relative factors within the serial crimes obtained by using the Principal Factor Analysis Scheme and adopt the fuzzy matter-element analysis Scheme to confirm the complex matter-element matrix. It can get the relation of degree of association by transferring into the degree of membership's matrix and association matrix. The results are shown as in Table 96.3:

It is obviously that the degree of association is in descending order. Factually, the fifth robbery happens in the highly degree of association's place 4209. The degree of association's difference between 4209 and 4186 is 0.03262. Therefore, this case's difference is less than 0.03262.

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# **Chapter 97**

## **Study on Protection of Water Environment in the Three Gorges**

**Yanfang Zhang**

**Abstract** This article has introduced legal defects existing in protection of water environment in the Three Gorges from five aspects, which includes the lack of a ruling law, lack of special river basins administrative organization and coordination mechanism, the public having tenuous consciousness of environmental protection, defects in water use system and lack of market mechanism for the pollution control. The author has put forward his own advice according to the above five aspects in the end, which are to formulate prevention and control regulations of the water pollution in the Three Gorges, establish water environment management committee, encourage the public to participate in these activities and perfect compensation systems for use of water and chargeback system for pollution discharge.

**Keywords** Three Gorges • Protection of water environment • Problems • Suggestions

### **97.1 Introduction**

The Three Gorges Project is a world-famous and cross-century engineering which has received much attention. After the impoundment of the Three Gorges dam, the Yangtze River flow greatly slows down and its capacity of self-purification has fallen, and environmental capacity of pollutants has also fallen sharply, while the level of pollution of water in the reservoir is increasing. In 2004, according to the Monitoring Results of the Ecology and Environment in Yangtze Three Gorges Project issued by the state environmental protection administration, it shows that at present, although most of the 26 wastewater treatment

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plants and 21 garbage disposal plants have been finished and put into use, and some ports in the reservoir region have ship garbage receiving place and garbage receiving ship, but the sanitary sewage and oil wastewater from ships are also rising. The amount of various pollutants in the reservoir region has a significant increasing trend, and the water environment is facing a serious pollution [1]. In the reservoir region of the Three Gorges, the protection of water environment has achieved some good effect, and the quality of water is overall good, but pollution of subprime river is relatively heavy, and in the Three Gorges reservoir region, local water area has formed the relatively obvious pollution zone, including the overweight pollution zone. Although in recent years, the situation is improved, but it is still not optimistic. How to use legal better to protect the water environment in the Three Gorges reservoir region has become a problem which is urgent to solve [2].

## **97.2 Problems About Law in the Protection of Water Environment in the Three Gorges**

### ***97.2.1 Lack a Ruling Law for Yangtze River Basin***

At present, we lack a ruling law for Yangtze River basin. For example, in the Australian Murray-Darling basin, a Murray-Darling River basin agreement was concluded in October 1987, and the purpose of this agreement is to promote and coordinate effective planning and management activities in order to make use of water, land and environmental resource in Murray-Darling basin fairly, effectively and sustainably [3]. This agreement has solved the affairs in the basin well, and it provides a law for the watershed management. While in the Yangtze River, we still lack a ruling legal instrument, which makes it hard for the river basin management department to handle affairs according to legal basis.

### ***97.2.2 The Three Gorges Reservoir Region Lacks Special River Basins Administrative Organization and Coordination Mechanism***

China has established the Yangtze River Water Conservancy Committee as the Yangtze River basin management institutions and passed legislation to confirm its legal status and gave it the management power. However, the Yangtze River flows through 19 provinces, cities and autonomous regions, and if we rely only on the Yangtze River Water Conservancy Committee to manage the river basin in so many administrative areas, its efficiency and effect will not be ideal. As the most important and the most special valley, there has been no branch management

mechanism which is specially established for the Three Gorges reservoir basin, which is not good for the protection of the water environment.

### ***97.2.3 Both the Prosecutor and the Public has a Tenuous Environmental Protection Consciousness***

In the process of enforcing law in the Three Gorges reservoir area, many environmental protection personnel take individual as the standard and value personal interests, which is the primary reason why the environmental protection supervision is not good and law enforcement is lax. And this is one of the roots for the insufficient funds and low efficiency [4]. In addition, the ordinary people in the reservoir region have poor consciousness to protect ecology in the water environment, so there are many direct polluting behaviors, which is also one of the elements to cause water environmental degradation.

### ***97.2.4 Water Use System has Defects***

In the new Water Law of the People's Republic of China, the item 54 formulates that people's governments at all levels shall actively adopt measures to improve the urban and rural residents' conditions of drinking water. Item 55 formulates that once using the water supplied by water project, people shall pay water charges to water supply department according to state regulations. The water price should be confirmed in accordance with the principle of compensation cost, reasonable profits, high quality and high price, fair burden. The specific measures will be formulated by people's government at or above the provincial level and the water conservancy administrative department at the same level or other water conservancy administrative department according to authority. Though the two rules has explicitly stipulated pricing principles and methods for water resources, government should take measures to improve the drinking water conditions, but there is no regulation for the fee to improve the relationship between the use of and sewage processing. At present, the people in reservoir region not only need to pay the raised price for the water, but also pay certain sewage processing fee. Although the burden is increased for ordinary people, it is helpful to perfect water price system and protection of water resources [5,6]. The fact is that the fee is collected, but government and the environmental protection departments continue to declare the lack of funds and hope state to give more support. Water raise is originally an scientific and effective measure to protect water resource, but the system is not strict enough so that the fee charged is mainly used to ensure the interests of water supply department, and it is rarely used for water resources management and protection, which increases people's burden, and water environmental protection funds have not gotten ensured.

### ***97.2.5 Lack of Market Mechanism for Pollution Abatement***

Currently in the Three Gorges reservoir region, no matter sewage treatment, waste disposal or pollution charges has not introduced market mechanism because of the lack of competition, which leads to the high cost in pollution and low efficiency in garbage processing; moreover, the water environment management funds primarily rely on state special financial, the sewage charge planned by National Environmental Protection Bureau and income from electricity of the Three Gorges Project; however, there is no social capital and foreign capital investment, and the special funds for the Three Gorges water environmental protection have not been established. The lack of market mechanism has directly caused a bad result in pollution abatement, and pollution in many places is very serious.

## **97.3 The Suggestion to Strengthen the Legal Protection for Water Environment in the Three Gorges Reservoir**

### ***97.3.1 The Suggestion to Formulate Regulations About the Prevention and Control of Water Pollution in the Three Gorges Reservoir Basin***

According to the advanced foreign experience of watershed management, we find that not only the river basins administrative agencies but also the watershed management special laws should be formulated so as to manage water. At present, China has not yet issued special law for the Three Gorges reservoir of the Yangtze River, and the existing special legislation is the Water Pollution Control Ordinance for Yangtze Three Gorges reservoir area in Chongqing. Although 85 % of the reservoir area is in Chongqing, the ordinance does not apply to the whole reservoir area. The author thinks that in addition to the prevention and control law for water pollution in Yangtze River basin, a more specific regulation like the control regulations for water pollution in the Three Gorges reservoir basin is still needed. The law should be formulated by Chongqing and Hubei Province with river basins administrative agencies, so that Chongqing and Hubei Province do not need separate legislation, and the regulations can fully embody the characteristics of the Three Gorges reservoir basin and needs, which will be useful for the water environment protection in the Three Gorges reservoir region.

### ***97.3.2 Suggestion to Establish a Management Committee for the Three Gorges Water Environment***

The author suggests setting up a management committee for the Three Gorges water environment, and it will exercise the function of management and

protection for water environment. At present, as the river basins administrative agencies, the Yangtze River Water Conservancy Committee is wielding various functions. But the author thinks that it is a bit farfetched for the Yangtze River Water Conservancy Committee to manage the entire Yangtze River basin, and it turned out that the management efficiency of the Yangtze River Water Conservancy Committee is not high. Both local environmental administrative departments and some state-owned enterprises which are responsible for pollution treatment project are calling for a special water environment management agency for the Three Gorges reservoir area to unified management. In addition to establishing a management committee for the Three Gorges water environment, we should also take the reference of foreign basin management such as establishing river basin and local coordination mechanisms and establishing the coordination agency in the management committee. The author thinks that the personnel of the coordination agency should be made up of members of the Three Gorges water environment management committee, local government and local environmental protection department and the coordination agency which represents multi-stakeholder to play an active role in the management of the Three Gorges reservoir area. Cooperating agencies should hammer at solving the conflict between holistic legislation for the valley and the local legislation to maintain coordination between overall interests and local interests so that all kinds of legislation can form an organic whole. The coordination agency also should make full collection of information on water environmental management and protection and research to supply information support for the watershed organizations, government and related departments to make decisions. At the same time, the coordination agency needs to publicize information and provide consultation service about water resource and water environment information for residents.

### ***97.3.3 Encourage the Public to Participate in the Management for the Three Gorges Reservoir Area***

Usually, there will be many relevant professional experts in the river basins administrative agencies of various countries, in the process of making significant decision, and their suggestions will be widely listened to and adopted; what is more, the suggestions will be used for scientific demonstrations. For example in Australia from 1994, any scheme about water resources in any river basin must make proper environmental assessment before it is passed so as to fully consider the environmental value. Any relevant water policy must have detailed plans before determined, and these plans must be estimated by authoritative professional department and approved by general public before implemented, otherwise it is illegal. When passing any law about water allocation, people must take the most scientific and most extensive information analysis for the premise so as to maintain the ecological environment that water rely on and realize the

ecological value and society value of water [5]. Moreover, in the view of river basin management that involves various social interests, foreign river basin management also pays attention to the public's participation, and it absorbs many residents and social circles in river basins administrative agencies as members who take up a big proportion, which are good for strengthening the democratization of watershed management, scientific and transparency so as to realize efficient utilization and sustainable development of the basin. These measures are good reference to the management of water resources in the Three Gorges reservoir area.

#### ***97.3.4 Perfect the Paid System for Water Resource***

First, we should clearly stipulate residents' fee for water in the legislation, and the water rates except for water costs and the reasonable profits must be used for the management and protection of water resources and also used to improve the quality of river body and drinking water in the Three Gorges reservoir area constantly; secondly, provision should be made more specific to earmark sewage treatment for its specified purpose only, and the fee must be used exclusively for construction and maintenance of the sewage treatment, and it should be made sure that sewage treatment fee has nothing to do with related personnel's personal income; third, the nature of the fee including sewage treatment fee should change from administrative charges to company charges gradually, which is also the inevitable requirement for water supply and sewage disposal to realize marketization.

#### ***97.3.5 Perfect the Paid System for Pollution Discharge***

The author thinks that we should stipulate the relevant finance departments to establish independent expenditure projects for pollution discharge fees and strictly distinguish it with other funds to fully guarantee the fees that are all used for protection and management of water environment. So, we must complement or revise the terms of the related laws as soon as possible. In addition, we should not charge the sewage treatment plant and other pollution treatment unit, and the main reason is that these units' pollutants are rooted in the pollutants that they have handled; if we change them, it will certainly affect their efficiency and enthusiasm of work. Moreover, even if the collection objects cannot be defined clearly, it shows that the system itself is not perfect, and we should improve it as soon as possible.

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# Chapter 98

## Study on the Ding Wenjiang's Geological Thoughts

Yanfang Zhang and Zhenmin Jin

**Abstract** As one the most famous geological scientists in the 1920s–1930s, Ding WenJiang have his own deep understanding of geological sciences. This paper aims to analyze his geology thought through his contribution in geology. Ding Wenjiang's thoughts have great scientificalness, innovativeness and perceptiveness, which plays an important role in the development process in Chinese geology.

**Keywords** Ding Wenjiang • Geological thoughts

### 98.1 Introduction of Ding Wenjiang

Ding WenJiang (1887–1936), styled Zaijun, pen name ZongYan, is born in Huangqiao town, Tanxing, Jiangsu Province. He is one of the founders and originators of Chinese modern geology. He studied in a rural school from 5 years old, and graduated with excellent performance when he was 15 (1900). After graduation, Ding Wenjiang studied abroad in Japan, soon because of the war of Russia and Japan, he thought the environment in Japan was not suitable for study, so he turned to England. In 1904 Ding Wenjiang arrived in England and studied with his friend Li Zuhong in a middle school in the Spalding of British eastern area. There not only did he get along with locals, and learned the mathematics, physics, chemistry, history, geography and other natural science, what's more, he also learned the Latin and French, which had greatly expanded the own aspect of knowledge and gotten edified and initiated by western culture. He studied the from one grade, and passed two level in only 1 year, finally he entered into the famous Cambridge university, but because

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of the economic reasons, he had only learn in Cambridge university for 6 months and left there. In 1907, he got into the Scottish Glasgow University where he had learned zoology and geology mastered not only scientific knowledge but also the scientific way of thinking. In 1911 Ding Wenjiang got the double degrees of zoology and geology from Glasgow University and return to China in the April. After returning he devoted to Chinese geological affairs, developed the education of geological education, and made great contributions to the development for Chinese geology.

## 98.2 Ding Wenjiang's Geological Thought

### 98.2.1 *Ding Wenjiang Attaches Great Importance to the Field Investigations*

He stresses that geological work needs field survey in order to get a first-hand material. In 1911, he began his first domestic trip, and the route is from Kunming to the Guizhou Province, from Guiyang to Zhenyuan, and from Hunan by ship to Hankou, at back to home from Shanghai. During the trip he took many instruments and chose the most difficult route, which shows his perseverance and observation. He also found that many versions of the maps were made according to the version measured by Catholic priest in Kangxi period, so a post road through Yunnan and Guizhou Provinces on the map was wrong for over 200 years. Meanwhile the trip is prepared for the later formal geological survey. In Roc 2 years (1913) he had a field trip survey for Taihang Mountain together with Solger; in which Ding Wenjiang have three important discoveries:

First, he pointed out that the noun of Taihang Mountain should have a new geographical definition that the mountain is north-south from Jiyuan, Qinyang in Henan Province to Fuping in Hebei Province, which is the real Taihang Mountain.

Second, the traditional Chinese geography has taken mountains as watershed of water, which is not accord with the fact. For example both Tang river and Zhang river flow from Shanxi through Taihang mountain and to Hebei, so are the Mian river and Zhan river, water they flow through Taihang mountain, too.

Third, his investigation report has confirmed in detail that iron resource is not like what Richthofeni said that Shanxi has the most abundant coal and iron in the world, and corrected his statement [1].

In the following year (1914), he went to Yunnan and Sichuan for an on-the-spot investigation. He spent a whole year for the investigation of copper in Dongchuan and Huili and tin of Gejiu in Yunnan, at the same time he inspected the stratum and geological structures, which had be discussed detailedly in Report of geology and mineral resources nearby Gejiu Yunnan. Roc 17 (1928) Ding Wenjiang went to Guangxi to fill in and draw geologic map using the military topographic map and collected many specimens and fossils. In addition, he also paid special attention to formation system and geological structures. In the second year, he organized the geological team to investigate the southwest region, and the geological travel was the biggest

his life and got a lot of achievements, which was also a great contribution for geology, mineral, geography and anthropology. As for geological work, Ding Wenjiang painted the elaborate and terrain and geologic map on the way, and he researched the strata fastidiously while he also carried through a more careful and thorough investigation for Devonian, Permian and Carboniferous, which has a great significance for the development for Chinese geology in the later days [2]. Besides, Ding Wenjiang was the first people who evaluated Xv Xiake Travel with a view of geonomy. He researched and learned the travel book travel with the view of modern geonomy and pointed out that in this book many records were similar with modern geography and geology. Of course, he had also pointed out some the deficiencies. Ding Wenjiang's geological thoughts has characteristic of seeking truth from facts this kind of seeking truth from facts and putting emphasis on practice, which establishes a good example for the later geologists and promotes the development of Chinese geology.

### ***98.2.2 Ding Wenjiang Emphasis on Using Geological Knowledge in the Practice of Mineral Resources Development***

In coalfield geology in China, Ding Wenjiang is the first geologist to carry through the coalfield drilling plan in China. He has investigated many coal mines in this life and puts forward a lot of opinions and suggestions. From 1921 to 1925, when he hold the post of the general manager of Peking coal mine company, he make the mine which was originally basically paralyzed get a output of 2,000 tons, which has set a good example for the mining sector. Besides, in 1920s, he studied the coal formation and mineral of Guangxi coalfield and wrote the preliminary survey report of Sichuan-Guangzhou Railway, which was highly evaluated by domestic and foreign scholars. In 1929 he also investigated the pale biology, geology and mineral in southwest region. Ding Wenjiang picked many plant fossils from Devonian, Permian, and Carboniferous, with quite a lot of researches, finally he classified Gigantopteris to Carboniferous, which finished the argument about the age ascription problem of Gigantopteris in coal-bearing pre-ordovician and also solved a series of problems about the geology in the coal-bearing pre-ordovician in the south of China. Then he and Yu JianZhang summarized the distribution of underground carboniferous biological strata in Guizhou, Guangxi and Yunnan with Yu Jianzhang, as carboniferous is an important coal forming period in southern part of China, his research played an important role in understanding pale geographic landscape in coal forming period. Besides that, he also had a deep research on copper in Dongchuan and Huili, tin of Gejiu in Yunnan and iron mine around Shijiazhuang-Taiyuan railway in Shanxi, and he marked distribution of mineral in the topographic map, what's more he had published many articles about that, such as Chinese mineral resources (1919), ore administration management (1920) accompanying with Modify mining coherent submissions with Weng Wenhao, then the foreign mining history and 50 years of China mining and so on.

### ***98.2.3 Ding Wenjiang has Paid Special Attention to Cultivating Geological Talents***

He thinks that geology cannot develop in China without geological talents. Development of Chinese natural science is late, so he actively cultivated Chinese geological talents in addition to founding geological agency after returning. In 1913, he founded a geological institute in Beijing, and he not only held the post of the professor in the institute, but also invited Professor Solger in Peaking University to help. In the teaching, he not only often took students to field survey also tried his best to cultivate students' ability of independent study and work. Students entered the research institution in Roc.3 and graduated in Roc.5. After graduation, some students stayed in geological survey, while the more excellent guys will be sent abroad for the further study. The research institution has cultivated a batch of outstanding geological talents, such as Xie Jiarong, Wang Zhuquan and Ye LiangFu and so on; these people became backbone strength of Chinese geology in the later. After Roc.5, the geological research institution was taken back by Beijing University and founded the department of geology [8, 9]. Until this time, Ding Wenjiang still paid special attention to cultivating geological talents, and he invited Li Siguang to hold post of the professor of the department of geology, and he also hired the North American paleontologists Grabau to teach students. Then, in 1916, Ding Wenjiang held the post of the professor in the institute again, and he was not only the first director of the institute, but also one of the original founders. In preparation, he planed to use geological institute to train and cultivate geological talents. Ding knew that China was lack of biologists, so he especially hired Grabau from America [3]. What is more, he had hosted two academic journals like Chinese ancient and geological report. Ding Wenjiang held the post of the professor of geology in Beijing University from 1931 to 1915 when he tried his best to impart knowledge of geology. Although he had been appointed administrative positions for many times in his life, he had always thought education and cultivation of the geological talents was the most important to him. In the teaching, he is responsible and careful and served the students with his whole heart. Just like what his assistant GAO Zhenxi said that what Ding Wenjiang gave to his students was not just the knowledge and training. His lively spirit, courage for responsibility, the thoroughness of training and sincerity to treat people had influenced the students imperceptibly, which was really more important.

## **98.3 Conclusion**

Ding Wenjiang has exerted his utmost effort for cultivating geological talents and the development of geology. Chinese neoteric geology is almost started from scratch, but he has achieved great success in a very short period. When he was alive, Hu Shi once said only geologists among the people who studied science in

China had achieved some valuable contribution. American scholar John Rupert Firth also said that the geological inquiry agency had its due position in the international academic community, and it had famous scholars, and its magazine was widely read, at the same time its studies make real contribution to developing the knowledge of museum history of the earth [4]. The geological inquiry agency is thought the best scientific research institution during the period of the Republic of China republic by people in the west, which proves that in the impression remaining in people's mind that Chinese mind are very dull is absurd and ridiculous [5]. Ding Wenjiang's friend Tao Menghe also pointed out that Ding was the politician in the academia for his contribution to development of geology. Grabau once said Ding had made the greatest contribution in building in the foundation of Chinese geology and planning the development way. Though Ding Wenjiang had studied abroad for years, he held a traditional spirit that people should learn to meet practical needs. And He had never talked about science false, however always fallen in real earnest [6]. Such as founding research institutions, cultivating talents and carrying through the on-the-spot investigations, which all show his enactment spirit for the development of geological science. Not only did he actively participate in geological scientific career, He had also advised many constructive propositions. Meanwhile he cultivated a kind of thought for geological science [7]. Ding Wenjiang's thoughts have great scientificalness, innovativeness and perceptiveness, which still has significance even today. Therefore, in Chinese geology Ding Wenjiang is not only an outstanding geologist, but also a geological science communicator.

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# Chapter 99

## Analysis of Coal Consumption Intensity

Guangming Li

**Abstract** Coal consumption is the main form of energy consumption in Xinjiang. The task of energy conservation and emission cut-down in a fragile ecological system presents a new challenge to Xinjiang's economic development. Facing a situation of coal-guided energy consumption, this paper has a helpful discussion on how to carry on a balanced development and how to modulate relative relationships.

**Keywords** Xinjiang • Coal • Consumption intension

### 99.1 Introduction

The industry sector is the coal consumption main department in Xinjiang. It is the main way of the energy conservation falls consumes to enhance the industrial-used coal efficiency [1, 2]. The results of the research indicated that the factors of influence on coal expense intensity mainly include: (1) social factor is the population quantity, quality, the expense ability, the engineers and technicians proportion and so on; (2) fund factor, such as scientific research investment, government investment and so on; (3) the technical factor is the profession (equipment) the scale, technological innovation ability, the equipment level and so on; (4) substitution effect, which can select better technology; (5) industrial factor, such as industrial structure, heavy industry proportion and so on; (6) system and policy factor [3, 4]. The research will selection suitable target according to these factors to relate these factors to the coal expense intensity influence, to choice gradual key point work provides the basis and to reduces the energy consumption for the government.

