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Preface

The Second Workshop of Blended Learning (WBL 2008), as part of the 7th International Conference on Web-Based Learning (ICWL 2008), was held in Zhejiang Normal University, Jinhua, Zhejiang, China during August 20–22, 2008.

WBL 2008 provided an international forum for the dissemination of original results in the design, implementation, and evaluation of blended learning systems and related areas. In particular, the aim of WBL 2008 was to bring together researchers from academia as well as commercial developers from industry to explore ideas, exchange and share experiences, and further build the blended learning research network. The inspirations and new ideas were expected to emerge from intensive discussions during formal sessions and social activities.

The main focus of WBL 2008 was on the most critical areas of blended learning, namely, 'e-Learning Platforms and Tools,' 'Design, Model and Framework of e-Learning Systems,' 'Practice and Experience Sharing,' and 'Pedagogical Issues.' In total, the workshop selected 17 papers from authors of different countries for presentation and publication, a task which was not easy due to the high quality of the submitted papers. Using stringent selection criteria, submissions were rigorously reviewed based on their originality, significance, relevance, and clarity of presentation by an international Program Committee from Germany, Spain, UK, Italy, Ireland, Romania, Hong Kong, Japan, Taiwan, and Macao.

On behalf of the Organizing and Program Committees of WBL 2008, we would like to take this opportunity to express our appreciation to all authors for participating in the workshop. Many of them travelled from different countries to participate. We would also like to thank our colleagues who helped with putting together the workshop: the Program Committee members for their timely and rigorous reviews of the papers, and the Organizing Committee for their help in administrative work and support. We owe special thanks to Qing Li for being available at all times when his helping hand was needed.

We would like to thank the sponsors, supporting organizations, and helpers for making the workshop a success. In particular, we are grateful to Zhejiang Normal University, City University of Hong Kong, and the Hong Kong Web Society for their sponsorship and assistance. With the strong support of Springer, the proceedings of the workshop will also be published in the *Lecture Notes in Computer Science* (LNCS) series. Without their efforts, the workshop would not have been possible.

We hope everyone who attended enjoyed the workshop program. Last but not least, we also hope that in the future more and more researchers and practitioners will become involved in this workshop and contribute further to the field of blended learning.

August 2008

Elvis Wai Chung Leung
Fu Lee Wang

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Abstract. Education can effectively reduce prisoners in reoffending, equip them the necessary skills and knowledge to earn their livings. As educational backgrounds of the prisoners vary a lot even they are roughly of the same ages, traditional classroom teaching is not appropriate. On the other hand, distance learning provides students higher flexibility and more choices in organizing the learning paths. Students taking courses in distance learning approach need to read study units and reference materials, such as textbooks and reference books and papers. For usual students, the resources can either accessed via the Internet or at the library in person. However, for prisoners, due to highly restrictive measures in material exchange into and out of the prisons, they are not allowed to access the Internet directly and all materials dispatched must be verified. This paper discusses requirements of prison educations and a framework for facilitating prisoners in taking distance learning.

Keywords: prison education, teaching material exchange.

1 Introduction

Researchers [1] [2] found that prisoners re-offend because they lack the necessary academic or social skills for them to function in the society. As such, education in prisons has been an effective way to equip prisoners the skills and knowledge so that they can earn their livings upon releases, so that they less likely to re-offend. There are vocational training provided in prisons and academic education has to be provided with the corporation with education institutes, such as universities. However, prisoners are aged differently, start staying in the prisons and last for different lengths. Even more complicated is that their education backgrounds are different even for those aged roughly the same. Therefore, it is next to impossible to adapt the traditional classroom education approach. Instead, distance learning enables prisoners to choose their desired courses at their own paces, and they can continue their studies after being released. In Hong Kong, the Open University of Hong Kong [3] is providing distance learning programs which suit prisoners' requirements.

1.1 Problems

Although distance learning is a preferable approach for prisoners, some usual restrictions imposed by prisons limit the accessibility and availability of the teaching and supporting

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resources. The following table 1 summarizes the various resources that are available to distance learning students and the corresponding problems encountered by prisoners.

Table 1. Problems on eLearning for Prison

Resources	**Description**	**Problems encountered or special arrangement required by prisoners**
Teaching materials	Study units, assignments are mostly available in soft-copies and hard-copies that are both available to the students. Soft-copy versions are available on CD-ROM or from the course supporting web-site, whereas hardcopy version will be delivered via postal mail.	Hard-copy versions of the materials are dispatched to prisoners after verifications by prison educational staff. Besides, they trust the software stored on the course CD-ROM, which will be dispatched to prisoners as well. However, the durations that prisoners can stay in computer rooms for accessing personal computers are limited, and soft-copy versions are therefore not as convenient as hard-copy versions.
Online course supporting portal	Universities providing distance learning mostly provide a portal that is accessible via the Internet and facilitates the learning of the students. Features are including online access to course materials, email and discussion forums.	Prisoners cannot access the Internet directly and the computers in the computer rooms are for clerical and programming related tasks only. Communications with tutors are strictly monitored, and communications with classmates regarding course contents are impossible.
Assignment submissions and extension applications	Assignment submission with hard-copy and soft-copy via the course portal are both acceptable. Students can apply extension by the course portal.	Prisoners can just submit assignments with hard-copies. For application of extension, prisoners can apply via phone call or letter via postal mail.
Surgeries and tutorials	Students can attend surgeries and tutorials for face-to-face lecturing.	Regular surgeries and tutorials are not available to prisoners and on-demand surgeries and tutorials are possible but need to be endorsed by both the universities and prison staff.
Examinations	Students attend the examination at the specified examination venues and date/time.	Special examination sessions are arranged in prisons.

With respect to the above table, the problems encountered by prisoners are:

1. It is difficult for prisoners to access to course materials in soft-copy format, and they have limited times to use personal computers.
2. It is difficult for prisoners to access to extraordinary teaching materials, such as reference books, papers or journals.
3. It is difficult for prisoners to communicate with course tutors and classmates.
4. It is impossible for prisoners to attend surgeries and tutorials.

This paper will propose a complete set of solutions regarding the above problems. The solution makes use of various hardware and software, which is to be used by

different involved parties. The following sections firstly introduce the data flows among the different parties for individual problems, and they are summarized at the end of these sections.

1.2 Limited Access to Personal Computer

There are computer rooms in prisons so that prisoners can use them according to a predefined schedule, but the durations are still limited. The software that is available on these personal computers is carefully screened. As such, these personal computers are only installed with office suite and software chosen by individual courses, not to mention recreational game and multimedia applications. However, similar to usual students, prisoners prefer accessing personal computers in their own cells after the day-time activities.

With respect to the problems mentioned above, prisoner must be able to perform the following tasks with the personal computers.

1. Place requests of hardcopy reference materials.
2. Place requests of softcopy reference materials and obtain the requested softcopy.
3. Submit questions regarding their courses to tutors or lecturers, and read the corresponding answers.
4. Submit articles to discussion boards and read the articles posted by lecturers, tutors and classmates.
5. Apply assignment extensions.
6. Submit assignments to the tutors.

From the perspective of prison staff, there are many practical problems to be handled so that prisoners can access their own personal computers in their own cells. Due to the fast pace of advancement in computer technologies, there are more and more issues to be addressed. By detailed investigation of various scenarios that prisons could use the computers, the following is a list of requirements of those personal computers.

- Personal computers should not be equipped with any communication devices or must be disabled. Otherwise, prisoners could communicate with outsiders or with other prisoners in the same prisons. This could cause serious discipline issues.
- Personal computers should not access to any temporary storage media, such as flash disc or USB storage stick. It is because these temporary storage media could become a mean of communication media as they are tiny sized. Furthermore, prisoners can easily obtain tiny sized storage media from outsiders during their visits, and the media might contain improper materials, such as pornographic multimedia files. Besides, prisoners could install their desired software, such as games, to their personal computers, which is highly undesirable. Eventually, these storage media would become another soft-money of the prisons, just like cigarettes.

There are two candidate devices, which are usual personal computers (especially notebook computers) and electronic book readers.

For accessing softcopy reference materials, electronic book (e-book) readers [6] are preferable, as they are capable to read usual e-book formats, such as Adobe Portable Document Format (PDF) and Microsoft Word. However, current e-book readers do

not equipped with keyboard and it is not possible to install tailor-made prisoner education software applications.

Personal computers are preferable due to fact that students need computer keyboards for word-processing or reading various learning materials, especially those multimedia files. It was recommended bulky desktop personal computers were preferable, due to the fact that they are not portable and prisoners must use the computers at the desired location in their cells. However, the drawback is that there are many other administration procedures required for the installation of these computers. Therefore, notebook or laptop computers are preferable and each prison can have its own notebook computer service center that is responsible for distributing and collecting the notebook computers. All students who are taking distance learning courses can apply for notebooks from the service counter. Once a student has completed his/her studies or courses, the notebook computer assigned will be revoked accordingly.

There are two candidate operating systems, which are Linux [7] and a Microsoft Windows version. Table 2 shows the advantages and disadvantages of these two operating systems.

Based on the above comparison table, the most critical consideration factor is the requirements stated by the distance learning courses. Furthermore, for better and easier management, notebook computers are preferable, compared with usual desktop computers. In order to let prisoners use notebook computers, baseline security issues have to resolved, such as the accessibility to temporary storage and networking devices.

Notebook computers without CD-ROM drivers are to be chosen. Peripheral devices are commonly connected to notebook computers via IEEE 1394 interface, Bluetooth and in particular USB. Built-in Bluetooth and USB devices can be disabled by either CMOS settings or software applications, and CMOS settings should be password protected. In order not to let prisoners change the hardware configuration, prisoners are not granted administrator privileges but prisoners are only usual users of the notebook computers. As such, notebook computers cannot make use of any temporary storage and networking devices. In case, there is a prisoner who is equipped with the knowledge of disassembling the notebook computers for clearing the CMOS protection, the notebook computers should be verified regularly to ensure the notebook computers are not compromised.

For actual data exchanges, prisoners will bring the notebook computers to synchronization stations in prisons for synchronizing the contents on the notebook computer hard drives with the folders on the synchronization stations. The preferable communication device to be used is the RJ45 port of LAN connections. At a synchronization station, the synchronization server provides a connection cable (a cross cable suffices because no routers or switches are involved) that prisoners can connect to their notebook computers. Then, the prisoners can start a script shown on the desktop of the notebook computers. The operations to be done by the script are:

1. Enable the RJ45 network port.
2. Obtain an IP address by DHCP.
3. Connect to the folder for the prison on the synchronization server.

Table 2. Comparison of two operation systems for Learning in prison

Aspects	Linux	Microsoft Windows
Requirements stated for non-computer courses	Students mostly need to use office suite for various clerical operations, such as word-processing and preparation of spreadsheets and presentations. There are free office suite software applications on Linux platforms.	A Microsoft windows version with recent Microsoft Office suite can fulfill all requirements stated by the courses.
Requirements stated for computer-related courses	Linux is the preferred platform for some operating specific courses and server programming courses only.	Windows are the preferred platform for most of the computer-related courses.
Manageability	It is much easier for customizing Linux by modifying the kernel source code, such as disabling the support for temporary storages, such as USB flash drive and networking devices. As such, it is easier to implement various policies with Linux.	It is almost impossible to customize the operating system at the kernel level. For implementing all necessary supplementary computer usage policy, it is necessary to source for commercial software solutions.
Supports of new hardware	The support of latest hardware in Linux is generally inferior to Windows, but it turns out to be an advantage as the chance of prisoners to use their own hardware devices is lower and hence less risky.	For instance, most hardware vendors provide support modules (such as drivers) on Windows platforms for their hardware. As such, Windows support most hardware even without installing any new modules (or drives). However, it enables prisoners to use their own hardware devices, which could introduce subsequent problems.
User friendliness	Prisoners are less familiar with the Linux user interface, even with graphical user interface of GNOME [8] and KDE [9]. As such, it is usually necessary to provide prisoners the necessary trainings. On the other hand, as prisoners are not familiar with Linux, it is less likely for them to crack the Linux operating system.	Almost all people have got familiar with Windows platforms, and it is therefore unnecessary to train prisoners for using Windows based computers. On the contrary, it is easier for prisoners to install their own various Windows-based software applications, which are highly undesirable.

4. Compare the contents on the notebook local folders and the dedicated folders for the prisoners on the synchronization server, and synchronize the two folders.
5. Start a software application that process the files downloaded to the notebook computer.
6. Disconnect the connection to the remote folder on synchronization server.
7. Disable the RJ45 network port.

The software application mentioned above is a module of the prisoner education software application. It is designed to handle various prisoner operations and will be discussed in the following sections accordingly.

1.3 Accessing and Requesting Extraordinary Reference Materials

Prisoners cannot communicate with any person, especially outsiders, without prior approval by prison staff, in particular outsiders. Therefore, if they read the study units or textbooks and some reference materials, such as books, journals or papers, are referenced, there is no proper channel for them to request those materials.

In order to tackle this issue, the prisoner education software installed on notebook computers enable prisoners to specify reference books by titles or any reference numbers, such as ISBN. Upon synchronizing, the requests will be uploaded to a central server to be reviewed and approved.

1.4 Communications with Learning Related Outsiders

Communications with outsiders are highly restricted for prisoners. However, learning is preferable to be carried out with two-way communications, especially with lecturers, tutors and classmates. Therefore, the prisoner education software application must enable prisoners to type messages and specify the recipients or target, such as lecturers, tutors or discussion board. Upon synchronization, the messages are consolidated at the central server to be reviewed and approved based on the usual guidelines of the prisons.

2 Related Works

The purpose of education and training in prisons should be to play a key role in improving the employability of prisoners and therefore contribute to reducing recidivism. Prisoners who do not take part in education or training are three times more likely to be re-convicted than those who do [10]. Prisons education is justified through human rights. We need to identify what type of education and training provision will have the greatest impact on meeting the individual learning needs of the prisoner and providing them with real alternatives to crime on release [10].

The problems that prisoners encounter mentioned above are related to the data file exchange with monitoring and approval features. However, the researches on education in prison were concentrated on using computers in facilitating prisoners' learning through computer aided learning software, such as the one mentioned in [4] [5]. There have been no solutions for facilitating the data file exchanges for prisoners with the education related outsiders, including the institutions or individuals. As such, the framework proposed in this paper is to enable prisoners to submit necessary requests and exchange messages with corresponding teaching staff.

3 Solution

To facilitate prisoners' learning, a prisoner software framework is required, which involves hardware and software.

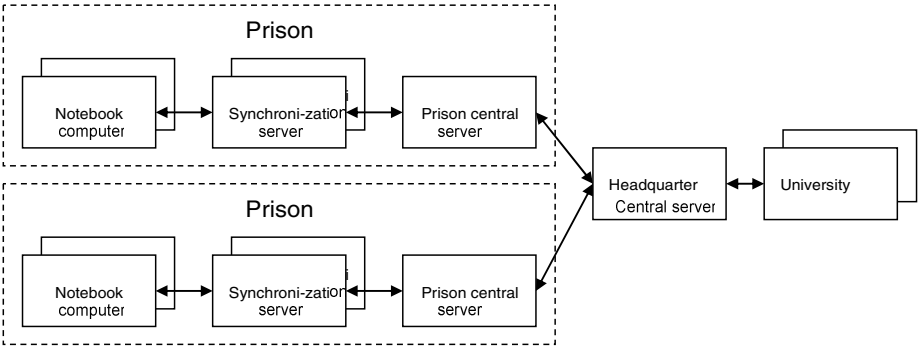

Fig. 1. The Prisoner Education Framework

As illustrated by Figure 1, there are several computer types involved, which are:

- Prisoner notebook computers – These are the computers used by prisoners for their studies, and are installed with prisoner education client software that enable them to request reference materials, communications with learning related outsiders and assignment deadline extension applications and assignment submissions. These computers are mostly isolated and cannot access to any temporary storage and network. The only possible way of communication is to be wired with synchronization servers for data file exchanges.
- Synchronization servers – These computers are installed on various dedicated locations in a prison that can be reached by prisoners, such as computer laboratories or common areas of the cells. Prison staff can schedule the times for prisoners to bring their notebook computers to the synchronization server for data exchange. Synchronization servers in a prison are connected to the prison central server via LAN, so that the data files obtained from prisoner notebook are uploaded to the prison central server, and in the reverse direction, new files for prisons stored in the prison central server are obtained by synchronization server and are replicated to prisoner notebook computers.
- Prison central servers – Each prison is installed with a prison central server, which acts as a file server for all synchronization servers in the prison. The prison module of the prisoner education framework will be installed on these servers so that prison staff can review and approve the materials to be sent to and obtained from universities and outsiders. Subsequently, these prison central servers will synchronize with headquarter central server. According to the policies adopted by prisons, prison central server can connect online with headquarter central server via VPN on top of broadband connection, or offline by replicating data to be synchronized on CD-ROM with encryption to be distributed through internal courier service.

- Headquarter central server – It is the gateway of the prison education framework, which can communicate with universities and hence the outsiders, including lecturers, tutors and classmates via discussion boards. Data exchange with universities can be implemented transparently via pre-defined communication mechanisms, such as via tailor-made communication software or web services that are implemented on headquarter central server and the corresponding servers of the universities.

3.1 Impacts to Various Involved Persons

By implementing the prisoner education framework, the ultimate beneficiaries are prisoners who can now access to the necessary resources for their studies. In this section, the impacts to the different involved persons are presented.

3.2 Prisoners

They can make use of notebook computers to read the reference materials, especially those in softcopy version only, requesting reference materials, and communicating with course lecturers, tutors and classmates via discussion board regarding any course related matters. Notebook computers enable them to make the best use of the prisoners' own times no matter where and when.

3.3 Prison Staff

The prisoner education software provides prison staff a consolidated view of all requests and communications of the prisoners with the outsiders. They can make sure that prisoners are requesting proper reference materials, and the messages do not cover any personal particulars or any restricted topics enforced by prison policies and guidelines. Figure 2 illustrates a sample screen layout for monitoring and approving message exchanges between prisoners and outsiders.

Besides, prisoner education software needs to synchronize the materials between prison central servers and headquarter central server, by either network connection or by CD-ROMs. In case, the synchronization is performed with CD-ROMs, prison staff at the prisons need to use the prisoner education software to prepare a CD-ROM that stored the latest files obtained from prisoners, and dispatch the CD-ROM to the headquarter in which the files are replicated. In the reverse direction, prison staff at the headquarter office need to create CD-ROMs for individual prisons that stores the files obtained after the prisoner education software communicates with universities. When the CD-ROM is distributed to individual prisons, prisoner education software will read the CD-ROMs and store the files to their local directories to be subsequently replicated to prisoner notebook computers.

Other than the synchronization between prison central servers and headquarter central server, the modules hosted on prison central servers and headquarter central server enables prison staff to manage prisoner education related information, such as creating/updating/deleting prisoner education profiles and relocation of prisoners.

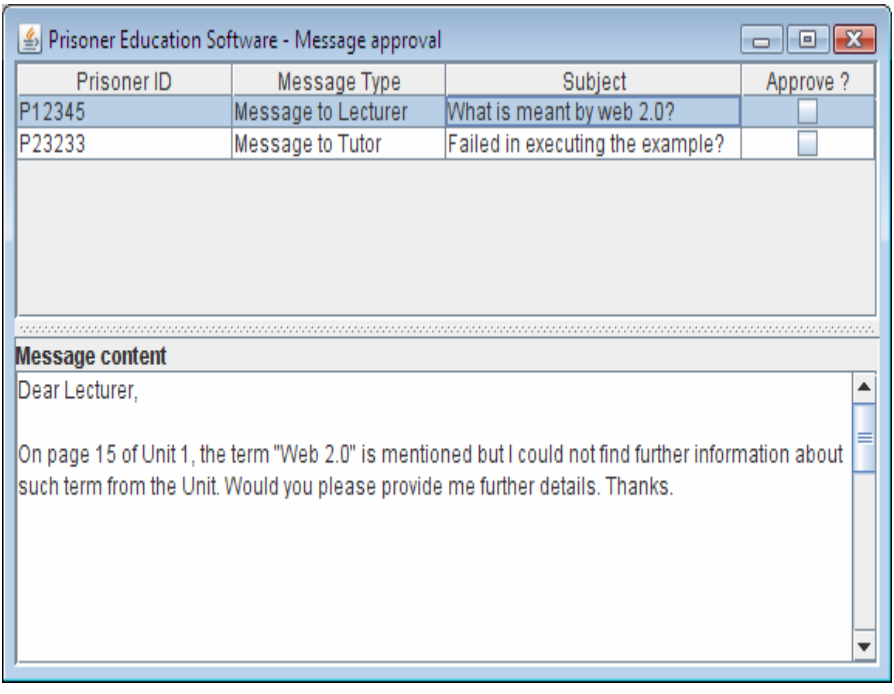

Fig. 2. The approval screen of the Prisoner Education software for prison staff to approve messages

3.4 Course Lecturers, Tutors and Classmates

The universities should dedicate a staff to manipulate their own education framework based on the contents sent from prisoner education software that is hosted in the headquarter office. Otherwise, communication mechanism should be implemented instead, such as by web services. As such, data files obtained from prisoners can be eventually synchronized with university education system as if prisoners are using the university education system directly.

3.5 Function Requirement of Prisoner Education Framework

The prisoner education framework involves recommendations on hardware and software. There are several software modules involved that are installed on notebook computers, synchronization server, prison central server and headquarter central server. In this section, the function requirements of these modules on various machines are presented.

3.6 Prisoner Notebook Computers

The module installed on prisoner notebook computers enables prisoners to prepare messages to be sent to course lecturers, tutors and discussion boards, specify the

reference materials to be obtained and assignment submission. Therefore, the requirements of the module installed on prisoner notebook computers are:

- Prepare messages targeted to course lecturers, tutors or discussion board
- Read messages sent from course lecturers, tutors that are sent to all students in the course (or tutor group), and all messages on discussion boards.
- Specify reference materials by titles or reference numbers, such as ISBN.
- Apply assignment extension.
- Submit completed assignment.

3.7 Synchronization Servers

Synchronization servers can be located in various locations in a prison that are connected to the prison central server, and the sole purpose of synchronization servers is to synchronize the contents of prisoner notebook computers and the prisoner central server. As such, the function requirements of synchronization server are:

- Enable prisoners to authenticate themselves by user name, password.
- According to the prisoner's identity, synchronize the various files on prisoner notebook computers with the prison central server.

3.8 Prison Central Server

The prison central server acts as a central repository for all synchronization servers in the prison, and it is to be accessed by synchronization server and hence indirectly accessed by prisoner education notebook computers for data exchanges. Therefore, it is a file server so that a dedicated directory on the server can be accessed by all synchronization servers. Furthermore, a module of the prisoner education framework is installed on the machine that can,

- Manipulate prisoner profiles, such as creating/updating/deleting operation
- Indicate prisoner relocation
- Verify and approve requests, messages and documents obtained from prisoner notebook computers
- Review historical records of prisoner synchronization and the corresponding contents
- Verify and approve data files obtained from universities or outsiders, so that those materials can be synchronized with prisoner notebook computers
- Generate CD-ROM based on files obtained from prisoner notebook computers, in case off-line synchronization with headquarter central server is chosen
- Synchronize files stored in the folders for remote file accesses by synchronization server based on the CD-ROM prepared by headquarter central server

3.9 Headquarter Central Server

The central server that resides at the headquarter acts as the gateway of the prisoner education framework with all outsiders, such as universities. Therefore, prison staff at headquarter can review and approve all data exchanges. Furthermore, the module of

the prisoner education framework that is hosted on headquarter central server machine implements suitable data file backup mechanism for disaster recovery and auditing purposes. As such, the requirements of the headquarter central server are,

- Import, review and approve data files obtained from synchronization, including both online via dedicated network connection, such as via VPN, or off-line by collecting CD-ROMs obtained from different prisons
- Send approved requests from outsiders via the Internet, such as university, with pre-agreed mechanism, such as via web services
- Retrieve materials obtained from outsiders, such as universities, with pre-agreed mechanism, such as by web services
- Based on the locations of the prisoners, prepare CD-ROMs for different prisons so that materials for particular prisoner are sent to the suitable prison
- In case, on-line synchronization is adopted, synchronize data files with different prisons based on pre-defined schedules

3.10 Function Requirement of Prisoner Education Framework

The prisoner education framework involves recommendations on hardware and software. There are several software modules involved that are installed on notebook computers, synchronization server, prison central server and headquarter central server. In this section, the function requirements of these modules on various machines are presented.

4 System Design and Case Study

In this section, a high level system design and diagrams are provided to illustrate the work flow of some critical operations.

Figure 3 presents a use case diagram of the prisoner education software and the operations of various involved parties.

Basically, there are three core categories of persons who will use the prisoner education software. They are prisoners, prison staff and university staff. For prisoners, they can request for courses, request for reference (in either hardcopy or softcopy format), sending messages to university lecturers and tutors, and submit assignments. For prison staffs, they are mainly responsible for the approvals of various materials that are sent and to be received by prisoners. For university staffs, they are mainly for synchronizing the messages and collection assignments with respect to the software.

The following diagram illustrates the sequence of operations performed by various persons for a prisoner communicate with university lecturer or tutor.

As illustrated in Figure 4, prisoner can communicate with university lecturers/tutors or classmates via discussion board with the following sequence of operations,

1. The prisoner prepares and submits a message to the prisoner education software.
2. A prison staff approves the message after reviewing its contents with respect to the guidelines imposed by the prison.

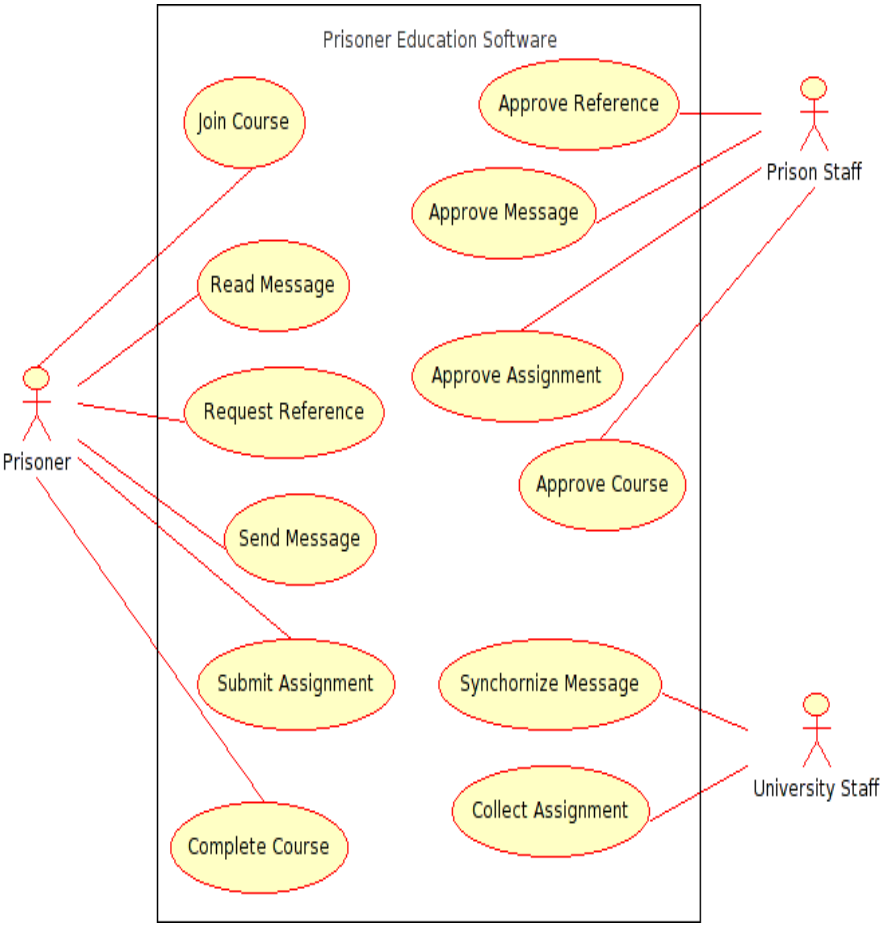

Fig. 3. Use Case Diagram of the Prisoner Education Software

3. A staff of the university obtains the message by accessing the prisoner education system and submits the message to the corresponding channels, such as to be sent by email on behalf of the prisoner or submitted to the discussion board. Upon the returns of the reply message by university lecturer/tutor or posting of reply message on the discussion board, the university staff synchronizes the message with the prisoner education software.
4. The prisoner reads the reply message with the prisoner education software.