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## 99.2 Sample Choice and Original Data

The sample data were collected from 1990 to 2007 in Xinjiang [5, 6]. The selection variables are all previous year's engineers and technicians proportion (%), technical activity total funds (10,000 Yuan), equipment purchase (10,000 Yuan), energy processing transfer efficiency (%), energy processing transfer efficiency electricity generation efficiency (%), the coal accounts for the energy expense total quantity the proportion (%), the natural gas accounts for the energy expense total quantity the proportion (%) and accounts for the gross value of industrial output with the heavy industry proportion (%).

The eight targets are mainly based on: (1) the social factor selects the engineers and technicians to account for the total number of staff and workers proportion ( $z_1$ ), which reflected the profession human resources to provide the condition as well as the research and development level; (2) the fund factor selects the technical activity funds ( $z_2$ ), reflected mainly the social economy to promote the endeavor which the advanced technology does ( $z_5$ ); (3) the equipment purchase for the technical factor selects ( $z_3$ ), energy processing transfer efficiency ( $z_4$ ) and energy processing transfer efficiency electricity generation efficiency ( $z_5$ ), the equipment purchase reflection profession equipment renews the behavior in service; the energy processing transfer efficiency is refers to in certain time the energy after the processing, the transformation, delivers in each kind of energy product quantity, and the same time invests each kind of energy quantity ratio which the processing transforms, observes the energy processing switching device and produces the advanced and backward craft, the important high-low management level status target; it is thermoelectricity generation primarily in Xinjiang. Therefore, the energy processing transfer efficiency electricity generation efficiency can reflect its use of the technical level; (4) the substitution effect selects the coal accounts for the energy expense total quantity proportion ( $z_6$ ) and the natural gas accounts for the energy expense total quantity proportion ( $z_7$ ), mainly considered the industry profession energy expends mainly by the coal primarily in Xinjiang, the natural gas that will have the good substitution function to the future coal expense used for the clean energy; (5) the industrial factor selection heavy industry accounts for the gross value of industrial output proportion ( $z_8$ ), the heavy industry energy consumption is principal problem in Xinjiang; (6) the system and the policy factor select overall coal expense intensity (10,000 tons/100 million Yuan), indicated as  $y$ .

## 99.3 The Practical Analysis

The principal components analysis is a kind of the statistical analysis method through which falls the Uygur technology changed into many variables the minority several principal components (i.e., synthesis variable). These principal components can reflect the primitive variable the major part of information. And they

usually express for the primitive variable some kind of linear union. This paper selects eight targets. All are revolving a subject, have the closing relevance, suitable with the main ingredient analysis.

### 99.3.1 Main Ingredient Analysis

After the primary data were standardized (standardized process omitted), the SAS software was used to carry on the principal components analysis, and got its analysis result as Tables 99.1 and 99.2. From Table 99.1, the first principal components (Prin1) technical progress factor is 67.38 %, the second principal components (Prin2) technical progress factor is 16.53 %, the third principal components (Prin3) technical progress factor is 9.17 %, and these three principal components accumulation technical progress factor is 93.08 %, already achieved above 85 %; therefore, three principal components to be selected carried on the analysis.

**Table 99.1** CMCV and TPF

	Prin1	Prin2	Prin3
$z_1$	-0.02156	0.708596	-0.66862
$z_2$	0.415176	0.062997	0.035197
$z_3$	0.408564	0.011189	0.080788
$z_4$	0.031019	0.68451	0.711087
$z_5$	0.380819	-0.07705	0.074013
$z_6$	-0.41271	0.054381	0.093418
$z_7$	0.409442	0.107649	-0.15767
$z_8$	0.419858	-0.069	-0.02183

**Table 99.2** CV

I	CV	DNTCV	TPF	ATPF
1	5.390623	4.068588	0.6738	0.6738
2	1.322034	0.588349	0.1653	0.8391
3	0.733685	0.469147	0.0917	0.9308
4	0.264539	0.089812	0.0331	0.9639
5	0.174727	0.105195	0.0218	0.9857
6	0.069532	0.03565	0.0087	0.9944
7	0.033882	0.022904	0.0042	0.9986
8	0.010978		0.0014	1

*Notes*

I: Integer

CV: Characteristic vector

CMCV and TPF: Correlation matrix characteristic value and technical progress factor

DNTCV: Difference of the neighboring two characteristic values

TPF: Technical progress factor

ATPF: Accumulation technical progress factor

**Table 99.3** Correlation coefficient and examination probability

	$z_1$	$z_2$	$z_3$	$z_4$	$z_5$	$z_6$	$z_7$	$z_8$
Prin1	-0.05	0.9639	0.9486	0.0720	0.8842	-0.958	0.9506	0.9748
	0.8436	<0.0001	<0.0001	0.7764	<0.0001	<0.0001	<0.0001	<0.0001
Prin2	0.8147	0.0724	0.0129	0.7871	-0.089	0.0625	0.1238	-0.079
	<0.0001	0.7752	0.9596	<0.0001	0.7267	0.8053	0.6246	0.7543
Prin3	-0.573	0.0302	0.0692	0.6091	0.0634	0.08	-0.135	-0.019
	0.013	0.9055	0.7850	0.0073	0.8027	0.7523	0.5931	0.9413

Note Pearson Correlation Coefficient,  $N = 18$  while  $H_0: \text{Rho} = 0$ , Prob > |t|

Meanwhile characteristic vector which gives according to Table 99.3, according to the above writes, the first three principal components relationship which expresses by the standardized variable, namely

$$\left\{ \begin{array}{l} \text{Prin1} = -0.022z_1 + 0.415z_2 + 0.409z_3 + 0.031z_4 + 0.381z_5 \\ \quad - 0.413z_6 + 0.409z_7 + 0.42z_8 \\ \text{Prin2} = 0.709z_1 + 0.063z_2 + 0.011z_3 + 0.685z_4 - 0.077z_5 \\ \quad + 0.054z_6 + 0.108z_7 - 0.069z_8 \\ \text{Prin3} = -0.669z_1 + 0.035z_2 + 0.081z_3 + 0.711z_4 + 0.0741z_5 \\ \quad + 0.093z_6 - 0.158z_7 - 0.022z_8 \end{array} \right. \quad (99.1)$$

Then each target includes coefficient the characteristic value square root product which corresponds with these principal components as shown in Eq. (99.1). We can use the CORR correlation process to extract the correlation as shown in Table 99.3.

$$\left\{ \begin{array}{l} \text{Prin1} = -0.05z_1 + 0.9639z_2 + 0.9486z_3 + 0.072z_4 + 0.8842z_5 \\ \quad - 0.958z_6 + 0.9506z_7 + 0.9748z_8 \\ \text{Prin2} = 0.8147z_1 + 0.0724z_2 + 0.0129z_3 + 0.7871z_4 - 0.089z_5 \\ \quad + 0.0625z_6 + 0.1238z_7 - 0.079z_8 \\ \text{Prin3} = -0.573z_1 + 0.0302z_2 + 0.0692z_3 + 0.6091z_4 + 0.0634z_5 \\ \quad + 0.08z_6 - 0.135z_7 - 0.019z_8 \end{array} \right. \quad (99.2)$$

In Eq. (99.2), the formula correlation coefficient absolute value is bigger, and this principal components are been showing much influence. Therefore, total amount (10,000 Yuan)  $z_2$  of the technical activity funds collection is decided mainly by the first principal components Prin1 size, the equipment purchase (10,000 Yuan)  $z_3$ , the energy processing transfer efficiency electricity generation efficiency (%)  $z_5$ , the coal accounts for the energy expense total quantity the proportion (%)  $z_6$ , the natural gas accounts for the energy expense total quantity the proportion (%)  $z_7$  and the heavy industry accounts for the gross value of industrial output the proportion (%)  $z_8$ , its coefficient quite is big.

Therefore the first principal components reflect the comprehensive consumption level of industry coal; the second principal component is related to the coefficient accounts for the total number of staff, the proportion (%)  $z_1$  and the energy processing transfer efficiency (%)  $z_4$ ; the third principal component is related to the proportion (%)  $z_1$ , the energy processing transfer efficiency (%)  $z_4$  and the natural gas accounts proportion (%)  $z_7$ . Moreover the proportion (%)  $z_1$ ,  $z_7$  and the proportion (%)  $z_8$  are used to reflect the coal consumption level in the market. The first three principal components have already contained the primitive variable 93.08 % information.

### 99.3.2 Returning Principal Components

To carry on the regression analysis using the principal components to industry profession coal expense intensity  $y$ , we obtain the result as follows:

$$Y = 5.43101 - 0.35679\text{Prin1} + 0.2504\text{Prin2} + 0.29196\text{Prin3} \quad (99.3)$$

(<0.0001) (0.02) (0.0387)

R2 = 0.83 DW = 0.738.

The operation results from Eq. (99.3), the return pass the examination, but because the DW value is 0.738, the existence autocorrelation quotes the AR elimination autocorrelation. The result is as follows:

$$Y = -0.43518 - 0.14783\text{Prin1} + 0.087498\text{Prin2} + 0.15097\text{Prin3} + [AR(1) = 0.71012] \quad (99.4)$$

(0.047) (0.0507)

(0.0135) (0.0000)

R2 = 0.96889 DW = 2.2.

To eliminate the autocorrelation, we use the model to simulate the confidence level as shown in Eq. (99.4) Then we can get the original state result:

$$Y = 0.435 - 0.008z_1 - 0.132z_2 - 0.129z_3 + 0.15z_4 - 0.129z_5 + 0.159z_6 - 0.15z_7 - 0.154z_8 + [AR = 0.71012] \quad (99.5)$$

In the Eq. (99.5), each factor coefficient with experience anticipates direction basic consistent.

### 99.3.3 The Result of Practical Analysis

- (1) The proportion of engineers increases 1% every time, and the industry profession coal expense intensity will decrease 0.800 tons/100 million Yuan. (2) The funds of technical activity total amount increases 10,000 Yuan every time, and the industry

profession overall coal expense intensity drops 0.131 tons/100 million Yuan. (3) The equipment fees increases 10,000 Yuan every time, the industry profession coal expense intensity decreases 0.129 tons/100 million Yuan. (4) The energy processing transfer efficiency rises 1 %, and the industry profession overall coal expense intensity rises 0.15 tons/100 million Yuan. The reason is that the transfer efficiency enhancement has stimulated the industry sector producing the expansion, which has led the overall coal expense intensity enhancement. (5) The energy processing transfer efficiency rises every time 1 %, and the industry profession overall coal expense intensity will decrease 0.129 tons/100 million Yuan. (6) The proportion of coal expense quantity rises every time 1 % point, and the industry profession overall coal expense intensity rises 0.158 tons/100 million Yuan, which is suitable with the actual tallies. (7) The proportion of natural gas quantity rises 1 %, and the industry profession overall coal expense intensity will decrease 0.15 tons/100 million Yuan. It indicates that new energy increasing, not only can be helpful in reducing the industry profession coal expense intensity, moreover it is helpful in alleviates Xinjiang's environment pressure. (8) The proportion of heavy industry quantity increases 1 %, and the industry profession overall coal expense intensity will decrease 0.154 tons/100 million Yuan.

## 99.4 Countermeasure Suggestion

The thermoelectricity generation is primarily power technology in Xinjiang, and more than 90% energy consumption dependence on coal. Taking the thermal power as the example: the national electricity generation efficiency is 40.24 % in 2007, but it is only 28.6 % in Xinjiang. So these can be improved from following several aspects.

**Enhancement Technical Improvement and Innovation** To depend on technology advancement and the technological innovation, to take conserve energy fall consume as the goal, next time, these will be the important measure and the direction to enhance the coal use efficiency in Xinjiang. To the special situation, in a short time, the industrial structure is very difficult to change by the raw material foundation industry primarily basic characteristic, but it is possible to carry on the partial adjustment, especially it is possible the profession internal technology structure and the product mix adjustment. Carries on the extension development through the newly built project, no doubt to be possible to achieve enhances the energy use efficiency of the goal, but majority of the professions need through the technological transformations, the technological innovation, the energy conservation falls consumes, this connotation way will achieve enhances the energy use efficiency of the goal.

1. To eliminate the small thermal power firmly, to promote energy conservation and to fall down the consumes
2. The new technology and the equipment will be able as soon as possible to accept for the profession, to use the energy fully to play the role using the efficiency aspect. To establish and consummate the energy conservation service system, to encourage and support conserves energy new technical and equipment's promotion.

**To Enlarge Industry Scientific Research Funds Investment** To enlarge science and technology funds investment may be a choice to have the key development of high new technology industry, to transform the traditional industry, to realize the industry economy and the knowledge economy interaction positively. It is not only to save the coal, also to enhance effective the coal efficiency.

**To Promote the Energy Consumption Pattern Adjustment** As the natural gas accounts for the energy expense total quantity, the proportion is risen every time 1 % point, the industry profession overall coal expense intensity will fall down 0.15 tons/100 million Yuan, therefore to suggest to use the renewable energy or other clean energy much in the industry profession, just as rich wind energy and the solar energy, so to reduce the use amount of the coal.

**To Adjust the Industry Structure Quickly** To introduce low consuming energy, the high technical level and to develop superiority consumes energy, to reduce the pressure of environment using coal in Xinjiang may specifically as follows:

1. In the existing highest unit energy consumption quota foundation, we can formulate and announce the main profession, the product unit source consumption rate and the ceiling standard in Xinjiang. To restrain strictly surpasses the standard the project in aspects and so on examination and approval, loan, industry and commerce registration, production permission
2. To conform Xinjiang's heavy industry. The heavy industry is the economy development to use coal many professions, it is proportion to rise instead causes the industry coal expense intensity to fall down 0.154 tons/100 million Yuan. This indicates the major industry was enhancing the coal to use efficiency aspect to make the important contribution. Therefore, the large-scale may be carried on reorganization restoration to the similar heavy industry, to cultivate the ultra large-scale heavy industry in Xinjiang.

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**Part XI**  
**Database and Data Mining**

# Chapter 100

## Information Resource Optimized Allocation Based on Environment Factors and Multi-Stage DEA

Qian Zhang, Guiming Chen, Ning Yan and Feng Geng

**Abstract** To research the equipment maintenance information resource quantificationally, from the perspective of bi-object decision for input and output of maintenance system, adopted environment factors to describe quality difference between the departments, introduced time-windows and then established the DEA allocation model of equipment maintenance information resource, and proposed a new allocation method. The result of example satisfies the fact, and it affords the reference for decision. It is benefit to advance the maintenance support efficiency and exert the function of maintenance resources adequately.

**Keywords** Information resources • Environment factors • Multi-stage • DEA

### 100.1 Equipment Maintenance Support Information and Allocation

Equipment maintenance information resource is the collection of information, the producer, and the relative information technology. Compared with the common equipment resource, equipment maintenance information resource is renewable and cannot be divided, and it is easy to be copied and shared. Its avail is holistic; the used benefit is proportional to the user quantity. The allocation needs to solve the inefficiency, optimized and the continuance problem [1, 2].

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Equipment maintenance information resource can be classified into six categories: information armament, information power, information equipment, information establishment, information facility, and information outlay. The information armament is called “supported object”, information outlay is called “indirect supported object”, and the others are called “direct object” [3].

In addition, equipment maintenance information resource constitutes three-dimensional academic model based on the connection between economy, impartiality, and security characters. The three ones are organic whole, and they affect the allocation efficiency together [4].

The basics of resource allocation strategy are time, space, and amount, allocation assignment is adjustment of the distributing and flow of resource to get more benefit by less cost, and making more information user to use the equipment maintenance information resource rationally and effectively, making resource be shared and valued adequately, advancing equipment support manage and decision levels [5].

Resource allocation refers to distribution and adjustment of the whole weapon system; it researches information resource production, consumption, shares, and explores resource flow between systems, departments, and the inner-information constructions [6]. The existing researches are almost focusing on theory and qualitative analysis; quantitative research is few because of information resource characteristic. Data Envelopment Analysis (DEA) need not to estimate parameters and confirm weight in advance; it ignores the dimension between parameters and system inner-motion, but pays attention to input and output effect [7], and those that make it have high superiority to research information resource quantitative allocation. The paper adopted DEA method to research on the basics of resource allocation strategy such as time, space, and amount.

## 100.2 DEA Allocation Model of Equipment Maintenance Information Resource

### 100.2.1 Selection of Parameters

The application of DEA should establish input and output parameters system rationally according to objectivity, applicability, pertinence, reliability. Considering DEA theory, parameters are chosen with linearity connection; they have less correlation and reflect the true information completely.

According to categories of information resource, input parameters are chosen, including information armament, information power, information equipment, information establishment, and information cost. According to three-dimensional model of aforementioned information resource, output parameters are chosen, including information safety degree, satisfaction efficiency of information shared, efficiency of information used, and the extent of cost saved.

### 100.2.2 Model Constitution

The value of DMU relative efficiency is affected by input and output level jointly. Bi-objective DEA model should be constituted to reduce input and enlarge output together. To express the preference of decision-makers for parameters and DMU, preference cone  $W$  is introduced to describe the important degree of input and output,  $K$  describe DMUs, and model with subjective preference as restriction is constituted [8, 9].

The bi-objective DEA CCR model with cone is

$$\begin{aligned} \min(\theta, -Z) \quad & s.t. \sum_{j=1}^n X_{ij}\lambda_j \leq \theta x_{i0} \quad 0 < \theta \leq 1, i = 1, 2, \dots, m \\ & \sum_{j=1}^n Y_{rj}\lambda_j \geq Z y_{r0} \quad Z \geq 1, r = 1, 2, \dots, s \\ & \lambda_j \geq 0, j = 1, 2, \dots, n \quad \begin{pmatrix} v \\ u \end{pmatrix} \in W \quad \lambda \in -K^* \end{aligned} \quad (100.1)$$

There are  $n$  DMUs,  $m$  input parameters, and  $s$  output parameters in each DMU. The input matrix is  $X = (x_1, x_2, \dots, x_n)_{m \times n}$ , output matrix is  $Y = (y_1, y_2, \dots, y_n)_{s \times n}$ , input DMU $_j$  vector is  $x_j = (x_{1j}, x_{2j}, \dots, x_{nj})^T$ ,  $y_j = (y_{1j}, y_{2j}, \dots, y_{sj})^T$ ,  $j = 1, 2, \dots, n$  is output vector.  $x_{i0}$  is the  $i$ -th input parameters of  $j_0$ -th DMU,  $j_0 = 1, 2, \dots, n$ ;  $i = 1, 2, \dots, m$ .  $x_{i0}$  is the  $i$ -th output parameters of  $j_0$ -th DMU,  $j_0 = 1, 2, \dots, n$ ;  $i = 1, 2, \dots, s$ ;  $x_{i0}$  and  $y_{r0}$  are the data of evaluated DMU.  $v, u$  are the weights of input and output, and  $\lambda$  is between DMUs.

Translate the bi-object  $\theta, -Z$  to single object efficiency  $\eta = q_1 \cdot \theta - q_2 \cdot Z$ , and  $a_1, a_2$  describe the preference for reducing input and enlarging output. If  $\eta = q_1 - q_2$ , the evaluated DMU is weak effective; if  $\eta = q_1 - q_2$ , and the optimum result in bilateral form of model (1) is  $(v^{*T}, u^{*T}) \in W$ , the evaluated DMU is effective.

Model (1) gets the DMU weight by subjective preference of decision-maker, neglects the quality difference between DMUs, such that the competition achievement can affect the relatively efficiency, and it should be measured together.

Environment background factors are introduced, department background is analyzed qualitatively, and the environment background factors are summarized that affect the output result. They are classified from one to four grades by quality; coefficient  $a_{ji}$  describes the  $i$ -grade value of  $j$ -th DMU [10].

- (1) The department attends the first-level correlated assignment or item; achieves the encouragement in the first-level competition; has the first-level significant laboratory or engineering research center. If the DMU implements one of them, add 0.1 ( $a_{ji} = 0.1$ ) to environment background factor value.
- (2) The department attends the second-level correlated assignment or item; achieves the encouragement in the second-level competition; has the second-level significant

laboratory or engineering research center. If the DMU implements one of them, add 0.08 ( $a_{ji} = 0.08$ ) to environment background factor value.

- (3) The department attends the third-level correlated assignment or item; achieves the encouragement in the third-level competition; has the third-level significant laboratory or engineering research center. If the DMU implements one of them, add 0.06 ( $a_{ji} = 0.06$ ) to environment background factor value.
- (4) The department attends the fourth or the other-level assignment or item; achieves the encouragement in the fourth or the other competition; has the fourth or the other significant laboratory or engineering research center. If the DMU implements one of them, add 0.04 ( $a_{ji} = 0.04$ ) to environment background factor value.

The other condition can be included in this four degrades and evaluated to corresponding value.  $r_j = \sum_{i=1}^4 a_{ji} k_{ji}$  ( $j = 1, 2, \dots, n$ ) describes the summation in the four degrades of the  $j$ -th DMU;  $k_{ji}$  is the environment background factor numbers in  $i$ -th degrade of  $j$ -th DMU.  $\xi = \frac{1}{2} \cdot (1 + \frac{1+r_0}{\max(1+r_j)})$  describes the output quality ratio of evaluated DMU to optimum one. The corrected model is

$$\begin{aligned} \min(\theta, -Z) \quad & s.t. \sum_{j=1}^n \frac{1}{2} \left[ 1 + \frac{1+r_0}{\max(1+r_j)} \right] X_{ij} \lambda_j \leq \theta x_{i0} \\ & 0 < \theta \leq 1, i = 1, 2, \dots, m \\ & \sum_{j=1}^n \frac{1}{2} \left[ 1 + \frac{1+r_0}{\max(1+r_j)} \right] Y_{rj} \lambda_j \geq Z y_{r0} \\ & 0 < Z \leq 1, r = 1, 2, \dots, s \\ & \lambda_j \geq 0, j = 1, 2, \dots, n \quad \binom{v}{u} \in W \quad \lambda \in -K^* \end{aligned} \quad (100.2)$$

The most of equipment employed are multi-stage problems, that is, making the initial allocation project firstly, implementing it by stages, then adjusting and optimizing it because of the influences from multi-fold factors. Disperse time variables (time-windows) are introduced to constitute the allocation model with preference, multi-object, and multi-stage, in the interest of using the yearly date adequately and calculating produce efficiency roundly and rationally.  $x_j(t_k), y_j(t_k)$  is input and output target of department  $j$  ( $j = 1 \dots n$ ) in  $k$  ( $k = 1 \dots i$ ) stage. The collections in all stages are described:

$$\begin{aligned} R_1 &= \{(x_1(t_1), y_1(t_1)); (x_2(t_1), y_2(t_1)); \dots; (x_n(t_1), y_n(t_1))\}; \\ R_2 &= \{(x_1(t_2), y_1(t_2)); (x_2(t_2), y_2(t_2)); \dots; (x_n(t_2), y_n(t_2))\}; \\ &\vdots \\ R_i &= \{(x_1(t_i), y_1(t_i)); (x_2(t_i), y_2(t_i)); \dots; (x_n(t_i), y_n(t_i))\}. \end{aligned}$$

It is assumed that a time-window  $M$  comprises  $l$  adjacent stages, the length is  $l$ , the reference collection  $R$  of the window includes  $nl$  DMU, and  $i$  stages compose  $i-l+1$  windows. The first window is  $(R_1, R_2, \dots, R_l)$ ; the second is

$(R_2, R_3, \dots, R_{l+1})$ ; ..., the  $i - l + 1$ -th is  $(R_{i-2}, R_{i-1}, \dots, R_i)$ .  $r_{i0}(t_0)$  is environment background value of DMU in  $t_0$  stage, and the model with preference, multi-object, multi-stage is

$$\begin{aligned} \min(\theta(t_0), -Z(t_0)) \sum_{j=1}^n \frac{1}{2} \left[ 1 + \frac{1+r_{i0}(t_0)}{\max(1+r_j(t_0))} \right] X_{ij}(t_k) \lambda_j &\leq \theta(t_0) x_{i0}(t_0) \\ 0 < \theta(t_0) \leq 1, i = 1, 2, \dots, m \\ \sum_{j=1}^n \frac{1}{2} \left[ 1 + \frac{1+r_{i0}(t_0)}{\max(1+r_j(t_0))} \right] Y_{rj}(t_k) \lambda_j &\geq Z(t_0) y_{r0}(t_0) \\ Z(t_0) \geq 1, r = 1, 2, \dots, s \\ \lambda_j \geq 0, j = 1, 2, \dots, n \quad \begin{pmatrix} v \\ u \end{pmatrix} \in W \quad \lambda \in -K^* \end{aligned} \quad (100.3)$$

### 100.2.3 Allocation Progress

Equipment maintenance information resource support system is highly complex, the allocation process from certain maintenance institution to the next one is analyzed, and others can be analyzed analogically.

Preference of I/O factors is got between maintenance departments by relativity analysis, and confirmed cores  $W, K$ .

Early input and output data are divided into several stages to solve the optimum;  $\theta^*, Z^*, \lambda^*, X^* = \sum_{j \in J} \lambda_j^* X_j, Y^* = \sum_{j \in J} \lambda_j^* Y_j$ ,  $(X^*, Y^*)$  are the projections on produce front surface, analyzed and optimized non-effective DMU, and got the corrected projects.

The corrected projects are used into stage model (3) with time-windows; the information resource allocation project is got finally by result analysis.

## 100.3 The Analysis of Example and Result

It is selected the resource allocation data of a maintenance institution in recent 3 years, and it needs to make the resource allocation project for next stage. It is supposed that the output result is lagged one year after input; 16 repair shops belonging to a maintenance institute are selected as DMUs; the data are shown in Table 100.1.

The decision-makers' preference and environment background factor may change; it needs to confirm as the different stages. In order to make the calculation easy, it is supposed that the factor is being kept steady in these 3 years.

Preference cores  $W$ :  $2v_1 = v_2, v_1 = v_3 + v_4, u_1 = u_2, u_2 = u_3 + u_4$ ;

Preference cores  $K$ :  $k_6 = 2k_2 + k_{12}, \dots, k_{11} = 2k_{12}$

$$k_{11} = k_1 + k_3 + 3k_4 + k_{12} + k_{13} + k_{14} + k_{15} + k_{16},$$

**Table 100.1** The original input and output value of DMU in recent 3 years

DMU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Information armament ( $x_1$ )	3	5	8	2	7	4	3	6	9	1	1	3	2	5	6	2
	6	7	8	12	7	9	3	6	9	5	5	3	2	9	6	12
Information power ( $x_2$ )	8	2	5	4	5	6	3	5	6	2	5	7	1	4	9	6
	5	2	5	4	5	16	9	5	6	9	5	7	9	8	9	6
Equipment ( $x_3$ )	15	12	5	4	5	12	9	5	6	2	5	7	9	8	10	16
	8	24	15	23	21	17	18	28	30	9	15	20	21	16	14	9
	10	13	12	23	15	7	18	28	22	9	15	20	21	16	14	9
	10	13	12	23	15	7	10	28	22	9	15	20	21	16	14	9
Information cost ( $x_4$ )	13.6	15	12.5	9.5	8.3	6.6	14	9.6	10.2	5.8	15	9	3	7.1	12	8
	13.6	11	22.5	10	8.9	6.6	14	9.6	10.5	25.8	10	9	23	6	12	18
	10	11	20	10	16	10	14	9.6	10	22	11	9	12	6	6	10
Safety degree ( $y_1$ )	15	17	5	8	19	4	9	20	11	13	16	15	18	8	7	10
	10	10	5	8	11	14	21	15	10	13	16	15	18	8	8	10
	10	16	5	18	11	19	21	15	10	13	10	15	18	18	22	11
Satisfaction of shared ( $y_2$ )	7	8	10	15	11	14	16	4	6	5	15	9	10	11	16	9
	7	8	7	25	11	14	6	14	10	5	9	9	12	11	16	19
	17	8	7	25	11	19	16	15	15	5	8	13	20	21	11	11
Efficiency of information used ( $y_3$ )	12	13	22	28	9	15	5	25	30	11	9	10	18	20	25	32
	10	12	28	9	12	15	25	25	11	9	10	12	10	25	32	
	9	10	12	25	9	22	15	22	22	11	8	10	20	10	20	22
Cost saved ( $y_4$ )	65	47	35.2	55	87	55	66	15	21	20	100	60	51	46	22	38
	45	35	24	55	80	55	60	9	16	20	90	60	52	44	22	38
	40	36	22	66	70	55	65	9	16	25	82	66	60	30	22	38

The weight coefficient of input and output is as follows:  $q_1 = 0.9, q_2 = 0.1$ . Program them with MATLAB. The result is shown in Table 100.2.

It is adopted that the length of time-window is 2 (one window comprises 2 adjacent stages) and the reference collection includes 36 DMUs. With 3 years' data, each year corresponds to one  $R$ ; there are 2 windows in 3 years together. The first window is  $(R_1, R_2)$ , and the second is  $(R_2, R_3)$ . Model (3) is adopted to analyze the relative efficiency  $\eta$  of 36 DMU in each window. The result is shown in Table 100.3.

It is supposed that the information allocation of this institution is steady relatively, there is no evident causation outside to influence the decision-making, and the quantity of adjusted information resource is enough in a certain range.

From the results, in the 2nd year efficiencies of repair shops 2, 4, 7, 13 in two windows are all 0.8 ( $q_1 - q_2 = 0.8$ ), and variance value is small, the data in the three stages are steady relatively, it shows that the allocation of the DMUs in the 2nd years is effective, and it can be adopted. Variance value of repair shops 3, 5, 9, 12, 14, 16 is small relatively, and the fluctuation is small, so it should adopt the project whose efficiency value is the largest. Variance value of repair shops 1, 6, 8, 10, 11, 15 is large relatively, and they all have 0.8, and the performance in different windows and stages is instable greatly. So it should adopt the compromise

**Table 100.2** The optimum input and output value of DMU in recent 3 years

DMU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Information	3	18	6	8	26	5	10	23	13	15	20	19	21	11	10	10
arma-	4	11	6	8	15	18	23	17	11	15	20	19	21	11	12	10
ment ( $x_1$ )	9	17	6	18	15	24	23	17	11	15	12	19	21	24	32	11
Information	8	9	12	15	15	18	18	5	7	6	18	11	12	15	23	9
power	3	9	8	25	15	18	7	16	11	6	11	11	14	15	23	19
( $x_2$ )	15	9	8	25	15	24	18	17	17	6	10	17	24	28	16	11
Equipment	8	14	27	28	25	19	6	29	12	13	11	15	21	8	27	9
( $x_3$ )	13	11	12	28	25	20	17	29	19	11	11	12	14	17	36	24
	10	15	8	25	15	22	17	20	25	13	11	18	23	29	29	10
Information	13.6	50	42	56	78	71	73	17	35	24	122	64	61	64	91	54
cost ( $x_4$ )	7	37	13	56	15	60	66	10	14	56	110	74	62	39	32	38
	10	21	22	67	48	81	72	52	18	30	36	57	73	82	32	36
Safety	15	18	6	8	26	5	10	23	13	15	20	19	21	11	10	10
degree	10	11	6	8	15	18	23	17	11	15	20	19	21	11	12	10
( $y_1$ )	10	17	6	18	15	24	23	17	11	15	12	19	21	24	32	11
Satisfaction	7	9	12	15	15	18	18	5	7	6	18	11	12	15	23	9
of shared	7	9	8	25	15	18	7	16	11	6	11	11	14	15	23	19
( $y_2$ )	17	9	8	25	15	24	18	17	17	6	10	17	24	28	16	11
Efficiency of	12	14	27	28	25	19	6	29	12	13	11	15	21	8	27	9
informa-	9	11	12	28	25	20	17	29	19	11	11	12	14	17	36	24
tion used	9	15	8	25	15	22	17	20	25	13	11	18	23	29	29	10
( $y_3$ )																
Cost saved	65	50	42	56	78	71	73	17	35	24	122	64	61	64	91	54
( $y_4$ )	39	37	13	56	15	60	66	10	14	56	110	74	62	39	32	38
	40	21	22	67	48	81	72	52	18	30	36	57	73	82	32	36

**Table 100.3** Relative efficiency with time-windows

DMU	1st year	2nd year	3rd year	Mean value	Variance
1	0.2632	0.1888/0.4440	0.8000	0.42	0.07
2	0.8000	0.8000/0.8000	0.3174	0.68	0.06
3	0.2191	0.1083/0.2229	0.2229	0.19	0.003
4	0.8000	0.8000/0.8000	0.8000	0.80	0
5	0.1609	0.2033/0.5029	0.5029	0.34	0.03
6	0.8000	0.0883/0.2809	0.4754	0.41	0.09
7	0.8000	0.8000/0.8000	0.8000	0.80	0
8	0.8000	0.2962/0.7627	0.4389	0.57	0.06
9	0.0172	0.1269/0.3431	0.5025	0.25	0.045
10	0.8000	0.0996/0.3967	0.8000	0.52	0.12
11	0.8000	0.1875/0.8000	0.4965	0.57	0.09
12	0.2569	0.2569/0.6849	0.4644	0.42	0.04
13	0.8000	0.8000/0.8000	0.4789	0.72	0.03
14	0.3256	0.1162/0.2985	0.4075	0.29	0.02
15	0.3986	0.3216/0.8000	0.6388	0.54	0.05
16	0.2893	0.3778/0.5232	0.1498	0.34	0.02

projects whose efficiency is in the middle. In addition, the decision department should pay attention to the fluctuation in the next-stage guidance, research the inducement, and take action to improve.

## 100.4 Conclusion

Adopted multi-object, DEA method to research information resource allocation constituted DEA model with environment background factor and time variable, made a suit of decision method, and validated them by instance. The result affords reference for equipment maintenance information resource optimization and adjustment, and it is important to allocation practice.

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# Chapter 101

## Adaptive Web Wrapper Based on Hybrid Hierarchical Conditional Random Fields for Web Data Integration

Yanhui Ding and Hongguo Wang

**Abstract** During the process of Web data integration, new related Web sites consisting valuable data will be identified constantly. Wrapper induction based on labeled examples is a widely accepted method. However, manually labeling the sampled Web pages in the new Web site is a time-consuming work. To efficiently extract the structured data from new related Web sites, a novel model, Hybrid Hierarchical Conditional Random Fields (HH-CRFs), is proposed in this paper. HH-CRFs are trained using the accumulated data in the system of Web data integration, and HH-CRFs perform type identification of Web object, Web object detection and attribute labeling together. Then, the labeled, sampled Web pages will be used to induce the wrapper of target Web site. Experimental results using a large number of real-world data collected from diverse domains show that the proposed approach can help to induce the target wrapper efficiently.

**Keywords** Web data integration • Wrapper • Hybrid Hierarchical Conditional Random Fields (HH-CRFs)

### 101.1 Introduction

Internet today contains a huge amount of information under the form of Web pages. During the last years, great efforts have been put to develop techniques of information extraction on the Web. A widely adopted approach is to define Web wrappers, procedures relying on analyzing the structure of HTML Web pages

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(i.e., DOM tree) to extract required information. Wrappers can be defined in several ways, for example, most advanced tools let users to design them in a visual way, for example selecting elements of interest in a Web page and defining rules for their extraction and validation, semi-automatically. During the process of Web data integration, new related Web sites containing interesting data will be identified constantly. And then, we need to construct wrappers for the new Web sites to extract the information. Wrapper induction based on labeled examples is a widely accepted method [1]. However, manually labeling the target Web pages in the new Web site is a time-consuming work.

In this paper, a Hybrid Hierarchical Conditional Random Fields model (HH-CRFs) will be trained using the accumulated data in the system of Web data integration into a new target Web site, which is different from but relevant to the extracted Web sites. HH-CRFs will perform type identification of Web object, Web object detection and attribute labeling together. Then, the labeled, sampled Web pages will be used to induce the wrapper of target Web site [1].

The rest of this paper is organized as follows. HH-CRFs and the training process are discussed in Sect. 101.2. The experimental setup and results are showed in Sect. 101.3. Finally, the conclusion is presented.

## 101.2 Adaptive Web Wrapper

### 101.2.1 Main Idea

In this paper, HH-CRFs model is proposed to perform type identification of Web object, Web object detection and attribute labeling in the sampled Web pages of target Web site together. Then, the labeled, sampled Web pages will be used as training examples to induce the wrapper for the target Web site.

### 101.2.2 Hybrid Hierarchical Conditional Random Fields (HH-CRFs)

#### 101.2.2.1 CRFs and HCRFs

A conditional random field is an undirected graphical model that defines a single exponential distribution over label sequences given a particular observation sequence. Let  $X$  is a random variable over the observations to be labeled, and  $Y$  is a random variable over corresponding labels. All components  $Y_i$  of  $Y$  are assumed to range over a finite label alphabet  $y$ . In a discriminative framework, CRFs construct a conditional model  $p(Y|X)$  with a given set of features from paired observations and labels. Formally, the definition of CRFs [2] is given subsequently:

**Definition 1** Let  $G = (V, E)$  be an undirected graph such that  $Y = \{Y_v\}_{v \in V}$ . Then,  $(X, Y)$  is said to be a conditional random field if, when conditioned on  $X$ , the random variables  $Y_v$  obey the Markov's property with respect to the graph:  $p(Y_v|X, Y_{V-\{v\}}) = p(Y_v|X, Y_{N_v})$ , where  $V - \{v\}$  is the set of nodes in the graph except the node  $v$ , and  $N_v$  is the set of neighbors of the node  $v$  in graph  $G$ .

Thus, a CRF is a random field globally conditioned on the observations  $X$ . In theory, the structure of graph  $G$  can be arbitrary, provided it represents the conditional independencies of the models. Many previous applications use the linear-chain CRFs, in which a first-order Markov's assumption is made on the hidden variables. By the Hammersley-Clifford theorem, the conditional distribution of the labels  $y$ , given the observations  $x$ , has the form:

$$p(y|x) = \frac{1}{Z(x)} \exp \left( \sum_{e \in E, k} \lambda_k f_k(e, y|_e, x) + \sum_{v \in V, k} \mu_k g_k(v, y|_v, x) \right) \quad (101.1)$$

where  $y|_e$  and  $y|_v$  are the components of  $y$  associated with edge  $e$  and vertex  $v$  respectively;  $f_k$  and  $g_k$  are feature functions;  $\lambda_k$  and  $\mu_k$  are parameters to be estimated from the training data, and  $Z(x)$  is the normalization factor, also known as partition function, which has the form:

$$Z(x) = \sum_y \exp \left( \sum_{e \in E, k} \lambda_k f_k(e, y|_e, x) + \sum_{v \in V, k} \mu_k g_k(v, y|_v, x) \right) \quad (101.2)$$

In HCRFs, the cliques of the graph are its vertices, edges and triangles [3]. So, the conditional probability in formula (101.1) can be concretely expressed as:

$$p(y|x) = \frac{1}{Z(x)} \exp \left( \sum_{v, k} \mu_k g_k(y|_v, x) + \sum_{e, k} \lambda_k f_k(y|_e, x) + \sum_{t, k} \gamma_k h_k(y|_t, x) \right) \quad (101.3)$$

where  $g_k$ ,  $f_k$  and  $h_k$  are the feature functions defined on three types of cliques (i.e., vertex, edge and triangle), respectively;  $\mu_k$ ,  $\lambda_k$  and  $\gamma_k$  are the corresponding weights;  $v \in V$ ,  $e \in E$  and  $t$  is a triangle.

### 101.2.2.2 CRFs and HCRFs

HCRFs can simultaneously conduct Web object detection and attribute labeling, while it never considers the problem of identification of Web object's type. For the features used in Web object detection and attribute labeling can also be used in the identification of Web object's type, this paper presents a HH-CRFs model,

which extends HCRFs by adding related edges and performs these three procedures simultaneously.

**Definition 2** Let  $e'$  be a related edge, if sample Web page  $p_i$  has the relationship with the accumulated data in the system of Web data integration.

In HH-CRFs, the cliques of the graph are its vertices, common edges, triangles and related edges. So, the conditional probability in formula (101.1) can be concretely expressed as:

$$p(y|x) = \frac{1}{Z(x)} \exp \left( \sum_{v,k} \mu_k g_k(y|_v, x) + \sum_{e,k} \lambda_k f_k(y|_e, x) + \sum_{t,k} \gamma_k h_k(y|_t, x) + \sum_{e',k} \psi_k d_k(y|_{e'}, x) \right) \quad (101.4)$$

where  $g_k$ ,  $f_k$ ,  $h_k$  and  $d_k$  are the feature functions defined on four types of cliques (i.e., vertex, common edge, triangle and related edge), respectively;  $\mu_k$ ,  $\lambda_k$ ,  $\gamma_k$  and  $\psi_k$  are the corresponding weights.

### 101.2.2.3 Related Edge

In this paper, the structured information and the characteristics of records from the system of Web data integration are applied to assist the building of related edges. Two heuristic rules are used in this paper.

- The attribute names of which type of Web object in the Web data integration system are similar to the semantic labels in the sampled Web pages of target Web site.
- Which type of Web object in the system of Web data integration has the similar characteristics with the leaf text node in the DOM of sampled Web pages, such as average number of character, vocabulary and pattern.

If one of the above heuristic rules is satisfied, related edges will be built in HH-CRFs model.

### 101.2.2.4 Parameter Estimation

Given the training data  $D = \{(y^i, x^i)\}_{i=1}^N$  with an empirical distribution  $\tilde{p}(x, y)$ , the parameter estimation is to find a set of parameters  $\Theta = \{\mu_1, \mu_2, \dots, \lambda_1, \lambda_2, \dots, \gamma_1, \gamma_2, \dots, \psi_1, \psi_2, \dots\}$  that optimize the log-likelihood function:

$$L(\Theta) = \sum_i \tilde{p}(x^i, y^i) \log p(y^i | x^i, \Theta) \quad (101.5)$$

To avoid over-fitting, the spherical Gaussian prior with mean  $\mu = 0$  and variance matrix  $\Sigma = \sigma^2 I$  is used to penalize the log-likelihood. The concave function can be optimized by the techniques used in other models. The gradient-based L-BRFS [4] is used in the experiment for its outstanding performance over other algorithms. Each element of the gradient vector is given by:

$$\frac{\partial L(\Theta)}{\partial \mu_k} = E_{\tilde{p}(x,y)}[g_k] - E_{p(y|x,\Theta)}[g_k] - \frac{\mu_k}{\sigma^2} \quad (101.6)$$

$$\frac{\partial L(\Theta)}{\partial \lambda_k} = E_{\tilde{p}(x,y)}[f_k] - E_{p(y|x,\Theta)}[f_k] - \frac{\lambda_k}{\sigma^2} \quad (101.7)$$

$$\frac{\partial L(\Theta)}{\partial \gamma_k} = E_{\tilde{p}(x,y)}[h_k] - E_{p(y|x,\Theta)}[h_k] - \frac{\gamma_k}{\sigma^2} \quad (101.8)$$

$$\frac{\partial L(\Theta)}{\partial \psi_k} = E_{\tilde{p}(x,y)}[d_k] - E_{p(y|x,\Theta)}[d_k] - \frac{\psi_k}{\sigma^2} \quad (101.9)$$

where  $E_{\tilde{p}(x,y)}[f_k]$ ,  $E_{\tilde{p}(x,y)}[g_k]$ ,  $E_{\tilde{p}(x,y)}[h_k]$  and  $E_{\tilde{p}(x,y)}[d_k]$  are the expectations with respect to the empirical distribution, and it can be easily calculated once for all;  $E_{p(y|x,\Theta)}[f_k]$ ,  $E_{p(y|x,\Theta)}[g_k]$ ,  $E_{p(y|x,\Theta)}[h_k]$  and  $E_{p(y|x,\Theta)}[d_k]$  are the expectations with respect to the model distribution.

### 101.2.2.5 Inference

The time complexity of inference algorithm will influence the performance of the proposed model greatly. In HH-CRFs model, the graph contains cycles. And because the loops may be long and overlapping, exact inference requires time exponential in the size of a graph's junction tree. So, the exact inference is not practical. Instead, approximate inference using the loopy belief propagation algorithm [5] is performed. Loopy belief propagation algorithm is an iterative method that is not guaranteed to converge, but relative research [4] and the experiment results show that it can be reasonably accurate in practice [5].

## 101.3 Experiment

The experiment is carried out based on our prototype system. There are more than 100,000 records in this system, including company information, job review, job information. On the other hand, in order to further test the performance of the proposed method, Web sites from two other fields, such as book and movie, are also included in the experiment. In each field, more than 8 Web sites are selected from

the Internet, and at least 1,000 Web pages are random crawled. Cross-validation is adopted to test the adaptability of building Web wrapper for new Web sites. (Table 101.1).