The scenarios for requesting reference materials and submission of assignments are similar. The operation initiated by prisoners and approved by prison staff. University staffs are responsible for synchronizing the data between prisoner education software and their internal email or discussion board systems.

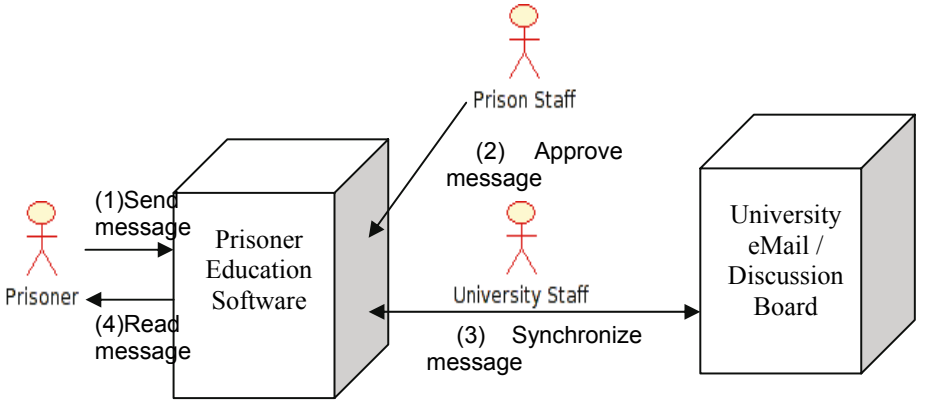

Fig. 4. The sequence of operations for a prisoner to communicate with university staff with a message

The prisoner education system provides different modules to different persons, such as prisoners, prison staff and university staff with user-friendly user interface, so that prisoners can perform various operations. Requests, messages and submissions synchronizations can be achieved by permanent Internet connections among individual prisons and headquarter. However, there may be cases that it is impossible to set up Internet connections for some prisons, such as restricted by prison policies or geographical limitations. Therefore, prisoner education framework proposes a supplementary synchronization mechanism by CD-ROM.

In case CD-ROM delivery is adopted by particular prisons, the prison central server can generate a CD-ROM based on the new collected requests on daily basis. Upon the CD-ROM is ready, it is delivered to the headquarter office so that the staff there can place the CD-ROM driver of the headquarter central server, and the headquarter central server will start reading and decrypting data from the CD-ROM, and the data are imported to the server. Afterwards, headquarter central server can send newly collected resources to corresponding universities via permanent Internet connection. If unfortunately, headquarter central server cannot access the Internet, the server module can export resources for individual university to be stored on CD-ROM with encryption. When the university gets the CD-ROM, they can use the university module provided by the prisoner education software to read its contents and hence update their own internal email or internal systems. Such data flow is visualized by Figure 5.

On the reverse directory, CD-ROM can be generated by the university module of the prison education software that stores all responses by corresponding course lecturers and tutors, and messages from discussion board. When the headquarter staff gets the CD-ROM, they can use the headquarter module to extract data from the CD-ROM to be imported to the headquarter central server. Finally, by selecting particular prison, the software can export resources for the prisoners in that prison to a CD-ROM. When the CD-ROM arrives at the prison, prison staff can import the contents from the CD-ROM by using the prison module to be imported to the prison central

server. Finally, prisoners can use their own notebook computers to obtain the resources that are targeted to them.

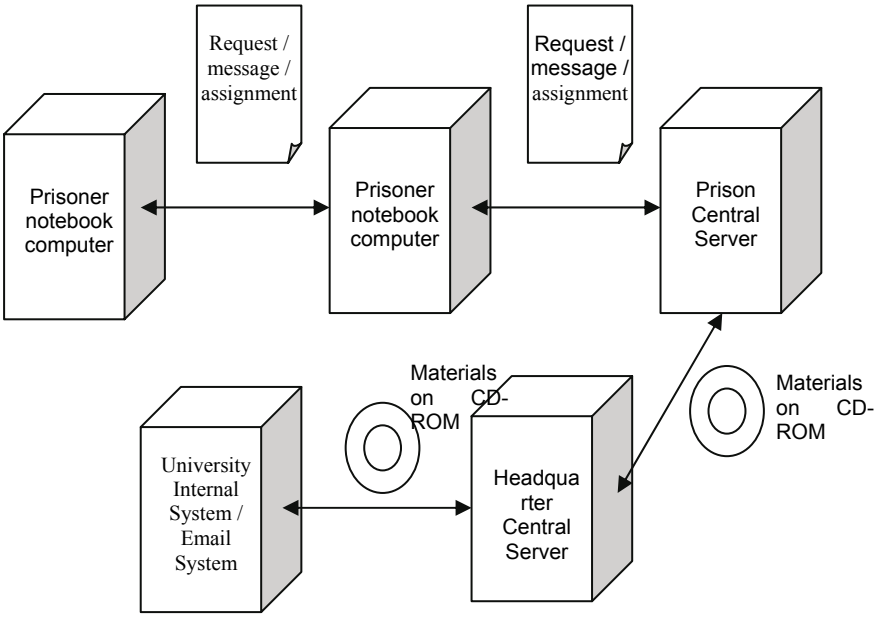

Fig. 5. The sequence of flow of materials

5 Conclusion

Education is a good approach to prevent prisoners from re-offending, and distance learning is a preferable learning mode for prisoners. Due to the following restrictions, prisoners cannot access to various resources that are available to usual students.

1. There are no existing e-learning facilities to assist prisoner students
2. It is too costly and cumbersome for prison staff to monitor class room learning in prison
3. There are no existing software and framework for resolving the above problems.

In order to break the barrier that prisoners face, this paper proposes a prisoner education framework that is a comprehensive and complete solution that facilitates prisoners' learning by enabling them to perform those operations that were otherwise impossible. For most operations, the sequence of operations can be summarized to be:

1. Prisoner requests for a material or submit a message or assignment.
2. Requests and submissions are synchronized to prison central server.
3. Prison staff reviews and approve the requests or the submission.
4. Approved requests and submission are synchronized with headquarter central server, either via permanent Internet connections or by CD-ROM transmission.

5. Requests and submissions are synchronized with university email system and internal operation systems manually by a university staff or by well-defined protocols, such as web services.

Regarding the reverse direction of the data flow, that is responses of the prisoner requests and messages/submissions, the sequence of operations is exactly the reverse sequence of the above.

Course lecturers and tutors are highly recommended to conduct supplementary classroom teachings in prison so that such combination of classroom learning and e-learning facilitated by the prisoner education framework can be a new kind of blended learning.

The proposed solution involves both hardware and software. Notebook computers with USB devices and CD-ROM driver removed are preferable, so that prisoners cannot use the computers improperly. Furthermore, various software modules of the prisoner education software are installed to synchronization server, prison central server and headquarter central server respectively. These modules enable communications between prisoners and learning related outsiders, such as course lecturers, tutors and classmates via discussion board. The software modules are designed with security in mind, so that prison staff can review all communications between prisoners with all outsiders.

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Advanced Methods of Web Learning

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Abstract. The exploitation of contemporary Information and Communication Technologies (ICTs) in the design process of advanced e-learning methods and systems is only one indispensable factor that needs to be addressed, considering that the principle need of students nowadays is the easy and straightforward access to educational material. In addition, the rapid technological evolution and the unceasing invasion of new technologies in the market, renders older technologies obsolete after only a short lifetime. Taking this into account, it becomes apparent that the cognitive material is affected in numerous ways and that the need to dynamically upgrade it is absolutely necessary in order for it to be constantly up to date and to follow closely the technological developments. Bearing in mind the two aforementioned factors, this paper presents an advanced educative web learning platform, which conforms to the above mentioned needs of contemporary education and students and learners in general.

Keywords: web learning, syllabus upgrade, cognitive material.

1 Introduction

The advance of the Internet and Information and Communication Technologies affects modern every-day life to a great extent and education is no exception. This advance, combined with the popularity of the Internet among users has led to the exploitation of ICTs by network engineers towards the integration of ICTs and the Internet with traditional teaching-learning methods. This integration has led to what is commonly known as e-learning or web learning. [1], [2].

Web learning (or e-learning) is the result of the advance of the Internet and the ICTs. It has completely changed education, the delivery of knowledge as well as the role of school. Web learning provides the opportunity to the user for distant learning through the Internet with multimedia means such as text, images, audio and video. [3], [4].

Furthermore, in recent years the development of web learning has been increasing rapidly. Due to this context, the subject of e-learning and its specifications and management have been widely studied. These include the authoring standards [5], the e-content [6], the e-content development and management [7], virtual classroom educational methods [8], [9], methodologies to improve the interoperability of the educational content [10], classification-evaluation of the e-student educational level and learning difficulties.

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Based on the above and aiming at creating a modern environment using user-friendly e-content, a special advanced web learning system was designed and developed for the dynamically adaptable education of students, based on a flexible-interoperable scheme of assistive informative and communicative tools and services. [11], [12], [13], [14], [15]

This web learning system was developed within the research activities and framework of Net Media Lab of N.C.S.R. 'Demokritos' and was based on the following facts. Firstly, education in general requires the dynamical adaptation of the syllabus. It is one of the most important features in an e-learning environment, whether it is about synchronous or asynchronous means of teaching-learning. In addition, it was established that the products of the market do not possess an embedded system that provides the opportunity for online operation and collaboration of the Instructors' Team, which dynamically reforms the syllabus.

2 An Introduction to the Web Learning System

This web learning system introduces an innovative method for the reformation and upgrade of the syllabus as well as for the methodology of the educative content structure. The electronic environment is basically the medium for the disposition, modeling and adaptation of the syllabus. The implementation of this method will bring the continuous dynamical upgrade of the syllabus content according to the technological evolution and the market and social needs. More particularly, in order to achieve this reformation and upgrade of the syllabus as well as its continuous feeding based on the technology evolution and the special needs of contemporary society, the following tasks must be undertaken:

2.1 Continuous Upgrade of the Syllabus

A considerable quantity of products and technologies are rendered obsolete due to the rapid technological advances, even in the course of one year. The capabilities of the informative and communicative mediums of the Internet render them very powerful supportive tools for the teaching procedure and methodology. Hence, it becomes more than apparent that the syllabus, which consists of text, audio, images and video must be dynamically reformed and adapted to the contemporary technological developments on an annual basis through a certain innovative procedure. This means that an A% of the syllabus remains static, while the remaining B% is dynamically reformed. By reformation we mean incorporation of new cognitive material in the already existing cognitive material rather than replacement. On the one hand, the stable A% represents basic theory knowledge and indispensable cognitive background. On the other hand, the variable B% represents the cognitive material that will be reformed by a special team of instructors - authors, in such a way in order to cover in full the new knowledge (techniques, products, methodologies) that have been developed in the meantime, satisfying hence, the needs of the market each time. The definition of these percentages (A % and B %) resulted from a detailed research of the market needs and are decided by the aforementioned special team of instructors - authors. The results showed that the B percentage, which is dynamically reformed, ranges between 25-30% maximum.

Based on the results of the detailed research of the market needs the percentages (A % and B %) were applied to the entire syllabus. This resulted in the gradual upgrade of students' education through an up to date and innovative procedure-methodology. This way, the continuous (annual) update of the instructed material is achieved, according to the rapid developments in the technological, social, pedagogical and geopolitical fields. Following closely the technological developments (products, techniques), which have the potential to drastically change the cognitive content of the educational material even within a year, gives the opportunity to new students to acquire indispensable up to date knowledge about new products and technical solutions, which will continuously upgrade their skills and will render them competitive members of the society and the market field.

2.2 The Authors Group

It was essential to the progress of the project to form a group of authors, allocated within the Greek borders and which will be responsible for the modeling and reforming of the syllabus. This context contributes to the redefining of the authors'-instructors' role as they participate actively in the modeling and reformation of the syllabus' content as members of a forum. With this context in mind the following tasks were undertaken: Firstly, a forum that is composed of authors-instructors and members of scientific institutions, for the conveyance of knowledge and know how was created with the support of network technology. Secondly, collaboration between the authors-instructors' team, the industry and the scientific institutions through the aforementioned forum was initiated for the up to date informing and knowledge of new products and technologies. This forum contributes to the improvement of the conveyance of information and knowledge to and from the industry, the teachers-instructors and the students. Through specific actions, the forum informs the aforementioned interested parties about new products, their prices and availability. In addition, this program contributes to the upgrade of the quality of the educative work not only with the use of innovative methods but also with the support of the author-instructor with newly updated educative material and electronic aids. Towards this direction, suitable educative material for the basic education and distance training through the Internet was produced and presented through the Web and a multi-subject database was created on the Web, which contains an electronic catalogue for new products, a terminology dictionary and a bibliography reference.

3 Web Learning Platform Presentation

The tools and services that were used for the design of this web learning platform are distinguished into two groups: the 'informative' and the 'communicative' tools. On the one hand, the 'informative' tools are divided into the purely informative and the supportive tools and include services related to the educational material and its presentation. On the other hand, the 'communicative' tools are divided into real time and non real time tools and include services that allow the communication of the different user groups. In particular, the 'informative' tools comprise the following: web directory, courses material, courses schedule, glossaries, references, video and audio

lectures, calendar-events, news, announcements and mailing lists. On the other hand, the 'supportive' tools comprise: exercises, examples and tests. As far as the communicative tools are concerned, in the 'real time' category the tools comprise: video and audio conference, instant messaging and chat. One the other hand, the 'non real time' tools comprise: discussion forums, message boxes, e-mail, video and audio e-mail.

The use of the communicative tools ensures the online collaboration and communication of the group of instructors-authors. This instructors-authors team uses the aforementioned tools, composes and uploads the dynamically adapted and reformed part of the syllabus (B %), which is added to the already existing syllabus. Hence, the instructors-teachers of the e-environment have access to the updated syllabus without having to get implicated in the reformation process. This web learning platform relates and manages the tools to the educational material courses according to the specific user level permissions. The e-environment distinguishes four user levels, namely, administrator, instructor-teacher/author, student and unauthorized user, each of which possesses a different role in the system as well as different supporting tools. Each of them interacts with the other through the relative tools of each level.

3.1 Administrative Tools

The role of the administrator is to coordinate and manage the web learning platform through the use of the administrative tools. The administrator determines which user level-group has the permission to use the corresponding tools and services. Moreover, the administrator can communicate with the instructor in order to be kept informed about the progress of the instructors' courses.

The environment provides administrative tools that are divided into three groups as follows: management of general services, management of 'informative' services and management of 'communicative' services (Fig. 1). The transactions executed in each group concern the retrieval, insertion and update of the corresponding data. In particular, the ''general services'' group of tools includes management of the data structures of: news, events, announcements and the users. The management of the 'informative' services is of major importance, as it enables the administrator to determine the type and the number of seminars, classes, courses, instructors and students. The 'communicative services' group includes services through which the administrator can manage: announcements, the e-library of courses and the discussion forum. Moreover, through certain services the administrator communicates with each of the instructors separately.

3.2 Instructor Tools

This particular web learning platform distinguishes two kinds of instructors: the instructor-author, who is a member of the authors' group, which is responsible for the dynamical adaptation and reformation of the syllabus and the instructor-teacher, whose only responsibility is the teaching of the courses. Normally, the instructor-author can be an instructor-teacher simultaneously, while the opposite is rare.

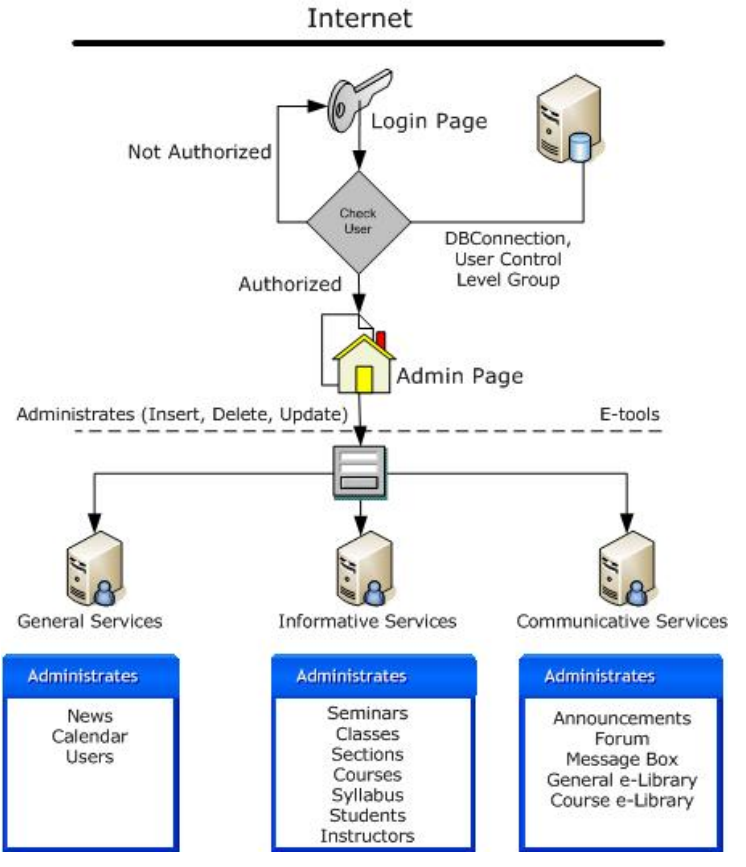

Fig. 1. Administrative tools

The instructors-authors, who form the group of authors determine, reform and adapt the educational material and also determine the way that the material will be presented to the instructor-teacher, the students and to the entire Internet community. Their communication and tasks take place online through the use of the various communicative tools such as discussion forums. On the other hand, the instructors-teachers access the e-content that is uploaded by the instructors-authors and use it for the teaching of the courses.

In addition, there is the possibility of communication between the instructor-teacher and the students, which aims at the resolution of questions. The provided tools help the instructor to organize the course in a way that will help the students in the direct comprehension of the courses (Fig. 2). Finally the tools enable the instructor-teacher to conceive the learning weaknesses of his/her students, and to select the education process of each course. In particular, the instructors' tools can be divided into three groups as follows.

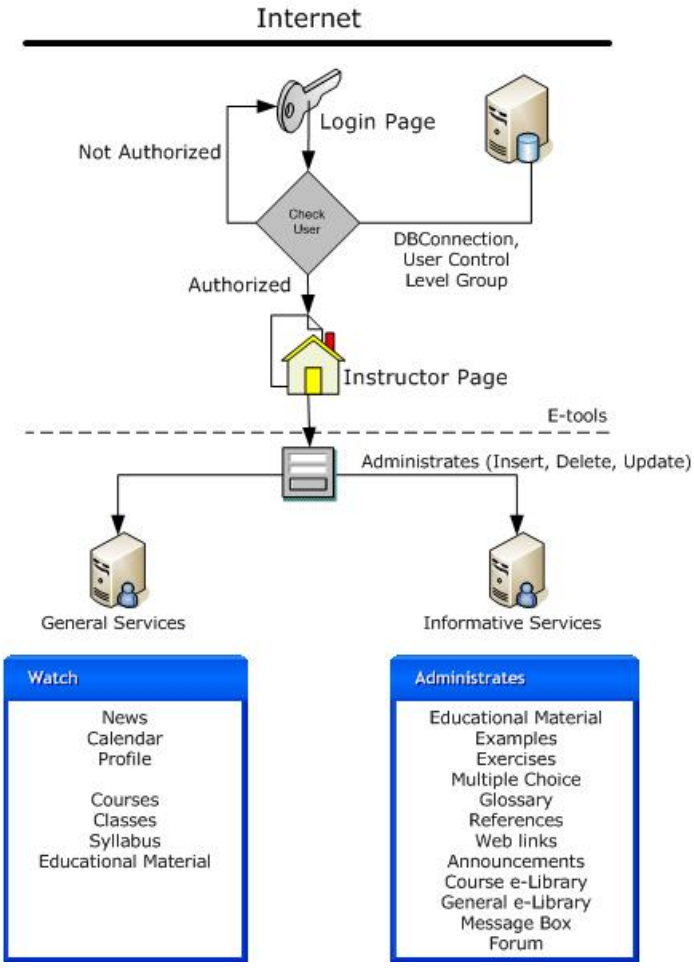

Fig. 2. Instructor tools

The first group includes general services such as management tools of news, events, courses retrieval/search, the syllabus and the educational material. The second group includes tools that allow the fast access to the already consulting material such as: examples, exercises, tests, glossary, references, web links, the e-library, announcements, solutions of exercises and discussions between students and instructors. Finally, the third and more basic group of the instructors' services is the one that enables the instructors-authors to reform, adapt and manage the educational material (chapters, sub-chapters, paragraphs) and the accompanying material (examples, exercises, tests, glossary, references, web links, e-library, announcements). In addition, there is the management of the discussions between the instructors-teachers and their students for the answer of questions, the discussions with the students on the practical application of the educational subjects and the message box from personal communication with the administrator.

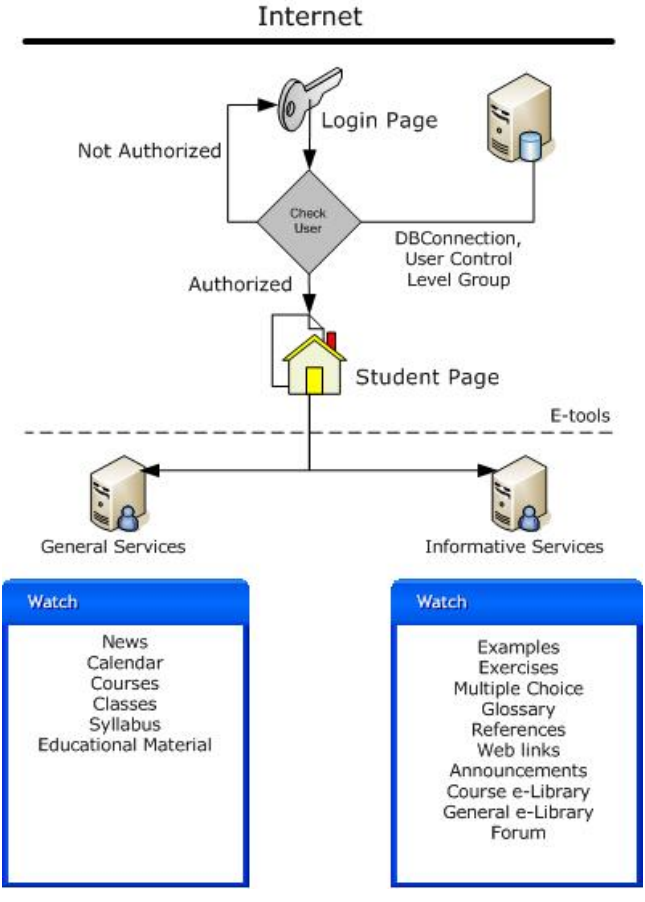

Fig. 3. Student tools

3.3 Student Tools

Students have access to all the information and services, at all times. This way, continuous access to knowledge and consequently, better course comprehension is achieved (Fig. 3). Students determine the successful development of the seminars and courses. Moreover, the students read the educational material registered by the team of instructors-authors and communicate and pose questions to the instructor-teacher and they are the ones that try to resolve exercises or questions of multiple choices.

Student tools are divided into two groups of tools. Firstly, into general services, which allow the fast access to: news, events, courses, the syllabus and educational material. The second group includes tools that allow the fast access to the consulting material: examples, exercises, solutions of exercises, multiple choices, glossary, references, web links, e-library. What is important in this group is the possibility of communication with the instructor-teacher via the discussion forums. Moreover, the

student has access to the answers of his/her questions and also has the opportunity to discuss with the instructor, the practical application of the theoretical subjects.

3.4 Unauthorized User

This level provides the possibility to the unauthorized user - visitor to browse through the e-content of the courses of the web learning platform. The innovation of this level lies in the fact that the visitor can have access to the consulting material for each course, but also to the discussion forums. Finally, this level follows the standard 'knowledge-access for all', giving the permission to the random visitor to obtain the knowledge of his/her object of interest.

4 Conclusions

Concluding, it is easy to realize the benefits of applying dynamical adaptation functions for the syllabus for all the interested users. First and foremost, there was the undoubted upgrade of the cognitive standard of both the teachers and the students. The continuous reformation of the syllabus brings up to date cognitive material to the students rendering them more competitive and enhancing their knowledge and skills according to the rapidly accelerating technological and market developments. In addition, the role of the instructor-author is upgraded to a great extent rendering him/her an active member of the education society as (s)he is now the molder of the educative program. Finally, the social role and the operation framework of schools changes drastically and there is an overall improvement of the educative results. The didactic methodology in the classroom changes as well as the classroom itself as there is the possibility for certain students to attend classes from a distance (distance learning). These changes and upgrades take place through the prism of globalization and in the following units: new pedagogical teaching techniques, social education and the role of the citizen in Europe and finally, European education.

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An Online Special Terminology Interpreting System for Bilingual Instruction*

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Abstract. An online special terminology interpreting system for bilingual instruction is presented in this paper. The proposed system aims to give a user prompt and accurate explains and translations when he encounters a new term in his bilingual learning. It consists of term display module, term add module, term modify module and term query module. By introducing AJAX technology, it outgoes other terminology interpreting system by better interactivity, higher efficiency and prompt revisability.

Keywords: special terminology interpreting system, bilingual instruction, Ajax.

1 Introduction

Bilingual education becomes a hotspot in China recently. Bilingual education means students should learn with two languages, namely, English and Chinese when necessary [1]. The goal of bilingual education is to provide an access to acquiring and utilizing information in English. Unfortunately, this transition model is based on a deficient view of the students' linguistic backgrounds. English words take several different meanings, and the variation may be tremendous. Yet new words, particularly, special terms of science and technology usually take a very meaning in a context of a certain subject. This forms the first obstacle of Chinese students in bilingual education.

A terminology interpreting system is to provide timely explanation when a learner encounters unfamiliar special words, so that the user can accomplish his leaning fluently[2]. This is indispensable as nonlinear organized web-based learning environments becoming more and more complicated [3].

In this paper, we propose an online special terminology interpreting system for bilingual instruction. This system is part of the web-based platform of bilingual course "Programming in c++" [4], it aims to help students to have an insight into the special

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terms in their studying times. So, the system was designed to be easy and convenient to use [5][6][7]. By introducing AJAX technology, the proposed terminology interpreting system outgoes others by better interactivity, higher efficiency and timely modification.

The rest of this paper is structured as follows. We first present the design principles of the system in section 2. Second, the implementation of the system is given in detail. The architecture of terminology interpreting system is presented. Finally, some concluding remarks and our vision for the next steps are presented.

2 Design Principles of the Propose

2.1 Why Introducing AJAX Technology

Although there are several terminology interpreting systems available, yet they may hinder users from continuing their study by the inherent disadvantages as follows[8].

1) Poor interactivity. Based on the traditional network design model, if a user queries a professional term, you'll have to stare at a blank screen because these systems must refresh the page, which tremendously decrease your learning interest and interrupt your learning process.

2) Low efficiency. Most of current terminology interpreting systems are independent ones, they are not committed to any web-based courses. So, when a user encounters a new term in an article, he has to open a main page of a terminology interpreting system for help. That is time-consuming, furthermore, he may be misled by several such operations.

3) Low revisability of term database. The term database modifying model of most current terminology interpreting systems are manual. So that it is a hard work to update the term database. Beside time-consuming, it is also error- importing. This leads to low revisability.

Ajax is short of Asynchronous JavaScript and XML, Ajax isn't a technology. It's really several technologies, each flourishing in its own right, coming together in powerful new ways.

Ajax Incorporates the Following Technologies

(1) standards-based presentation using XHTML and CSS;
(2) dynamic display and interaction using the Document Object Model;
(3) data interchange and manipulation using XML and XSLT;
(4) asynchronous data retrieval using XMLHttpRequest;
(5) JavaScript binding everything together.

Ajax applications change in real time. They can let you drag boxes around, they can refresh themselves with new information, and they can completely re-arrange the page without clearing it. And there's no special plug-in required. Ajax is just a style of design, one that milks all the features of modern browsers to produce something that feels fewer webs and more desktop.

The core idea behind AJAX is to make the communication with the server asynchronous, so that data is transferred and processed in the background. As a result the user can continue working on the other parts of the page without interruption. In an AJAX-enabled application only the relevant page elements are updated, only when this is necessary.

Some Characteristics of Ajax Applications

(1) Continuous Feel: Traditional web applications force you to submit a form, wait a few seconds, watch the page redraw, and then add some more info. Forgot to enter the area code in a phone number? Start all over again. Sometimes, you feel like you're in the middle of a traffic jam: go 20 meters, stop a minute, go 20 meters, stop a minute ... How many users couldn't endure too many error message and gave up the battle? Ajax offers a smooth ride all the way. There's no page reloads here - you're just doing stuff and the browser is responding [9][10].

Real-Time Updates: As part of the continuous feel, Ajax applications can update the page in real-time. Currently, news services on the web redraw the entire page at intervals, e.g. once every 15 minutes. In contrast, it's feasible for a browser running an Ajax application to poll the server every few seconds, so it's capable of updating any information directly on the parts of the page that need changing. The rest of the page is unaffected.

(2) Graphical Interaction: Flashy backdrops are abundant on the web, but the basic mode of interaction has nevertheless mimicked the 1970s-style form-based data entry systems. Ajax represents a transition into the world of GUI controls visible on present-day desktops. Thus, you will encounter animations such as fading text to tell you something's just been saved, you will be able to drag items around, you will see some static text suddenly turn into an edit field as you hover over it.

(3) Language Neutrality: Ajax strives to be equally usable with all the popular languages rather than be tied to one language. Past GUI attempts such as VB, Tk, and Swing tended to be married to one specific programming language. Ajax has learned from the past and rejects this notion. To help facilitate this, XML is often used as a declarative interface language.

(4) User first: Ajax was born with the idea to make user much more comfortable when he using web application by providing user with close-to-instantaneous performance, rich interfaces and tremendously improved user experience. This is the most important point In the above mentioned.

Based on the characteristics of Ajax applications, we chose Ajax to improve user experience. In web-based learning environment, students' learning is highly dependable on the learning environment, and vulnerable to outside interference. The traditional web application often leads students give up their learning because of its shortcoming for support student's learning, such as poor interactivity, unresponsiveness, simplistic interfaces, low usability. Fortunately, Ajax can overcome this.

Based on the characteristics of Ajax applications, we chose Ajax to improve user experience. In web-based learning environment, students' learning is highly dependable on the learning environment, and vulnerable to outside interference. The traditional web application often leads students give up their learning because of its

shortcoming for support student's learning, such as poor interactivity, unresponsiveness, simplistic interfaces, low usability. Fortunately, Ajax can overcome this.

2.2 Architecture of Terminology Interpreting System

The architecture of Terminology interpreting system (illustrated in Fig. 1) is based on a client-server platform model. The current form of Terminology interpreting system constitutes an open and flexible architecture with simple structure, which allows and supports the basic functionality that the platform is intended to offer. For this reason, the functionality of the system can be easily enriched by added another module. In addition, the Terminology interpreting system is characterized from openness due to the fact that is based on open technologies and international standards. More specifically, the implementation of the system is mainly based on (a) Ajax, including HTML, CSS, JavaScript, Dom, XML, etc., for generating a good interactive and friendly user client interface; (b) Java&JDBC, for implementing the server function of the system and realizing the communication between the server of system and database; (c) Mysql, for management the system's data.

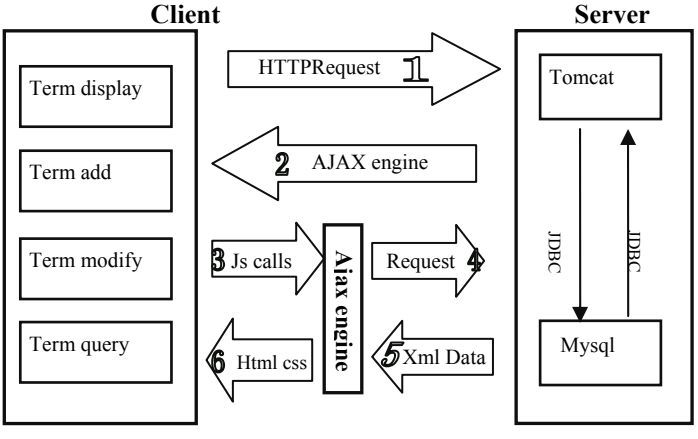

Fig. 1. Architecture of Terminology Interpreting System

Functional Description. In comparison with the previous Terminology interpreting system, this system uses Ajax to increase user experience in web-based learning environment. Exploiting with Ajax, the system takes the following measures to provide student with a student-centered web-based learning environment:

(1) Automatically add explanation to term: Automatically add links to terms in the page. As long as the term is in the database, the terminology interpreting system will add link to it automatically.

When Tom was reading an article about java servlet in the network course, although he learned the term java before, the mean of it is always not clear. Learning may be interrupted if Tom doesn't know the mean of it. Fortunately, in this system, Tom can move mouse to the link to get the explanation of the word. The system will

jump out a suggested frame, which includes the explanation of the term, the link of modifying the explanation of the term, the catalogue of the term and terms related to the term. (Fig 2.)

Fig. 2. Interface of the terminology interpreting system

(2) Search Suggesting Module: A function like Google suggest, the interface is simply prominently features a text box to enter search terms. Everything appears to be the same until you start typing in the textbox. As you type, Search Suggesting Module requests suggestions from the server, showing you a drop-down list of search terms that you may be interested in. Each suggestion is displayed with a number of results available for the given term to help you decide.(Fig. 3) The function may be very helpful for students when they type the “term” in the text box to search the mean of term, for he maybe don’t know the full spell of the term.

Fig. 3. Interface of search suggesting module

(3) Save automatically: Supposed that submission is failed after you changed the explanation of the term in term modify module. Don’t be depressed! The system has saved it automatically for you, you can find it in the drafts.

(4) Preload page: You click the link to the next part of the article after you have read the first part of the article, you’ll have to stare a blank page for five minutes

sometimes even much longer in the traditional web system, and you'll lose your interest at the same time. The terminology interpreting system takes into account this point for you. When you enjoy the first part, the system guesses you'll read the next part and load it for you in background. So, when you click the link, the second part of the article is OK for you!

Client Side. As depicted in Fig. 1, the client side includes four main modules, term display module, term add module, term modify module, term query module. Detailed functional descriptions of the four modules are as follows:

(1) Term display module: There are two ways to display the interpretation of the terms. Firstly, the system automatically add explanation to term (Fig. 3), every term in users' reading articles will be added links to show explanations as long as the term is in database, as mentioned above. In addition, the style of the link is deferent with the others links in the system and decorated with dotted underline to help student to identify the link, which can be seen in Fig. 2. So, the student can better enjoy the article and gain knowledge in the reading. Secondly, learners can visit main page of terminology interpreting system (Fig. 4), there are the list of new terms, the catalogs of terms and top 10 of contributors. Learners can see the explanations of terms, modify term, add term and query term.

Fig. 4. Main page of terminology interpreting system

(2) Term query module: If a learner find a new term in reading and want to know the mean of it, he click a link added automatically by system to see the explanation, this is the result of query module. In another case, a learner is reading a article about XSL, he can type "XSL" in the below of user interface to query the explanation, he also can go to main page of system to get the answer. The system gives "search suggest" to help user to query the term.

(3) Term modify module: If learner find some areas of improvement for explanation of term when he/she see explanation, he can click the modifying link nearby to

modify the explanation. Save automatically function can help learner save the page edited by learner. In order to guarantee the accuracy of explanation of term, student user's modifications need to be audited by teacher users. The explanations of terms in system are all audited.

(4) Term add module: Learner also can add term in system if find a term need to be made clear. Save automatically function also is used to prevent mishaps. Student user's modifications also need to be audited by teacher users.

Server Side. We choose Java and Mysql as functional implementing tools at server side, as they are efficient and open. When the Sever receives a request form a client, it processes the task by searching the database. When the work is done, it transmits the answer to the client or tells it a failing message.

Communication Mechanism between Client and Server. The communication mechanism between client and server is asynchronous. As can be seen in Fig. 1, the processing flow is as follows:

(1) Initial request by the browser – the user requests the particular URL.

(2) The complete page is rendered by the server (along with the JavaScript AJAX engine) and sent to the client (HTML, CSS, and JavaScript AJAX engine).

(3) All subsequent requests to the server are initiated as function calls to the JavaScript engine.

(4) The JavaScript engine then makes an XmlHttpRequest to the server.

(5) The server processes the request and sends a response in XML format to the client (XML document). It contains the data only of the page elements that need to be changed. In most cases this data comprises just a fraction of the total page markup.

(6) The AJAX engine processes the server response, updates the relevant page content or performs another operation with the new data received from the server. (HTML + CSS)

3 Implementation of the System

The core of implement of system is using Ajax to get rich user experience. More specifically, the core is achieve the function mentioned above, automatically add explanation to term, search suggest, save automatically, preload page etc. The general process to achieve the functions is the same. In this paper, take 'search suggest' as an example for illustrating the implement of system.

3.1 Implement of Search Suggest Module

Basic Principle of Search Suggest. The basic principle of search suggest (Fig. 5) are as follows. Firstly, user input a key word in text box; secondly, send a XMLHttpRequest to server; thirdly, server transmit the request and return data to client; at last, client transmit the return data[11].

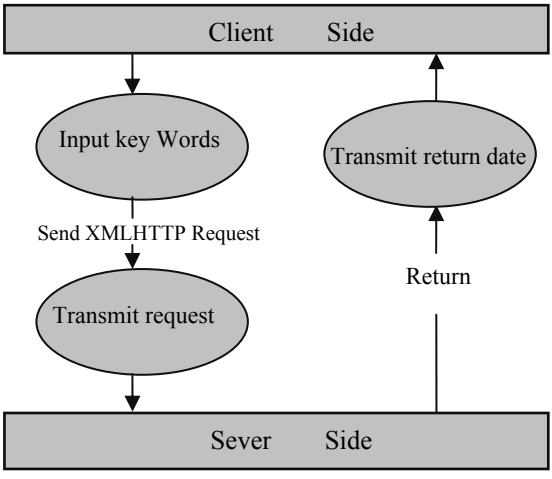

Fig. 5. Basic principle of search suggest

Client. Based on the basic principle of search suggest, the flowchart of transmitting data in client is depicted in Fig. 6.

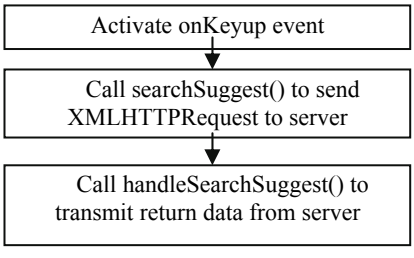

Fig. 6. Flowchart of transmitting data in client

(1)*Create XML/HTTP/Request.* We use searchsuggest() to send a request to server. At first, define an XML/HTTP/Request object called searchReq, use crearteAjaxObj() to create searchReq. In the function createAjaxObj(), statement "httprequest =new ActiveXObject("Msxml2.XMLHTTP");" to create the httprequest if the browser is IE, or use "httprequest=new XMLHttpRequest()" if the browser is the others. In the searchSuggest(), use searchReq.open() to send a request[12].

(2)*Transmit return data.* You'll find it that handleSearchSuggest() is used to transmit return data. If the data is received successfully, use document.getElementById('search_suggest') to get the div which id is search_suggest, and then use innerHTML to create the div which includes the return data. At the same time, use suggestOut() and suggestOver() to change the display to response the state of mouse and use the function setSearch() to put the item choosed to the search text box. The code of handleSearchSuggest is as follows.

```
function handleSearchSuggest() {
if (searchReq.readyState == 4) {
var ss = document.getElementById('search_suggest')
ss.innerHTML = '';
var str = searchReq.responseText.split("\n");
for(i=0; i < str.length - 1; i++) {
          var suggest = '<div
onmouseover="javascript:suggestOver(this);" ';
suggest += 'onmouseout="javascript:suggestOut(this);"
';
suggest += 'on-
click="javascript:setSearch(this.innerHTML);" ';
suggest += 'class="suggest_link">' + str[i] + '</div>';
ss.innerHTML += suggest;
         }  } }
```

Server. You can find how to work in server from Fig. 7. System use Java and Mysql. At first, connect to the database, then execute the SQL statement "select title from suggest where title like '"+search+"%' order by title", put the result into a vector called vData. The full code is in the appendix.

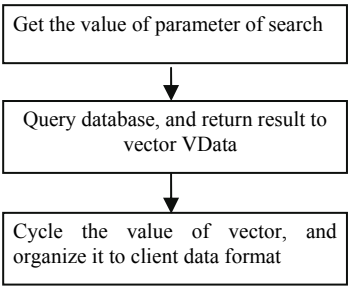

Fig. 7. Flowchart of transmitting data in server

4 The Application Note

Take an example, when Tom was reading an article about java servlet in the network course, although he learned the term java before, the mean of it is always not clear. Learning process may be interrupted if Tom doesn't know the mean of it. Fortunately, in this system, Tom can move mouse to the link, the system will jump out a suggested box (Fig. 2). Tom can get the simple mean of "java" form the box or click the "detail" link to get more, he also can click the link "modify" to modify the mean of term if he think it can be improved. The related terms of "java", such as jsp, ajax, javascript, are also displayed in the box, Tom can click the corresponding link to get the mean of the term which he is interested in.

During his reading, he may want to know the mean of asp, which is occurred to him. He can use the search input box in the right side of the bottom of page to search

it (Fig. 2). When he is inputting, he can get the help of "search suggest" (Fig. 3) and get a drop-down list of search terms that he may be interested in.

He also can go to main page (Fig. 4) of the system to search the term or modify the term. He also can add term in system if find a term need to be made clear.

5 Conclusion and Future Work

We have presented an online special terminology interpreting system for bilingual instruction. It aims to aid teachers to give a prompt and precise illustration of special terms in their instructions, and also for students' web-based leanings. By utilizing AJAX technology the proposed system bear the superority of prompt interaction, higher efficiency and timely revisability.

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Design and Implementation of Principles of Computer Organization Virtual Lab Based on Component*

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Abstract. This paper proposed the design model and implementing method of PCOVL (Principles of Computer Organization Virtual Lab) based on component technique. The system is implemented with Java language, which makes it independent of operating system. In PCOVL system, chip instruments are developed with Java Bean component so that it is scalable and gets good performance in software reuse. A trigger-dispatching mechanism based on data-driven is presented to schedule the components and transmit data. The control of component synchronization and cooperation is implemented by the multithreading scheme and lock technique. In PCOVL, users can design experiments visually, change states of components randomly at running time, observe the experimental phenomena, and finally get experiment results.

Keywords: PCO (Principles of Computer Organization), virtual lab, Java bean, data-driven, multithreading.

1 Introduction

With the rapid development of Internet, modern remote education has become an important research subject. Virtual Laboratory□VL□, based on the Internet, is a key to improve the quality of remote education since experiments are significant for many engineering and application courses[1]. By using VL, the traditional approach to teaching and experimentation has greatly changed at any educational level. The user can access virtual lab and perform experiments at anytime, in any places [2].

Principles of Computer Organization (PCO) course is an important basic course for undergraduates majoring in computer science. It introduces the organization and architecture of computers, emphasizes on both fundamental principles and the critical role of performance in driving computer design. PCO experimentation is very important in the course, which requires a lot of hands-on exercises. As a consequence, it is necessary to develop a PCO Virtual Lab to help users to remotely share laboratory resources and realize virtual experiments.

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Remote education system of computer hardware courses has been improved a lot. Brigham Young University describes a computer organization course on the Web [3]. Students can write and execute assembly language programs on a virtual machine with LogicWorks 3 (Interactive Circuit Design Software), which provides graphical means for user input and simulation output. They can also design and implement the CPU of the virtual machine via a CAD package. The University of Edinburgh develops HASE system [4]. It is a hierarchical computer architecture design and simulation Environment, encompassing both hardware and software. The virtual laboratory of the University of Calgary [5] comprises two locations: a remotely controlled instrumentation laboratory and a digital design experiments collection where the operation of the basic digital circuits is simulated with html applets. Huang proposed a java-based distance learning environment [6], which is a computer-aided instruction (CAI) system for electronic instruments. Students can learn how to use oscilloscopes, function generators, and logic analyzers.

At the same time, the research of using the pure software to develop virtual lab is very important in computer simulation [7-10], in which a lot of popular techniques have been adopted, For example, HTML, CGI, Java Applet, Java Servlet etc. In addition, the VL based on component techniques has good application in many fields. Such as digital image processing virtual lab [11], virtual computer network lab based on NS2 [12], digital signal processing virtual lab [13], and intrusion detection system virtual lab [14].

The paper introduces a powerful and user-friendly PCO Virtual Lab based on component techniques. The system is implemented with Java language and encapsulates often-used integrated circuit chips in the Java Bean component. These components are dispatched by a trigger scheduling mechanism based on data-driven, which supports real-time, dynamic and concurrent guarantees. By choosing the required components, users can design their experiments visually, test some selected pins, observe the experimental phenomena, and finally get experiment results. It will do great favor to the teaching and experiment for users. The PCOVL is available on the web at http://202.197.66.217:8080/vlab/pco.jsp.

2 Design of PCOVL

2.1 System Architecture

Fig. 1 shows the architecture of PCOVL, which is based on B/S mode. The server includes Web Server, PCO experiment components and Java Bean components. It provides compiled java class files and sends the client the Java Bean components and subclasses according to the client's requests. The client realizes the function of the virtual experiment components and generates the experiment results. It is implemented with Java Applet embed in HTML files. Users can submit their self-developed components to the Web Sever besides using the components offered in PCOVL. In this way, the system will be more applicable and scalable.

There are some interactions between client and server sides. Firstly, the client tries to connect with web server through browser. After entering the virtual laboratory, browser will download the Applet pages automatically from the server to the client.

Through the Applet, users can choose the experiment component, configure parameters of components, and start to run experiment. Then the client will submit the configuration parameters to the server and request for the Java class files of corresponding components. The server will send these Java class files to the client when it receives the request. Then the codes will be executed on Java Virtual Machine (JVM) at local. At last, the simulation result will be returned to the client.

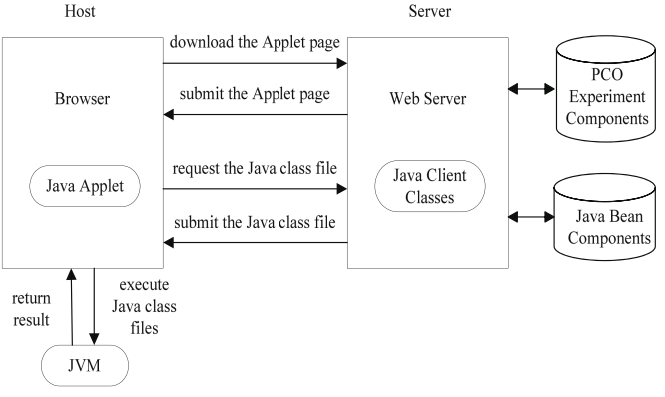

Fig. 1. PCOVL architecture

2.2 Main Modules

In PCOVL, each virtual integrated circuit chip is encapsulated in JavaBean component. Users can select components and connect them by clicking and dragging the mouse to do experiments. We define a base JavaBean component named DeviceCarrier to describe the common attributes and behaviors of components. When we develop a new component, we will just inherit DeviceCarrier class and program functional method of the component, which facilitates system reuse and expansion. According to the functions of components, we can classify them as signal source component, middle-handler component and output component. These components lie in different modules of system.

As shown in Fig. 2, PCOVL system consists of three main modules: data generator module, simulation module and display module. Data generator module produces the digital signal according to the requirement of experiments. Simulation module is responsible for dispatching and controlling the executive sequence of components, which includes components-relevant module, data-handler module and dispatch-control module. The display module shows the dynamic simulation results to users in the form of graphics.

The processing of the whole system is as follows: At first, the user sets the attributes of data source components to produce signal source. Secondly, receiving the source data, dispatch-control module determines which component will execute. By accessing components-relevant module, dispatch-control module finds out the first-class components connecting with data source components, and invokes them to output results. Then, it sends the results to the second-class components which connect

with the first-class components, and drives the second-class components to run. The second-class components adopt the same interactive processing to drive the third-class components. The system repeats in this way until it generates the experiment results. Finally, display module receives and analyzes experimental outcomes and shows them to users.

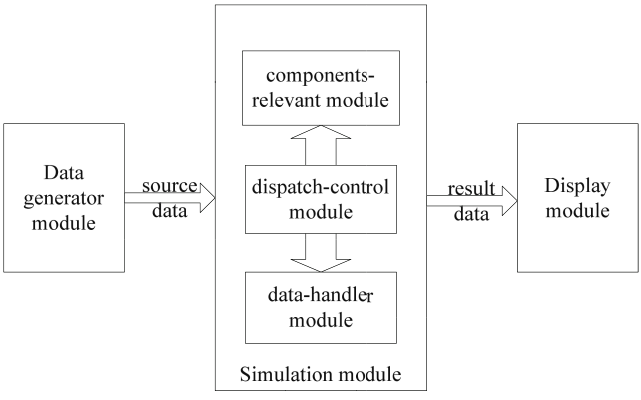

Fig. 2. System modular structure

3 Generation and Display of Data in PCOVL

3.1 Data Generator Module

Data generator module is mainly to produce the source data of simulation experiment. The generation of data has two ways: one is steady data from the switch component, the other is jumping data from the monopulse component and sequential pulse component. In the design and implementation of data generator module, we must consider the following three factors.

Firstly, users can change state of switch component randomly to produce a new source data when the system is running, how to guarantee real-time and correct response to the operation is must be considered. Secondly, the value of monopulse component is instantaneous, which jumps in short time and then retires to original state. How to realize instantaneous value and change other components' state is difficult. Thirdly, the sequential pulse component generates a pulse signal at a specified time interval, how to respond periodically is a key point.

The switch component has two states: close and open, corresponding to output signal 0 and signal 1. In the process of experiment, users can change its state randomly by double-clicking switch component. The system realizes dynamic changes and real-time responses by calling methods mouseClicked() and repaint(). Once users do some action on switch component, its state must be opposite to original one. Therefore, whenever system monitors the mouse event, it finds the component touched off according to the current coordinate position of mouse. Then it gets methods and current attributes of component with Java Reflection technology of JavaBean. After that, it

updates the state attribute and repaints component as new state on the original coordinate position. Finally, it invokes the corresponding method to output new data.

The monopulse component produces instantaneous output, which is also realized by mouseEvent and repaint technology. When the monopulse component is double-clicked, the system captures the event, and then converts the component state into bright from the former dark. Later on, the component produces signal 1 and informs result to its relevant components. After that, it changes state into dark and produces signal 0, then informs relevant components again.

The sequential pulse component is rather complicated, which must need a clock. It transmits a regular signal sequence of alternating 1 and 0 with equal duration. The system implements the sequential pulse component with a Timer of Java. In a cycle of the Timer, by calling method SequencePulseEvent(), the system outputs signal 1 and signal 0 successively and informs all succeeding components of these changes. In the method, before outputting, the sequential pulse component judges its relevant succeeding components whether satisfy the condition to handle new data or not. If the condition is satisfied, the sequential pulse component generates output and informs the succeeding components; otherwise, it waits a period of time and judges again. The system repeats in this way at regular intervals, until the end of the experiment, and then it stops.

3.2 Display Module

Output-display module is mainly used to receive and display experimental results. Therefore, the display components only define “read” and “write” methods of attributes. There is only one kind of display component in the module: virtual signal light.

In PCOVL, all data is binary code, which can be demonstrated by the bright and extinct state of virtual signal light. When the results access virtual signal light, the system changes the state of component according to the value of its input pin. If the value is 1, the component becomes bright, then the state attribute is set to bright by calling method setNewState(); otherwise, the component becomes extinct and the attribute is set to extinct. In PCOVL, the “red lamp” icon is used to show the bright state of virtual signal light and the “white lamp” icon is used to show the extinct state of virtual signal light.

4 Component Execution and Control

In PCOVL, we must consider the following problems: (1) Each component has several inputs and outputs, which makes the relationship of components complicated. (2) The components interact with each other by transmitting data between input pins and output pins. The key point is how to manage the executive sequence of components so that the system can get good simulation performance. (3) Some special components with bidirectional pins, such as memory component, can randomly change the attribute of bidirectional pins into “input” or “output” according to requirements.

In order to solve these problems, PCOVL introduces multithreading scheme into the system and proposes the trigger scheduling mechanism based on data-driven to control the executive sequence of components, which meets the requirement of

concurrency, cooperation and synchronization of threads. The simulation module consists of components-relevant module, data-handler module and dispatch-control module. In the following, we will discuss how to design these modules.

4.1 Components-Relevant Module

Since each component has many input and output pins, their connect relationships are very complicated. The system presents a self-recorded mode to record components relationship. In this way, each component possesses a connect-relationship table to record its succeeding components, which is implemented by ConnectTable class.

The ConnectTable class is designed as a two-dimensional and variable array, and each dimension is realized by ArrayList of Java. The first dimension represents all output pins of component. The second dimension records the information of the succeeding components including two elements: component and pin, which is implemented by ConnectState class. ConnectTable defines three methods (addElement(), removeElement() and nextDevice()) to add, delete and get connect information for the appointed output pin respectively, which make the table be easily expanded and maintained. At the start of experiment, each component creates its connect-relationship table according to the topology of experimental flow. The values of pins stored in table will be updated dynamically in process of experiment. For example, the connect-relationship table of Component 74LS181 is shown in Table 1.