The experimental results based on our prototype system (Job field) are showed in Table 101.2, which lists recall, precision and F1-measure on each field. And comparisons of other vertical-level performance of CRFs and HH-CRFs are showed in Fig. 101.1.

From the reports in Table 101.2 and Fig. 101.1, it can be known that HH-CRFs achieve an obvious, sometimes dramatic, improvement on almost each field compared with CRFs. It substantiates that in HH-CRFs model, type identification of Web object, Web object detection and attribute labeling together are performed, which can further improve the semantic annotation accuracy of Web object.

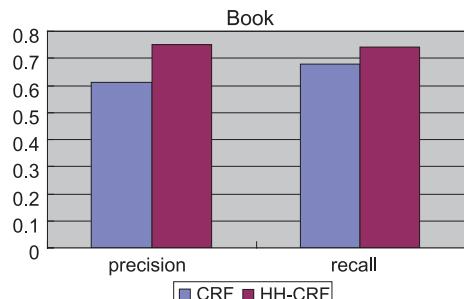
**Table 101.1** Overview of the experimental dataset

Field	#Site	#Pages	Attributes
Job	8	100,000	Job title, company, location, work type, number of position, description
Books	10	30,000	Title, author, ISBN-13, publisher, publish date
Movies	10	10,000	Title, director, genre, rating

**Table 101.2** Results on the job field

Fields	CRFs (%)			HH-CRFs (%)		
	Recall	Precision	F1	Recall	Precision	F1
Job title	49.13	46.81	48.09	55.23	68.29	61.06
Company	52.34	51.96	52.14	61.63	70.24	65.65
Location	72.34	81.43	76.61	91.84	75.13	82.64
Work type	75.31	62.93	68.56	92.27	63.14	74.97
Number of position	75.39	81.47	78.31	80.35	86.38	83.25
Description	46.67	54.22	50.16	74.19	72.18	73.17
Average F1			62.31			73.46

**Fig. 101.1** Comparisons of vertical-level performance of CRF, HCRCF and HH-CRF



## 101.4 Conclusion

To efficiently extract the structured data from enormous Web sites in various verticals, HH-CRFs model will be trained using the accumulated data in the system of Web data integration to a new target Web site, which is different from but relevant to the extracted Web sites. HH-CRFs can perform type identification of Web object, Web object detection and attribute labeling together. And then, the labeled, sampled Web pages will be used to induce the wrapper of target Web site. Experimental results using a large number of real-world data collected from diverse domains show that the proposed approach can help to induce the target wrapper efficiently.

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# **Chapter 102**

## **Study of Township per Capita Income Distribution Based on the Spatial Data Mining**

**ShunMin Wang and Xiaoxiao Liang**

**Abstract** The spatial location of the regional township has an extremely important impact on the per capita income. For analyzing the concerned per capita income distribution law and trend, this paper proposed spatial data mining method. The results show that regional per capita income has strong spatial correlation characteristics. The statistical indicators reveal that the regional economy has significant positive spatial autocorrelation characteristics, showing the features of cluster in general.

**Keywords** Spatial data mining • Region • Spatial correlation

### **102.1 Introduction**

At present, the regional township per capita income is a measure. Location factor is an important one for the per capita income, on which domestic and foreign scholars have already performed some research, such as foreign geographers and economists launched multi-faceted researches on spatial distribution of population [1]. Spatial analysis was also used for the location influence on the per capita income, including the relationship between spatial analysis and the per capita income. Domestic scholars applied space-related research to figure out the distribution, including the use of spatial point pattern analysis, spatial autocorrelation analysis and spatial interpolation methods to analyze the spatial pattern of per capita income. The results of the analysis are not yet further data mined, that is to say, calculated the

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spatial distance between the towns, while ignored its spatial location attributes, still have not revealed the spatial interaction and spatial pattern. The clustering relationship between per capita income and location can get different regions' per capita income cohesion trends, distribution laws and development trends. In the field of data mining, data clustering research work focuses on the effectiveness of large databases and the actual clustering analysis to find the appropriate method. In this paper, spatial data mining method of correlation analysis is used to analyze the region's per capita income distribution characteristics.

## 102.2 Spatial Data Mining Methodology

### 102.2.1 Study Method

The common types of spatial data mining algorithms include the spatial association rule mining, spatial classification algorithm and spatial clustering algorithm. Spatial autocorrelation is a widespread characteristic pattern of the real space. The correlation analysis refers to the same variable in different spatial positions, together with the measurement and evaluation of spatial unit attribute value aggregation degree [2]. The spatial correlation of the regional townships of per capita income is taking comprehensive consideration of the spatial and per capita income information, studying the interaction between the township's spatial location and per capita income. To study the spatial autocorrelation, the measurement of global and local indicators should be applied; while global indicators are used to validate the spatial pattern of the entire study area, local indicators are used to reflect certain geographic phenomena on a regional unit or the relevance with the neighboring regional units on the same phenomenon or attribute values.

#### 102.2.1.1 Global Spatial Correlation Analysis

Global spatial autocorrelation is a description of the spatial characteristics of the property values in the whole region, indicating that the attribute information and its location there generate significant interaction, judging whether the property value exists characteristics of the aggregation in space [3]. The most commonly used global spatial index is the global Moran's  $I$ , which is used to measure the relationship between spatial elements and to assess the distribution of elements present in aggregated distribution, discrete distribution or random distribution. Formulas and meanings are as follows; global Moran's  $I$  is calculated as follows:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n W_{ij} (x_i - \bar{X}) (x_j - \bar{X})}{\sum_{i=1}^n \sum_{j=1}^n W_{ij} \sum_{i=1}^n (x_i - \bar{X})^2} \left( \bar{X} = \frac{1}{n} \sum_{i=1}^n x_i W_{ij} \right) \quad (102.1)$$

The formula shows the number of spatial units involved in the analysis;  $x_i$  and  $x_j$  denote some attribute value, that is, the value of  $x$  in spatial unit  $i$  and  $j$  at observation;  $W_{ij}$  is the spatial weight matrix. The Moran's  $I$  domain is  $[-1, 1]$ , and in a given significance level, if Moran's  $I$  value is greater than 0, it is significantly positively correlated, which indicates that farmers' per capita income is very high. The greater its value, the greater the correlation of the spatial distribution and the more obvious the degree of aggregation in space. Conversely, if the index value is less than 0, it is a significant negative correlation, indicating farmers' per capita income is higher. When the value tended to be zero, it means that rural per capita income level shows a random distribution.

### 102.2.1.2 Correlation Analysis of the Local Space

Global spatial autocorrelation condition is assumed that space is homogeneous, existing a cover of the entire region [4]. However, regional elements of the space often exit heterogeneity. Local spatial correlation analysis should be applied to measure the correlation between spatial feature attributes, that is, the correlation between the adjacent. A single spatial unit of local indicators (local Moran's  $I$ ) can be expressed in the following formula:

$$I_i = \frac{(n - 1) \times \sum_{j=1}^n W_{ij} (x_i - \bar{x})}{\sum_{j=1}^n W_{ij} (x_i - \bar{x})^2} \quad (102.2)$$

Variables in the formula act ditto.

Because of the existence of some differences between the regions of the townships, the results for per capita income of farmers in the regions can be analyzed by the application of Moran's  $I$  results in the calculation of the corresponding standardized value  $Z(I)$ , by which to evaluate the observation attributes gathered in space, discrete or random distribution of state characteristics, as well as to judge the existence of significant presence of spatial autocorrelation relationship ( $I$ ), which is calculated as follows[5]:

$$Z(I_i) = \frac{I_i - E(I_i)}{\sqrt{\text{Var}(I_i)}} \quad (102.3)$$

$E(I)$  is the theoretical expectation, and  $\text{Var}(I_i)$  is the theoretical variance. Their meaning is as follows; if  $I_i$  is significantly positive, and  $Z(I_i)$  is greater than 0, then the  $I_i$  value will be greater and the positive correlation will be stronger, indicating that the per capita income of farmers in townships around the area is relatively higher, which belongs to high-value areas;  $I_i$  was significantly positive, and  $Z(I_i)$  was less than 0, indicates that the per capita income of farmers in those areas is relatively low, which belongs to low-value areas;  $I_i$  is significantly negative, and  $Z(I_i)$  is greater than 0, means that the township region and its per capita income

of farmers in the surrounding town area show significant difference, and the per capita income of region is higher than that of the surrounding towns;  $I_i$  is significantly negative, and  $Z(I_i)$  is less than 0, indicates that rural per capita income for the township area and its surrounding towns area is significantly different and is under the region's per capita income of the surrounding towns.

### 102.2.1.3 Spatial Association Indicators (G Statistics)

Formula is defined as follows [6]:

$$G_i(d) = \frac{\sum_{j,j \neq i}^n w_{ij}x_j}{\sum_{j,j \neq i}^n x_j} \quad (102.4)$$

$G_i(d)$  is the G statistic for the  $i$  village or town. When  $Z(G)$  is positive, the position I was surrounded by higher values of observations; while  $Z(G)$  is negative, the position I is surrounded by smaller values of observations.

### 102.2.2 Research Procedures

Regional per capita income has huge amounts of data and the spatial and non-spatial characteristics. Considering the feature of the regions' per capita income, this article discusses the law of the regional per capita income spatial distribution with the perspective of spatial data mining. Above all, it analyzes the space characteristic properties of the region per capita income and its space relation. Secondly, the spatial distribution characteristics of the regional per capita income should be learned by

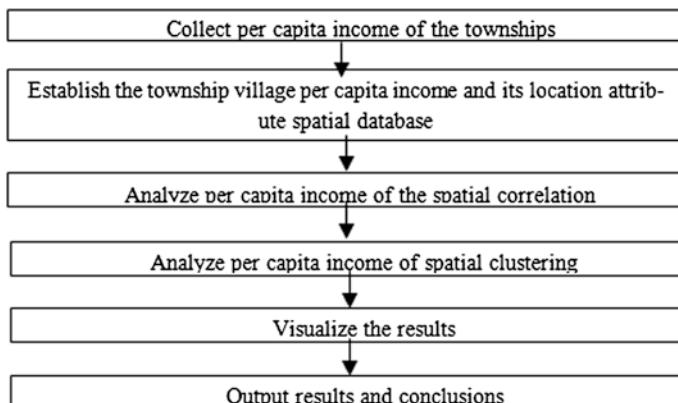


Fig. 102.1 Specific flowchart

spatial clustering analysis method. Finally, the analysis of regional per capita income output needs to be visualized, to provide a reference for social applications sector decision making. Specific flowchart is shown in Fig 102.1:

## 102.3 Data Sources and Preprocess

### 102.3.1 Spatial Data

Under the circumstances of MAPINFO, the task of coordinate registration and digitization of the administrative map of Neijiang city is completed, and the topological relations are established. In 2010, the township administrative division of Neijiang city is divided into eight towns and six villages.

### 102.3.2 Attribute Data

Attribute data are mainly obtained from the 2011 site investigation of “The overall planning of Neijiang City Central area New Village construction.” Taking into account that some administrative township village zoning had been adjusted, the data should be analyzed as follows. The villages with farmers without per capita income statistics are excluded from the scope of the study. Such areas cover the main city area Sihe township, Jiaotong township administrative village, which do not have the rural population and income level statistics. After the above processing, a total of eight townships and 175 administrative villages participate in data analysis.

## 102.4 Result Analysis

### 102.4.1 Spatial Variation Difference of Rural Per Capita Net Income

According to the spatial database created above, by means of the function of spatial statistical analysis modules in GeoDa, it can be concluded from the statistical database that the per capita income of east area is higher than that of the west; in general, space differentiation characteristics, in Lexian town, the Jiaotong township, Baima town, Linjia town and Yongan township x's level, are significantly better than the other towns in the region, and at the same time, there exist certain regional differences within these towns, such as Baima town eastern urban region is superior to the western rural areas. This reflects the prosperity of the development of township enterprises, but the development is not balanced between the various towns, with a

**Table 102.1** Neijiang city per capita Moran's  $I$  index and  $Z$  value

Index	Moran's $I$	Expected value( $E$ )	Test value( $Z$ )
Per capita income	0.071	-0.041	2.276

more significant regional disparity, especially when down to village level, the gap is more obvious. For instance, the income of Linjia town Yanwan village (6,980) is nearly four times higher than that of Tongzi village (1,715) in Gongjia township. From the space perspective, the magnitude of the township village farmers' per capita income spatial differences tends to expand. In order to further analyze the spatial variation characteristics of the farmers' income, the global and local spatial autocorrelation analyses are applied, respectively.

#### **102.4.2 Global Spatial Autocorrelation Analysis**

GeoDa software is used to calculate the global spatial autocorrelation index of the regional township farmers' per capita net income and then to calculate the corresponding  $Z(I)$  values; the results are shown in Table 102.1. The global Moran's  $I$  coefficient of the calculation of per capita income is 0.071, positively. This suggests that the spatial distribution of per capita income in the region as a whole has a strong positive autocorrelation. In standardized test, the value of  $Z$  is 2.276, indicating that the region is not randomly distributed. The results show a significant spatial clustering mode, namely the spatial association of the regional economy with high-income areas and high-income areas and high-income areas are adjacent, while low-income areas and low-income areas adjacent to the overall trend.

#### **102.4.3 Local Spatial Autocorrelation Analysis**

In order to further understand the internal regional difference in net income of farmer average per capita's spatial difference, the local spatial autocorrelation analysis is applied, which further analyzes the differences within the region in the township. MATLAB and GeoDa are used to calculate the township local autocorrelation index and spatial lag value (Table 102.2).

From the above analysis, we can see that each villages and towns per capita income exists apparent positive correlation and  $Z$  values of Yongan town, Baima town, Lexian town and Lingjia town are positive, indicating that these townships are significantly influenced by the central city development; however,  $Z$  values of Fulong township, Tuojiang township and Quanan township are negative, indicating that those townships are surrounded by the poor townships of economic ability. It can be seen that several eastern townships of the central city become linked together, forming central zone of strong economic ability, while western

**Table 102.2** The central district of Neijiang city township per capita G statistic and its Z value

Township	Local G statistic ( $G$ )	Test value( $Z$ )
Yongan town	0.625	1.501
Tuojiang town	0.574	-1.987
Sihe township	0.726	1.761
Baima town	0.501	2.065
Jiaotong town	0.695	1.571
Quanan town	0.257	-2.092
Shijia town	0.443	0.517
Gongjia town	0.234	-1.333
Linjia town	0.213	1.258
Jingmin township	0.817	0.638
Fengmin township	0.203	0.101
Fulong township	0.731	-1.329
Zhaoyang township	0.571	1.871
Lexian township	0.817	2.266

areas form township zones of comparatively weak economic ability. Meanwhile, it shows that the interaction range within the small townships is small and contact strength is insufficient.

## 102.5 Conclusions and Recommendations

Through the above analysis of the spatial differences of Neijiang city farmers' per capita income level, we can draw the conclusions as follows:

First, Neijiang city township economy as a whole has a strong spatial autocorrelation characteristic. The townships of stronger economic ability gather together, while one of the weaker economic ability clusters together, and the relevance improves continuously.

Secondly, Neijiang city township farmers' per capita income levels are not balanced, and demonstrated spatial heterogeneity is higher in the east than in the west.

Lastly, organic links between towns covered among the area are not sufficient. There are at least two growth points within the region, yet the regional economy has not melted into one. Except the central township such as Jiaotong and Sihe township, Linjia town, Yongan town, Baima town and Lexian town constitute a significant growth pole, which can be considered as the emergence of regional sub-center. However, the center of town radiation range is not ideal, and the radiation effect is relatively limited.

Through the above analysis, this paper considers the future direction of development of the Neijiang city area that should deploy the regions globally and arrange the urban and rural areas as a whole. For the centralized development

of cities and towns, advantage of their status quo basic conditions are taken, the development of leading industries is focused, the industrial clusters are deepen, the formation of scale benefit is set up, the relatively isolated points to the interrelated cluster development are upgraded and intensity of the radiation to its surrounding areas is further increased.

This article describes the spatial data mining algorithms and discusses its application prospects in the construction of the Regional Town and Country Planning. Spatial data mining is an emerging technology, and its applications are gradually explored, and we hope that this article can serve as a reference for the regional township spatial structure planning and its system construction.

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## Chapter 103

# Research on Micro-Blog Search and Sorting Algorithm Based on Improved PageRank

Shiren Ye, Shuige Yan, Changchun Yang, Kefei Yu, Hong Ding and Jing Yang

**Abstract** Based on basic PageRank, this paper proposes micro-blog search and sorting algorithm based on improved PageRank algorithm. It improves search algorithm based on link structure, makes a discussion aimed at 2-degree deep link of micro-blog pages and similarity of different micro-blog page topics, and raises the improved PageRank algorithm, which improves the effect of micro-blog sorting algorithm effectively. The experiment shows that the proposed algorithm is effective.

**Keywords** Micro-blog • 2-degree deep link • Similarity • Pagerank

### 103.1 Introduction

Nowadays, with the rapid development of network technology, micro-blog has become a very important information carrier on the internet, and especially widespread at the mobile terminal, with high usage frequency and obvious communication effect. Algorithm aimed at search and sorting for micro-blog also emerges as the time requires, helping users find relevant contents and topics they are interested in quickly via search engine [1]. At present, according to micro-blog and search algorithm of micro-blog, the search can be divided into search according to content and search according to link structure. At the earliest, PageRank algorithm was applied to Google search engine, and at present, it is a relatively successful and classical algorithm which uses page link analysis to make sorting. At the same time, PageRank algorithm conducts search only from the perspective of web page link, rather than considering other contents on the page, therefore the obtained result only reflects situation about page click rate. The classification effect of micro-blog content sorting can be increased by combining PageRank algorithm and comprehensive analysis of page contents [2].

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## 103.2 Analysis of Micro-Blog Behavior Characteristic Factors

### 103.2.1 *Comments*

Micro-blog is a kind of commentary medium, so abundant information will gather in comments or replies of the micro-blog, which are points that people will pay much attention to when they search on the micro-blog. After reading articles on the micro-blog, readers often express their feelings or provide further information, which will be reflected in comment column of the micro-blog, and this becomes a link between author and readers [3]. At the same time, author of the micro-blog can find the reader's micro-blog via comment section, so an effective channel for mutual communication is formed.

On the other hand, the concern degree of the micro-blog or author can be reflected according to comments and replies of the micro-blog. A topic circle will form for relatively populous micro-blog; thus, population effect will be triggered. Comments of micro-blog often reflect direction of recent public opinions, and meanwhile they also represent the contact degree between readers and the group. Generally speaking, comments of micro-blog can often be divided into reader identity of comment, issue time of comment, and content of comment, which are attributes that algorithm involved in this paper will pay special attention to [4].

### 103.2.2 *Link*

Link in micro-blog includes link from micro-blog to micro-blog, link from micro-blog to micro-blog articles, link from micro-blog articles to micro-blog articles, link from micro-blog articles to micro-blog, link from micro-blog articles to non-micro-blog, and so on [5]. The link involved in this article mainly refers to link from micro-blog articles to micro-blog articles.

### 103.2.3 *Classification and Label*

Classification of micro-blog articles is an article archiving method set by the micro-blog author according to his own interest or content of the article. Because the article type needs to be chosen when the article is issued, articles of the same type can be organized together according to certain category, which is beneficial to search and retrieval. In addition, classification is also channel for discovering personal interest and concern.

### 103.3 Page Sorting Algorithm Improvement Based on PageRank Algorithm

#### 103.3.1 PageRank Algorithm

PageRank algorithm was raised by Larry and Sergey from Institute of Technology, Stanford University of the United States in 1988. Such algorithm is mainly applied to authority for the page, and it is a method irrelevant to inquiry contents. The page will be graded according to the link degree of the page, and then sorting will be made according to the page weight.

The main idea of PageRank algorithm is to use method similar to voting, which regard every link that is linked to the page as a vote for this page, so the link number determines the authority degree of this page. In academic circles, an excellent paper will be cited by many papers, so authority of paper is reflected in citing number. The more it is used for reference, the higher its value will be, and the greater its contribution to relevant fields will be [6].

In the web pages, micro-blog belongs to the page type after simplification, so PageRank algorithm can also be used to conduct search. When there is a link in page A that points to page B, then it shows that page B is cited for once. At the same time, PageRank value of page A has to be shared out to page B accordingly [7]. When search within the scope is finished, importance of the page can be determined by PageRank value of every page, thus sorting results of pages are produced.

For micro-blog, if many micro-blog pages forward one micro-blog at the same time, then this micro-blog will get comparatively high PageRank value. Also, when a micro-blog is directed by another micro-blog with high PageRank value, it will get comparatively high PageRank value.

#### 103.3.2 Improvement for PageRank Algorithm

Firstly, PageRank algorithm is only concerned about link issues in the page rather than any topic and content in it, so it is easy to result in page convergence. Therefore, the topic may be deviated in the search process, which is mainly caused by the fact that page topics and contents cannot be judged. For example, Tencent micro-blog depends on the communication platform of QQ, so frequency of registration and forwarding comments is high. As a result, if PageRank algorithm is used, a large amount of Tencent micro-blogs may appear in the searching results.

Secondly, there is not much browsing and comment for newly built micro-blogs, so their PageRank value is low. Under the condition of searching according to PageRank value, probability for newly built micro-blogs to be searched is relatively low, and pages relevant to topics and contents cannot be reflected in this way.

Aimed at the above shortcomings, when PageRank algorithm is improved, relativity among pages will be emphasized. By comprehensive judgment of contents and links, two relevant pages will be used as partial order structure, to form topological structure among all relevant page nodes. In specific speaking, the forwarded micro-blog page node is regarded as father node of forwarding nodes, and every subordinate node represent the subclass. By analogy, tree topological structure with hierarchy structure can be obtained. In this paper, relativity among all nodes is re-defined as follows:

**Definition 1 (Node Depth)** Refers to the layer position where the certain node  $A$  is located in micro-blog tree layer system, marked as  $Depth(A)$ . Depth of the root node is set that as 0.

**Definition 2 (Same Degree)** Refers to the path length of two certain nodes  $A$  and  $B$  which have the same father node in micro-blog tree layer system, marked as  $SameD(A, B)$ .

**Definition 3 (Different Degree)** Refers to the shortest path length two certain nodes  $A$  and  $B$  moves up along the micro-blog tree layer system till they meet the same father node, marked as  $DiffD(A, B)$ .

**Definition 4**  $A$  and  $B$  are two certain topic nodes in micro-blog tree layer system, topic similarity in the micro-blog page  $Similar(A, B)$  is calculated as:

$$Similar(A, B) = \frac{2 \times SameD(A, B)}{Depth(A) + Depth(B)} \quad (103.1)$$

**Definition 5** 2-degree deep of micro-blog page refers to two certain topic nodes  $u$  and  $v$  in micro-blog tree layer system, in which the micro-blog page  $v$  is linked page  $u$ , and 2-degree deep is marked as  $out(v, u)$ , with the calculation formula of:

$$out(v, u) = \sum_{r \in O(u)} N(r) \quad (103.2)$$

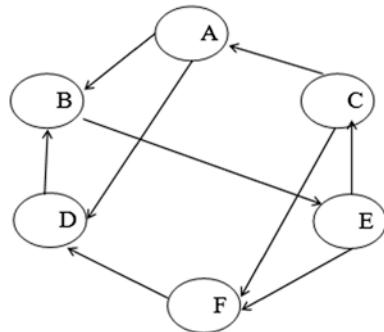
In which  $O(u)$  refers to collection of chain-out pages of the micro-blog page  $u$ .  $N(r)$  refers to the chain-out number of page  $r$ . Suppose there are six micro-blog pages that contain different topics, refer to Fig. 103.1 for their micro-blog network topological graph after comment and forwarding.

Suppose Fig. 103.2 is different topics  $(A, B, \dots, J)$  in the micro-blog pages.

The improvement algorithm of combining topic similarity in the micro-blog pages and page 2-degree deep link is defined as:

$$PR(u) = d + (1 - d) \sum_{v \in I(u)} \frac{PR(v)}{N(v)} \left( 0.5 \times Similar(u, v) + 0.5 \times \frac{out(v, u)}{\sum_{w \in O(v)} out(v, w)} \right) \quad (103.3)$$

**Fig. 103.1** Link relationship of micro-blog pages



## 103.4 Experimental Analysis

Topic similarity of different micro-blog pages obtained by micro-blog network topological graph and tree diagram consisting of different topics in micro-blog pages is as follows:

$$\begin{aligned} \text{Similar}(A, C) &= \frac{1}{2}, \quad \text{Similar}(A, B) = \frac{10}{11}, \quad \text{Similar}(B, D) = \frac{3}{5}, \quad \text{Similar}(C, E) = \frac{4}{7} \\ \text{Similar}(A, D) &= \frac{6}{11}, \quad \text{Similar}(D, F) = \frac{2}{3}, \quad \text{Similar}(B, E) = \frac{3}{5}, \quad \text{Similar}(C, F) = \frac{2}{3} \\ \text{Similar}(E, F) &= \frac{8}{9} \end{aligned}$$

The PR value of each micro-blog page can be calculated as follows:

$$\text{PR}(A) = d + (1 - d) \frac{\text{PR}(C)}{2} \left( 0.5 \text{Similar}(A, C) + 0.5 \frac{\text{out}(C, A)}{\text{out}(C, A) + \text{out}(C, F)} \right)$$

$$\begin{aligned} \text{PR}(B) = &d + (1 - d) \left[ \frac{\text{PR}(A)}{2} \left( 0.5 \text{Similar}(A, B) + 0.5 \frac{\text{out}(A, B)}{\text{out}(A, B) + \text{out}(A, D)} \right) \right. \\ &\left. + \text{PR}(D)(0.5 \text{Similar}(B, D) + 0.5) \right] \end{aligned}$$

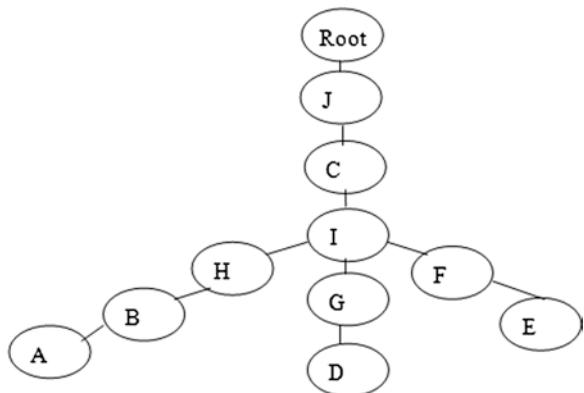
$$\text{PR}(C) = d + (1 - d) \frac{\text{PR}(F)}{2} \left( 0.5 \text{Similar}(C, E) + 0.5 \frac{\text{out}(E, C)}{\text{out}(E, C) + \text{out}(E, F)} \right)$$

$$\begin{aligned} \text{PR}(D) = &d + (1 - d) \left[ \frac{\text{PR}(A)}{2} \left( 0.5 \text{Similar}(A, D) + 0.5 \frac{\text{out}(A, D)}{\text{out}(A, D) + \text{out}(A, B)} \right) \right. \\ &\left. + \text{PR}(F)(0.5 \text{Similar}(D, F) + 0.5) \right] \end{aligned}$$

$$\text{PR}(E) = d + (1 - d)\text{PR}(B)(0.5 \text{Similar}(B, E) + 0.5)$$

$$\begin{aligned} \text{PR}(F) = &d + (1 - d) \left[ \frac{\text{PR}(C)}{2} \left( 0.5 \text{Similar}(C, F) + 0.5 \frac{\text{out}(C, F)}{\text{out}(C, F) + \text{out}(C, A)} \right) \right. \\ &\left. + \frac{\text{PR}(E)}{2} \left( (0.5 \text{Similar}(E, F) + 0.5 \frac{\text{out}(E, F)}{\text{out}(E, F) + \text{out}(E, C)}) \right) \right] \end{aligned}$$

**Fig. 103.2** Topic tree of micro-blog pages



**Table 103.1** The PR value of micro-blog pages

The number of iterations	PR(A)	PR(B)	PR(C)	PR(D)	PR(E)	PR(F)
0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1	0.89375	1.02909	0.89955	1.00795	0.97000	0.93021
2	0.88929	1.02377	0.89807	0.97069	0.97349	0.92516
3	0.88930	1.01904	0.89824	0.99495	0.97285	0.92525
4	0.88930	1.02194	0.89821	0.99496	0.97228	0.92523
5	0.88930	1.02194	0.89818	0.99496	0.97263	0.92521
6	0.88930	1.02194	0.89820	0.99496	0.97263	0.92522
7	0.88930	1.02194	0.89820	0.99496	0.97263	0.92522

The PR value of micro-blog pages are calculated after a number of iterations as shown in Table 103.1.

After seven iterations, the PR value of each page basically becomes convergent iterative process end. The PR value of 6 micro-blog pages can be ranked as

$$\text{PR}(B) > \text{PR}(D) > \text{PR}(E) > \text{PR}(F) > \text{PR}(C) > \text{PR}(A).$$

The experimental results show that micro-blog search and sorting algorithm based on improved PageRank can improve performance effectively.

## 103.5 Conclusion

Based on micro-blog search algorithm, this paper improves PageRank algorithm based on link structure. Based on 2-degree deep link of micro-blog pages and topic similarity of different pages, PageRank algorithm proves to be feasible via experiments. The improved PageRank algorithm optimizes the sorting quality issues for micro-blog pages with different topics and increases the effect of micro-blog sorting algorithm.

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# Chapter 104

## Frequent Itemsets and Association Rules with a Certain Probability in Data Mining

Shou-Gang Chen, Tie-Song Shen and Yu Xiang

**Abstract** Data mining, referred to as knowledge discovery in databases, is the extraction of patterns representing valuable knowledge implicitly stored in large databases or data warehouses, and the regional data mining research is quite limited. We acquired information from our regional data mining is based on the data mining with probability. First, the new algorithm is presented. Second, we calculated the support and the confidence by the numeric parsers. Finally, we propose a region-based location strategy and tested the conclusion.

**Keywords** Frequent itemsets • Association rules • Open education

### 104.1 Introduction

Data mining [1] is a process that the interesting knowledge is discovered from large amounts of data which stored in the database, data warehouse, or other information base. Frequent pattern mining is that find pattern frequently appears in the data set (such as itemsets, subsequence, or substructure) from mass data. This paper presents a frequent itemsets with probability and find out the strong association rules on this basis then feedback organization superiority in some areas.

The analysis of frequent itemsets and their association rules is one of the basic methods of data mining, where most of the research is in progress to optimize the mining frequent itemsets [2]. Frequent pattern mining search a recurring contact from given data set, in which the typical case is the market basket analysis. The market basket analysis analyzed the association among the customer purchase goods and the customer shopping habits then do a better marketing strategy to help retailers to display goods, in order to purchase goods convenient and increase organizational effectiveness. Many researchers analyze student's achievement based on association rules in the field of education [3], which draw some

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interesting knowledge through association rules then to promote the improvement of teaching quality, and help teaching is carried out smoothly, optimize the student's course selection and teachers timetable, which based on the association of student achievement [4].

The frequent itemsets and association rules have been applied in the field of education seen from the above. The province school's control is inadequate under this system which teaching and testing is separated, and a number of schools are not in the same region. How to analyze the quality of teaching and management level for each school and then implement effective control is an interesting question. A certain probability of frequent itemsets and association rules model is established, which based on the data mining of open education student achievement database.

## 104.2 Basic Knowledge

The basics are as follows:

- (1) Itemset: it is a set, such as  $I = \{I_1, I_2, \dots, I_m\}$ , contains m elements, and each transaction T is a collection of items,  $T \subseteq I$
- (2) Association rules: it is an implication, such as  $A \Rightarrow B$ ,  $A \subset I$ , and  $B \subset I$
- (3) Support and Confidence: Implication (rule)  $A \Rightarrow B$  was established, who has support degree s, in which the s is that the T in the transaction contains the probability of  $A \cup B$ , denoted by  $p(A \cup B)$ . The confidence c is a transaction T to meet the rules  $A \Rightarrow B$ , transaction A and transaction B, with the percentage of A's Affairs, denoted by  $p(A|B)$ . The following formula:

$$\text{Support } (A \Rightarrow B) = p(A \cup B) \quad (104.1)$$

$$\text{confidence } (A \Rightarrow B) = p(A|B) \quad (104.2)$$

- (4) Frequent itemsets: If  $\text{confidence}(I_i) \geq \min(\text{predefined support})$ ,  $I_i \subseteq I$ ,  $i = 1, 2, \dots, m$ , then  $I_i$  is frequent itemsets.

Because of the open education's schools are scattered, the enrollment and the examination number are different in different regions. Because, the size of school is not the same in the various regions, the data have regional characteristics, and the support will not be able to reflect reality on the global analysis of the data of all schools, so a specific condition must be added what is probability. That the probability of each rule in an area is decided the number of people in this region accounted for the proportion of the total number of people in this region, it is denoted by  $P_j$ ,  $j = 1, 2, \dots, n$ , and the n is the number of the researching region. We have established the true degree of support ( $\text{SUPPORT}(A \Rightarrow B)_j$ ) and confidence ( $\text{CONFIDENCE}(A \Rightarrow B)_j$ ). The Model is as follows:

$$\text{support}(A \Rightarrow B)_j = p(A \cup B) = \text{SUPPORT}(A \Rightarrow B)_j P_j \quad (104.3)$$

$$\text{confidence } (A \Rightarrow B)_j = p(A|B) = \text{CONFIDENCE}(A \Rightarrow B)_j P_j \quad (104.4)$$

We implement the support analysis and the confidence level analysis on the frequent itemsets on the rule, and then, we calculate the real support and confidence in their regions according to the formula (104.3) and (104.4). We think that it is valuable information.

### 104.3 Data Processing

The original database as shown below, we selected four fields in the table of student achievement, which would be useful to data mining.(xxdm, xh, sjh, zhcj); the xxdm represents school code (Chongqing Radio and Tv University has 48 open education units,  $j = 48$ ), the records number is 256,604, and the raw data are as shown in Fig. 104.1.

It is clear that we analyzed the data and association rules what is detrimental on this data structure. We cleaned up the data, and the rules are as follows: The 48 xxdm is divided into eight regions based on the position and their relationship, region1 (two units directly under), region2 (nine units in the Chongqing urban), region3 (six units in the Chongqing suburban), region4 (six units in the Chongqing exurb), region5 (five key units), region6 (nine units in the Chongqing suburban), region7 (four units in the Chongqing exurb), and region8 (seven industry units);

	Xxdm	Xh	Sjh	Zhcj
▶	5120401	0751201400881	2001	74
	5120401	0751201400881	2007	53
	5120401	0751201400881	2204	77

◀ ◀ | 1 / 256604 | ▶ ▶ ▶ ⌂ |

Fig. 104.1 The raw data

	Xxdm	Xh	denglun	english3
▶	region5	1051201462227	grade2	grade2
	region5	1151201404515	grade2	grade5
	region5	0951201406314	grade1	grade3
	region5	0951201403244	grade2	grade5
	region5	0951201461661	grade1	grade3

◀ ◀ | 1 / 80369 | ▶ ▶ ▶ ⌂ |

Fig. 104.2 Treatment of data

We removed the data of absent students, 2,001 corresponds to Deng Xiaoping Theory, 2,204 corresponds to English3; The students' achievement is divided into five levels: grade1(90–100), grade2 (80–89), grade3 (70–79), grade4 (60–69), and grade5 (<60). According to the rules to remove the noise data, the following figure is that the number of records is 80,369, as shown in Fig. 104.2.

## 104.4 Data Analysis

We analyzed the different level support of the Deng Xiaoping Theory and English3, and the results are as follows:

It can be seen from Table 104.1, and the overall distribution of scores is normal. The English3 is more difficult than the Deng Xiaoping Theory according to that a failing grade number of the English3 is more than the number of the Deng Xiaoping Theory, which is consistent with the laws of our courses. We proposed a rule1: Deng Xiaoping Theory (grade5)  $\Rightarrow$  xxdm<sub>j</sub>, find the rule1 confidence (Deng Xiaoping Theory (grade5)  $\Rightarrow$  xxdm<sub>j</sub>),  $j = 1, 2, \dots, 8$ . 1 represent region1,..., 8 represent region8 in the Table 104.1. And then, to calculate confidence (Deng Xiaoping Theory (grade5)  $\Rightarrow$  xxdm<sub>j</sub>) according to the Eqs. (104.2–104.4). The  $P = \{0.05, 0.26, 0.07, 0.07, 0.23, 0.16, 0.05, 0\}$  calculated by the every part of area and total areas ratios (Table 104.2).

As we can see from the figures, the real CONFIDENCE(rule1) is bigger than 1, which illustrate is abnormal. We calculate the average of CONFIDENCE(rule1), which is 0.9832 who illustrates the mathematics model of the structure is reliable, and it is close to 1. Then, we calculate the discrepancy

**Table 104.1** The support of Deng Theory and English3

Support(grade)	1	2	3	4	5
Denglun	0.1458	0.3297	0.2699	0.1000	0.1546
English3	0.1117	0.3511	0.2211	0.0916	0.2245

**Table 104.2** Confidence(rule1) and CONFIDENCE(rule1)

	1	2	3	4	5	6	7	8
confidence (rule1)	0.0455	0.3516	0.0892	0.0320	0.1811	0.1093	0.0608	0.1305
CONFIDENCE (rule1)	0.9095	1.3524	1.2739	0.4576	0.7873	0.6831	1.2153	1.1868

**Table 104.3** Discrepancies

	1	2	3	4	5	6	7	8
Discrepancy	0.0738	0.3629	0.2907	0.5256	0.1959	0.3001	0.2321	0.2035

(|CONFIDENCE (rule1) – 0.9832|) of the every region real CONFIDENCE is shown as the Table 104.3.

Too many variables, trends, and events will affect the student score. Suppose, there is ideally except the examination ring; in this case, the CONFIDENCE (rule1)'s uncommon event occurred. The higher the number of the discrepancy, the more questions occurred in the examination ring; conversely, the examination is a regime of performance targets set by servants. The Table 104.3 showed that region4, region2, and region5 are bigger than others; region1, region5, and region8 are smaller than others.

This conclusion is consistent with what happens in the real world. According to the data processing, we have realized that region1 (two units directly under), region5 (five key units), region8 (seven industry units) who do better; region4 (six units in the Chongqing exurb), region6 (nine units in the Chongqing suburban), region2 (nine units in the Chongqing urban) who do not better. The discrepancy of region2 and region6 has individual adaptation in differences based on absolute value of the numerical symbols, though their troubles are similar, each region has faced them differently.

## 104.5 Conclusion and Prespection

We have verified the correctness of the mathematical model and dug out the meaningful information based on the actual situation and numerical analysis. In order to straighten out the exam management, we have made a thorough investigation with the management way and method of immediate units, key units, and industry units. We focus on rectification of bad units.

Of course, this article studies the two frequent itemsets association rules. In the next step, we will be doing a research in much more frequent itemsets. We think that teaching management and enrollment management are very important. The data model was proposed is suit for researching in the somewhere with regional characteristics.

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# Chapter 105

## Mining Microblog Community Based on Clustering Analysis

Changchun Yang, Hong Ding, Jing Yang and Hengxin Xue

**Abstract** In order to explore the potential microblog network community structure, this paper proposed an algorithm based on the discovery of community in microblog using clustering analysis. First, according to the characteristics of the microblog network, we defined the network model. Next, we conducted cluster analysis using K-means algorithm based on network model. Finally, LC module degree function was used to determine the optimization community structure. Through experimental comparison, we found that this algorithm takes into account the communication between users. It is conducive to optimizing the conditions of community found and more in line with the actual situation of the microblog network, deriving more accurate result of division of the community.

**Keywords** Microblog model • Community structure • K-means algorithm • Information group degree • LC module degree

### 105.1 Introduction

With the arrival of Web2.0, the social network site is gaining popularity. As one of the social network site, microblog has become the focus of many researchers. Now, there are two methods of exploring complex network community structure. One is hierarchical clustering [1–3] in sociology; another is graph segmentation in computer science. Hierarchical clustering is the traditional method of detecting the network community. The GN algorithm was proposed by Girvan and is widely used in hierarchical clustering. The representative method of graph segmentation is Kernighan–Lin algorithm [4] and spectral bisection method [5].

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K-means algorithm [6] was put forward by MacQueen based on classification of clustering. This algorithm is one of the widely used clustering methods. It is simple, and the algorithm convergence speed is fast. This paper proposed an algorithm of finding microblog network community using K-means algorithm and microblog network attributes. This algorithm defined a concept of group information degree. It dynamically sets the weight of network edge. In line with the minimum relational degree principles to select new clustering center, maximum relational degree principles to pattern classification was used until all the nodes are divided over [7]. The algorithm can be closer to the characteristics of the microblog network and find the cluster center and makes the quality of community greatly improved.

## 105.2 Problem Definition

### 105.2.1 Microblog Network Structure

Based on the study of complex networks, the general network structure is divided into non-directed graph structure and unidirectional graph structure. In microblog network, set each user of bloggers for a node. Users have two types of information: follow and follower. Set the follow for the node in-degree and follower for the node out-degree. So, one-way side and two-way side are two types of edges in the network. The phenomenon of “Backed by the face” is very obvious. As can be seen from the relationships between nodes in the network, the microblog network structure is a hybrid digraph.

According to the concept of microblog network community, the existence of the microblog community depends only on the exchange of information between the users. It means that the users switch information with each other between the post and comments, nothing to do with the direction of the follow among users. This paper sets user to node, proposing the concept of node information group degree that means the reciprocal of sum of the number of retransmission and comments between nodes. Node information group of degree can be a very good response in microblog network bloggers and more accurately in the microblog network community mining. On the basis of node information group degree, the microblog network structure is simplified to the non-directed weighted graph.

The microblog network is a triplet  $G = (V, E, w)$ , where  $V$  is a set of nodes,  $E$  is a set of edges, and  $w$  assigns a weight to each edge. The node information group degree is  $v_i$ , forwarding number in nodes  $v_j$  and  $j$  is  $r_{ij}$ , the number of comments between nodes  $v_j$  and  $j$  is  $c_{ij}$ , then the expression of  $v_i$  is

$$d_{ij} = 1/r_{ij} + c_{ij} \quad (105.1)$$

Setting the weight of edge to the node information group degree, the expression of  $w_{ij}$  is

$$w_{ij} = d_{ij} \quad (105.2)$$

### 105.2.2 Node Relation

The node relation [8] between two adjacent nodes in the network of microblog is determined by the weight of their shared edge. The shared edges between adjacent nodes, the smaller, the weight, the greater, the probability of the path is not to transfer information between communities. They have great probability of belonging to the same community. The relations among them are more close, and the node relation is bigger.

As can be seen analysis, node information group degree between the communities is bigger than within the community. Clearly, the smaller the information group degree between nodes  $i$  and  $j$ , the greater the node relation between them and the their probability of belonging to the same community is higher. Then, we can define the node relation of two adjacent nodes.

$$\text{node Relation } (v_i, v_j) = 1 - w_{ij} \quad (105.3)$$

Both adjacent nodes and non-adjacent nodes are the nodes of microblog network. Maybe there are multiple paths or no paths between non-adjacent nodes. Obviously, if the path between two nodes is longer, the node relation is smaller. The node relation between the two non-adjacent nodes is converted to seek the shortest path between two nodes. The shortest path of two non-adjacent nodes is defined as the path of pass edge at least. Namely, the shortest path between nodes is the path containing the least number of nodes among all the paths connecting the two nodes. Therefore, we can use the breadth-first search algorithm to obtain the shortest path between all non-adjacent nodes and then find the maximum node relation between non-adjacent nodes.