Table 1. The connect-relationship table of 74LS181

Storage position in the first dimension	Output Pin	Relevant information of the second dimension				
0	15	74LS181(1), 13				
1	16	74LS245(0), 0				
2	17	74LS245(0), 1				
3	18	74LS245(0), 2				
4	19	74LS245(0), 3				

4.2 Data-Handler Module

With the complicated interrelationship of components, the executive sequence of components is not linear. How to transmit data between components is must be considered seriously. In PCOVL, the data transmission is realized by direct transmission mode. In this mode, data are stored in pins, and they are directly transmitted from one component to its succeeding components.

The direct transmission mode will lead to the problem of data omitting. The input pin of component is a shared resource. Its value can be modified by the preceding components and read by the component itself. It is very clear that the data may be lost in this mode. For example, if the old data in input pins of component are not handled, and the new data of the input pins is generated by the preceding components, the new data will cover the old one. In this case, the old data are lost. In order to guarantee data correct transmission, the module sets a flag bit (dataflag) for each input pin. Only

if the component has dealt with the old data in input pins, the preceding components can set new value to the input pins.

While one component can be run in the experimental flow, it firstly calls method nextDevice () to get information of its succeeding components. Then according to the "dataflag" values in input pins of the succeeding components, the component decides whether to output the new data or not. If there is one succeeding component in which the "dataflag" is 1, the component can not output any new data to its succeeding components. In this case, the component will randomly waits for a period of time, then checks "dataflag" values of the succeeding components again. Only if the "dataflag" values of all succeeding component are 0, which means that all the old data in input pins of the succeeding components have been dealt with, the component can complete its function and output new data. Then the component set the new data to the input pins of the succeeding components. The way of setting flag bit avoids data missing and ensures that all the old data can be handled timely.

4.3 Dispatch-Control Module

Dispatch-control module uses a trigger scheduling mechanism based on data-driven to control the executive sequence of components. It improves efficiency and real-time responses of the system. The trigger scheduling mechanism based on data-driven can be described as follows:

Each component is as a thread, and all components communicate with each other by wait-notify mechanism and lock technology. Only if a component receives new data from its preceding components and notified by them, it will be driven to execute its function. Otherwise, it is always in waiting state, and will have no chance to run.

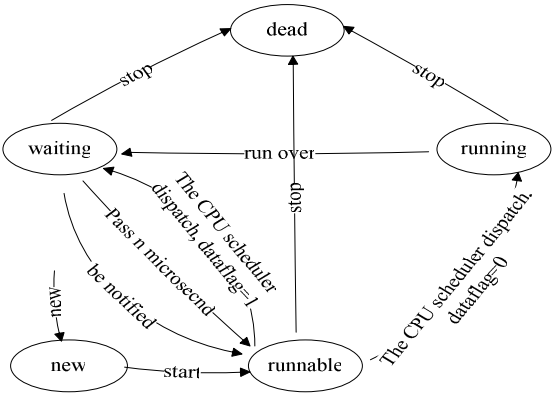

Fig. 3. The state transition diagram

The concrete process is as follows: At first, the initial values of all components' pins are null, and the value of "dataflag" is set to 0. When a user starts experiment, dispatch-control module analyzes the experimental flow, then constructs each component as a thread and puts it into a thread group. Except data source components, most components call method wait() to be in waiting state. When data source component

has been allocated by the CPU scheduler, it will call method nextDevice() to obtain the information of relevant succeeding components. If the values of "dataflag" in the succeeding components' input pins are 0, the data source component will get and invoke its functional methods with Java Reflection technology. Then it generates new outputs and sends them to the input pins of the succeeding components. Finally, the data source component notifies its succeeding components and waits for being triggered by user again.

If there is any succeeding component in which the "dataflag" is 1, the data source component randomly waits for a period of time and then check the "dataflag" values again. If all succeeding components are notified, the data source component can adjust itself to a state waiting for running. When it is allocated by the CPU scheduler, it will do the similar operation as the data source component. The difference is that it will be in waiting state again after it notifies its succeeding components. When users click "stop" button in the experiment, the thread group will be stopped, and the experiment will be finished. The state transition diagram is shown in Fig. 3.

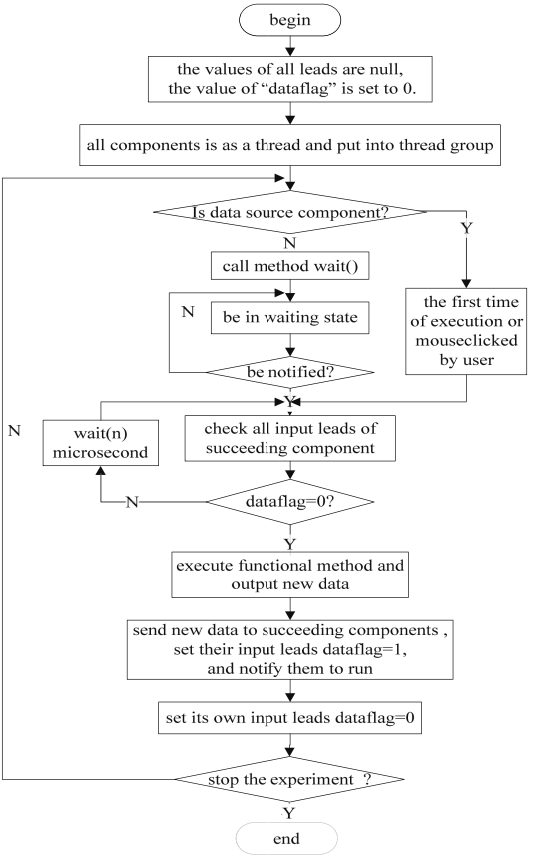

Fig. 4. The flow sheet of components dispatch

In order to guarantee successful execution of component, all components must do an atomic operation which can not be interrupted. The atomic operation includes the following operations:

(1) Execute functional method and send new outputs to the succeeding components.
(2) Set values of "dataflag" in input pins of the succeeding components and notify them.
(3) Change the values of its own "dataflag" of input pins.

PCOVL adopts class-lock mechanism to guarantee the execution of atomic operation. The class-lock mechanism represented by synchronized (Class) means that: all threads share only one lock, the component which owns the lock will execute preferentially, and the rest threads should stay in the waiting queue. Only when the atomic operation is over and the lock is released, waiting threads can contend for the lock to execute their function. The process of components scheduling is shown in Fig. 4.

For the special component with bidirectional pins, its pins can be changeable while running. The system defines an attribute variable named "Direction" to represent its running direction. When a component is running, we can get and set "Direction" dynamically by calling methods getDirection() and setDirection() with Java reflection technology. Then, the component does the corresponding operation according to the current value of the attribute Direction.

5 An Example in PCOVL

PCOVL provides many chip components, such as 74LS08 (AND), 74LS32 (OR), 74LS06 (Inverters), 74LS86 (XOR), 74LS273 (8-bit register with clear), 74LS181 (arithmetic logical unit/function generator), 74LS138 (3-to-8-line decoders), 74LS245 (tri-state octal bus transceiver), 74LS161 (synchronous 4-bit binary counters), Intel 6116(static random access memory), 28C16(8-bit 2K parallel EEPROM) and etc.

Fig. 5 illustrates the user interface of the PCOVL system. The left panel is component column, which provides a lot of experiment instrument components for users to choose. The right panel is experiment operation window. Here we will take the ALU (Arithmetic Logic Unit) experiment for example to explain the whole experiment procedure as follows.

Step 1: User firstly chooses components and connects them according to the requirement of the experiment. Two pieces of 74LS273 are used as registers to save input-data A and B, which are controlled by monopulse components. Two of 74LS181 (4-bit ALU) connect with each other to perform 8 binary arithmetic logic operations. The ALU has nine functions: add, subtract, logical AND, logical OR, logical NOT, two's complement, shift right, shift left, and transfer. The results are sent to 74LS245 component and shown on virtual signal lights.

Step 2: User sets the value of each component one by one. As shown in Figure 5, input data A in binary is 01000101, input data B is 00000011, and the functional lines of ALU (CN,M,S3,S2,S1,S0) are set at H,L,H,L,L,H respectively. It means that ALU will do add operation (A+B).

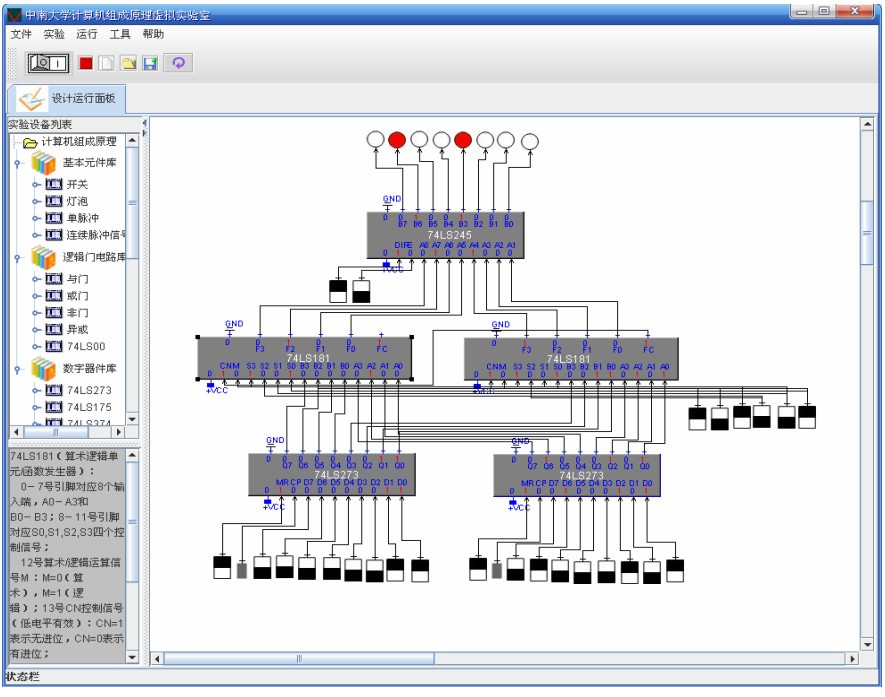

Fig. 5. The ALU experiment

Step 3: The user presses “Electricity” button to run the experiment. Then the user double-clicks monopulse component to generate pulse signal. As shown in Figure 5, the results (01001000) are displayed on virtual signal lights.

During this experiment, users can examine the various functions of these chip components, and verify the ALU's correct operation as specified in its operation table.

6 Conclusion

The paper discusses the architecture and implementing scheme of PCOVL in details. The PCOVL system adopts virtual lab platform based on Internet so that it can satisfy the requirement of remote education. There is a good interaction between users and system because of the visualized user interface. The virtual experimental instruments are implemented with Java Bean, which improves the developing efficiency and achieves the software reuse. The system proposes a trigger scheduling mechanism based on data-driven to dispatch components, which improves efficiency and concurrency of system. In PCOVL, users can not only do experiments mentioned in PCO course, but also design and develop new instruments by themselves to do new experiment. PCOVL provides a well reference model for developing virtual lab of computer hardware courses, which requires random, real-time, dynamic and concurrent processing.

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Design of a Real-Time On-Line Web-Based Collaborative Learning Environment for Embedded Applications

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Abstract. Developments in computer networking and the Internet in the last decade have provided new possibilities and new challenges for designing web-based learning environment for embedded applications. The design elements should facilitate instruction delivery, interaction, quality of learning and support for learner. This paper presents a technology, which supports remote experimentation on an embedded system. The ability to combine practical applications with visualization of real hardware using powerful and efficient virtual instrumentation and multimedia tool is the advantage of technology-based education. The paper describes the hardware and software structure of such a system and the interface between various data processing units. The design is based on interfacing a graphical programming tool such as LabVIEW with an embedded development board. It describes the ongoing research in this area exploiting current telematics techniques, which supports remote experimentation with real hardware via the Internet.

Keywords: Web-server, Virtual Instrumentation, Data acquisition, LabVIEW, Remote Learning, Embedded System.

1 Introduction

Advancement in Internet Technologies has provided the new opportunity to computer aided instruction designers to develop easily accessible interactive and intelligent courseware for web based learning. Internet plays a major role in on-line learning, since it provides wide range of learning opportunities and experiences to the user at their own place. The developments in networked environment and the proliferation of high bandwidth communication technologies have the potential to transform the nature of distance collaboration in professional systems. There have been numerous developments in systems that support collaboration that have resulted in system architectures to support information sharing and remote communication. However, the main concern is not only to improve the human-computer interaction, but also to improve the human-human interaction, with the computer being the means of communication.

One of the important components of the remote learning environment is the *virtual laboratory tools* integrated to perform real hardware tasks in real time. At the core of

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the remote laboratory lies the concept of collaborative distance learning, where tools and equipment used in the learning process may be distributed over several geographical locations [2].

Important ingredients in technical training are practical laboratory activities, recognized as an efficient approach to understand the theoretical concepts as well as to draw vital experimental data from remote locations for analysis and design. For building web-based environments that support such real experimentation, there are two requirements. First, the web environment must provide interactive content for performing hands-on operations allowing multiple trial-and-error cycles. Second, the web environment must support collaborative activities. Collaboration is an essential ingredient in the recipe to create an effective learning environment in technical education, as it provides the opportunity to discuss and exchange information or knowledge. Literature seems to support the fact that the social interactions amongst learners play an important part in the learning process [6][8].

The main hardware used in the implementation of a remote learning system for embedded application consists of National Instrument's Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) and data acquisition card NI PCI 6251 installed on a web server. The web server is used primarily for data acquisition and control operations. This data acquisition hardware along with an embedded board is connected to web server and accessed by the remote clients connected via the Internet. The control application is developed using the graphical programming tool LabVIEW [9]. The web- server is configured to meet technical specifications, i.e., distribution, authorization and security when the connection is established between the server and the client [3].

2 System Architecture

2.1 Hardware Structure

Theoretically, an embedded system is a combination of piece of microprocessor-based hardware and the suitable software to undertake a specific task. In this context the experiment is developed based on a microcontroller, which is programmed to control the parameters of the stepper motor. Many microcontrollers, including the PIC16F877, can be connected to a computer through a parallel port. This allows a developer to use a program such as WinPicProg to communicate with the microcontroller.

A web server with a data acquisition and NI ELVIS workstation constitutes the main functional units of the system. The NI ELVIS uses LabVIEW-based software, where various virtual instruments (VI) and control commands are simulated. The NI ELVIS combines hardware and software into one complete laboratory suite [10]. Fig. 1 gives a block diagram of the main hardware structure and components in the system.

The analog and digital outputs of NI ELVIS workstation are configured to generate the control signal to the embedded board. The parameters to be configured are available on the user interface, which are accessed and controlled by the remote clients. The web server uses the LabVIEW as the main tool for configuration and to interface with the external applications. HTML pages are created for the easy access to clients, which are supported by popular web browsers.

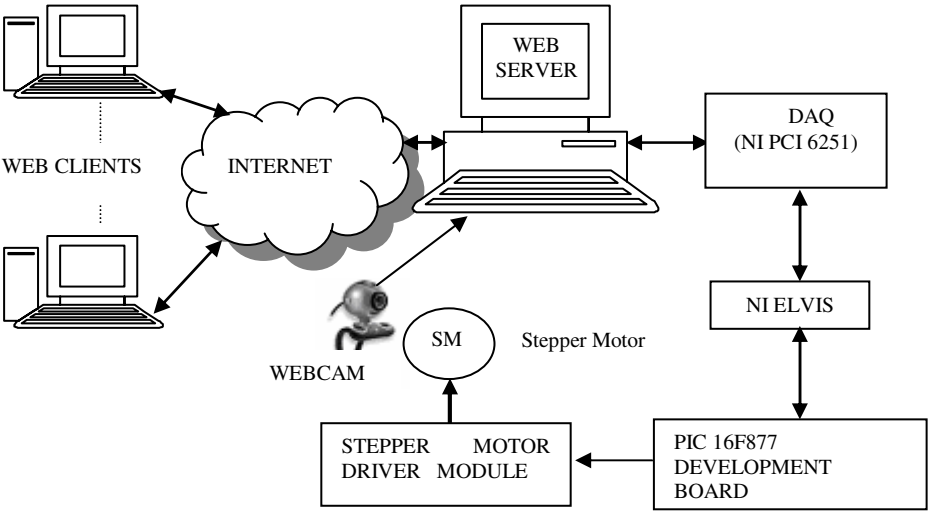


Fig. 1. Hardware structure

LabVIEW has been chosen to implement local instrument control, as it is a powerful instrumentation and analysis, programming environment for PCs running Microsoft Windows XP and various other operating systems. A graphical programming language called G enables programming in a block diagram manner and subsequent compilation into machine code.

A web camera with audio inputs interfaced with the web server transmits audio and video signals to the client in real time enabling the remote user to experience the remote environment.

2.2 Web-Server Interface with Microcontroller

Fig. 2 summarizes the microcontroller interface with the web server and the data flow between the different stages of the system. The assembly code developed to control the stepper motor are simulated and converted to HEX file by MPLAB, which is a Windows-based Integrated Development Environment (IDE) for the Microchip Technology PIC microcontroller families. The hex code developed is transferred into the microcontroller using programming software WinPicProg. The microcontroller is connected to the web server through the data acquisition card and NI ELVIS workstation.

The microcontroller development board is installed on a parallel port of the server. The microcontroller drives the stepper motor when controlling commands are received from the remote clients. Depending on the microcontroller output, the stepper motor driver module built with the required driving circuitry, outputs the driving voltage to the corresponding coil of the stepper motor. Table 1 describes the Microcontroller interface with NI ELVIS.

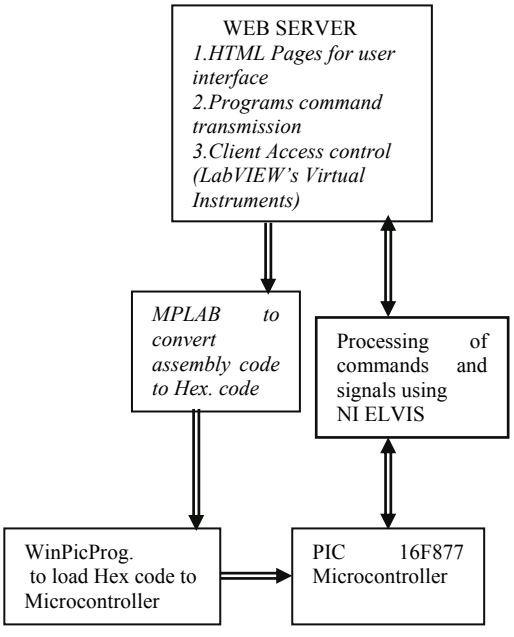


Fig. 2. Microcontroller interface to web server

2.3 Web Server Settings and Collaborative Learning

The LabVIEW built in web server has the feature that whenever LabVIEW applications are loaded into a system, it acts as a web server. The LabVIEW programs are called Virtual Instruments (VI), which are developed and converted to HTML page and stored in the root directory. The VI developed for the experimentation is mentioned in the VI access list and IP addresses of users are mentioned in browser access list of server configuration. The user may access any of the HTML pages saved at root directory of the web server. The benefits of LabVIEW web server are: shortest development time, best user handling and client run on Windows, Linux, Mac and with nearly every browser [4]. At the client side, LabVIEW runtime engine has to be installed.

Table 1. Microcontroller Interface with ELVIS

SI. No.	Name	Function
1.	Port A	Output: Drives stepper motor
2.	Port C	Output: Displays digital data for the corresponding analog input at Port E
3.	Port D	Input: Receives signal from digital output port (8 lines) of NI ELVIS
4	Port E	Input: Receives signal from analog output (1 line) port of NI ELVIS

The collaborative and supported learning environment is embedded in a web browser and navigated using a tab system developed in HTML. Functionally it has three distinct but interconnected sections comprised of learning support resources, i.e., remote experimentation facilities, collaborative working and communication tools [5]. Collaborative learning environment provides opportunities to interact, practice, and learn and to understand the need of working. The Information and Communication Technology (ICT) tools support collaborative activity in e-learning and this application is implemented using Skype communication tool [1]. It is used for both audio and video communication between remote client and server.

The remote experimentation facilities developed using various IT tools are limited to measurement, analysis and simulation of typical electric and electronic circuits [2]. The graphical programming tool LabVIEW along with data acquisition system facilitates the control and operation of the embedded system application remotely.

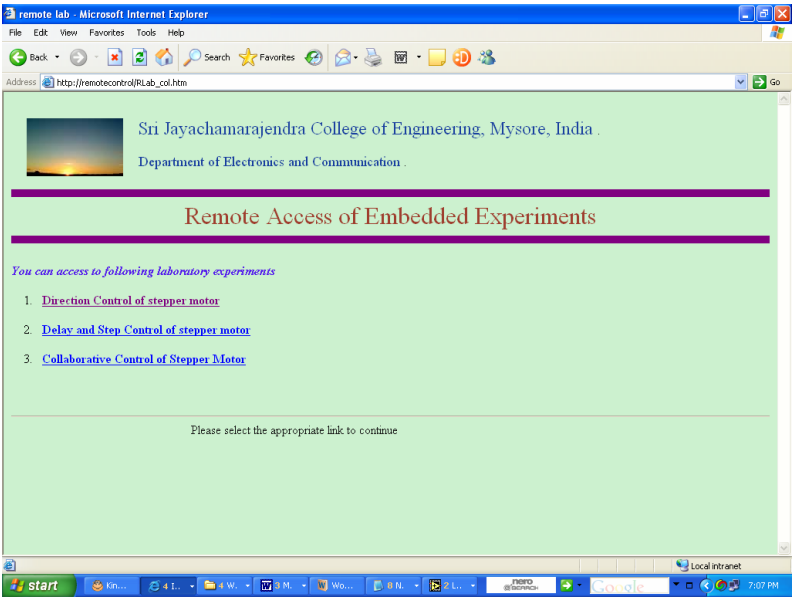
3 User Interface and Collaborative Control

3.1 User Interface for Remote Learning

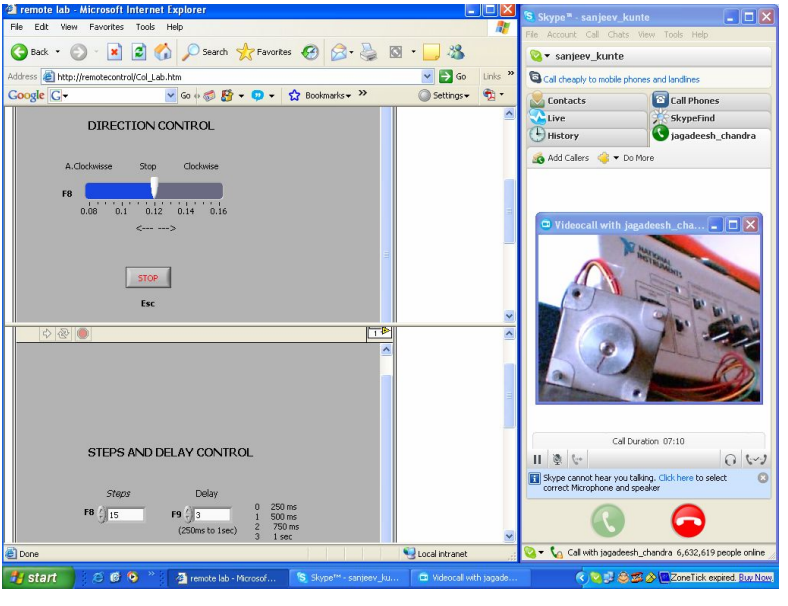
The web-based remote control of a system has a realistic and user-friendly interface through which users can control it in real-time. LabVIEW with its intuitive graphical interface provides the development platform for the control programs and the Virtual Instruments [9]. The graphic interface at the client side is developed by creating a HTML page, which contains procedures and instructions to the remote users including links to the experiments and is stored in the web-server [7]. The principle behind the implementation is to deliver an image of the control panel (front panel) of the Virtual Instrument to the client. Remote users can access the embedded experiments through the home page shown in Fig. 3(a). Once the remote user access the corresponding experiment, the web page shown in Fig. 3(b) is displayed on the desktop. Many registered users can access the corresponding web page and observe the resulting control action, but only few clients are permitted to conduct the experiment at a time. Users are allowed to do the experiments for the time set by server or control can be transferred from one client to another based on the request received by server.

The main functions and features of the user interface are summarized below:

- The system is developed to access and control the different features of the same experiment at remote locations simultaneously.
- The real-time video and audio of the stepper motor is captured, so that client can observe the remote application realistically.
- The options that appear on the front panel enable the user to control the features of the stepper motor in a remote environment using mouse or keyboard. For example, the stepper motor is made to run in a clockwise direction by dragging the control button to right end on the slide shown in Fig 3 (b). Similarly for anti-clockwise rotation, the control button is dragged to left end. Placing the control button at the center of the slide can stop the motor. In case of keyboard control, the keys are assigned different control operations wherein operating the keys results in the corresponding control action.



(a) Home Page



(b) Control Panel and Real-Time Video window

Fig. 3. Web pages at remote client

3.2 Collaborative Control

The implemented system facilitates the collaborative control wherein two users can access the control of different parameters of the same experiment. The third experiment displayed on the home page of Fig 3 (a) supports this feature. The users can access the corresponding control panel shown in Fig 3 (b), which has two control parts in it. The first part (upper control panel) is used to control the direction of rotation of the stepper motor and the second part (lower control panel) sets the speed and the step count. Both the panels can be accessed by two different users separated geographically and can send request to gain control over any one part. The web server releases the control of upper control panel to one user and lower control panel to another user. Single user can also control both the panels if the server grants permission.

4 System Operations and Control

A microcontroller is an amazingly useful device. Akin to a very specialized CPU, a microcontroller consumes very little power and can be programmed to perform a wide variety of tasks quickly and reliably.

The microcontroller is programmed to control the stepper motor with the following parameters:

1. Direction of rotation
2. Step count
3. Speed of rotation or delay between the steps.
4. Run / Stop operation.

The remote access and control of the microcontroller is possible when it is interfaced with Virtual Instruments developed using a graphical programming language like LabVIEW. It integrates data acquisition, analysis and presentation in one system.

The analog output channel of NI ELVIS is interfaced with the I/O port of the microcontroller, in which control signals are generated by converting the analog signal into the digital form through the ADC present in the microcontroller. Virtual instruments of LabVIEW simulate the analog signal based on the stimulus received from the control panel. The ADC conversion and control action generated by the microcontroller is shown in Table 2.

Table 2. ADC output and control action

Analog Input	Digital Output	Control Action
0.08V	0000011	Anticlockwise rotation
0.12V	0000101	Stop
0.16V	0001000	Clockwise rotation

The control features, i.e., step count and the delay between each step are implemented using the digital interface of the NI ELVIS through data acquisition system. The digital outputs are interfaced with the I/O port of the microcontroller, which are user-configurable. Based on the inputs received from the control panel, the digital

writer of the graphical tool generates the digital data which are available at the ELVIS ports. The microcontroller reads these ports and takes suitable action based on the application program present in it. The control features and the corresponding keyboard operation performed on the front panel of the remote users are described in Table 3.

Table 3. Control features and the key operation

Key	Control Feature	Digital Output Bit positions 7 6 5 4 3 2 1 0	Steps	Delay (in msec)
F8	Step Count	* * 0 0 0 0 0 0 to * * 1 1 1 1 1 1	0 to 63	--
F9	Delay	0 0 * * * * * * 0 1 * * * * * * 1 0 * * * * * * 1 1 * * * * * *	--	250 500 750 1000

* Indicates don't care term.