Assuming the shortest path of microblog network between non-adjacent nodes  $vi$  and  $vj$  is *short Path* ( $vi, vj$ ), then the node relation between non-adjacent nodes can be expressed as the product of all nodes relation on the shortest path. If the number of shortest path is  $s$  between non-adjacent nodes, then choose the largest product as the node relation of non-adjacent nodes.

$$\text{node Relation } (v_i, v_j) = \max_s \left\{ \prod_{(v_i, v_k) \in \text{shortPath } (v_i, v_j)} \text{nodeRelation } (v_i, v_k) \right\} \quad (105.4)$$

Formulas (105.3) and (105.4) can be used to construct microblog network node relation matrix  $R$ .

$$R = [\text{node Relation } (v_i, v_j)]_{|V| \times |V|} \quad (105.5)$$

Clearly,  $R$  is a symmetric matrix, because node relation by itself does not affect the results of the community divided. In order to facilitate the calculation, the value of main diagonal elements is set to the corresponding node degree.

$$R_{|V| \times |V|} = \begin{cases} \deg(vi) & i=j \quad \text{and} \quad vi, vj \in V \\ \text{node Relation } (v_i, v_j) & i \neq j \quad \text{and} \quad vi, vj \in V \end{cases} \quad (105.6)$$

### 105.2.3 LC Module Degree

The original community module degree (NG module degree) is a metric proposed by Newman to measure the quality of network division. It is not conducive to the measure of the larger situation of the community size differences. However, the size of microblog network community is greatly different, and then it may not achieve the desired results using the NG module degree. In this paper, we use LC module degree; it has the connection with density of the community and cohesion coefficients and does not associate with the sum of the degree of internal nodes. The expression of LC module degree is defined as follows. The value of  $Q$  is bigger, and the community structure is more obvious.

$$Q(S_1, S_2, \dots, S_n) = \begin{cases} 0 & n = 0 \\ \frac{\sum\limits_{i=1}^n L(S_i)Coh(S_i)}{n} & n > 1 \end{cases} \quad (105.7)$$

$ni$  is the number of nodes in community  $S_i$ ,  $E(S_i)$  is the number of edges in the

$$L(S_i) = \begin{cases} 1 & ni=1 \\ \frac{2E(S_i)}{ni(ni-1)} & ni>1 \end{cases} \quad (105.8)$$

community  $S_i$ .

$A(S_i, S_j)$  is the total number of edges in the connection community  $S_i$  and  $S_j$ .

$$Coh(S_i) = \begin{cases} 0 & E(S_i) = 0 \\ \frac{E(S_i)}{E(S_i) + \sum\limits_{j \neq i} A(S_i, S_j)} & E(S_i) > 0 \end{cases} \quad (105.9)$$

## 105.3 Algorithms

The traditional K-means clustering algorithm uses the principle of maximum distance to select a new cluster centers and use the principle of minimum distance to conduct pattern classification in the mode characteristic vector sets. The principles applied to the discovery of the microblog network community can be understood as the minimum node relation principle to select a new cluster center, and then as the maximum node relation principle to conduct pattern classification until all the nodes are divided. The steps of microblog network community discovery algorithm based on K-means algorithm are as follows.

Input: Adjacency matrix of microblog network

Output: Community structure of microblog network

Step 1. Assume  $\text{center} = \emptyset$ ,  $V1 = V0 - \text{center}$   $k = 2$  According to equation (105.3) and (105.4), the node relation matrix  $R$  of microblog network can be calculated.

Step 2. Select the node that has maximum node relation in nodes sets  $V_1$  as the first cluster center.

$$\text{center} = \text{center} \cup \{cx\}, V_1 = V_1 - \{cx\}$$

Step 3. If  $|\text{center}| \neq k$ , go to step 4, else go to step 5.

Step 4. Use matrix  $R$  to calculate the average node relation between the nodes in sets  $V_1$  and the nodes in cluster center. Select the node that has minimum node relation as a new cluster center. Go to step 3.

$$r_j = \sum_{i=1}^{|\text{center}|} r_{ji}/|\text{center}|, r_{\min} = \min_j(r_j)$$

$$\text{center} = \text{center} \cup \{v\}, V_1 = V_1 - \{v\}$$

Step 5.  $V_1 \neq \emptyset$ . Compute the node relation between node  $v_j$  and node in cluster center. Node  $v_j$  belongs to a cluster that has the maximum node relation. A cluster is a community, output community result of division.

Step 6. Calculate the LC module degree of the current community division.

If  $Qk \geq Qk - 1$  and then  $k = k + 1$ , go to step 3, else the algorithm stops.

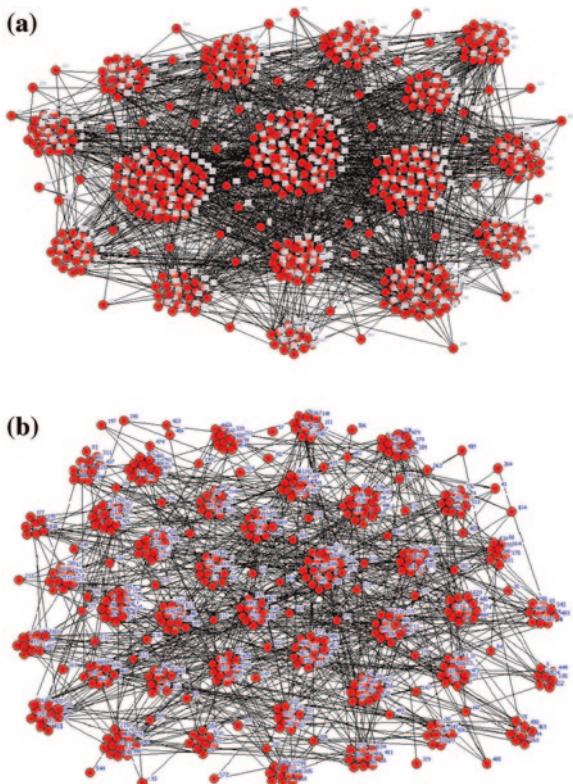
## 105.4 Experiments

In order to test the feasibility of the algorithm, this paper used the Sina microblog data from Web site <http://www.datatang.com/data/11819>. We selected two sets of test cases, each case was built by two groups of deep link user data. The first group selects the star user “YAO Chen” as the original node. Her followings and followers are one deep link, and their followings and followers are two deep link. We collected information from 551 users. The second group selects the ordinary user “Guo Jiu Ye” as the original node. We also collected information from 551 users by using the similar method.

Original K-means algorithm and the algorithm we proposed to test on above test cases were used. Figure 105.1 shows the community division structure of two sets of experimental data by using Ucinet. Figure 105.2 shows the LC module degree trend when network is divided into  $k$  communities.

It can be seen from Fig. 105.1, there are 16 communities in Fig. 105.1a, and the community scale is big. Figure 105.1b has 40 communities, but most of them are small group structure. The community structure in Fig. 105.1a is more obvious than in Fig. 105.1b. The original node of the first group data is a leader node. She is more influential. The communication in the two deep link users by her is frequent. Therefore, the community divided structure is obvious. The second group data take an ordinary user as the original node. The two deep link users lack communication, so their community division structure is not very obvious. There are some scattered nodes after the original network is divided into the communities, this is because some users just only follow other users, but have none or little information between them. How to remove these scattered users to get a pure community structure should also be studied in the future research.

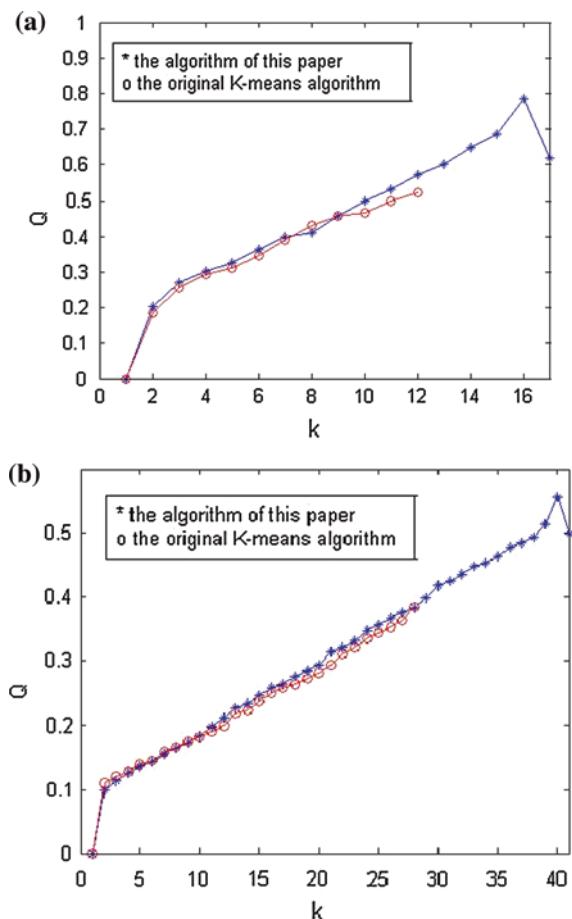
**Fig. 105.1** **a** The community division structure of first group data. **b** The community division structure of second group data



It can be seen that the original k-means algorithm takes the cluster structure of all nodes as the final results. The LC module degree is completely a upward trend. The purpose of this algorithm is to obtain an optimal community division structure. When LC module degree reaches the maximum value of community, the division structure is the best result. The original k-means algorithm obtained 12 communities in Fig. 105.2a. Our algorithm obtained 16 communities, and almost all the LC module degrees are higher than in original k-means algorithm. The community structure is more accurate and clear. The line trend of our algorithm is close to the original K-means algorithm, but the number of community is more than the original K-means algorithm. The resulting community structure corresponds to LC module degree greater than the original K-means algorithm. According to the principle, the greater the Q value, the more obviously the community structure shows that the final community structure of our algorithm is more accurate than the original K-means algorithm.

Comparing the combination of the results of two groups of experiments, we take the exchange situation between users as consideration factor of communities division; therefore, we could get a clearer community structure. The more frequent the exchange situation is, the more evident the community structure is. Even when faced

**Fig. 105.2** **a** The LC module degree trend of first group data. **b** The LC module degree trend of second group data



with the users lacking communication, the condition of community division has weak advantage; it can be seen from Fig. 105.2b that the number of communities by our algorithm is still more than the original K-means algorithm, and the community structure becomes more clear. The Above analysis shows that the community division structure by our algorithm is better than the original K-means algorithm.

## 105.5 Conclusions and Future Work

This article quoted the main ideas of the K-means clustering algorithm. It proposed a method to divide microblog network community. The algorithm proposed the concept of node relation. It makes the value more accurate by calculating the network edge weight dynamically. The users' interest similarity degree exists in microblog network. How to put this information into the community discovery algorithm is the research goal in the future.

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# Chapter 106

## Research on the Knowledge Storage Methods of SPF Tree

Guorong Chen, Juli Deng, Jinliang Shi and Jun Zhou

**Abstract** To use the historical records in fault diagnosis efficiently, we have put forward out a method of SPF (system-phenomenon-fault tree), and the method gives us a novel way to solve the problem of fault diagnosis. To improve the efficiency of SPF, we study the knowledge storage method of SPF in the paper. Reviewed the concept and characteristics firstly, came out an complex component storage method of “linear lists + Linked list,” solved the storage method of components and their relationships; used random storage method to storage component and failure phenomenon, fault and solution considering their relationships of peer-to-peer; proposed “Breadth-first + Strength-first” to enhance the retrieval hit rate and reduce the time cost; we defined the data structures and implemented the storage methods, which proved its correctness and efficiency.

**Keywords** Knowledge storage • Fault diagnosis • Knowledge engineering • SPF tree

### 106.1 Introduction

Historical record involved some important information, and it can help us to diagnose the similar problems [1–3], but it is very difficult that discovers the useful information quickly and accurately. The authors proposed a method, named SPF (system-phenomenon-fault tree), and built the fault diagnosis framework based on the SPF tree in Ref. [4], but it did not tell us how to store the information [5–7], so the SPF tree run in low efficient cannot play the ability of strong self-learning and fast retrieval. In this paper, we intend to study the in-depth storage method and enhance the quick and intelligence capabilities of SPF.

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## 106.2 The Fault Diagnosis Based SPF

Generally, we are accustomed to find the cause of the fault from failure phenomenon [8–11]. In order to solve the relationship between fault and its phenomenon, SPF is defined a map of fault and its phenomenon according to the affiliation of the system; in the map,  $S$  is root,  $C$  are trunks,  $P$  are branches, and  $F$  are leaves, as Fig. 106.1. The trunks of component can be implicit in the failure phenomenon if we defined a rational function relationship  $R$ , so the SPF tree can be expressed as a four-parameter set of { $S$ ,  $P$ ,  $F$ ,  $R$ }.

From the definition of SPF tree, we can see that the problem of retrieval faults from its phenomenon may be transformed into retrieval the maximum reference number problem in the SPF tree.

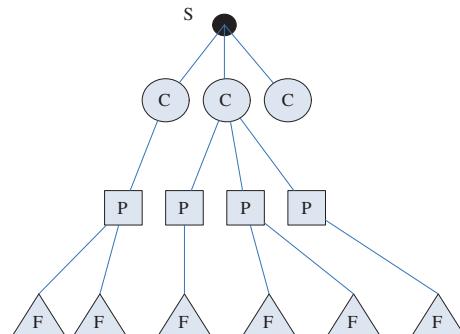
$$A = \max(F_{ij}) \quad (106.1)$$

There,  $F_{ij}$  is the cite number of leaves in SPF.

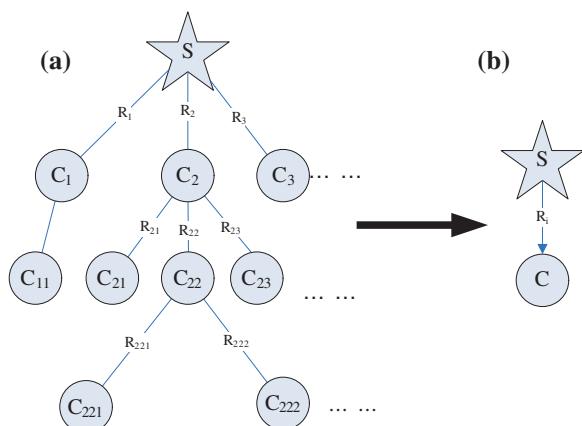
SPF has the following characteristics:

1. The component  $C$  is flexible and virtue.  $C$  is virtual component packaged the inner structure and relationships in SPF tree; it can be expressed as Fig. 106.2.

**Fig. 106.1** SPF tree



**Fig. 106.2** The component  $C$  **a** the component with complex structure **b** the virtual component package the inner structure and relationships



While we retrieve the component, the node will unfold as needed, may step into and navigate to an inner component.

2. There lies a relational transformation matrix  $R$  among component, failure phenomenon and fault, and the matrix decided the efficiency of SPF tree.
3. The relational transformation matrix  $R$  is dynamic. The value and element of  $R$  may change with the development of SPF.

### 106.3 The Knowledge Storage Methods of SPF

The fault diagnosis method of SPF may be defined as four-parameter set of  $\{S, P, F, R\}$ , so we study the knowledge storage methods of SPF from the four aspects.

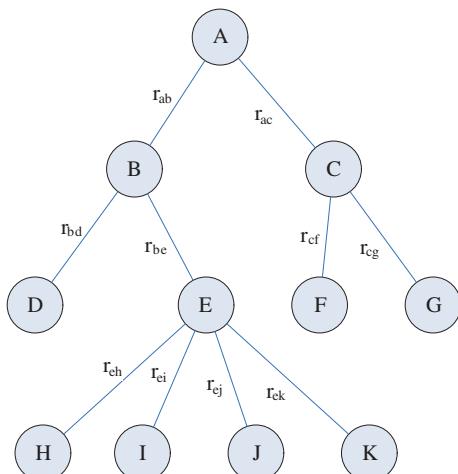
#### 106.3.1 Component C

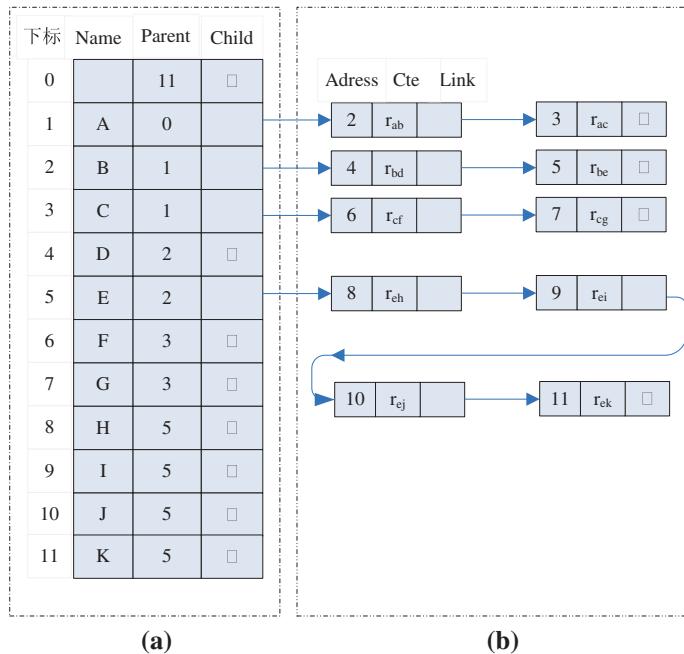
We may take apart a machine as its structure, and it may form a component tree as Fig. 106.3. From it, we can see that the most important relationship in the tree is parent-child relationship and brotherhood, and the relationship may be recursively expressed. For example, root node A has null child or brothers, node B have father a, children D and E, brother C.

So, we must express the node and the parent-child relationship and brotherhood, while we store the component tree, we can store the component tree according the following three steps:

1. To store the nodes. Using linear list to store the nodes information according their structure and relationships, it shows as row name in Fig. 106.4a.

**Fig. 106.3** The component tree





**Fig. 106.4** The storage method of component

2. To store the parents. According to the relationships of parent–child in the tree, stores the address or serial number of the parent, if the node is root node, and the parent is null (□), it shows as row Parent in Fig. 106.4a.
3. To store the children. According to the relationships of parent–child in the tree, stores their children, if the node has no children, the pointer point to null (□), it shows as row Child in Fig. 106.4a.
4. To store the brothers, change the row of Child’s pointer, and points to the left or first child, the first child’s pointer points to the next child, and so on, until the last child, it shows in Fig. 106.4b.
5. Records the number of nodes in line 1.

### 106.3.2 Failure Phenomenon P

Because, component C is fixable, so we can find a case of C–P has relationship of peer-to-peer always. In the case, we may omit the inner structure of node, and the C–P is the basic peer-to-peer virtue relationship. So, the failure phenomenon P may use random storage method to storage component and the failure phenomenon, and the pointer of P point to C, the method help us to find the retrieval root of failure phenomenon, as Fig. 106.5.



**Fig. 106.5** The peer-to-peer relationship of C-P

There, it particular note is that C may be repetition, because there may be have same component but different fault, so there may be multiple P corresponds to a C.

### 106.3.3 Failure Phenomenon F and the Troubleshooting Way M

The cause of fault is the key of problem; it is very easy to troubleshoot the problem if we find out the cause. We should maintain the database of fault cause, especially digs out the useful data from the new maintenance records; it needs to create a new record if there is no same record in the database and sets the citing rate  $r_{ij}$  as one; it does not need to create a new record if there has a same record and set  $r_{ij}$  as  $r_{ij} + 1$ .

There is correspondence between troubleshooting way M and failure cause F too. So, failure phenomenon P may use random storage method to storage and the pointer of F point to M, as Fig. 106.6.

In summary, the whole SPF tree arrived as Fig. 106.7.  $R_{SC}$  is the cite rate between S and C; S and C have relationship of correspondence, and F and M have relationship of correspondence too;  $r_{PF}$  is the cite rate between node P and F.

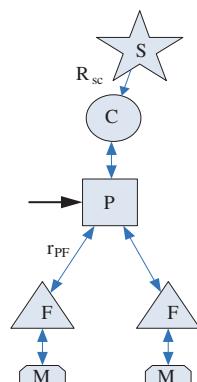
### 106.3.4 The Retrieval Method of SPF Tree

In Fig. 106.7,  $R_{SC}$  and  $r_{PF}$  denote the rate of trunk and branch, and it may be improve the retrieving efficiency and reduce the time cost in retrieval if we make full use of

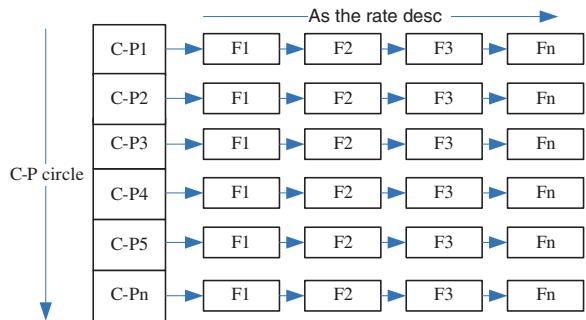


**Fig. 106.6** The correspondence relationship of F-M

**Fig. 106.7** The virtual structure of SPF



**Fig. 106.8** The retrieval circle



the two parameters. So, the failure phenomenon (or component-phenomenon) may link and form a ring end-to-end and looks the phenomenon link as the first retrieval layer; temporarily forms the phenomenon link table as descending order of the rate of leaf of  $r_{PF}$  in real case, so we can locate fault cause quickly and accurately.

The retrieving process is divided into two steps: the first step retrieves the trunk in failure phenomenon; the second step retrieves the branch in failure cause. The first step special emphasis on the traversal of the SPF tree, breadth-first searching algorithm is the most efficient. On the other hand, because the phenomenon link table has rate of leaf as descending, using order searching algorithm may get the desired results, as shown in Fig. 106.8.

## 106.4 The Implement of Storage Method

The storage of component is the most important step in real system. Commonly, the component of a machine seldom changes, so using the variable-length array defines the components is derisible:

```
#define LIST_INIT_SIZE 100//init length, it may change in real case
#define LIST_INCREMENT 10//defining the increment as 10
typedef struct {
    ElemType *elem;//the base address
    int length;
    int listSize;
    String name;
    String parent;
    Pointer *child;
} SqList
```

The children nodes perhaps do not store with their parents, but they may link to their parents as pointer, using the linked list to describe the data storage structure is easier to implement:

```
typedef struct LIST_C{
    ElemType name;//node name
```

```

ElemType parent;//parent name
struct LIST*next;
}LIST_C SPF_Link_C

```

Because, the fault phenomenon and component is correspondence, we can define the fault phenomenon as follows:

```

typedef struct LIST_P{
    ElemType Phenomenon;
    Pointer*P_C;//the pointer from fault phenomenon to component
}LIST_P SPF_Link_P

```

Similarly, the fault cause and troubleshooting way is correspondence, we can define the fault phenomenon as:

```

typedef struct LIST_F{
    ElemType Fault;//fault cause
    Pointer*F_M;//the pointer from fault cause to troubleshooting way
}LIST_F SPF_Link_F

```

## 106.5 Results

In order to enhance the ability and speed up data retrieval efficiency of SPF, the storage method is studied in the paper and arrived the following results:

1. By proposed a “linear form + linked list” component storage method it ensures the storage needs of the relationship between the node and the node in the data storage.
2. Taking into account the correspondence between component and fault phenomenon, fault cause and troubleshooting way, random storage method is used to store them.
3. By proposed the breadth-first + strength priority algorithms in retrieval ,it enhances the ability and speeds up data retrieval efficiency significantly.