5 Conclusion

Collaborative distance learning has grown tremendously in the past several years. Advancements in web technology facilitate to undertake remote design and testing in a truly real-time on-line environment. In today's changing environment, the web-based courses offer flexibility in learning, but learners should be equipped with computer skills rather than traditional computer environment.

The development of web-based learning environment for embedded applications uses the integration of Information Technology tools with any required electronic hardware. The National Instruments hardware along with LabVIEW used at the server-end constructs the complete experimental set-up. The ICT tools are used to provide audio-visual media (ex., text, image, sound and video clips) as well as the ability to support interaction between the learner and other. This methodology creates an environment for remote access of applications that performs advanced embedded system experiments remotely. This paper has technologically exploited the opportunities that have arisen due to innovations in embedded system technology as well as Internet communications and applied it to web-based learning. The synergy between them is likely to offer up more than the sum of its parts.

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A Novel Pen-Based Flowchart Recognition System for Programming Teaching*

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Abstract. The electronic white board and the tablet PC are bringing new technologies to modern education. This paper presents a pen-based flowchart recognition system for programming teaching, which uses hybrid SVM-HMM algorithm for sketch recognition. In this algorithm, ICA is used to reduce the dimension of features, a set of fuzzy SVMs are used as preliminary feature classifiers to produce fix length feature vector, which acts as a probability evaluator in the hidden states of Hidden Markov Models, and HMMs are employed as finally classifiers to recognize the unknown pattern. Experiment results show the hybrid algorithm has good learning and recognition ability. And based on this algorithm, an intelligent whiteboard system for programming teaching is designed to identify the sketches into the programming flowchart, and finally converts it into C language programs. User's evaluation shows it is natural for the teachers and the students with a flexible and effective interactive teaching pattern. Therefore, such system brings a new programming teaching patterns and help students to stride the obstacle between the flowchart and the programming language. Students can learn the abstract programming idea and the concrete coding skills effectively and efficiently by the visual comparative learning assisted by the intelligent whiteboard system.

Keywords: teaching system, sketch recognition, SVM, HMM, ICA.

1 Introduction

The electronic white board and the Tablet PC are bringing new technologies to modern education. Sketching on such equipments provides an intuitive user interface. It issues the challenges to allow the teachers sketching information on electronic white board with more intelligent manners which supports the recognition of sketches, while the traditional manner supported by the commercial electronic white boards only have drawing functions.

Recent researches are engaged in the development of Table PC based systems that interpret various visual languages [1], including mathematical expressions [2], chemical diagrams [3], digital circuits, mechanical systems [4], and UML class diagram [5].

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Such systems focus on the creation, manipulation and recognition of diagrammatic languages, which help instructors convert the physical diagrams into the subject concepts and furthermore facilitate the concept modeling for students. In these systems, the recognition of primal symbols, such as rectangle, circle, arc, etc., is the essential processing. However current recognition algorithms are almost based on geometric rule inference, which are sensitive to the noise of the sketches. The methods of sketch understanding can be classified into two categories. The first category recognizes the sketch without timing information. Such algorithms regard the sketch as image or graphics, and classify the sketches using rule-based or classify-based algorithms (such as SVM, etc.) [6][7]. The other category of recognition algorithms thinks it is important to take advantage of timing, and usually use Hidden Markov Models (HMM) and Dynamic Bayesian Networks to learn temporal patterns [8][9].

This paper proposes a hybrid SVM-HMM sketch recognition algorithm combining the two classifiers into an ideal one, which supports a single stroke recognizer for the flow chart tutoring system. HMM is good at dealing with sequential data, while SVM shows superior performance in classification. But HMM has some shortcoming such as the poor ability of classification, poor ability of pattern recognition, the high dependence on the statistical knowledge of the pre-experimentation, etc. SVM is a powerful supervised learning theory, coming from the theory of statistic learning [10]. By minimizing the sum of the empirical risk and the complexity of hypothesis space, SVM gives good ability of generalization for pattern recognition problems [11]. Furthermore, the former approach usually provides an intra-class measurement while the latter proposes inter-class difference. The goal of the recognition algorithm in this paper is to make use of the advantages of SVM and HMM to overcome some of their shortages.

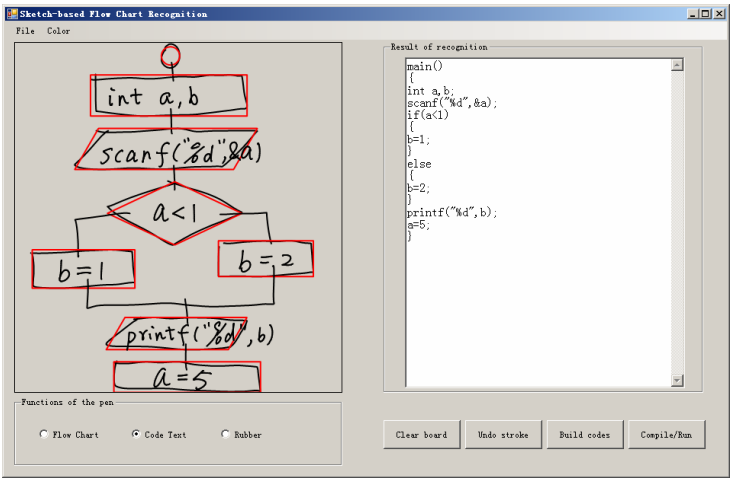

Fig. 1. This shows the pen-based programming teaching system. Left panel is the sketching area on which teacher draws the symbols of a flowchart and some program instructions. The red symbols are the refined results of recognition. Right panel is the C programming code transformed from the left flowchart. Teacher may use the right-bottom buttons to run the codes.

This paper also introduces a programming flowchart teaching system based on pen interface (Fig.1), which can recognize teachers' free-hand sketches as flow chart diagrams and transform them into C programs. Firstly, the system is built on pen-based interface, which can support the teachers to present the flowcharts and C programs simultaneously on the electronic whiteboard by sketching on the Pen-based HCI. Secondly, the system can recognize the free-hand sketches using the graphics recognition algorithms in this paper, and translate the sketching flowcharts into corresponding C programs. By transforming the graphics into the symbols of the domain-specific knowledge automatically and comparing the correspondence between them, it is helpful to build connection between the abstract concept and the concrete graphics during the learning activities. By user evaluation in the course of programming, it seems that the practical system is very useful for students to learn the structural programming ideation.

The remainder of the paper is organized as follows. Section 2 describes the feature extraction and reduction of the flowchart pen-based sketch. Section 3 and Section 4 details the hybrid SVM-HMM recognition algorithm, which is the kernel of the pen-based teaching system. Section 5 provides experimental results and discussions. Section 6 presents conclusions.

2 Feature Extraction

2.1 Stroke Features

Feature extraction is a process of transforming free-hand sketching to a feature vector which represents the geometric and the action characteristics of drawings. The algorithm includes three steps: sampling, pre-processing, and feature computing. After employing sampling firstly, each stroke is represented by a finite set of ordered pairs of $<p_i, t_i>$, where p_i is the position (x_i,y_i) at the time of t_i. The feature vector of a stroke consists of the feature vectors of all sample points, each of which is represented by the local features:{direction (d_i), curvature(c_i),length ratio from start point(l_i), speed(s_i), distance from center of gravity(dc_i), angle from center of gravity(a_i)}.

$$d_i = \arctan(\frac{y_{i+\delta} - y_{i-\delta}}{x_{i+\delta} - x_{i-\delta}}) - \arctan(\frac{y_{i+\delta} - y_i}{x_{i+\delta} - x_i}) \tag{1}$$

$$c_i = \left| \sum_{j=i-\delta}^{j=i+\delta-1} \varphi(d_{j+1} - d_j) \right| / length(p_{i-\delta}, p_{i+\delta}) \tag{2}$$

$$l_i = length(p_i, p_{start}) / length(p_{end}, p_{start}) \tag{3}$$

$$s_i = length(p_{i+\delta}, p_{i-\delta}) / (t_{i+\delta}, t_{i-\delta}) \tag{4}$$

$$dc_i = \sqrt{(y_i - center_y)^2 + (x_i - center_x)^2} / \max(width, height) \tag{5}$$

$$a_i = \arctan((y_i - center_y)/(x_i - center_x)) \tag{6}$$

where ($center_x$, $center_y$) is the position of center of gravity of the stroke, (*width*, *height*) is the minimum box of the stroke, *length*() is the length along the stroke.

2.2 Feature Reduction

The feature of a stroke is an $m \times n$ matrix $\boldsymbol{x}$, which m is the number of features of one sample point, and n is the number of sample points. In the high-order statistic, Independent Component Analysis (ICA) not only can distinguish the signal of mixing but also can draw the lower characteristic in the signal effectively. Here we replace the primitive features with the ICA features and $\boldsymbol{x}$ can be regarded as the result of a linear mixture model in ICA:

$$x = As \tag{7}$$

where components of $\boldsymbol{s}$ are independent sources and unknown, $\boldsymbol{A}$ is unknown, and $\boldsymbol{x}$ is the observation. ICA tries to estimate the matrix $\boldsymbol{W}$ in the reconstruction model:

$$y = Wx \tag{8}$$

Regarding matrix $\boldsymbol{x}$ as the observation value of random vector, it can be taken by the maximum m eigenvalues of $\boldsymbol{x}$ as a matrix P_m. Then $\boldsymbol{x}$ can be replaced with P_m^T, and apply the ICA algorithm as followings:

$$WP_m^T = y \Rightarrow P_m^T = W^{-1}y \tag{9}$$

where each row of $\boldsymbol{y}$ represents an independent base vector. Finally a stroke can be represented by a row feature vector $\boldsymbol{F}$, which is consisted of the coefficients projected onto the linear combination of independent base vector in $\boldsymbol{y}$.

3 SVM with Probability Output

3.1 Binary SVM with Probability Output

In traditional SVM with the training set $\{c_i, d_i\}_{i=1}^{l}$, the classification results are $d_i = \{1, -1\}$, where l is the size of training set. So it can only be applied to binary classification problems. For the convenience of composing the hybrid model with HMM, a fuzzy SVM is introduced to change the output form into the probability value. In general, a SVM has following form:

$$f(x) = sign(\sum_{i=1}^{l} y_i \lambda_i^* K(x, x_i) + b^*) \tag{10}$$

where the parameters are obtained by maximize the objective function:

$$Q(\Lambda) = \sum_{i=1}^{l} \lambda_i - \frac{1}{2} \sum_{i=1}^{l} \sum_{j=1}^{l} \lambda_i \lambda_j y_i y_j K(x_i, x_j) \tag{11}$$

The restriction condition is:

$$\sum_{i=1}^{l} \lambda_i y_i = 0 \qquad 0 \le \lambda_i \le C \tag{12}$$

By resolving the quadratic programming problem, SVM try to maximize the margin of separation, at the same time minimize the training error. According to Vapnik's statistic learning theory, the risk boundary satisfies $\forall \alpha \in \Lambda$,

$$R(\alpha) \le R_{emp}(\alpha) + \sqrt{\frac{h(\log(2l/h) + l) - \log(\eta/4)}{l}} \tag{13}$$

holding probability $1-\eta$, where $0 \le \eta \le 1$, Λ is the parameter space, h is the dimension of $f(\cdot, \alpha)$. For SVM and giving input vector, larger separation between the positive samples and negative samples, less the upper boundary of VC dimension h, which means to reduce the complex in hypothesis space.

To carry out the fuzzy SVM, a Sigmoid function maps the SVM of each independent topological relation to posterior probability [7]:

$$P(S_i \mid X) = \frac{1}{1 + \exp(A_i X_{out} + B_i)} \tag{14}$$

where A_i and B_i is the Sigmoid parameters of each SVM, X_{out} is the distance between any query X and SVM.

3.2 Multi-class SVM

The probability of (14) is still a binary problem. To deal with multi-class problem, we use one to one combinations of binary SVM. We construct binary SVMs for one class C_i to each other class $\{C_j | 1 \le j \le M, i \ne j\}$. The output of each SVM is calculated by equation (14), which can be combined into a feature vector for class C_i:

$$V(x) = [P_{i1}(C_i \mid x), P_{i2}(C_i \mid x), ..., P_{ij}(C_i \mid x), ..., P_{iM-1}(C_i \mid x)]^T \tag{15}$$

where, $P_{ij}(C_i|x)$ is the output of SVM distinguishing class C_i and other class C_j, $i \ne j$, M is the number of classes in the problem. Then this feature vector is transformed to a probability output of class C_i by a Gaussian Model:

$$\begin{aligned} &P(C_i \mid x) = N(V(x), \mu, \Sigma) \\ &= ((2\pi)^{-d/2} \mid \Sigma \mid^{-1/2}) \exp[-\frac{1}{2}(V(x) - \mu)^T \Sigma^{-1} (V(x) - \mu)] \end{aligned} \tag{16}$$

Finally, we can obtain a feature vector containing every probability output of classes:

$$O = \{P(C_1 | x), P(C_2 | x), ..., P(C_M | x)\} \tag{17}$$

4 SVM-HMM Hybrid Approach

4.1 The Hybrid Model

This paper proposes a hybrid model combining SVM and HMM. The model is composed of three steps. First, the raw sketch data is sampled and the features of stroke are calculated. To solve the problem of variable length of one stroke and to eliminate the redundancy of feature information, ICA is used to transform the feature matrix into fix length feature vector. Second, a set of SVMs are used as preliminary feature classifiers. The outputs of SVMs are converted into the form of posterior probability, which acts as a probability evaluator in the hidden states of hidden Markov models. Third, a HMM are employed as finally classifiers to recognize the unknown pattern. Consider *M* classes $l = \{l_1, l_2, ..., l_M\}$ with their respective *M* groups of SVMs and a group of HMM $\lambda = \{\lambda^1, \lambda^2, ..., \lambda^M\}$, where each group of SVM is corresponding to the feature vector of class *i* with *M*-1 binary SVMs, and each HMM is a left-to-right HMM with the same length *M*.

An HMM $\lambda(A, B, \pi)$ is a stochastic process for producing a sequence of observed values. It is specified by three parameters A, B, π . $\boldsymbol{A}$ is the transition probability matrix $a_{ij} = P(\omega_{t+1} = j \mid \omega_t = i)$, $\boldsymbol{B}$ is the observation probability distribution $b_{jk} = P(v_t = k \mid \omega_t = j)$, and π is the initial state distribution. $\omega^T = \{\omega_1, \omega_2, ..., \omega_N\}$ is the set of HMM states and $v^T = \{v_1, v_2, ..., v_M\}$ is the set of observations. In hybrid model, the probability outputs of SVM act as the posterior probability of observation of HMM. After training, the model parameters of HMM $\lambda(A, B, \pi)$ are obtained, where B is the Gaussian parameters of the probability outputs.

4.2 Training Processing

The process of training is: 1) estimate the parameters of SVMs, 2) produce the new feature vectors formed by probability outputs of the trained SVMs, and 3) estimate the parameters of HMM. Given a set of samples, the training algorithm of multi-class SVM is composed of a number of binary SVMs, the parameters of which can be obtained by solving a convex quadratic programming problem subject to linear constraints. One classifier C^{ij} for every pair of distinct classes <*i*,*j*>. Each classifier is trained with the samples in the i^{th} class with positive labels, and the samples in the j^{th} class with negative labels. Given a set of observation sequences produced by SVMs $v = \{v^1, v^2, ..., v^k\}$, Baum-Welch algorithm [8] is used to estimate the parameters of every HMM. For each HMM, the outputs of the samples of one symbol are

averaged, and the proportion of the number belonging to one symbol to the number of total samples determines the initialize probability distribution π .

4.3 Recognition Processing

The recognition processing is performed along the three steps as described above. Suppose a free-hand sketch symbol is feed into the system, a reductive row feature vector $\boldsymbol{F}$ is feed into a set of SVM groups, and produce a new feature vector v defined by probability outputs as the observation sequence of HMMs $\lambda = \{\lambda^1, \lambda^2, ..., \lambda^M\}$. Finally, the unknown symbol v is assigned to the class having the highest probability estimation $\log P(v \mid \lambda^i)$.

5 Experiments

5.1 Recognition Algorithm Experiments

In our experimental, we construct a practical sketch-based C programming teaching system, which can recognize 6 distinct flow chart symbols: {operation, decision, I/O, connector, termination, line} as Table 1.

Table 1. The symbols of the flow chart

Name	Operation	Decision	I/O	connector	termination	line
Symbols						

The experimental database consists of 1200 flow chart symbols drawn by 10 peoples, in which each kind of symbol is drawn 20 times by one person. We ran separate tests for 5 training data groups, which are respectively composed of 10,20,30,40,50 samples from each symbol class. And the remaining samples are used for the test sets in each group. The recognition rate is illustrated in Fig.2. We observed that the recognition rate is low by 10 training samples. With the number of training samples, the recognition rate increase quickly, and keep high when more than 30 training samples. The hybrid algorithm shows good recognition ability under small samples and represents strong learning ability. Furthermore, the hybrid algorithm is compared with the recognition algorithm based on pure traditional HMMs, and also shows better performance as listed in Table 2.

5.2 User Evaluation for Programming Teaching

An experimental intelligent whiteboard system is designed using the hybrid SVM-HMM recognition algorithm for a C programming course. During the user evaluation for programming teaching, the teachers and students are classified into two test groups. The first group uses our intelligent whiteboard system to teach the loop structure in the C programming course. In this group, the students were trained by the

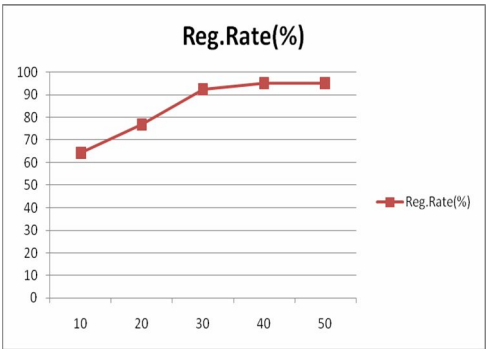

Fig. 2. The recognition rate of different sample groups shows that it increases with the number of training samples and keeps high over 30 training samples

Table 2. Comparative results of SVM-HMM with HMM approach show the hybrid method has better performance than traditional HMM approach

Symbol	SVM-HMM hybrid approach	Traditional HMM approach
operation	97.21	96.40
decision	96.30	95.27
I/O	96.31	94.89
connector	92.15	90.31
termination	93.28	91.44

visual comparative learning, in which the teacher drew the loop structure flowchart on left of the electronic whiteboard, the corresponding C codes were generated automatically, and the students learned the concept and coding of the loop structure through comparing the simultaneously changes between the flowcharts and the codes. The second group uses traditional teaching method to learn the same contents by the blackboard and the PowerPoint slides.

After the semester, a questionnaire survey was conducted to the testers about the teaching and learning effects. Teachers found that the intelligent whiteboard affords a more efficient teaching method than that of the traditional ones. In addition, students are fond of using the intelligent whiteboard to accomplish their learning tasks.

From the analysis of the user evaluation, it is indicates that the natural interaction, the efficiency and the satisfaction have received great reputation. Graphics are usually used to present the flowchart notions clearly, such as the object of the flowchart and the relations between objects. Free-hand sketch is one of the natural and effective approaches to the expression of intentions, which helps the teachers to show the programming concepts as naturally as how they do on paper. The combination of pen-based HCI and whiteboard enable students to blend learning efficiently. By observing the corresponding relationships between the sketching flowchart and the codes, the students can obtain the immediate feedback, which makes the whiteboard natural for the teachers and the students with a flexible and effective interactive pattern. Therefore, students can learn the abstract programming idea and the concrete coding skills effectively and efficiently by associating the graphics with domain concepts.

6 Conclusions

A pen-based flowchart system for programming teaching is presented in this work, which makes use of the advantages of SVM and HMM to overcome some of their shortages. In this work, ICA is used to reduce the dimension of features, a set of fuzzy SVMs are used as preliminary feature classifiers to produce fix length feature vector, which acts as a probability evaluator in the hidden states of Hidden Markov Models, and HMMs are employed as finally classifiers to recognize the unknown pattern. Experiments show the algorithm is good enough for flowchart sketch recognition.

This work also introduces the pen computing into programming teaching, which can recognize teachers' free-hand sketches as flow chart diagrams and translate them into C programs automatically. The system provides the users with a visual teaching environment that facilitates the construction of top-down design flow charts and the implementation and simulation of algorithms as flow charts. It helps students to stride the obstacle between the flowchart and the programming language, and to learn the structural programming ideation effectively.

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The Case of Interactive Web-Based Course Development

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Abstract. Development of the web-based learning technology supports strong enhancement to the lifelong education. This paper introduces how to design and implement web-based courses by network technology. To adapt the learning custom of the online learner, we adopt interactive and easy-sharing instructional mode and pay more attention to the display attribute of the multimedia during the process of designing and development web-based courses. In the "Civil Law" instructional practice, we divide the learning process into five parts: independent learning, online question-answering, test and examination, case study and discussion, and mock trial.

Keywords: Web-based Education, web-based course design, web-based instructional mode.

1 Introduction

As socialization of education trending evident, more and more people prefer lifelong education as their new learning choice. And network technology supports strong enhancement to the lifelong education. In recent years, many types of Chinese web schools hold a great lot of vocational training. In this project, we design and develop the series of "Civil Law" web-based demonstration courses for the School of Continuing Education Tsinghua University. The design and development of the course base on the technology of Tsinghua Distance Education Learning Management System. According to the function of the system, we design and implement the characteristic instructional mode and process under the instructional requirements, and try to build an interactive and collaborative web-based learning environment.

2 Web-Based Learning System

The project based on the former web-based learning system of the School of Continuing Education of Tsinghua University. As shown in Figure1, the web-based learning system includes an educational portal, several instructional operation systems and a technology support platform.

The educational portal provides uniform portal to other instructional operation systems, including many functions such as single sign-on, application roaming, application administration, user registration, and information release, etc. All of the operation systems can be shown in the uniform format via this portal.

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The instructional operation systems are the corresponding subsystems in the web-based learning. The subsystems always includes real time teaching system, course on demand system, question-answers system, homework management system, test and examination system, resource management system, educational administration system, and quality assessment system. All instructional operation systems that compose the functions of web school give a whole support in web-base instructional procedure.

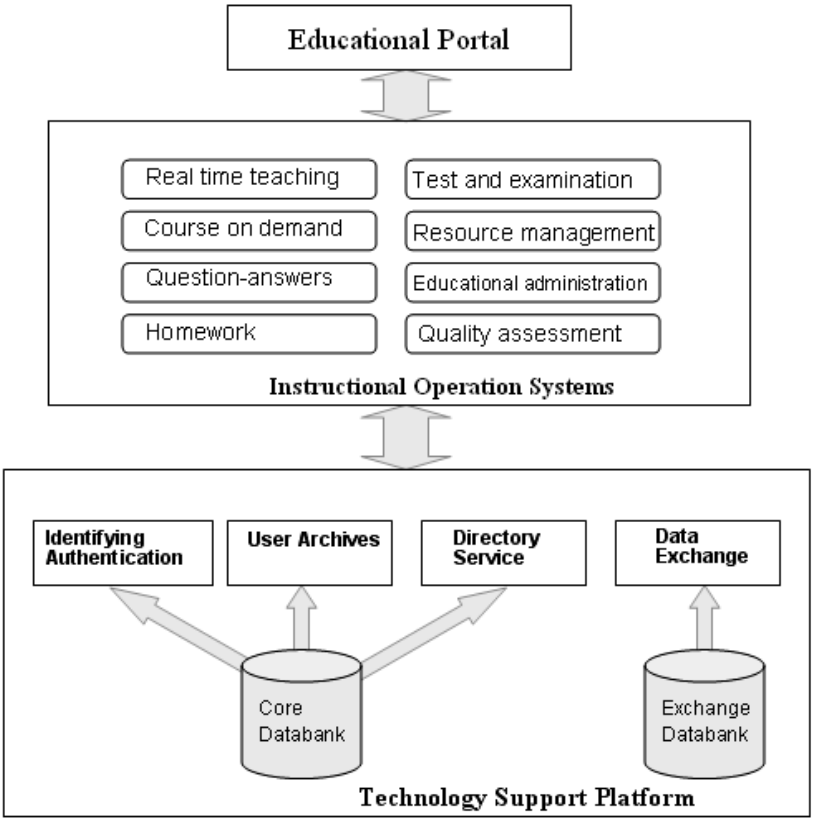

Fig. 1. Web-based Learning System

The technology support platform provides essential basic services to the educational portal and instructional operation systems. It is composed of 4 modules: they are identifying authentication, user archives, directory service, and data exchange module.

3 Brief Learning Process in Web-Based Course

Traditional f2f learning and Web-base learning each has its strong point. But the latter has its' own advantages below:

- It can be propitious to learners' independent learning. In web-based learning learners can find different instructional materials according to their different aptitude level;
- Interactivities between teachers and learner or that between different learners are enhanced in web-based learning;
- Instruction content is more vivid after being processed by network and multimedia technology. So learners comprehend the knowledge better.

Basing on the web-based learning system, we give emphasize to design some particular teaching process such as independent learning process, online question-answering process, test and examination, case study and discussion, and mock trial, etc.

3.1 Independent Learning Process

Distance learners acquire and master knowledge in independent learning process, so we set several teaching modules in every chapter, such as, learning objectives, difficulties, knowledge explanation, self-test, and thinking, etc.

The learning objectives and difficulties module definitize the learning task and difficulties in every chapter, making sure that the distance learners can have pertinent and clear learning.

In the knowledge explanation module, we adopt video stream technology to establish live videocast classroom online. Teachers who have years of teaching experience are appointed in this module. We try to simulate f2f classroom environment as much as possible, make distance learners attain knowledge more directly. The Figure 2 shows how the live videocast classroom works. The top left corner in the picture is teacher's video; right-hand of the picture is dynamic show of teaching content, such as power point document, video, flash, website, or any other types of documents. The dynamic show corresponds to teacher's prelection content. Bottom of left-hand is index, showing key point of whole course. Each point can link to corresponding learning paragraph.

The self-test and thinking modules provide online self-test after class. Learners will consolidate knowledge and find problem in their learning process when they finish their self-test.

3.2 Online Question –Answering Process

The online question-answering process aims to explain learning difficulties to learners. Interactivities between teachers and learners carry on in this module. It's different from the independent learning process which trying to help learners acquire what they should or want to learn but helps learners solve their learning problems.

We combine asynchronous answering and auto-answering database into one module. Learners put questions anytime they found. And teachers termly answer the questions. Question and answer pairs will be inserted into auto-answering database. Now the database has stored almost 340 pairs. Questions put by both learners and teachers during the instructional process will be processed and record in database, which reflect difficulties and key points in teaching.

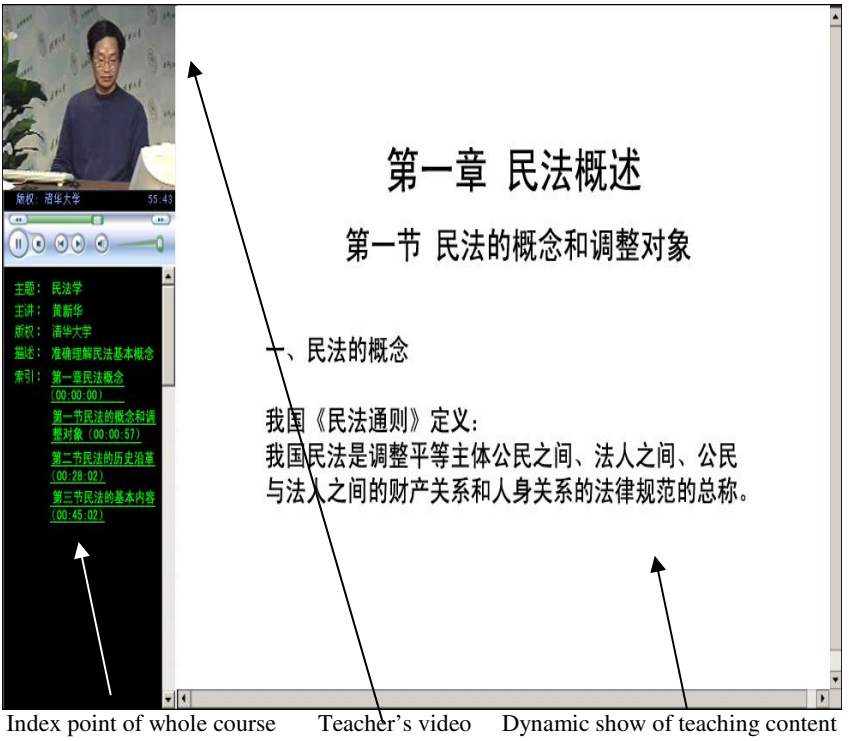

Fig. 2. Live Videocast

Auto-answering database is in form of question and corresponding answer pairs. On the learning schedule user can find answer by key words indexing. Database will update along with using frequency of online courseware. More times to use, more abundant will the database be.

3.3 Test and Examination Process

After the independent learning and the question-answering process, learners should take test or exam to solidify their learnt knowledge. Test and examination function helps learners detect their learning effect.

In the test and examination process, learners take test and exam through the web-based learning system to consolidate learnt knowledge. Teachers can upload test questions and answers and other learning enchiridions via network. Distance learners can set item difficulty by themselves when they take online stochastic test.

According to feature of the subject, we adopt 4 types of test questions, including 270 judgments, 600 single-choice tests, 600 multiple-choice tests, and 76 subjective tests. The subjective test is case study, choosing valid verdicts that comprise primary content of the civil law. Each case has 2~5 questions. Learners must answer all questions when they read cases. And they can find reference solution to make self-judgment.

3.4 Case Study and Discussion Process

We designed case study and discussion process thinking of the feature of "civil law" course. Learners participate to analyze the civil case, and understand foundational method to analysis. They can apply their learnt knowledge into real casus.

We have designed almost 12 casus, such as, "what is natural person's right to name?", "Whether it infracts a person's right to privacy?", etc. We set many modules in each case, for instance, "background materials", "viewpoint discourse", "expert comment", "reference statute", and "classroom simulation discussion", etc.

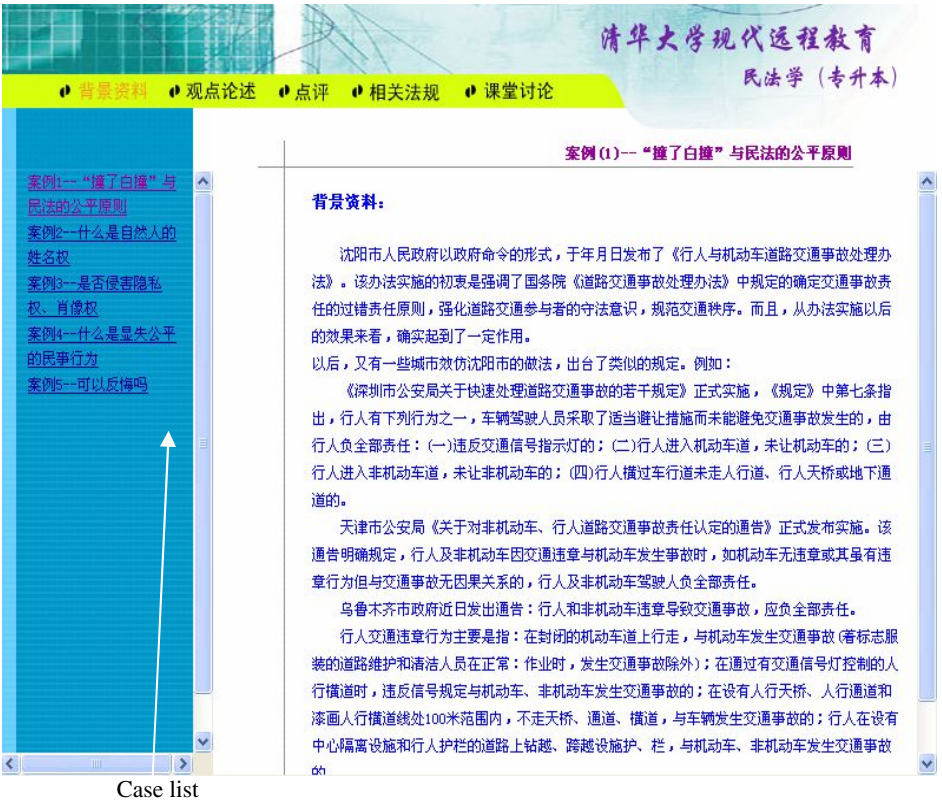

Fig. 3. Case Study

Learners find out reference background where case happened in the "background materials" module, and scan the teacher's topic to discussion, then think how to analyses the case to make a conclusion in the "viewpoint discourse" module; "expert comment" and "reference statute" modules help learners find out correspondent legal gist to reason more thoroughly. At last, in the "classroom simulation discussion" module, learners can discuss with their teacher through video stream broadcasting. They can thoroughly understand whole analysis process about the case, and have ability to apply their knowledge of law.

The Figure.4 shows that how the “classroom simulation discussion” module works. Teacher takes a presentation on the topic of “viewpoint discourse” module. Learners in f2f classroom can come out with their standpoints and distance learners can write down what they think of the case in this module. The bottom of the picture4 is the real time chat room.

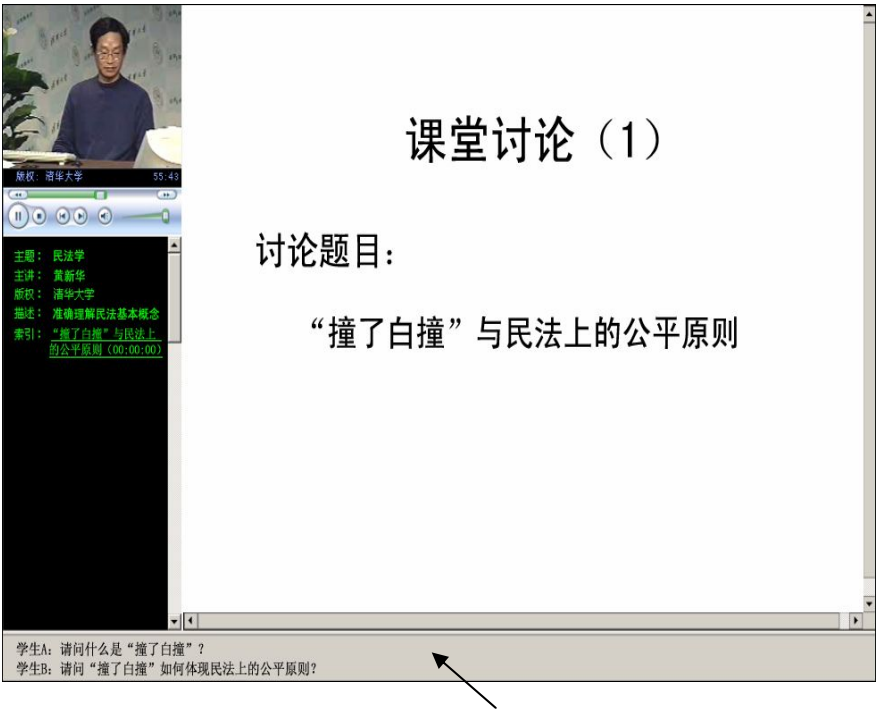

Fig. 4. Simulation Discussion Online in the Course

3.5 Mock Trial Process

“Mock trial” process makes learners clear on the civil procedure. Learners integrate and apply their knowledge of law into practice. This process has two modules, named “case scan” and “role play”.

In the “case scan” module, we write a play, which can exactly reflect the whole trial, and shoot the role players with multi-camera, recording the whole trial. Distance learners can browse the video online to see the mock trial. We adopt streaming media broadcasting and index technology, so learners can scan whole trial or any paragraph they want. All dialogue in the mock trial will be lettered for distance learners to read. See the Figure.5.

In the “role play” module, we mark off different roles according to different cases. Distance learners can choose roles to play online. Computer systematically controls the navigation of the whole online mock trial. While the video plays forward to the

Fig. 5. Mock Trial

selected role, the video pauses and the role-player can input the texts which represent the content he or she wants to express. In the process, the role-player can do comparison with the reference solution (video) provided by the system, in order to master the key points more correctly.

As to the design of “role play” process, there're much more extensions .For example, at sometime, many roles can be permitted to play together online at real time, form a special online courtroom, and collaborate together to accomplish a trial.

4 Correlative Technology

4.1 Compression of Video

In development of interactive course-ware, we should add compressed video segment of the chief teacher.

MPEG-1, MPEG-2, MPEG-4, VCD, DVD and AVI are leading video compression formats at present. Each of them has its strong point and application area.MPEG-1 format is mostly used to store and retrieval image sequence and sound, resolution reaches 525 or 526 lines, density of data reaches 1.5mbps. MPEG-1 format is used to make VCD, CD-ROM and the video published on web. MPEG-2 format is a coding standard of high quality image and sound, it is directly relevant to digital video television broadcast. Its resolution reaches 720 x 480 pixels, Bit rate reaches 15 Mbit/s. MPEG-2 format is usually used in making DVD. MPEG-4 format is a low data rate communication standard of multi-media. Its object is working reliably on web with interact function.

After comparing characters of each compression format and balancing difficulty of transform within different format, we adopts MPEG-2 format to store high quality video image (stream: more than 300K, size: 768□576), and we adopts MPEG-4 format (stream: more than 300K, size: 320□240) to supply searching and browsing on web.

4.2 Script Command

A script command consist of three parameter: time element, type element and content element. Time element describes when the script command happened. Type element show the type of the script, which can be the type that media-play supported or user-defined. Content element contains the content of the script that will be embedded in the html pages to form a whole interactive course-ware. The content of the script can be text, figures, URL addresses, etc.

We adopt VB script to embedded the teaching video segment and the real-time chat room into the web-base course to implement the interactivity.

5 Conclusions and Further Work

This paper mainly introduces the case that we design and implement the web-based demonstration course according to the feature of the online instruction. In the whole design of web-based courses; we pay attention to design the process of web-based instruction, and utilize the interactive and sharing feature of the network. Learners are able to master the knowledge by their study of the whole process in the web-based course. Of course, there're much more issues that need to be researched, such as, the design of collaborated learning process, the collaborated role-playing at mock trial, the application of the network video discussion, and so on.

After one term experimentation, this web-based course was successfully used in distance education of Tsinghua University. Till now, it is used by myriad learner during the three terms. We investigated the effect of the web-based course, 'Civil Law', collecting many opinions: "In the web-based course, I can almost finish my study only by myself.", "The test and examination database is very useful to distance learner and it is very essential to prepares for the final exam.", "Teachers can answer many normal questions online in question and answer system.", "It is interesting that the mock trial shows the whole proceeding of real court.", "I hope we can have more chances to participate in mock trial and to take role plays ". But we also find these

opinions: “Role play in mock trial is not so flexible”, “Question and answers system should add phonic and graphic function, so that, we will have more exact helps”, etc.

During a long time using, we find that many problems should be researched and applied in the design of this web-based course. Such as, how to design the collaborative learning tache, how to make the role play more flexible in mock trial, how to apply phonics, graphic and video technology to the question and answering system, etc.

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Designing an Intelligent Coach for a Collaborative Concept-Mapping Learning Environment

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Abstract. Education should emphasize more on the process of creating conducive environments rather than merely on the product of learning. Merlin is a collaborative and cognitive tool that enables the students to express and visualize their ideas to their peers. By reviewing various types of coaching techniques being used by different tutoring systems, we aim to identify suitable mapping between a tutoring aim and its corresponding coaching technique as well as any possible drawbacks. Results of the comparative analyses will be used to determine how Merlin agents can improve mapping between the adaptation and pedagogical modules in ITSs, leading to more effective adaptation of tutoring strategies.

Keywords: Collaborative, Concept-Mapping, Coach.

1 Introduction

Education is less a process of instruction and more a process of creating environments. As [1] observes, "In education, one should concentrate less on creating process of instruction, but more on the process of creating learning environments". To develop lifelong learning skills, students need to learn how to learn via inquiry and understand the sociocognitive and metacognitive processes that are involved [2]. [2] applied the principles of cognitive apprenticeship and case-based learning in designing a learning environment using groupware technology. Cognitive apprenticeship creates a meaningful social context in which learners are given many opportunities to observe and learn expert practices. Collins, Brown and Newman, 1989 offer six instructional methods of cognitive apprenticeship namely modeling, coaching, scaffolding, articulation, reflection, and exploration [3].

Merlin agent-assisted collaborative concept map version 1 [4] is a collaborative and cognitive tool that enables students to express and visualize their ideas to their peers. Merlin's main components are: chat tool, concept mapping tool, the cognitive apprenticeship tool and the post-explanation facility. The Merlin collaborative concept map has incorporated cognitive apprenticeship scaffolds to enhance the effectiveness of learning. By studying existing learning systems on collaborative learning and intelligent tutoring, improvements are proposed to increase the degree of coaching and advice to be provided to students.

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2 Collaborative Learning

The success of a lecture depends on the lecturer being aware of the capabilities of all students. However, factors such as economic pressure, large class size, and diverse student backgrounds make it difficult to achieve these requirements. In this information age, education has made a step from the traditional transmissive classroom to go online. The transmissive paradigm emphasizes on the transfer of knowledge from lecturer to student. Hence, it may not be conducive or meaningful as active learning occurs when students can take a pro-active role in questioning, sharing ideas and applying prior knowledge to develop new ideas. Students are more likely to learn from collaborative learning experiences mediated by technology than from transmissive pedagogies [5] & [6].

A common example of collaborative learning is the on-line forum. According to [6], online forums provide an opportunity to enhance community building and promote collaborative dialogue that can help increase the flexibility of learning while motivating students to actively participate in their learning. By enabling peer-to-peer interaction, online forums can support the essential elements of a learning conversation by providing scope for multiple perspectives through discussion, dialogue and interaction. The structure of bulletin boards used is based on cognitive apprenticeship models of learning; where learning is scaffold by peers as well as experts. In this study, technology is integral and also supportive of the social processes of learning by enabling asynchronous communication. The combination of peer-supported teams and tasks designed for self–direction supported the key learning outcomes of collaboration, social responsibility and decision–making with a view to help learners actively engage in learning.

[7] propose how to better fit a Web-based environment for hands-on activities, how to encourage flexible work and how to integrate a collaborative workspace into the flexible context of engineering education. They used fragments in an eJournal, which were shared to sustain collaboration in Web-based engineering educational environments. Based on the fragments in the eJournal, one can develop different kinds of tools and services, which provide awareness about the group activities, group progress, and the social structure of the community. As such, the eJournal can be considered as an instrument to create and augment the interaction process; i.e., the collaboration among students, between professors and students.

3 Intelligent Tutoring Systems

Applying collaborative learning techniques in synchronous distance learning environments brings difficulties to facilitators, who have to monitor and guide participants in the application of collaborative skills. It is very difficult for a human facilitator to track many teams working at different times with members located in different places [8]. The design model of an Intelligent Tutoring Systems (ITS) is directed towards the separation between the domain knowledge and the tutor shell whereas the architecture is composed of a user model, a knowledge base, an adaptation module, a pedagogical module and a presentation module. The collaborative tutoring or learning system is grounded on the collaborative learning environment where it facilitates learning

across distance and time in which two or more people are trying to learn or work together in a collaborative effort.

An Intelligent Collaborative Learning System (ICLS) would be able to understand and interpret peer-to-peer conversation, and could actively support the group during their learning activities. The systems need not only powerful natural language understanding capabilities, but also the knowledge required to advice, support and guide the group toward maximum effectiveness [9]. This research has focused on developing and implementing a model of collaborative interaction based heavily only on psychological group learning support strategies. CSCL systems offer software replicas of many of the classic classroom resources and activities such as online presentations, lecture notes, reference material, etc. Chat tools and bulletin boards enable students to participate in online discussions, but provide no guidance or direction to students during or after these dialogue sessions [9]. Hence, the direction of research has shifted to intelligent tutoring systems as a possible solution.

The following subsections compare the different techniques used by Intelligent Tutoring Systems (ITS) in designing coaches to reflect the issues to be improved in the proposed improvement to Merlin version 1.

3.1 Tutoring Technique: Hinting Strategy

The objective of the project proposed in [10] is to provide assistance to workers who are learning to make effective use of a management information system in their workplace. This involves activities that range from training to performance support to just-in-time help. The approach taken is to develop a task-oriented performance support system that is tightly coupled with a peer help system (PHelpS). PHelpS uses a task-oriented performance support system to index help requests and user knowledge and involves knowledge-based support for locating a peer somewhere in the distributed organization which is ready, willing and able to provide help when needed. Some features included are hint fields, which will provide more pop-up explanations, context-specific help tabs, case-based Help tabs and a peer helper which is automatically selected based on the constraints of willingness, ability and availability to help. Merlin collaborative concept map version 1 has partially resolved this issue by enabling synchronous chat and explicit visualization of concept maps in a common workspace. In addition, cognitive apprenticeship function tabs and post-test explanation facility have been incorporated. User testing results are promising and indicate better learning effectiveness in collaborative groups using Merlin than those who did not.

[11] describes a study of the hinting strategies in a corpus of human tutoring transcripts and the implementation of these strategies in a dialogue-based intelligent tutoring system, CIRCSIM-Tutor V.2. They describe their hinting strategies and a model for choosing among them based on domain knowledge, the type of error made by the student, the focus of the tutor's question and the conversational history. They used two rules in giving hints: evoke terms or synonyms or try to give an intermediate step. The hinting strategies involve giving an intermediate causal link, referring to an anatomy object, evoking terms and linguistic hint. They use heuristic rules to choose a hinting strategy based on the category of the student's answer, the tutorial plan, and the tutoring history. They then decide the content by searching the domain knowledge base to instantiate the strategy. So their hints are focused on both the student's needs and the current tutorial plan.

[12] have identified some areas for improvement in Merlin version 1 as follows:

- The task-planning scaffold allows students to determine the sequence of tasks that would help them achieve their common goal. However, there is no indication of individual goals. Hence, it would motivate the students to plan more effectively if they could set their own individual goals in relation to the common goals and assess the achievement of common goals in relation to individual goals and vice versa.
- The modelling scaffold in Merlin version 1 is provided through the provision of steps that an expert would make in the form of annotations on static web pages. Although the annotations are easy to understand, more explicit modeling in terms of the provision of real-life cases and corresponding concept maps may be more helpful.

As such, in Merlin version 2, a common as well as an individual task ontology for planning are used to enhance the task planning/learning goals and cognitive modeling aspects of cognitive apprenticeship. The pilot test shows that by explicitly stating learning goals (individual and common) and modelling through the provision of real-life cases and concept maps the quality of learning experiences in virtual collaboration is enhanced.

COMET on the other hand, develops algorithms for generating tutoring hints since the tutor should provide as little guidance as possible. It does not allow the students to get lost while navigating and learning [13].

3.2 Tutoring Technique: Reasoning

[8] describes the design and evaluation of a coach that helps students collaborate while solving Entity Relationship modeling problems in a computer-mediated learning environment (COLER). Unlike previous work generally emphasizing dialogue analysis or expert models, this work evaluates a new approach to support collaboration that identifies learning opportunities based on differences between problem solutions and tracking levels of participation. The work demonstrates how intelligent agents can produce reasonable collaboration advice in domains for which structured problem solutions exist by using a few basic knowledge sources, and illustrates several methods of evaluating the knowledge and reasoning of complex knowledge-based systems. COLER's coach is a pedagogical agent to facilitate collaboration. It does not tutor ER modeling, but encourages students to discuss and participate during collaborative problem solving. The coach is implemented as a personal assistant for each student and has the capability to perform specific tasks autonomously. The design of the coach was based on socio-cognitive and cognitive dissonance theories, as its goal is to promote group-learning interactions and maintain balanced participation. As shown in Figure 1 as illustrated in [8], the coach involves different modules that cooperate in the solution of the main problem: when and what advice to give.

One of the approaches to uncertainly modeling of user states of knowledge and profile is by using Bayesian Networks where it combines the rigorous probabilistic formalism with a graphical representation and efficient inference mechanisms [14]. The help provided to the student can be personalized using Bayesian Learning

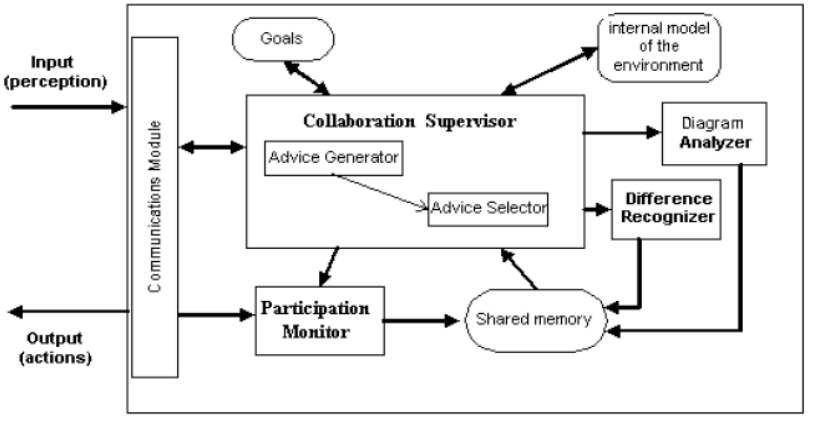

Fig. 1. Coach Architecture

Practices in analyzing individual cases by using probability. As there are many uncertainties built into this process, Bayesian networks which utilize probability theory as a formal framework for uncertainty management will be adopted in Merlin version 2. Another related work is Andes's Bayesian networks in Intelligent Tutoring System (ITS) for individual assessment. Andes' Bayesian networks deal with the issues of Context specificity, Guessing, Mutually exclusive strategies, Old evidence, Errors, Hints, Reading latency, Self-explaining ahead and Self-explanation menu selections [15]. Andes' models provide long-term knowledge assessment, plan recognition, and prediction of students' actions during problem solving, as well as assessment of student's knowledge and understanding as students read and explain worked out examples.

3.3 Tutoring Technique: Pedagogical Argumentation

The aim of research in [16] is to develop and validate a dialogue model from a computational and educational perspective. Given that dialogue can facilitate conceptual development, there is a need to investigate whether intelligent systems can be designed to engage their users in such dialogue. The authors use an 'investigation by design' methodology for modeling effective educational dialogue. Consequently, a dialogue-game framework and computer modeling work-bench is developed for pedagogical argumentation within a collaborative context. A prototype CoLLeGE (Computer based Lab for Language Games in Education) System implements the pedagogic and dialogue game framework called "learning as knowledge refinement" [17]. The CoLLeGE approach is able to prompt belief revision and conceptual change in students.

3.4 Tutoring Technique: Learning Companion

Computer can be simulated as two coexisting agents, a teacher and a companion. The two agents, the computer teacher and the computer companion, together with the

human student, form a three agent learning model which is called the Learning Companion System (LCS) [18]. The learning companion plays the role of a human student companion in learning.

The main purpose of EVA (Virtual Learning Spaces in English) project in [19] is to develop models, architectures, and a multi-agent environment for collaborative learning and experimentation. Each space in EVA consists of a number of components composed of a set of deliberative and auxiliary agents. The research focuses on theoretical and practical issues of personalized collaborative learning with artificial leaning companions, personal learning assistants with activities planning, and experimentation activities with agents. The conceptual architecture of EVA is structured into four essential learning elements, called Virtual Learning Spaces, which are knowledge, collaboration, consultation and experimentation.

PROPA is an ITS prototype developed to teach explanatory analysis skills in the domain of satellite activity whereby explanatory analysis is the process by which an analyst formulates explanations for past or predicted events. PROPA provides a workspace, called the "Argument Palette." This means that this system falls under the competitive mode so the student constructs arguments by proposing candidate explanations, recording statements of evidence, linking evidence to candidate explanations, and assigning evidential weight to links. On the other hand, Goodman, learning companion, LuCy, acts as a peer in an ITS environment to ensure the availability of a collaborator and to encourage the student to reflect on and articulate his past actions, and to discuss his future intentions and their consequences.

The combination of the student-learning companion collaboration and individualized coached practice allows a student to obtain guidance and support from the tutor while learning with a peer through collaboration. In PROPA, the student can request a hint or ask a specific question using the inquiry component and in either case, the coach gives back a self-contained response. LuCy instead promotes dialogues, which encourage the student to reflect and evaluate past actions. It does this by prompting the student to explain the reasoning behind actions, and justify decisions leading to the actions. The differences within these two approaches, which are PROPA coach and LuCy are identified and it will be implied suitably in the work proposed as it gives different impact to the student's learning process.

4 Intelligent Coaching in a Collaborative Concept Map

The proposed work is an extension to Merlin version 1 and version 2. Andes's application is for individual assessment. We are trying to convert this to a collaborative environment. In addition, the proposed work will focus on enhancing the coaching/hinting strategies as well as incorporating the learning companion models in the collaborative concept mapping learning environments.

4.1 Improvements to the Chat Tool

Collaborative discussions need not always result in positive outcomes. Possible reasons are students digress from the points of discussion or there are dominant parties in the group or students do not know what to discuss. Hence, there is a need to investigate features and factors for successful dialogue. These features and factors can be

emulated and embedded in Merlin collaborative concept map's coach to enhance interaction scenarios aimed at supporting learning.

4.2 Improvements to the Coach in Merlin

In contrast to COMET, the coaching agent in Merlin currently matches keywords from the chat box with the knowledge base and retrieves and presents related concepts when the students click on the Hint button and presents HTML pages with the expert's strategy presented in a static textual explanation manner. There is a need to increase the coaching agent's role to include comparison of the student's input with an expert solution and advise them step-by-step how to proceed. The type of advice to be presented to the student is varied. The best choice of advice is based on learner's entry level according to prerequisite or background knowledge e.g. experience, motivation, capability, etc. Therefore, there is a need to identify which advice is the best in view of the students' plan and entry level.

4.3 Proposed Solution

Merlin version 3 aims to improve the mapping between the adaptation and pedagogical modules in ITSs which leads to more effective adaptation of tutoring techniques. It encourages real-time collaboration in concept mapping learning environment. It also encourages correlation between individual and collaborative workspace. The adoption of coaching and learning companion strategies will enhance the hinting strategies.