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# Chapter 107

## Study on Software Failure Data

Jinming Fang, Zhijun Chen and Jungang Lou

**Abstract** Software reliability is of very important in software quality assurance, and software reliability model is the most effective method for software reliability assessment. It stands a good chance that early failure behavior of the testing process may have less impact on later failure process; nonparametric test method is adopted to detect the trend of AE value when the value of  $m$  varies, and Sen's slope estimator is applied to estimate the trend degree in the data sets.

**Keywords** Software reliability prediction • Relevance vector machine • Software reliability • Software reliability model

### 107.1 Introduction

In modern society, computers are used for many different applications, such as nuclear reactors, aircraft, banking systems, and hospital patient monitoring systems [1, 2]. As the demand of the application quality becomes higher and higher, the research on the computer software reliability becomes more and more essential [3, 4]. The software reliability is defined as the probability that the software will operate without a failure under a given environmental condition during a specified period of time. To date, the software reliability model is one of the most important tools in software reliability assessment [5, 6].

There are still some issues that need more discussions. For example, should all failure data or only recent failure data be used in model training? Due to the common knowledge in software testing, early failure behavior of the testing process may have less impact on later failure process. Many researchers suggested that not

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all available failure data should be used in model training; rather only the last  $m$  recorded data should be used, but to our best knowledge, there were not any experimental results to support this. We study this problem by analyzing the trend of AE serials when  $m$  changes on four data sets using the Mann–Kendall test method and Sen’s slope estimator and confirmed that early failure behavior of the testing process may have less impact on later failure process.

## 107.2 Methods for Software Reliability Prediction

### 107.2.1 Support Vector Machine

SVM has gained an increasing attention from its original application in pattern recognition to the extended application in function approximation and regression estimation [7, 8]. Based on the SRM principle, the learning scheme of SVM is focused on minimizing an upper bound of the generalization error that includes the sum of the empirical training error and a regularized confidence interval, which will eventually result in better generalization performance. Moreover, unlike other gradient descent-based learning scheme with the danger of getting trapped into local minima, the regularized risk function of SVM can be minimized by solving a linearly constrained quadratic programming problem, which can always obtain a unique and global optimal solution. Thus, the possibility of being trapped at local minima can be effectively avoided.

The basic idea of SVM for function approximation is mapping the DATA  $x$  into a high-dimensional feature space by a nonlinear mapping and then performing a linear regression in this feature space. The SVM model used for function approximation is given by:

$$t = f(T; w) = \sum_{i=1}^M w_i k(T, T_i) + w_0 \quad (107.1)$$

$k(x, x_i)$  is defined as the kernel function, which is the inner product of two vectors in feature space  $\varphi(x)$  and  $\varphi(x_i)$ . By introducing the kernel function, we can deal with the feature spaces of arbitrary dimensionality without computing the mapping relationship  $\varphi(x)$  explicitly. Some commonly used kernel functions are polynomial kernel function and Gaussian kernel function. In this paper, we made the choice to utilize Gaussian data-center basis functions:

$$K(x_i, x_j) = \exp \left\{ -\frac{\|x_i - x_j\|^2}{r^2} \right\} \quad (107.2)$$

where  $r > 0$  is a constant that defines the kernel width, and the value of  $r$  plays a very important role in SVM prediction.

Thus, a nonlinear regression in the low-dimensional input space is transferred to a linear regression in a high-dimensional feature space. The coefficients  $w$  and  $b$  can be estimated by minimizing the following regularized risk function  $R$

$$\begin{aligned} R &= \frac{1}{2} \|w\|^2 + R_{\text{emp}}[f] \\ &= \frac{1}{2} \|w\|^2 + C \frac{1}{l} \sum_{i=1}^l |T_i - f(t_i)|_\varepsilon \end{aligned} \quad (107.3)$$

where

$$|T_i - f(t_i)|_\varepsilon = \begin{cases} 0 & \text{if } |T_i - f(t_i)| \leq \varepsilon, \\ |T_i - f(t_i)| - \varepsilon & \text{otherwise} \end{cases} \quad (107.4)$$

$\|w\|^2$  is the weighting vector norm, which is used to constrain the model structure capacity in order to obtain better generalization performance. The second term is the Vapnik's linear loss function with  $\varepsilon$ -insensitivity zone as a measure for empirical error. The loss is zero if the difference between the predicted and observed value is less than or equal to  $\varepsilon$ . For all other cases, the loss is equal to the magnitude of the difference between the predicted value and the radius  $\varepsilon$  of  $\varepsilon$ -insensitivity zone.  $C$  is the regularization constant, representing the trade-off between the approximation error and the model structure.  $\varepsilon$  is equivalent to the approximation accuracy requirement for the training data points. Further, two positive slack variables  $\xi$  and  $\xi^*$  are introduced.

Thus, minimizing the risk function  $R$  in Eq. (107.2) is equivalent to minimizing the objective function:

$$\min J = \frac{1}{2} \|w\|^2 + C \sum_{i=1}^l (\xi_i^* + \xi_i) \quad (107.5)$$

$$\text{s. t. } \begin{cases} (\omega, \phi(T_i) + b - t_i \leq \varepsilon + \xi_i) \\ t_i - (\omega, \phi(T_i) - b \leq \varepsilon + \xi_i^*) \\ \xi_i, \xi_i^* \geq 0 \end{cases} \quad (107.6)$$

## 107.2.2 Experiments

### 107.2.2.1 Data Sets

The performance of our proposed approach is tested using the same real-time control application and flight dynamic application data sets as cited in Park et al. and Karunanithi et al. We choose a common baseline to compare our results with related work cited in the literature. All six data sets used in the experiments are summarized as follows in Table 107.1:

**Table 107.1** Data sets

Data sets	Description	LOC	Failure number
DATA 1	Real-time command and control application	21,700	136
DATA 2	Flight dynamic application	10,000	118
DATA 3	Flight dynamic application	22,500	180
DATA 4	Flight dynamic application	38,500	213
DATA 5	Class compiler project	1,000	27
DATA 6	On-line data entry	40,000	46

### 107.2.2.2 Measures for Evaluating Predictability

In comparing different models, it is necessary to quantify their prediction accuracy, in terms of some meaningful measures [9, 10]. Three distinct approaches that are very common in software reliability research community [1] are reviewed next. The need to predict the behavior at a distant future of the test phase using present failure history is very important [2]. Using the variable-term-predictability approach, a two-component predictability measure is average relative prediction error ( $AE$ ) as follows:

$$AE = \frac{1}{k-m} \sum_{i=m+1}^k \left| \frac{\hat{t}_i - t_i}{t_i} \right| \quad (107.7)$$

where  $\hat{t}_i$  denotes the predicted value of failure time, and  $t_i$  denotes the actual value of failure time.  $AE$  is a measurement of how well a model predicts throughout the test phase.

## 107.3 Trend Test and Estimation

We computed the relative prediction error for DATA 1–4 in the cases  $m = 5–30, 35, 40, 45, 50, 55, 60$  on each models. All the values are computed with  $\sigma^2 = 1$  and  $\alpha_i = 0.5$  ( $i = 1, 2, 3, \dots, m$ ), and the value of  $r$  is 1, 2.2, 3.5 for DATA-1, 2, 3.7, 5 for DATA-2, 1, 2.2, 4 for DATA-3 and 0.4, 1.2, 3 for DATA-4. We can see from the table that the values of  $AE$  change when  $m$  varies. For example, the values of  $AE$  vary from 0.27 ( $m = 26$ ) to 1.72 ( $m = 60$ ) when DATA-1 is used with  $r = 2.2$  and 1.64 ( $m = 10$ )–6.32 ( $m = 60$ ) and when DATA-3 is used with  $r = 4$ . Due to the variation as well as the existence of outliers, it is difficult to visually discern any trends from Table 107.1 and the plots of the relative prediction error for each data. Because mere eyeballing does not suffice, we will apply statistical techniques for trend test and trend estimation in this section.

To verify the null hypothesis that a sample  $x_1, x_2, \dots, x_n$  does not exhibit a trend, Mann [3] used a linear function of a test statistic originally developed by

Kendall [4] to test whether two sets of rankings are  $s$ -independent. The direct application of this test statistic  $S$  for our purposes is known as the Mann–Kendall test for trend. In this context, the value of the test statistic is computed by:

$$S = \sum_{j=1}^{n-1} \sum_{k=j+1}^n \operatorname{sgn} (x_k - x_j) = \sum_{j=1}^{n-1} \sum_{k=j+1}^n \left\{ \begin{array}{lll} 1 & x_k - x_j & > 0 \\ 0 & x_k - x_j & = 0 \\ -1 & x_k - x_j & < 0 \end{array} \right. \quad (107.8)$$

Of all  $n' = \binom{n}{2} = n(n-1)/2$  pairs of values  $x_k, x_j$  ( $k < j$ ),  $S$  counts

those pairs for which the earlier observation  $x_k$  is smaller than  $x_j$  and subtracts the number of pairs for which the latter observation is smaller. When a value of  $S$  is close to zero, it suggests that there is no trend in the data, whereas a high absolute value of the test statistic hints at the existence of a trend. For the calculation of  $S$ , tied pairs, that is, those pairs for which  $x_k = x_j$ , are not taken into account. However, the existence of such tied pairs does influence the variance of the test statistic. The variance of  $S$  is given by:

$$\operatorname{Var}(S) = \frac{1}{18} [n(n-1)(2n+5)] \quad (107.9)$$

Under null hypothesis, the distribution of  $S$  is always symmetric and the expected value of  $S$  is equal to zero. Moreover, for  $n$  approaching infinity, the distribution of  $S$  converges to the  $S$ -normal distribution. Allowing for a continuity correction, the value of the test statistic  $Z_{\text{statistic}} = \frac{S - \operatorname{sgn}(S)}{\sqrt{\operatorname{Var}(S)}}$  can be compared with the quantile of the standard  $S$ -normal distribution in order to check whether the null hypothesis of no trend in the data can be rejected.

The values of  $Z$  calculated for the series of  $AE$  on four data sets are listed in Table 107.1. Both are larger than  $\lambda_{0.975} = 1.960$ , which is the 97.5 % quantile of the standard  $S$ -normal distribution. Consequently, in each case, the null hypothesis shows that the time series with no trend can be rejected at a Type I error level (i.e., a long-term probability of rejecting the null hypothesis when it is true) of 5 %. This means that although we have not been able to visually discover any trends in Table 107.2, trends are present in the data, and these trends are  $S$ -significant. Moreover, the positive signs of the  $Z$  values show that the four trends are increasing.

To determine the estimates for the slopes, we apply a nonparametric procedure developed. This method is not affected by outliers, and it is robust to missing data. Like the calculation of the value of the test statistic  $S$ , the approach focuses on all pairs of data points  $x_l, x_k$  ( $l < k$ ). For each of these pairs, the slope  $q_{kl} = (x_l - x_k)/(l - k)$  is calculated. Sen's slope estimate is defined as the median of the  $n' = n(n-1)/2$  slopes obtained.

A two-sided  $S$ -confidence interval for the estimated slope can be derived by the procedure described in [4]: After sorting the  $n'$  slopes in increasing order, the lower limit of the  $S$ -confidence interval is given by the  $((n' - c_\alpha)/2)$ th

**Table 107.2** Trend test for data 1–4

	<i>r</i>	Z statistics	Explanation	Estimated slope	95 % <i>S</i> -confidence interval
DATA 1	1	5.8541	Increasing	0.1184	[0.0930,0.1553]
	2.2	5.1730	Increasing	0.0241	[0.0176,0.0301]
	3.5	5.5947	Increasing	0.1222	[0.0900,0.1657]
DATA 2	2	2.9352	Increasing	0.0567	[0.0217,0.0783]
	3.7	3.8433	Increasing	0.0226	[0.0116,0.0338]
	5	2.8054	Increasing	0.0430	[0.0138,0.0700]
DATA 3	1	4.7190	Increasing	0.0500	[0.0323,0.0691]
	2.2	2.9027	Increasing	0.0146	[0.0040,0.0250]
	4	5.4974	Increasing	0.0760	[0.0515,0.1022]
DATA 4	0.4	5.8379	Increasing	0.0776	[0.0626,0.0978]
	1.2	4.4109	Increasing	0.0200	[0.0120,0.0300]
	3	6.1460	Increasing		

largest of these slopes, while the upper limit is given by the largest slope, where  $c_\alpha = \lambda_{1-\alpha/2} \sqrt{\text{Var}(S)}$ .

At last, the slope estimates and their respective 95 % confidence intervals are shown in Table 107.2. As anticipated, after the calculation of the values of the statistic, the estimated slope is positive for both AE series. Moreover, none of the *S*-confidence intervals contains the value zero, and this corroborates the earlier finding that the trends are *S*-significant at a Type I error level of 5 %.

With regard to the AE series on all data sets, we would have expected an increasing trend rather than the decreasing one that we detected. A possible explanation for the observed behavior is the fact that recent failure history records the latest characteristics of the testing process; thus, it could contribute to more accurate prediction of near-future failure event.

## 107.4 Conclusion

In this paper, we have conducted comparative studies on model performance between SVM-based and ANN-based SRMs. Data collected from real software projects are used in the studies. Then, we have analyzed the trend of AE serials when *m* changes on four data sets using the Mann–Kendall test method and Sen’s slope estimator and confirmed that early failure behavior of the testing process may have less impact on later failure process.

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# Chapter 108

## Research on Web Log Mining

Zhen Rong, Yan Tang and Su Liu

**Abstract** The article introduces each stage of Web Log Mining process in detail, including data preprocessing, user recognition calculation and user clustering method. We aimed at specifying the inevitable steps that are required for obtaining valid data from the log file. The proposed methodology is applied to the Web log files; especially, we focused on improving the user identification heuristic rules of data mining, which allows accurate identification of the user. On the selection of timeout, used Advance prediction for it, which can represent the web users' behavior patterns better? The experiment results indicate that the mining efficiency and the quality of those association rules obtained by improved genetic algorithm have significantly improved.

**Keywords** Data mining • Web Log Mining • Data preprocessing

### 108.1 Introduction

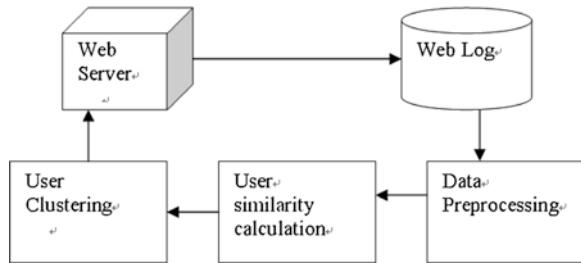
Web Log Mining is to the process of classifying Web user clustering with similar browsing behavior and interests of users, which can use the results to improve. At present, the main methods include [1]: clustering based 006Fn the frequency and duration of the user to access the page, clustering similar users based on the user's access path, based on page content and navigation path of a combination of user clustering method, content based on user navigation path network user clustering method, Some method based on the time of the visit. Some users browsing patterns as a sequential pattern, taking into account the user browses the time factor. These methods each have their own pros and cons. If you consider pages viewed by users in a specified time path, identify the path the particle size may be too difficult, if you consider the time factor is also lacking, you will not dig out the real user browsing path.

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**Fig. 108.1** The steps in the Web Log Mining



There are three steps [2] in the Web Log Mining:(1) First, preprocessing of Web log, including the first Web log pretreatment, and extraction of the user's navigation path. (2) Then, based on the extraction characteristics of the user, calculation of the similarity of users. (3) Finally, selecting an efficient clustering algorithm for user clustering. The whole process is shown in Fig. 108.1.

## 108.2 Data Preprocessing

Web Log Mining demands good-quality data in order to carry out the data analysis. If there is “junk” at the input, the same will be at the output, regardless of the method of knowledge extraction used. This applies even more in the area of Web Log Mining, where the log file requires a thorough data preparation. As an example, we can present the usage analysis, where we aimed at finding out what our Web visitors are interested in [3].

The data preparation for our experiment consists of the following steps: data cleaning, user similarity calculation and user clustering.

### 108.2.1 Data Cleaning

At the stage of data cleaning, you can use the user's transaction identification method to get the transaction path. It could be done in the stage of Web log pretreatment. Web logs generally include requesting host's IP address, request time, requesting the type of service, the requested URL, the reference page Ref and browser type [4]. There are three Web log records in Fig. 108.2:

The contents in Web log are useful. From the log, we can get the relationship between user behavior and data, including a large number of unrelated information in these logs; however, in some non-graphic image Web site, for example, gif, jpg, jpeg, map, css, js, cgi, such as the suffix, all belong to the interference information. In order to increase the accuracy of mining information sources, we must eliminate these irrelevant data from the general order to the convenience of further

```
2012-03-19 22:53:06 W3SVC2007539856 192.168.0.5 GET /default.asp - 80 - 114.80.93.54
Mozilla/4.0+(compatible;+MSIE+6.0;+Windows+NT+5.1) - 302 0 0 416
2012-03-19 22:53:06 W3SVC2007539856 192.168.0.5 GET /com/default.asp - 80 - 114.80.93.54
Mozilla/4.0+(compatible;+MSIE+6.0;+Windows+NT+5.1) - 200 0 0 22855
2012-03-19 02:36:43 W3SVC2007539856 192.168.0.5 GET /ygytd/ygytd.asp Page=2 80 -
222.180.173.97 Mozilla/4.0 http://jyzx.eqgtfw.gov.cn/ygytd/ygytd.asp 200 0 0 21798
```

Fig. 108.2 The records of Web log

processing; after cleaning the data format conversion, all the pages are numbered, and this number can be used instead of the URI. This can greatly shorten the processing time.

### 108.2.2 User Identification

Purified completion of the data, according to certain rules to identify each user to access the site, if you are using different rules, then identify the user will be different, the rules of good or bad impact on the effect of clustering. Until now, commonly used heuristic rules are as follows [5]:

- A different IP address on behalf of different users.
- The same IP address, the default operating system or browser on behalf of different users.
- The same IP address, user operating system and browser in the same circumstances, if the user requests a page cannot arrive to determine whether a new user has access to any page.
- This heuristic rules could not recognize this, trying to add two rules:
- In the same IP address, the difference time in different operating system or browser does not exceed 10 min; we see they are the same user.
- In the same IP address exceeds the allotted time, the access path is exactly the same, on behalf of the same user.

After adding the heuristic rules, we can identify each user effectively and eliminate the influence of browser and operating system largely.

### 108.2.3 Session Identification

The session is an effective access of the user on the server, during a visit to the site enter the site to leave the site, it carried out a series of activities [5]. During web server logs, the user may be visiting the site many times, the task of the session identification is belong to the same user each time you visit the request identified. Its definition is as follows:

User session US can be seen a pair  $\langle \text{userid}, \text{PS} \rangle$ , userid is the user ID, the PS is the collection of user Web page request in a period of time. Pid is a request identifier of the page.

$$\text{US} = \langle \text{userid}, (\text{Pid}_1 \dots, \text{Pid}_k) \rangle \quad (108.1)$$

There are usually two ways to identify a user session: one is to set the entire user session timeout, and the other is that US in the user session must meet the following conditions:

$$\text{Time}_k - \text{Time}_1 \leq T \quad (108.2)$$

where Time is a access time of the session,  $\text{Time}_k$  is the time of the last page,  $\text{Time}_1$  is the session of the first page access time, and  $T$  is the set of timeout threshold.

Another method is as follows: if users' consecutive two-page time difference exceeds certain boundaries, we could think the user has started a new session, expressed as:

$$\text{Time}_i - \text{Time}_{i-1} \leq T \quad (108.3)$$

The  $\text{Time}_i$  is the time of  $i$  session to access the page time,  $\text{Time}_{i-1}$  is the time to access a page of the  $i-1$ th session, and  $T$  is the timeout threshold.

Generally,  $T$  will select 30 min, try to predict, it is estimated that a more scientific, such as the first forward reference path method to identify the transaction, sports gymnastics scoring method could be used to calculate the optimal time.

For example, as shown in Fig. 108.3, the same user IP: 122.198.80.11, if  $T$  select the traditional 30 min, the user session identification is divided into five short sessions, each session is not possible to reflect his behavior of browse complete.

In the selected data sample, with the improved methods, selecting the threshold dynamic and changing the fixed threshold, the experiment proved that identifying the same number of sessions will be more accurate, as shown in Fig. 108.4:

ip	method	uri	refer	agent	port	byte
122.198.80.11	GET	26	1	Mozilla/4.0+(KHTML, like Gecko) 80	22922	
122.198.80.11	GET	91	99	Mozilla/4.0+(KHTML, like Gecko) 80	85150	
222.178.70.153	GET	26	1	Mozilla/4.0+(KHTML, like Gecko) 80	22922	
122.198.80.11	GET	26	1	Mozilla/4.0+(KHTML, like Gecko) 80	22922	
222.178.70.153	GET	95	99	Mozilla/4.0+(KHTML, like Gecko) 80	21767	
122.198.80.11	GET	90	99	Mozilla/4.0+(KHTML, like Gecko) 80	23009	
139.227.3.254	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	1468	
122.198.80.11	GET	89	99	Mozilla/4.0+(KHTML, like Gecko) 80	19844	
125.86.5.196	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	1468	
122.198.80.11	GET	87	99	Mozilla/4.0+(KHTML, like Gecko) 80	68556	
125.85.222.103	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	1468	
222.177.134.209	GET	26	1	Mozilla/4.0+(KHTML, like Gecko) 80	22922	
222.177.134.209	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	0	
222.178.152.216	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	1468	
222.177.134.209	GET	92	99	Mozilla/4.0+(KHTML, like Gecko) 80	18495	
222.178.221.118	GET	76	1	Mozilla/4.0+(KHTML, like Gecko) 80	1468	

Fig. 108.3 The result of  $t = 30$  min

ip	method	uri	refer	agent	port	byte
122.198.80.119	GET	76	1	Mozilla/4.0+(coi 80	0	
122.198.80.11	GET	98	1	Mozilla/4.0+(coi 80	15901	
122.198.80.11	GET	76	1	Mozilla/4.0+(coi 80	0	
122.198.80.11	GET	76	1	360se	80	0
122.198.80.11	GET	98	1	Mozilla/4.0+(coi 80	0	
122.198.80.11	GET	92	6	Mozilla/4.0+(coi 80	18963	
122.198.80.11	GET	26	1	Mozilla/4.0+(coi 80	22855	
122.198.80.11	GET	92	99	Mozilla/4.0+(coi 80	18495	
122.198.80.11	GET	92	1	Mozilla/4.0+(coi 80	18495	
122.198.80.11	GET	87	99	Mozilla/4.0+(coi 80	68556	
122.198.80.11	GET	89	99	Mozilla/4.0+(coi 80	19844	
122.198.80.11	GET	26	1	Mozilla/4.0+(coi 80	22922	
122.198.80.11	GET	91	99	Mozilla/4.0+(coi 80	85150	
122.198.80.11	GET	90	99	Mozilla/4.0+(coi 80	23009	
122.198.80.11	GET	26	1	Mozilla/4.0+(coi 80	22922	
122.198.80.11	GET	26	1	Mozilla/4.0+(coi 80	22922	
122.198.80.11	GET	92	99	Mozilla/4.0+(coi 80	18495	
122.198.80.11	GET	92	108	Mozilla/4.0+(coi 80	18495	
122.198.80.11	GET	26	1	Mozilla/4.0+(coi 80	22922	
122.198.80.11	GET	93	1	Mozilla/4.0+(coi 80	935	

Fig. 108.4 The result after changing the time

#### 108.2.4 Transaction Path Extraction

Generally, the user pages from the buffer is not really interested in web pages, the user only as a connection to access other pages, there is no other meaning.