The proposed system architecture as shown in Figure 2 consists of student model, pedagogic model and expert model. The Parser Layer determines the students' interaction activities. The Dialogue Agent will be the communication tool for the students' interactions where new data, which are the statements from the students, will be parsed to the student model and all the student files and activities will be stored in the Dialogue History. The student model, used as a reference, maintains each individual's learning status. The student modeling shell for the system architecture is divided into few components such as Personal data, Performance, Teaching History, Preferences, Navigation and Learning Styles. The student model for each component is an instantiation from the student model design pattern. Parameters in the student model can be edited without affecting other unrelated components in the architecture.

The student will be directed to different status in the Domain Knowledge Base based on the personalized analysis using probabilistic approach by Bayesian Network. Behavior Analyzer Agent classifies user problems, which received from the Detection Agent into errors and passes it to the pedagogical module. Different agents with their respective pedagogical abilities will solve the user problems with the help from a student model. The pedagogic model consists of Domain Knowledge Base, pedagogic rules, pedagogic ontology and pedagogic tasks. Domain Knowledge Base Manager helps in coordinating the users to use and update all kinds of knowledge stored in knowledge base.

The pedagogic model passes the state of solutions to the Instructional Layer, which invokes Response Generator whenever feedback is needed. Consequently, the Response Generator initiates a response and control passes to the Interface Agent which playing the role to display the interface to the students. The Expertise Layer endows the agent with pedagogical intelligence. The production rules will be generated using JESS whereas Protégé 2000 is used to generate domain ontology and goal.

A Learning Tutor Agent, which has both a tutoring engine and an inference engine will be included in this model as well. The Expert Model passes expert rules to the dynamic solution graph, which will invoke the Response Type Selector to select the response to be passed to the Instructional Layer.

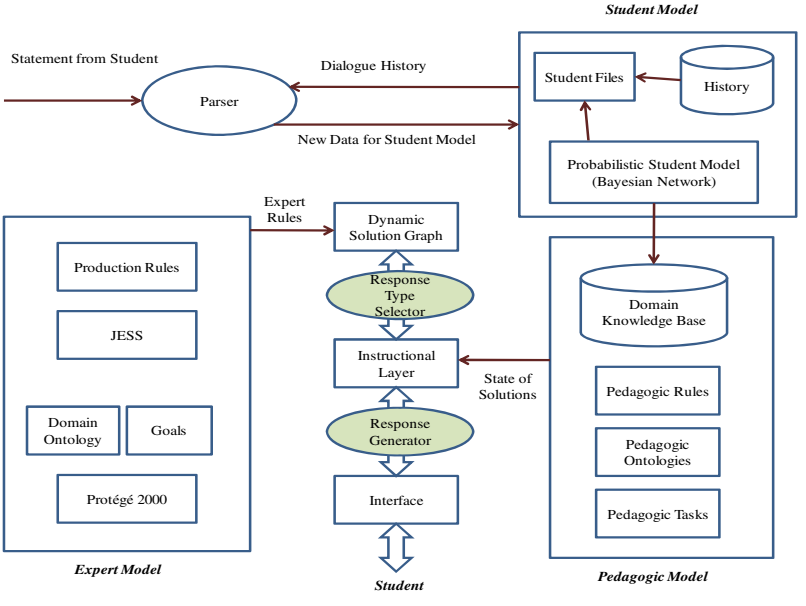

Fig. 2. Proposed Architecture of Merlin version 3

5 Conclusion

The main objective of this research is to enhance the coaching method in collaborative learning environment, Merlin, in an effort to improve the interactivity process. By reviewing existing learning systems on collaborative learning and intelligent tutoring, improvements are proposed in Merlin version 3 to increase the degree of coaching and advice to be provided to students. Besides improving the mapping between the adaptation and pedagogical modules in Intelligent Tutoring Systems, it encourages real-time collaboration in concept mapping learning environment.

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A Theoretical Framework of Ecosystem of Learner Development for Designing a Practical Ubiquitous Learning Environment

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Abstract. The paper proposes a theoretical framework of knowledge spiral-based ecosystem of learner development for designing a practical ubiquitous learning environment, which is based on theories of social constructivism. Through describing the model, we argue that ubiquitous learning environment should be embedded in an educational information infrastructure and blending used with traditional learning technology in practice. In the paper we connect technical view, pedagogical view, sociological view and cross-cultural view and suggest implementation should be in the context of authentic world. We offer two cases of pilot studies as trials to describe how to design such a seamless learning space using this model.

Keywords: Ubiquitous learning, learning environment, theoretical framework, ecosystem.

1 Background

Since Weiser brought us concepts of Ubiquitous Computing and Calm technology in 1988, technical circle seems to have been matured enough to bring mobile learning and ubiquitous learning to our life.

In current researches, people always interchange use terms of "mobile learning" and "ubiquitous learning" though the latter usually uses sensor network and is context-awareness. When we check out the definitions of "ubiquitous learning" or "mobile learning" or "1:1 learning" or some else, we will find that most definitions take technology as the starting point, e.g. m-Learning is e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone(Quinn, 2000) [1]. And the other often cited definition is defined as "anyone can learn in anytime, anywhere using digital device." 1:1 learning (a student uses at least one computing device for learning.) is more closely to education, but it also is not so clear in describing the nature of ubiquitous learning (Tak-Wai Chan, et.al. 2005) [2]. As Keegan critics, learning cannot be 'electronic' and it cannot be mobile too [3]. In Telenor mLearning Wap project Keegan and his colleagues gave a definition of m-Learning which tries to describe the significance of m-learning from a social and cultural view: the use of mobile terminals in learning and attributes its growth to an in creasing mobility and the growing need for flexible learning.

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In Japan, most mobile phones with functions of TV and radio receiving, camera and photographing, general-purpose manage tools such as calendar and memo, QR bar identification, media player, Internet access, data preservation and GPS navigation could been gotten easily and cheaply. Governments of Japan, Korea and Taiwan respectively brought up nation and area wide plans, namely U-Japan, U-Korea and U-Taiwan. These funds and policy support provide schools opportunities of implementing mobile learning or ubiquitous learning in practice.

In the practice, researchers found that ubiquitous techniques not only bring us some new teaching models and positive influences, but also bring us some new problems and negative influences. There is an urgent need for a theoretical framework in practice to overcome these obstacles to implementing ubiquitous techniques.

2 Problems and Analysis

When we analysis problems that prevent U-learning from practice, we find that: on the respective of hardware, contrasting to desktop computers, handhelds have relative small screens, low resolution, slow processing, limited storage capabilities, low network speed, different enterprise standards, and battery life and heat dissipation issues will prevent intensive use of streaming media or broadband networks. As well, handhelds are not rapidly increasing with Moore's Law. Therefore even having characteristics of high portability, mobility and accessibility, in pursuing intricate knowledge via ways of social cooperation and communication, handhelds can't replace face to face discourse and videoconference in very near future.

On the respective of learning, many teachers reported the distractions posed by laptops and mobile phones. Levine (2002) suggested a model of integrating laptops into classroom which is a laptop-up laptop-down system [4]. During lecture time, students are told to close their laptops and pay attention, and when they need use them they open their machines.

On the other side, many researchers reported that U-learning has strong strengths on quick reminders and alerts, personal knowledge management, peer to peer communication and learning for special content such language skills and in a particular context such as museum. Besides them, Fitch(2004) have found that mobile devices can facilitate faculty-student interactions and in-class participation, thus increasing engagement and active learning [5].

Therefore, we argue that as well as other media, mobile device have its niche in ICT implications. Mobile terminals are not super media. To use them effectively and efficiently, we have to be under a systemic theoretical framework.

3 A Proposal on Theoretical Framework

3.1 Knowledge Spiral: Views on Knowledge

The social and cultural approach argued by Vygotsky (1978) was widely accepted by researchers. He stated that, ``Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological).

This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals." [6]

In the field of knowledge management, Nonaka (1995) developed Vygotsky's points and argued a SECI model which detailed described dynamics of knowledge evolution as a knowledge spiral [7]. He pointed out that this process could include four stages: Socialization, Externalization, Combination and Internalization. On understanding of knowledge, Cognitive Flexible Theory argued by Spiro, et al. (1988) suggested that knowledge could be divided into two domains: Well-structured knowledge and Ill-structured knowledge which are respectively correspondence Nonaka's Explicit knowledge and Tacit knowledge [8].

These statements are very helpful for us to understand how learn occur in an authentic world and in every stage of learning, what behavior happens to an individual learner.

3.2 Ecosystem Model Developed by Sugai and Maesako

Other researchers (Sugai, 2002, Zhao, 2003) developed Vygotsky's arguments as by the way of communication within a social network, people develop social construction of knowledge through problem solving and collaboration [9][10]. They also view the social network as a dynamic ecosystem. The models of ecosystem technically describe the authentic world when it is as context of learning occurs.

Sugai (2002) gave a model of ecosystem of learner for development which are based on Bronfenbrenner(1979)'s model [11]. This model is helpful for us to understand learner's situation within a social network.

Sugai (2002) develop Bronfenbrenner's Ecological system theory (1979) to an ecological learning environment model (see Fig. 1).

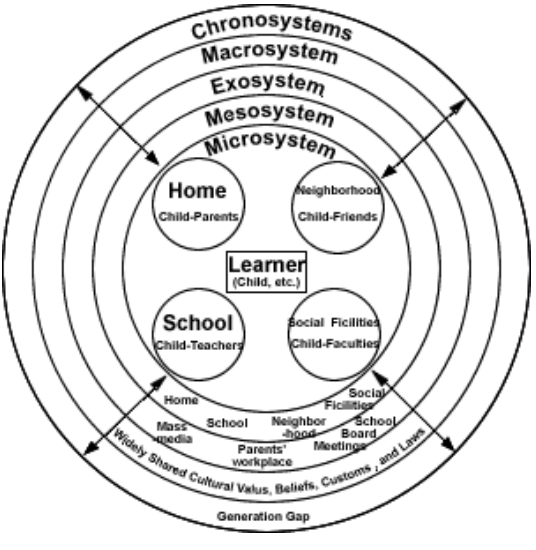

Fig. 1. Bronfenbrenner's Ecological system model (Bronfenbrenner, 1979)

Sugai's ecological system model of learning environment is just like a nested structure. Learner is at the center of structure. Once we focus on a learner, we have to be care of all kinds of indirectly influences on the learner from all levels of environment around him too. From a viewpoint of system theory, we could understand relations between the learner and environment. If environment do not influence the leaner directly, we see them as context. Multilevel environment bring the learner multi-context.

As illustrate in Fig. 1, microsystem contains fields which the learner get experience by directly involvement. The fields include school, home, social facilities, e.g. museum, library, etc. Learner can directly interactive with teachers and classmates in schools, parents or guardians in home, friends in neighborhood or faculties in social educational facilities.

Mesosystem contains schools, home, neighborhood and social educational facilities. Exsosystem contains mass media, parents' workplace, school board meetings etc. Macrosystem contains national widely shared cultural values, beliefs, customs and laws. Chronosystems provide a chronic framework to analysis learner's development in view of history.

Through such a relationship analysis, we could discovery what may be core needs of learner and what kinds of events could do influence a learner in his development.

From a viewpoint of technology-enhanced learning, Maesako (1997, 2006) further develop this model of ecosystem and suggest a model of local educational information infrastructure [12][13]. Using wireless techniques especially at 5GHz and mobile handhelds, even an ill student could access teachings and activities in classrooms from home or a hospital (see Fig. 2).

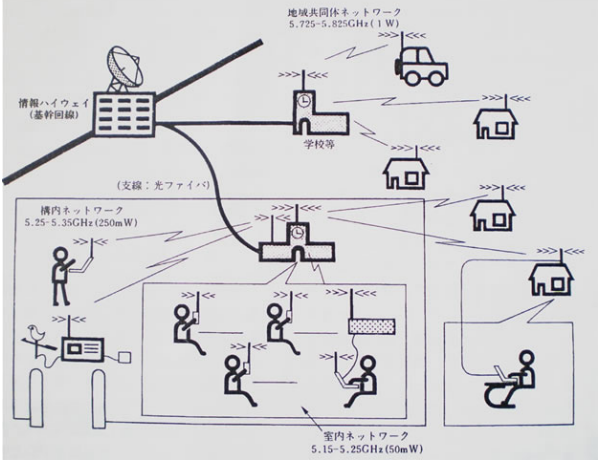

Fig. 2. Local wireless educational information infrastructure (Maesako, 1997)

Further, we can expend this ecosystem model of local wireless educational information infrastructure to equip schools, social facilities, e.g. museums, science museums, galleries, zoos, ocean aquariums, libraries, media centers, parks, historic sites, net-cafes, stations, airports, adolescent activity centers, lifelong learning centers and citizen centers with wireless network and sensor network. Using mobile handhelds,

every learner could get stronger ability of communication and computing and could immerse in a seamless learning space.

Within a covering area of access point devices, learners can use wireless LAN with high network speed to access a local server and directly use a videoconference system by going to a particular fixed spot. Out of a covering area of access point devices, learners can use cell phone network to do personal knowledge management, receive quick reminders and do peer communication.

In technical level, a unified and user-friendly user identity is needed so that we need consider a system of public key infrastructure just like Eduroam project.

3.3 A Framework of Knowledge Spiral-Based Ecosystem of Learner Development

Vygotsky(1926) argue that development of children' experience is depend on learning environment [14]. Teachers are organizers, mediators, managers and a part of this learning environment. At a more operation level, on designing a practical learning environment, Following his points, social constructivists did plenty of jobs, for example, Activity Triangle Model argued by Engeström (1987), Constructivist Learning Environment Model argued by Jonassen (1997, 1999), Conversation Theoretical Model argued by Laurillard (2002) , Systemic Instructional Design Model argued by He (2002)[15][16][17][18][19]. Also, Situation Learning Theory, Community of Practice, Cognitive Apprentice, Scaffolding and studies on CSCL gave clues for learners on learning strategies through distributive cognition and everyday computing.

Based on researches by Sugai, Maesako, Spirol and Nonaka, we suggest a theoretical framework of Knowledge Spiral-based Ecosystem of Learner Development(see Fig. 3). This theoretical framework could be used to design a ubiquitous learning environment.

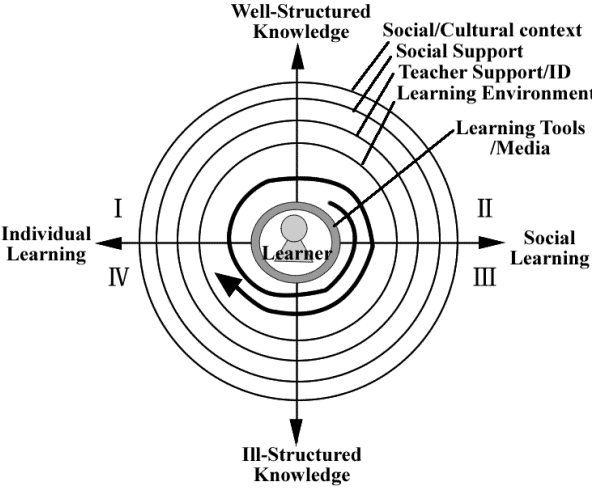

Fig. 3. A theoretical framework of a ubiquitous learning environment

In four areas, learner develops knowledge through a spiral curve in context of historical and cultural. At all levels of nest, social/cultural context, social support, teacher support (instructional design), learning environments provide support to a learner. Mobile devices are as learning tools/media just around learner and nearest to a learner.

As described by vertical axis of knowledge structure, in the area I and II, a learner develops knowledge commonly in a virtual space by using methods of mediated communication, whereas in the area III and IV, a learner develops knowledge in a real space by using methods of face to face communication. This axis is some like Nonaka's axis of explicit knowledge and tacit knowledge. Also as described by horizontal axis of learning scale, in the area I and IV, a learner develops knowledge in a personal space mainly by using methods of self reflection, whereas in the area II and IV, a learner develops knowledge in a social space mainly by using methods of social communication and social activities.

According to analysis of the nest structure, we could easily design a learning environment using ubiquitous techniques. Mobile techniques are helpful to learner for constructing a seamless learning space which connects real space with virtual space so that learner could develop his knowledge continuously.

To learn effectively and efficiently, it depend pattern of knowledge (of science or of social science), context, cultural background, and so on.

For example, we examine researches on e-learning practical models which inside and outside classroom. Keegan find that there are two important developments in distance education: "the individual flexible teaching model" in Europe, and "the extended classroom model" in the USA and China. In the former, an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life. In the latter, the students are organized into groups required to meet regularly at local study centers and applies technologies such as video conferencing, satellite distribution, radio and television.

Nowadays we could use mobile technology to connect the two sides of spectrum of e-learning inside and outside fixed space to create a seamless learning space. In this seamless learning space, instructor or learner could direct learning more flexibly depending on a special context. They could develop instructional design for instructor directed learning or learning design for learner's self-regular learning. Implementing the instructional/learning design, developing a set of self-developing knowledge package as learning resource, using the knowledge toolkit and package in learning ecosystem, revising instructional/learning design and develop knowledge through receiving feedback, finally instructor, learner and all the other involver develop knowledge during learning together.

To examine our model, as pilot studies, we investigated Teacher Job-hunting Cooperative Network in China and HyperMirror Classroom Project in Japan.

4 Pilot Study 1: Teacher Job-Hunting Cooperative Network in China

In China, problems of employment of graduates have been drawing attention from students, universities and society. Graduates need active in several spots and master

new knowledge through these activities. Using traditional way, it is difficult to direct them continuously. Teacher Job-hunting Cooperative Network was special for graduates from normal universities in northeast area in China.

Fig. 4. Online user interface of Teacher Job-hunting Cooperative Network

In 2001, Northeast Normal University and other 16 universities in Northeast of China established the "Organization for Graduates' Employment Cooperation of Normal Universities in Northeast" and now its numbers have expanded to 28. According to statistics, the organization attributed an increase of 2-3 percents for graduates' employment.

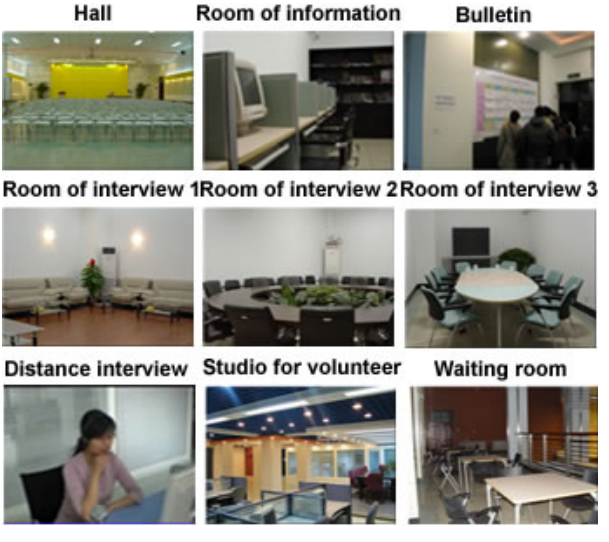

Fig. 5. Real spaces of Teacher Job-hunting Cooperative Network

Since 2008, the organization launched Teacher Job-hunting Cooperative Network run by the studio in which numbers are volunteers from the university. Every year, the organization handles with resumes of about 100,000 students. All the service is free of charge.

In its real space, if it is need that it could offer space freely for lecture and interview relating to employment. As illustrated in Fig. 5, real space is designed for the aims of publishing of information and interviewing. Room of interview 3 provide blackboard for simulating a classroom. After identity verification, graduate could do distance interview with employer through web-based video phone system in an interview room.

In this pilot study, we find that basic infrastructure consist of real spaces provides identity verification for both two sides of employer and employee, and space for lecture and interview via face to face or distance video. Everyday message sending to individuals by mobile phone and web is helpful to construct a ring of information and communication linking kinds of real spaces of Organization for Graduates' Employment Cooperation.

5 Pilot Study 2: HyperMirror Classroom Which Connect Japan and World

Real time international educational cooperation and two way distance teaching and communication always is a difficult for distance educators. Since 2001, Maesako conducted a series of experiments using a distant deeply interactive video communication environment which called HyperMirror. "HyperMirror system" has connected with China, Afghanistan, Korea, Kenya, Mongolia, Thailand and USA.

In a technique view, HyperMirror enhanced videoconference system. HyperMirror system provides users with the feeling of being together through involve all the participants into a same screen. Both two sides of participants can share their gestures and do non-verbal communication. The system can provide a virtual background which could be an image or a movie so that you could do a virtual tour. Some other interesting applications include: distance interactive skit, distance cooperative painting, etc. Fig. 6 and Fig.7 show examples.

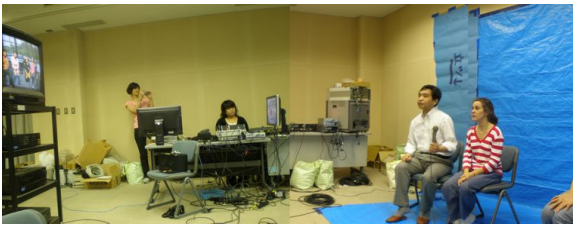

Fig. 6. Real space in HyperMirror Classroom

HyperMirror system and other videoconference system could provide stronger experience than mobile phone. On the other side, one of these systems' weak points is limited number of participants. Not everyone could have chance to join in. Therefore in a HyperMirror classroom, one important implementation of U-learning is to collect the response from all the audience via mobile phone.

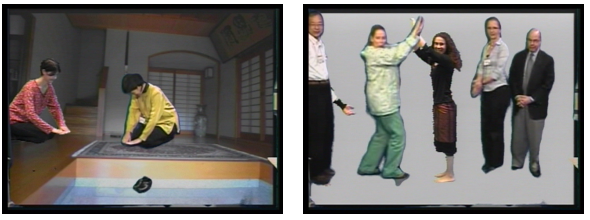

Fig. 7. Virtual space of HyperMirror on the screen

6 Conclusion

In these pilot studies, we explore how a future ubiquitous learning environment could be designed in an authentic context. We find that U-learning could be an excellent approach to connect all kinds of learning spaces and turn them into a seamless learning space. But just like most other exciting learning, mobile device have its weak points too. We need hybrid the implication of tradition learning, e-learning and U-learning to realize a better blended learning. The most important prior condition is that, we should better understanding the nature of learning and knowledge.

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Computer Assisted Learning with Card Game in System Design Concept

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Abstract. Interactivity and competition will give learners high motivation to play game and let learners interesting in game. Educational game not only accommodates learner entertainment, but also plays a role of educational tools. In order to assist learners in study system analysis and design, we create a card game about Rapid Application Development. Learners can gain some experience from requirements planning, user designing, construction and implementation. This game assists learners remember and realize the practical experience in system design. We expect that learners can obtain the ability to make decisions and method which solve the problem mutually when they playing this game.

1 Introduction

System analysis and design is a critical course for the basic concept. The major goal of system analysis and design is to improve organizational system. It is useful to help learner understand and follow the software engineering process that leads to the creation of information system. Programmer can analysis overall system and scheme out system architecture. There are some enterprise discussed the level of recent university graduates is not qualified in their workplace. System analysis and design teach learner concept about system design and how to work efficiently and economically in real application. Therefore, how to establish and cultivate student system analysis and design concept is important even let them acquire some experience from simulation.

For simulation, game is a suitable simulation educational tool for learners. People play games for amusement. On the other hand, games also lead the learner to practice. Game also can simulate for work or education. Competition, cooperation, encouragement, virtualization, interactivity and beautiful interface are the reasons why games attractive. Game can become one of the educational tools, and it is the most popular one. Goals, rules, challenge, and interactivity are key components of games. Games generally include psychical and physical stimulation. Academic knowledge sometimes hard to express the real meanings form class, but game can help to develop training on skills, offer some test method. We may regards games as an educational and simulate role.

Card game is one the traditional games which can be any game using playing card. It can merge in various kinds of games. The most common card game in daily life is poker. Poker refers to a set of 52 cards. Some card games follow various kinds of

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game. Some card games integrated the story to make the game more interesting and attractive. Magic Cards is a well-known game which is creates by Richard Garfield and introduced in 1993. Magic Card is a collectible card game which has six million players in seventy countries. Even thought it is an old game but it still popular today. Generally, two or more player uses a deck to play Magic Cards. Like poker of bridge, Magic has more cards and complex rules than other card games. It not only has physical product, but also publish internet-based Magic Cards version of players.

2 Related Work

In some research about card game, a lot of card games are applied in the teaching. There some people make use of some equipment to strengthen the authenticity of the card game. In 2006, Diaz, M. [1] designed a networked virtual card game for multiple users. It used some device to bring learners in visual environment which augment the truth. Learners can use this device anywhere when there internet is available. At the same year, Albert H. T. Lam etc. [2] proffered a technique to enhance existing trading card game. It used visual device support place's prototype to increase card game's reality. According to players' input command, the system identified it and output response. The game can retain the original playing rules and style. In 2005, Katayose H. and Imanishi K. [3] developed a trading card game based on ART. Learners can gain experience with the device on their arms.

For educational card game, Alex Baker [4, 5, 6] designed a card game which can help learners gain some experience about software process in class. Learners who studied this course are lacked effective experience in the past. In addition, Carrington, D. [7] devised a physical card game "Problems and Programmers (PnP)" which is a competitive card game in 2002. The game's rules and methods are based on Waterfall model. Let learners find out about the procedure of Waterfall through the game. The trouble and tool in game can make learners study several different ameliorative methods. Learners gain practical experience from the competitive and interesting game.

Except software engineering, Chandra, N. etc. [8] designed a financial trading market simulating card game in 2002. Learners can use it to simulate trading environment. One player serves as the marketing and sales director role, uses different market tactics, marketing and stock option, regards obtaining the largest profit as the goal. Another player acts as the businessman in the market, buys products and sells it according to the market manager's market tactics. This game simulates marketing and sales director and businessmen's tactics that aim at market environment and strategy. Another subject is about object-oriented thinking learning, Kim S. B. etc. [9] designed Smalltalk Card Game (SCG) in 2006. Students can experience and understand Object Oriented concepts by expending basic rules of game.

3 Rapid Application Development (RAD)

Rapid Application Development (RAD) [10] is a rapid method to develop systems. With the fast change of commerce and the high performance computer tools appearance, more and more people doubt if it is necessary to build a system in such a long

time. For this reason, RAD came out for developing a system in short time. RAD is invented by James Martin, who wrote, "Rapid Application Development (RAD) is a development lifecycle designed to give much faster development and higher-quality results than those achieved with the traditional lifecycle. It is designed to take the maximum advantage of powerful development software that has evolved recently." in his book. (See Fig. 1)

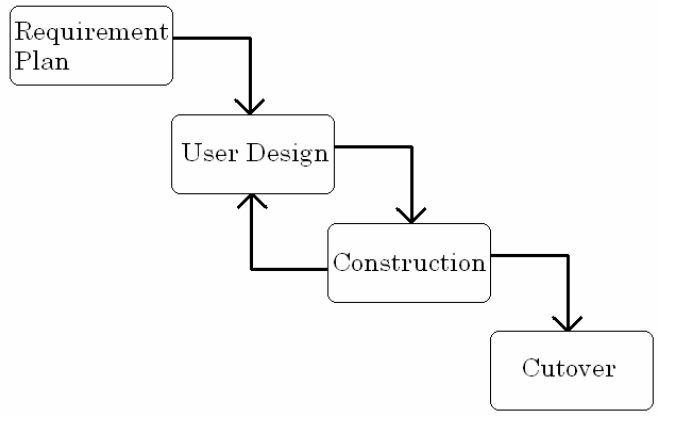

Fig. 1. Rapid Application Development Model

In order to focus on the requirements of user interface and system functionalities, RAD sacred systems analysis and systems performance to decrease the time of planning and designing phrase. Most time RAD put more emphasizes on prototyping, it is also possible draw back from designing phase to planning phrase. Generally speaking, the situations are not too bad to fall back previous phrase. The users' high participance makes the system performance better than the traditional method's system.