After the extraction of the transaction path, the path of a user then combined in a record, ultimately in the database shows each user's information includes: user id, all the affairs of the path (instead of page number), each path of each to access the page corresponding to the residence time [6]. Maximal forward reference path algorithm (MFP) is a new method to solve the transaction identification; a forward reference path is equivalent to a transaction.

This method uses the reference page in the log record fields sufficiently, so you cannot through complete the path, after the session identification directly, which simplifies the process of data preprocessing from the user session and can identify Affairs effectively [7].

### 108.3 User Similarity Calculation

The main intersection operation that Web users based on user's browsing path similarity calculation, between the collections of the path of a user session using

Traditional methods, such as the cosine of the angle method or the Jaccard correlation coefficient calculation method [8]

The distance  $d$  describes the differences in the data, and the similarity  $s$  describes the degree of similarity of the data. Similarity and distance are defined as:  $d = 1/s - 1$ ,  $s = 1/(d + 1)$ . Because they have such a relationship, so we can use the method of calculating the distance to compute similarities.

Jaccard similarity: a common feature in the ratio of the total characteristics of the two sets of data. This method can be used for data in supermarket shopping data and for other non-numeric data.

Similarity calculation method or the session path as an ordered sequence to consider, or did not consider the residence time of the user to access the page. This cannot really find similar users.

Another clustering method of the Web user is taking into account the user browsing time factor and getting the user's browsing mode as sequential patterns. However, this method uses the session path of the user characteristics, making the path granularity too coarse. In addition, the residence time of the calculation page uses the mean residence time (the total residence time of the entire path divided by the number of pages). However, users usually are more interested in the contents of the page to stay, not interested in the contents page or reference page shorter residence time, the average time is difficult to discover the user's real interest, which affects the clustering results.

Literature [9] proposed a new similarity calculation method. The transaction path as an ordered sequence, fully integrated with the user browse in the path of the time factor.

## 108.4 User Clustering

There are a large numbers of clustering algorithms in data mining, and the choice of algorithm depends on the type of data, purpose of clustering and application. According to different classification criteria, the clustering algorithm can be divided into different categories. According to clustering results of different clustering [10]:

*Hard clustering algorithm:* In such algorithms, an object is a cluster with the degree of membership. The membership has only two possible values; usually, 1 represents an object belonging to a cluster, and 0 indicates that the object does not belong to a cluster. When an object belongs to a cluster, it is called a hard division. Description, it can be hard clustering algorithm is not able to describe the ambiguity problem in the real world. For example, some I cannot simply that it belongs to which cluster does not belong to which cluster, but the extent to which belong to that cluster. The value of Hard clustering algorithm is only 0 or 1, a.

Relatively easy calculation, in general, the calculation speed of the hard clustering algorithm is faster.

*Fuzzy clustering algorithm:* Fuzzy clustering algorithm is a improvement in hard clustering algorithm. Clustering results are still using the object to represent the degree of membership of the cluster, but the degree of membership values is not just 0 and 1, but with the interval [0, 1] a value to represent the object in membership value does not exclude its values in other classes. General, in the same cluster analysis, an object on all classes of membership and unit is 1. Fuzzy clustering is a combination of fuzzy set theory and cluster analysis. They are able to describe the real world affairs better. In fuzzy clustering algorithm relative to hard clustering algorithm, clustering results are more reasonable.

*The possibility of clustering algorithm:* This combines cluster analysis and the theory of probability. This is a typical extent also [0, 1] on the value. Relative to other clustering algorithms, in the possibility of clustering algorithm, noise suppression is relatively strong

## 108.5 Summary

Web site is one of the most important tools for our learning and advertisement and for universities and other foundation. Therefore, content and design of Web pages are very significant for Web designers. Analyzing of the web user access log files can help understand the user behaviors and web structure, and by improving the design of web components and web applications [11].

With the development of Web Log Mining, it has been widely used, research more and more by many people. Yang et al. [6] in their research described factors influencing the quality of Web portals and considered well-organized messages and relevant contents to be the most important factors of usability. Of course, the Web Log Mining research will tend to be more mature.

The aim of this study is to help the Web designer and Web administrator to improve their Web site by the user behaviors and Web structure in the Web site. So, raw log files were preprocessed, and the path analysis technique was used to investigate the web log files of URL information. The proposed methodology was applied to the user access log files in a government Web server. The results and findings of this experimental study can be used by the web admin is ration and web designer in order to plan the upgrading and enhancement to the website. Web log application of path analysis provides us with a count of the number of times each link has occurred in the dataset and a list of association rules. The graph link is very easy to interpret. It contains association rules that are very helpful in understanding the path that administrators take as they log in through the government Web site. It is helpful to use these results for better organization of the government Web site. Besides, it is possible to take this study much further by investigating the Web log data on a continuing basis.

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# Chapter 109

## Assembly Sequence Planning Based on Assembly Knowledge Database

Rong Li and Ying Tian

**Abstract** An assembly sequence planning method based on assembly knowledge is put forward. Three types of the assembly knowledge were defined, and the knowledge database was established, which include products' part designing knowledge, joining knowledge, and assembly rule knowledge. According to all of the knowledge, assembly model was building and simplified. Supported by above knowledge assembly model, by firing the state matrix, all the feasible sequence can be obtained. Then, the sequences of the joining were acquired from the knowledge database, which were insert into the feasible sequence, and the assembly sequence were obtained. Finally, a simple case is provided to illustrate the effectiveness of the proposed method.

**Keywords** Assembly knowledge • Assembly sequence planning • Petri net

### 109.1 Introduction

With increasing global competition, customer requirements are rising high. To remain in market under such competition, manufacturers must strive continually to reduce assembly time and cost. The determination of proper assembly sequence is critical, because it affects server aspects of the assembly process as well as the finished assembly. Assembly sequence planning (ASP) can help to reduce overall manufacturing assembly time and cost by helping manufacturers reduce the number of

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fixture and tool changes or the number of reorientations during the assembly process, and so on. In addition, designer can use assembly planning to verify that a design can be assembled safely without any interference or collision between components.

Recent years, ASP has attracted many researching efforts. Gottipolu and Ghosh [1] generated feasible sequences by analyzing contact and mobility constraints. Laperriere and ElMaraghy [2] generated assembly sequences using geometric and accessibility constraints. Attempts have also been made to generate sequences directly from the CAD model of the assembly. Reddy B. has developed a new approach for generation, representation, and selection of assembly sequence. In the paper, the contact and the translational functions are built, which are extracted from CAD model of the assembly [3]. Smith developed and automated assembly planner using a genetic algorithm to find assembly sequence plans for a product [4, 5]. Mok introduce a method for generating assembly sequences and part mating operations directly from CAD STEP files [6]. These algorithms can be used conveniently on the computer, and all the feasible sequences can be determined. However, as the number of components in a product increases, the number of feasible sequences also increases. For solving ASP, assembly knowledge is considering; then, the methods of based on knowledge Petri net is proposed.

## 109.2 Constitution of Assembly Knowledge Library

An assembly is a collection of manufactured parts, brought together by assembly operations to perform one or more of several primary functions. ASP begins with the creation of a CAD model to the assembly. But, the model only expresses the geometric models of the individual component that represents the geometry and positions in the world coordinate space. The CAD model provides enough information for graphic display of the assembly, but it is inadequate for assembly planning. Saaksvuori reports that up to 70 % of a designers time can be saved if the existing knowledge base of an organization can be reused for new design [7]. So, the assembly knowledge library is a very important need. According to research of assembly's knowledge, three kinds of knowledge database have been set up. The first is product's part lib, which are gotten together by designers. The second is connecter-structure case base, which react strongly to product assembly. And, the third is rules knowledge base. The assembly knowledge library is the foundation of assembly model and assembly planning in future.

### 109.2.1 Product CAD Database

Industries now realize that the best way to reduce life cycle costs is to reuse design knowledge. Such reuse of existing designs is beneficial from many different perspectives. It reduces design time by eliminating the need for modeling

and analysis for the assembly being reused. Furthermore, the existing CAD model is already tested and has been used in some product successfully. This further reduces the product development time and cost. So, it is necessary to establish parts library with endorse design knowledge sharing. Entity relation of product's part database is set up by IDEF1.

In the parts library, two kinds of parts are constituted; one is the standard parts, and the other is the custom parts. All of the solid models are built based on UG, and the family table library of standard parts is established, the database library of parts is established by using SQL Server 2000, and the application program is developed with VC++6.0 and UG/OPEN, so as to parts library system is established.

### 109.2.2 Joining Knowledge Database

Joints on a structure are inevitable because of various engineering requirements and products are very rarely monolithic. Existing designer systems have limitations on capturing the nongeometric aspects of designer intent on an assembly with joints. Therefore, the development of an assembly formalism to specify joining relationships symbolically is a prerequisite for an intelligent assembly modeling system.

A relational joining knowledge model that can explicitly describe various logical and physical relationships among the components of the joining is defined as follows:

$$\Sigma = J_m - A_s - T - P_n \quad (109.1)$$

The relational model of an joining knowledge is a three tuples, where  $J_m = \{j_1, j_2, \dots, j_m\}$  is a set of symbols, and each symbol corresponds to joints(standard part) in the joining.

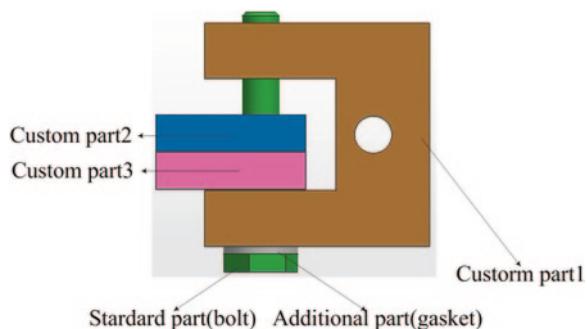
$A_s = \{a_1, a_2, \dots, a_s\}$  is a set of symbols, and each symbol corresponds to additional part in the joining.

T is the symbol to operate the joint.

$P_n = \{p_1, p_2, \dots, p_n\}$  is a set of symbols, and each symbol corresponds to custom part in the joining.

The example of joining is shown in Fig. 109.1

**Fig. 109.1** An example of a joining



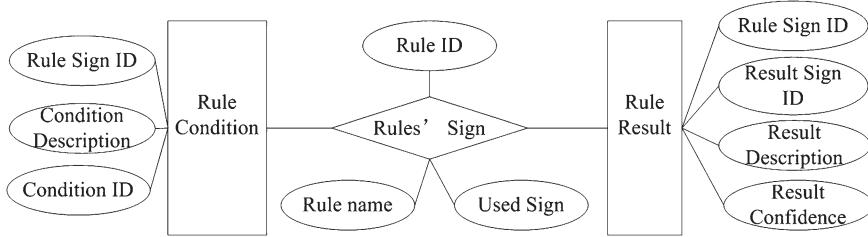


Fig. 109.2 E-R Model of assembly rule lib

### 109.2.3 Assembly Rule Knowledge

According to the combination of research and related literature, most of the assembly rule knowledge is causal relationship or logical relationship. For example, ODN  $\leq 16$ ,  $L \geq 25$ , IDN  $> 10$  (ODN is the outer diameter, IDN is the inner diameter, and  $L$  is the length of the pipe), these rules are referenced by production rule. So, the rules database is established by the object-oriented method (the E-R model of the assembly rule is shown in Fig. 109.2).

## 109.3 Assembly Model Based Assembly Knowledge

### 109.3.1 Knowledge-Based Petri Net System

The elementary Petri net is extended to form the knowledge-based Petri net. Knowledge-based petri net (KBPN) is defined by 8-tuples [8]:

$$\text{KBPN} = (S, T; F, W, M_0, C_f, K_S, K_T) \quad (109.2)$$

where,

$S = \{S_a, S_c\} = (s_1, s_2, \dots, s_m, s_{c1}, s_{c2}, \dots, s_{cn})$  ( $m, n > 0$ ) is a finite set of places, and  $S_a$  is similar to a set of places in the usual Petri net.  $S_b$  is a set of flow-control places,  $S_c = (s_{c1}, s_{c2}, \dots, s_{cn})$ .  $S_c$  is used to store the part's properties knowledge, which is stored in the products database or the joining database.

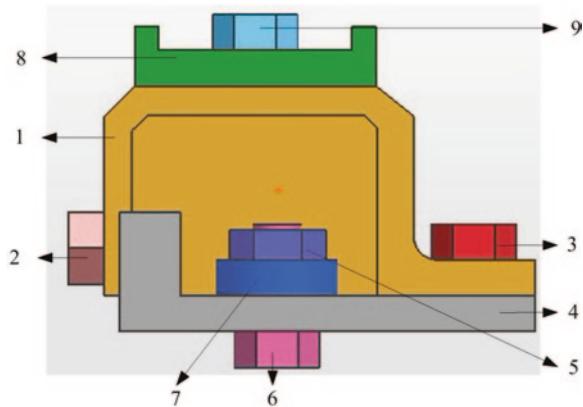
$T = \{T_a, T_b\} = (t_1, t_2, \dots, t_n, t_{r1}, t_{r2}, \dots, t_{rm})$  ( $n, m > 0$ ) is a finite set of transitions, and  $T_a$  is similar to a set of transitions in the usual Petri net.  $T_b$  is a set of rules,  $T_b = (t_{r1}, t_{r2}, \dots, t_{rm})$ . These rules are stored in the assembly rules database.

$S \cap T = \emptyset$ ,  $S \cup T \neq \emptyset$ ;  $F \subseteq S \times T \cup T \times S$  is a set of directed arcs, which is used to link places and transitions.

$W$  is weight function on arcs.

$C_f \subseteq (S \times T)$  is arc label of the KBPN, which includes permitted arc labels and inhibited arc labels.

**Fig. 109.3** Complicated assembly



$K_S$  represents knowledge associated with places.

$K_T$  represents knowledge associated with transitions.  $M_0$  is initial marking.

### 109.3.2 Application Example

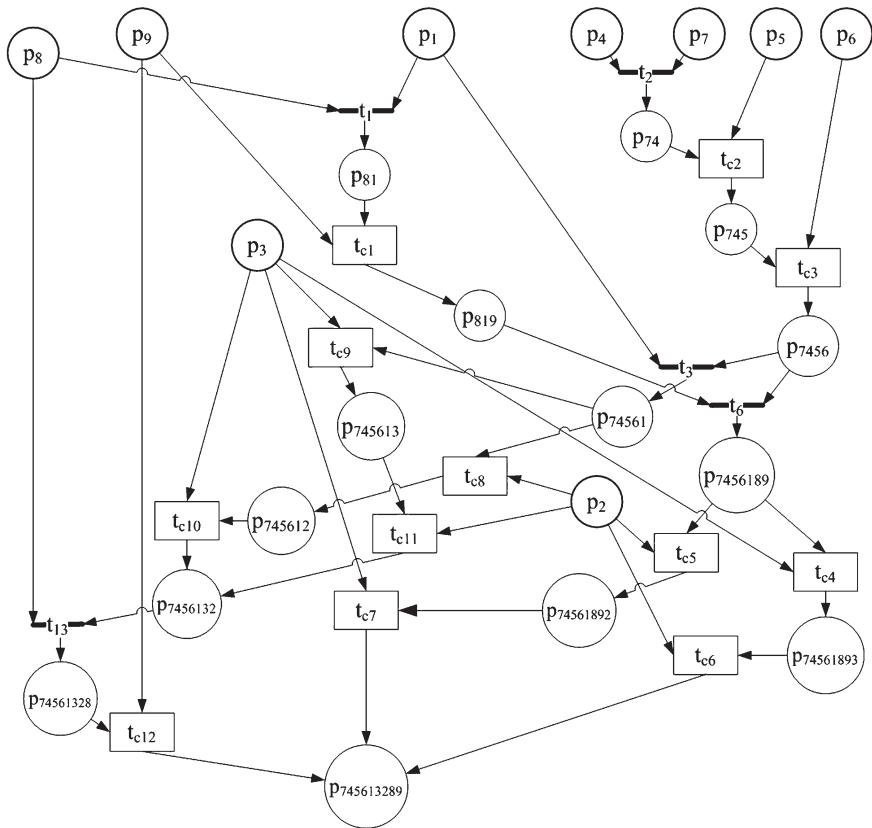
For the purpose of illustrating the solution procedure developed in the previous section, the assembly product is provided as application example shown in Fig. 109.3. The assembly's KBPN is established in the Fig. 109.4, as we all known.

All of the parts are stored in the product database, and many attributes attach to the part are stored in, too, such as weight, size, class, and so on. They are the design knowledge of the parts. For example, according to the assembly rules knowledge, heavier part is assembled early. Four joining is acquired according to the joining knowledge. So,  $p_1$ ,  $p_8$ , and  $p_9$  consist of one of the joining, which is named as  $p_{jA}$ , and  $p_1$  is first assembly in the joining. As the same reason, the  $p_{jB}$  represents the  $p_4$ ,  $p_5$ ,  $p_6$ , and  $p_7$ ; and the simplified KNPN is obtained in the Fig. 109.5.

## 109.4 Assembly Sequence Planning

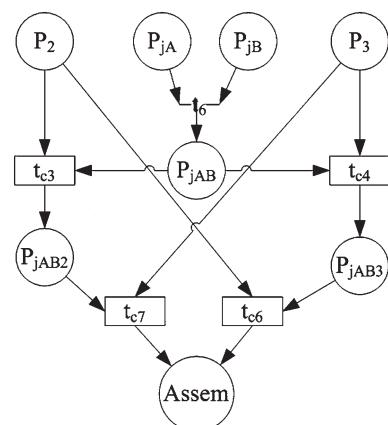
ASP can plan an important role in product design. In this paper, the assembly sequence is obtained by the KBPN. It is assumed that all of the transitions can be fired in the KBPN, so all the feasible assembly sequence may be generated by firing the model. Because of the assembly knowledge, the KBPN is simplified, so the nodes are reduced and the feasible sequences become less. The assembly sequence is obtained by the following algorithm:

1. The  $T$  vector is established, which is used to store transition;
2.  $C$  is the incidence matrix of the KBPN being established, and the element is indexed sequential data set in the  $P \times T$ ;



**Fig. 109.4** Simplified KBPN of the assembly

**Fig. 109.5** Simplified KBPN of the assembly



**Table 109.1** Relationship Matrix of Fig. 109.5

	$t_6$	$t_{c5}$	$t_{c4}$	$t_{c7}$	$t_{c6}$
$p_2$	0	-1	0	0	-1
$P_{jB}$	-1	0	0	0	0
$P_3$	0	0	-1	-1	0
$P_{jA}$	-1	0	0	0	0
$P_{jAB}$	1	-1	-1	0	0
$P_{jAB2}$	0	1	0	-1	0
$P_{jAB3}$	0	0	1	0	-1
assem	0	0	0	1	1

3.  $M$  is the station vector of KBPN, which reference the assembly is finish;
4. The station equation of KBPN is shown in the following equation.

$$M_0 + C \cdot x = M \quad (109.3)$$

where  $x$  is the transition vector,  $x = [x_j], x_j \in \{0, 1\}$ .

$$c_{ij} = \begin{cases} 1 & \text{if transition } t_j \text{ pointing } p_i \\ -1 & \text{if transition } p_i \text{ pointing } t_j \\ 0 & \text{others} \end{cases} \quad (109.4)$$

So, the sequence is obtained by solving the equation. For example, the assembly in the Fig. 109.4 and the relationship matrix is shown in the Table 109.1. And, from the Fig. 109.5, we can know that  $M_0$  represents the initial state, and  $M$  represents the final state of the assembly.

$M_0 = [1, 1, 1, 1, 0, 0, 0, 0] T$ ,  $M = [0, 0, 0, 0, 0, 0, 0, 1] T$ . So, the solutions are  $x1 = [1, 1, 0, 1, 0]$ ,  $x2 = [1, 0, 1, 0, 1]$

And, they represent the feasible assembly sequence of the assembly. According to the joining knowledge, sequences of the  $p_{jA}$  and  $p_{jB}$  can be obtained, and then, the final assemblies sequences are obtain by inserting them into the feasible sequence. So,  $p_1 P_8 P_9 - P_4 P_7 P_6 P_5 - P_2 - P_3$  is one of the assembly sequences.

## 109.5 Conclusion

This paper discussed a method of using assembly knowledge to plan sequence of assembly. Assembly knowledge is classified into three types, and every one was stored in the different knowledge database. All of the knowledge was used to establish the assembly model, so the KBPN is simplified, and the nodes of the model were reduced rapidly. According to the knowledge, many sequences which break the rules can be removed to improve efficiency of the assembly sequence planning. According to the firing theory, all of the sequences can be obtain by firing the simplified KBPN of the assembly. And then, joining knowledge is acquired

from the database, and the sequence of the joining was inserted into the feasible sequences, so the assembly sequences are established. Finally, an example verified that this approach is validity and efficiency.

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