In RAD, there are four main aspects, tools, people, methodology and management. Each one of these is necessary if any one of these ingredients is insufficient, the development speed will not be high. Development lifecycle merged all the components together as effectively as possible. In short, RAD needs proper working methodologies, well trained employees and simplified management with efficiency.

Requirements planning involve planning and analysis. In this stage, high level managers and knowledgeable workers decide the system requirement. However these decisions are made based on commerce environment and problems. After the system is planed, the users and system analyzers will do the requirement analysis to meet the goal. Such kind of developing stage is similar to the traditional method.

In users designing stage, users and system experts will join the meeting together. They applied some tools to assist system prototype planning in high speed. These prototypes will convert to the physical basis in future development. Using the computer tools to plan will shorten developing time.

In construction stage, professional designing workers generate the program codes with some tools, users are also involved at the same time. In some small system, construction phase and user design phase can integrate together.

Cutover stage, also known as the Deployment Stage, this stage involves final user testing and training, data conversion, and the implementation of the application system.

4 RAD Card Game

Our research is to design a card game with RAD as the learning object. With the simple game rules, learners can gain some practical experience in RAD progress. Learners can experience RAD developing progress, tools, methodologies and the possible problems. When learners involve in the game, they will meet the problems, then try to solve them. They even need to modify the methods by themselves.

The game is played by round, each round is separated the following steps.

1. Decide if the learner will move forward to next stage.
2. Draw one card.
3. Play the card depends on the stage the learner involved.
4. Discard the redundant card.

After all the learners do through the steps, then jump to next round.

According to RAD four aspects, the stage sequence is requirements planning, user designing, construction and implementation. Each player has five cards, no mater how many cards are discarded in one round. Player can draw the cards until each one has five cards. If there are no more cards, then shuffle the cards which are discarded as the prepared cards. In order to reach the equally of the game, each player has the same number and type cards, player who reach the goal win this game.

There are seven kinds of cards; they are project card, plan card, code card, employee card, requirement card and event card.

Project card recorded the system quality, the system budget and the required employee number. Project card is the goal of each player. Player has to consider the budget, employee and system quality. (See Fig. 2 (a))

Plan card is divided into simple plan, normal plan and complete plan. Plan card can be placed five cards on the table at most. The plan card quantity decided how much resource can use. (See Fig. 2 (b))

Requirement card is similar to mission card which presented the mission conditions. Requirement card represent user's requirement in system development. Player has to reach the requirement to enter next stage. (See Fig. 2 (c))

Employee card describes employees' information, such as name, ability, skill, personality and salary. Player can replace any employee card if he/she has another better card. At last , employee card is useless for the first round till next round. (See Fig. 2 (d))

Event card has all kinds of events. Some events has to meet some conditions then it will be launched else it is in vain. However if the competitor has enough preparation, then the event cards are useless. (See Fig. 2 (e))

Approach card has opposite function to event card. Approach card helps player with high progress. Method has its active condition, like event cards. (See Fig. 2 (f))

In the beginning, player draws a card from project cards. With the objective, the player who completed all the four stages won the game.

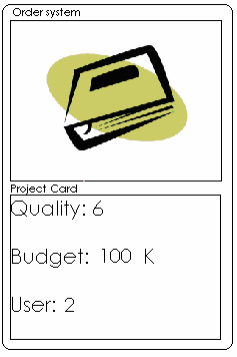

Fig. 2. (a) Project Card

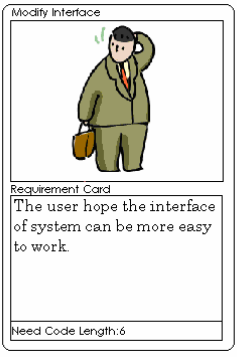

Fig. 2. (b). Requirement Card

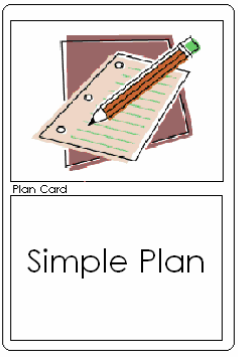

Fig. 2. (c). Plan Card

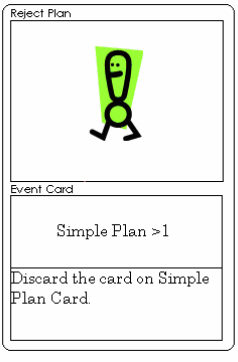

Fig. 2. (d). Event Card

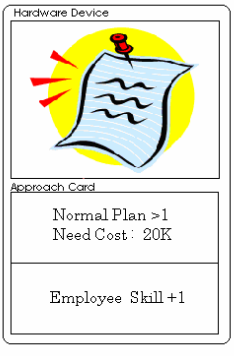

Fig. 2. (e). Approach Card

Fig. 2. (f). Employee Card

Planning is the basic stage, player draws five cards first. (See Fig. 3) Then player draw a card from plan cards then play a plan card on the table. Plan card level will effect the situation that player will meet. If player got another plan card which is better than the previous card on the table, it can be replaced by another high level plan card. Plan card is the only kind card which can be place in planning stage, the other kinds of cards are not allowed.

After planning stage, then the requirement stage comes. (See Fig. 4, 5 and 6) Make sure each player has five cards on the hand. Then player draw a card from requirement cards then evaluate if the requirement card is reasonable and reachable. If yes, then play the requirement card on the table, else discard the card and finish this round until next round. The same procedure repeats with the rule. Project card recorded the user quantity limitation; if the user quantity is four then the player has to complete four requirement cards.

Entering construction stage, player follows the requirements of the card to place the employee cards which are allowed to place on the plan cards. (See Fig. 6, 7 and 8)

The first round to put the employee card can not work till next round. If the plan card is covered enough employee cards, player can replace other better employee card. And it also follows the rule which means the replace employee card is useless in the first round. All the employee cards can perform four kinds of jobs that are normal construction, rapid construction, check errors and debug. The work efficiency of the employee is depends on the skill. According as the requirement card complexity divided by employee's skill equals the progress which the employee can do in this round. Meanwhile, player can use approach cards to progress the employee work in high speed or apply the event cards to disturb other players' progress. When player has filled all the requirements, he/she can back to previous stage to receive another requirement.

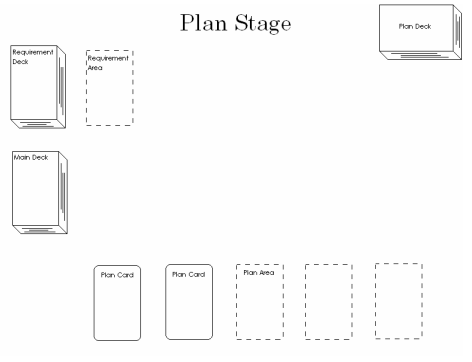

Fig. 3. Plan Stage

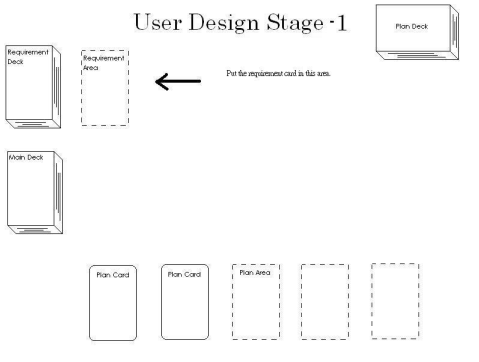

Fig. 4. User Design Stage (step 1)

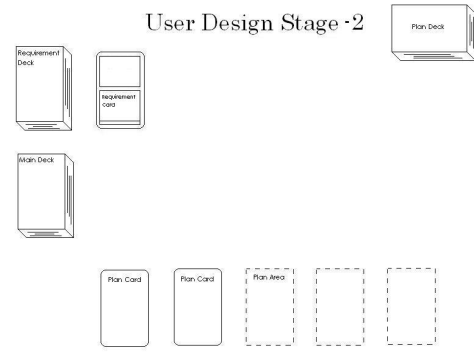

Fig. 5. User Design Stage (step 2)

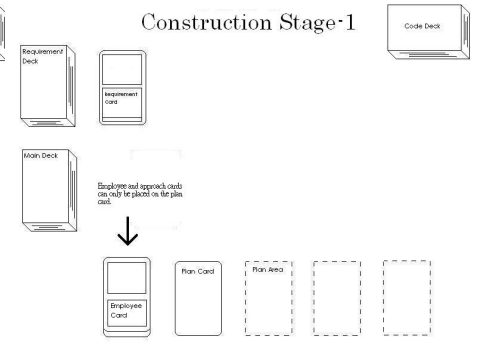

Fig. 6. Construction Stage (step 1)

Cutover stage is the final stage which player with requirement card's requirement puts all the code cards on one of the employee cards. (See Fig. 9) Employee cards and approach cards can do the same job but it can't be replaced in this stage. On the other

hand, other players can't use event cards to affect other players. When player thinks he/she is ready, then it is final stage (See Fig. 10).

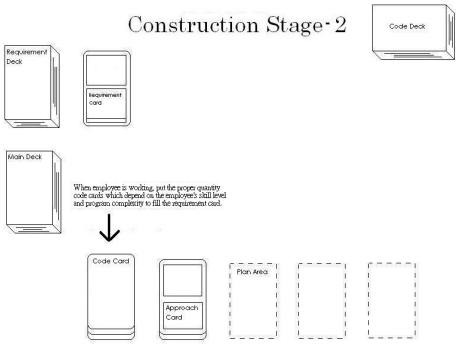

Fig. 7. Construction Stage (step 2)

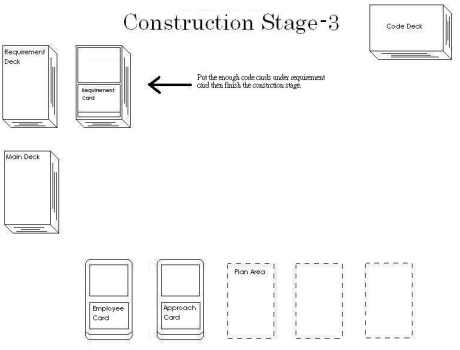

Fig. 8. Construction Stage (step 3)

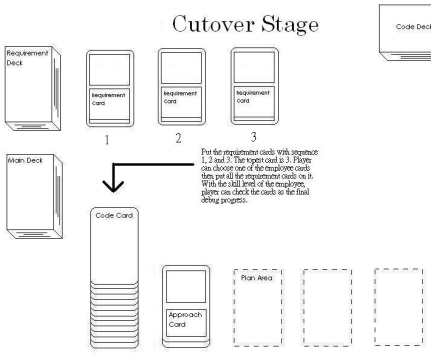

Fig. 9. Cutover stage

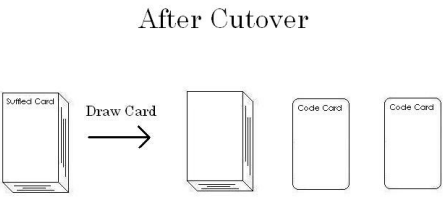

Fig. 10. After Cutover Stage

In transfer stage, player shuffles the code cards first then draw and turned the same number code cards which the requirement card requested. If there is no bug then the player won the game. If there is serious bug, player has to back the first stage. If it is normal bug, player back to requirement stage then repeat requirement and construction. If there is simple bug, player back to cutover stage and debug until it is finished. The first player completed the transfer stage won the game.

5 Discussion

We found another famous card game [Problems and Programmers] which is also target on software engineering. We did some comparisons in Table 1. The two games have different teach models as the learning objective. Also our RAD card game will develop to a computer based game. With the comparison, we can develop better card game in the near future.

Table 1. Comparison of [Problems and Programmers] and [System Design]

	Problems and Programmers	System Design
Background and Designing Model	Software Engineering -Waterfall Model	System analysis and deign -Prototype Model
Player Number	2 or more players	2 or more(Physical) 1(Computer game)
Proceed Type	Round	Task and Round
Card Category	5 kinds	6 kinds
Game Stages	5 stages	5 stages
Cards in hand	5 cards	5 cards
Conditions of Winning	According to program code to reach the requirements then win the game.	According to task requirement and user requirement to reach the requirements then win the game.
Game Objective	Learning waterfall model from this game and players can imitate other players' tactic.	Learning prototype model from this game and players can imitate other players' tactic. The player had to realize the users' requirements then he/she can handle it.

6 Conclusion

RAD is a card game which can assist learners gain practical experience according different stages from planning stage to cutover stage. Learners fulfill individual's requirement to complete their mission. Learners must study system analysis and design course as prerequisite. The flexible RAD card game assists students in studying different methods while encountering different problems.

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Application of PageRank Technique in Collaborative Learning

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Abstract. With the rapid development in web 2.0, lots of realm communities provide free platforms for users to enrich their knowledge through online communication, sharing and socializing without boundaries. As an on-line system may interact with thousands of users, it is almost impossible for the field experts or teachers to give instant help manually, which is not only inefficient, but also human laborious. To cope with it, an E-learning community should construct an efficiency knowledge acquiring mechanism. To assure this mechanism, this research applies PageRank-based mechanism to rank knowledge items synthetically. The system appraises the knowledge items provided by learners based on their rank, other users remarks and most importantly teachers' and realm experts' remarks, thus picks out the KIs to the knowledge base. In return the users' grade will be upgraded or degraded by their KIs. Learners are served with knowledge that best matches their needs and encouraged by each other. Thus this study sets up an aspiring and aggressive collaborative learning environment. Experiments results have shown that the developed system.

Keywords: Collaborative/cooperative learning, PageRank, knowledge acquiring, fairness gene.

1 Introduction

Recent progress of computer and network technologies has encouraged the development of web-based learning environments [1, 2], in which people obtain knowledge from kinds of realm communities without being limited by location and time. With all of e-learning's promise and the research effort spent on it, a literature review has unveiled major concerns about its effectiveness and appropriateness [3].

However, research indicates that a high rate of users who attend e-learning communities quit [4]. By considering the responses of users who participated, it is possible to better understand their dissatisfaction of not getting help in time. How to

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provide users effective resource and instant help is practicing by many realm communities. But these communities only provide discussions; the users are likely confused with all these answers and material. Nevertheless, most of the answers obtained from the discussion group could be incorrect; though the most desirable approach is to obtain the answers from the realm experts. Unfortunately, for a popular on-line community with thousands of users, it is human laborious and almost impossible.

Some researchers provide auto-reply e-learning system [5, 6]. However, current auto-reply system should first roughly format questions compatible with the system, and can only provide answers within the knowledge base of the system. Some researchers put forward personalizing e-learning systems [7, 8]. In our approach, we encourage users for collaborative learning and pick out or recommend the most suitable user answers. The structure of the paper is as follows. In section 2 we present the system architecture, while in section 3 we put forward the user ranking sub system based on PageRank technique. In section 4 a blog website for instruction is described as a case study of the proposed methodology, while in section 5 results based on experiments are provided. Finally, section 6 gives our concluding remarks and describes briefly future work.

2 System Architecture

2.1 General Architecture

The general architecture of the proposed CELS (Collaborative E-Learning System) includes three main components (Fig. 1). The first entity is the User or in most cases the Group of Users. It includes single users, participating in the learning process as individuals, as well as users participating in the educational process in groups, e.g. collaborative learning. The second entity is Group of Experts or professional teachers. They can be realm experts and IT engineers. Realm experts solve realm questions and IT engineers design and continuous improve the system. The last entity is the CELS itself, including all hardware and software systems. It also includes the internet networks and the database of the system.

2.2 Data Flow of the Architecture

In this subsection we describe the data flow between the entities of the system. Users of this system can both present knowledge entities to other users and acquire knowledge entities from the system's knowledge base or directly from other users. Users' behavior in the system, esp. the behavior of presenting KIs (Knowledge Item), will affect his grade and credit in this system. And in return transfer the parameters to the evaluation subsystem.

In our system we add a temp knowledge base (temp KB) to temporarily store KIs presented by the users. KIs in the temp KB should first assess by realm experts and teachers after officially adopted by the knowledge base (KB). KIs can not be stored in the KB permanently; outdated and improper ones will be abandoned. The evaluation subsystem partly sees after it.

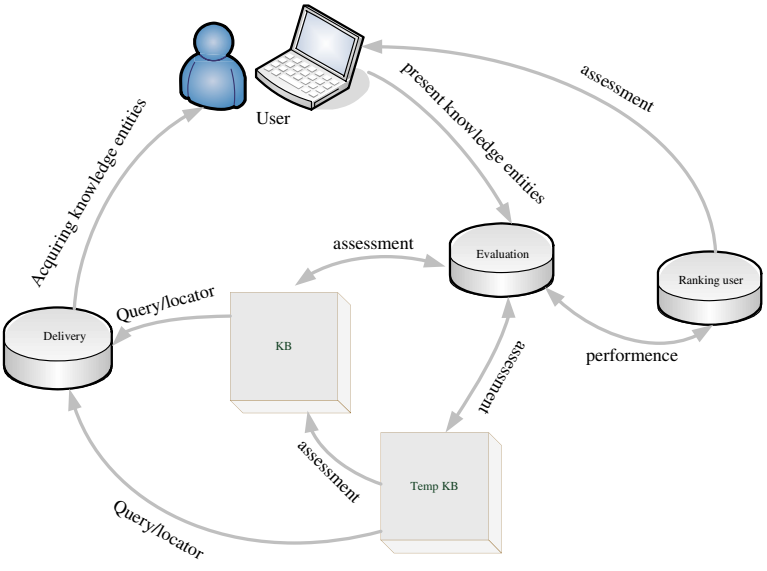

Fig. 1. General Architecture of CELS

The evaluation process produces assessment information and sends it to KB, temp KB store. In addition it creates a performance information flow to and from user ranking process. The delivery process accepts users' demands, creates queries and locates KI in KB and temp KB. Of course KIs in the KB will be preferentially chosen.

3 PageRank-Based Knowledge Item Ranking Mechanism

3.1 PageRank Technique

PageRank TM invented by Larry Page and Sergey Brin is a web PageRanking technique. Its main function is to rank a web page's weightiness, and thus to optimize query results. Larry and Sergey studied the comparability between network hyperlink structure and literature referencing mechanism, applied referencing analyzing theory to analyze network hyperlink structure. For example, we consider web page A votes web page B ticket when A links to B, which increases web page B's weightiness. Thus optimize the sorting algorithms. PageRank's mathematic model is as follows:

$$PR(u) = (1-d) + d \sum_{v \in B(u)} PR(v) W^{in}_{(v,u)} W^{out}_{(v,u)} \tag{1}$$

$$W^{in}_{(v,u)} = \frac{I_u}{\sum_{p \in R(v)} I_p}, W^{out}_{(v,u)} = \frac{O_u}{\sum_{p \in R(v)} O_p} \tag{2}$$

PR(u) is page u's PageRank value, d is the balancing gene (generally 0.8-0.9), $W^{in}_{(v,u)}$ and $W^{out}_{(v,u)}$ is link(v, u)'s weightiness; Iu is page u's inner links and Ou is u's outer links, R(v) is a list of web pages pointing to page v[9]. In our system, a knowledge item is not only relevant to knowledge items he provided, but also relevant to whom referring them.This paper exploits the theory of PageRank technique to assist ranking knowledge items provided by users.

3.2 PageRank-Based KI-Rank Model

The value or weightiness of a knowledge item is mainly decided by the following factors (the number i is a positive integer):

1. The knowledge item provider. Generally the higher accomplishment the provider has the higher weightiness the knowledge item gets. We use Grade(i) to denote knowledge item i's provider's grade.
2. The cited state. Mainly consider two aspects: cited frequency and the quoters. If this knowledge item is frequently cited and its quoters are high grade professional or realm specialists, it will be regarded as a valuable item and its weightiness will be greater. We use Cited(i) to denote knowledge item i's citing state.(Fig.2.)

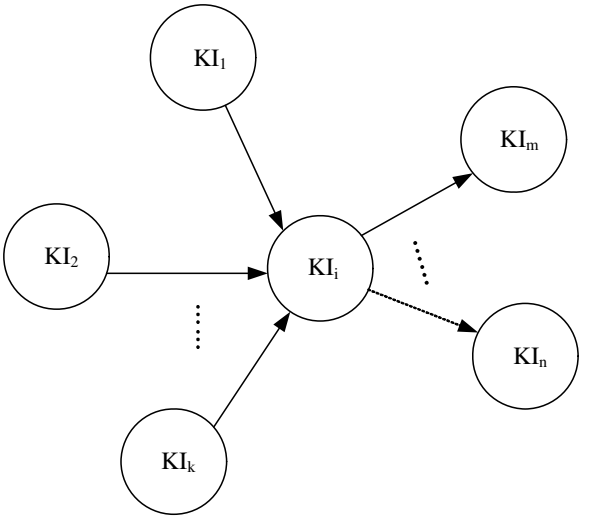

Fig. 2. Correlativity Model of KEs

3. The citing state. All knowledge items knowledge i cited should also be considered when appraising knowledge i. We use Cite(i) to denote knowledge items i cited. (Fig.2.)
4. Other users' feedback. Before knowledge item i is put into the KB, it will first be put into temp KB. In this state, other users' appraisal will be considered. We use Score(i) to denote it. Score(i) is a weighted mean.

5. Obsolescence of item i. it's a knowledge blasting era, timeworn knowledge can probably be inappropriate or even be wrong. So we should take it into account. Obsole(i) to denote item i's obsolescence. And it is decided by the following two aspects:

   (i) Date knowledge item i created. If this item is never cited or browsed after its created, Obsole(i) = curdate – createddate(i). curdate denotes current machine date and createddate(i) denotes date knowledge item i created.

   (ii) Cited date. If item i was cited after created, Obsole(i) = curdate – citeddate(i) *§. §is a parameter relevant to the quoters' grade and credit.

Based on the forementioned, we set up our model for knowledge items referencing PageRank.

$$W(u) = (1-d) + d \sum_{v \in \beta(u)} W(v)C(v,u) \tag{3}$$

$$C(v,u) = \frac{Grade(u)Cite(v,u)Cited(v,u)Score(u)}{Obsole(u)} \tag{4}$$

Here W(u) denotes knowledge item u's weightiness; d is a fairness gene, preventing from network cheating which induces the knowledge item deposited or run-up; Cite(v,u) denotes item u cites knowledge item v, that is, v affects u; Cited(v, u) denotes item v cites item u, which represents item u; B(u) is a collection of knowledge items citing item u.

3.3 KI-Rank Procedure

Based on the analysis of 3.2, this study presents a detailed KI-rank procedure (Fig.3.). The parameter minweight and maxweight are lower bound and upper bound respectively. Any KI whose weightiness greater than minweight and less than maxweight is put into the temp KB, only whose weightiness greater than maxweight can be put into the KB. The parameter limitdays is a limit time-interval for appraising a KI.

4 User Encouragement Mechanism

We set up a mechanism to encourage users Collaborative Learning. A user always ready to help other users with high-grade knowledge items should be encouraged. Grade(i) denote user i's grade. Users' grades are nonnegative numbers, can only be assigned within 100. User's grade denotes user's specialty capability and also his credit.

The user's grade will be increased if one of the following happens:

1. One ore more of his knowledge items put into the KB. This user's grade will be greatly increased. Grade(i) = Grade(i) + mk, m and k are positive numbers.
2. His knowledge items accepted by other users, esp. adopted by the user who requesting it. His grade will be increased too.

$$\text{Grade(i)} = \text{Grade(i)} + \text{k}. \tag{5}$$

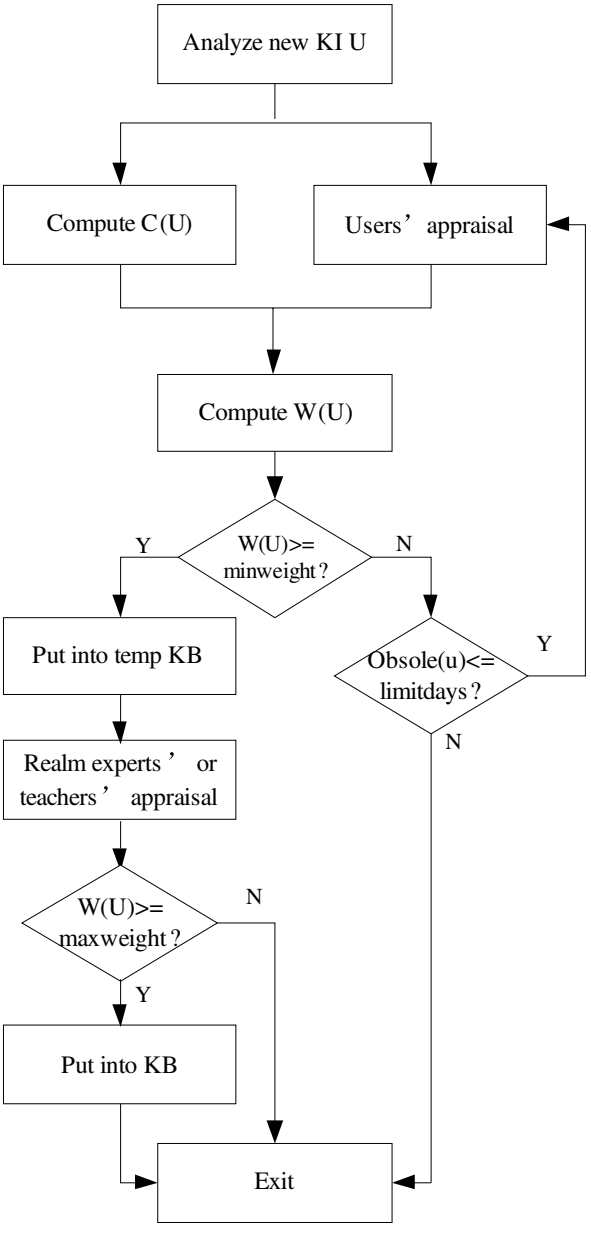

Fig. 3. Flow diagram of ranking a KI. This flow presents a detailed KI-rank procedure as described in 3.3.

The user will be punished if one of the following happens:

1. Participating network cheating which induces the knowledge item deposited or run-up. Grade(i)=Grade(i) – nk, n and k are positive numbers.

2. Publishing illegal or badly infective information.

$$\text{Grade(i)} = \text{Grade(i)} - k. \tag{6}$$

The forementioned k, m, n should be carefully decided in given e-learning systems. In our case e-learning system we will assign them according to our system.

5 Experiments and Interpretations

This study developed a demo collaborative learning system to practise our approach. This system is to assist database studying. Original KIs in the KB are from the textbook and realm experts. The users of this system are made up of teachers, realm experts and learners (mainly students). We select totally 50 students: 10 juniors, 25 sophomores and 15 fresher. 5 teachers and 2 realm experts engaged in this practice.

Table 1 presents the performance parameters of our approach. The cKIs is the candidate KIs put into the temp KB; cError rate equals unqualified cKIs divide by cKIs picked out; fKIs is the final KIs put into the KB; fError rate equals unqualified fKIs divide by all final KIs. The parameter cError rate and fError rate are manually computed by teachers and realm experts (totally 20 people). That means a 10000 KIs' collection is divided into 20 sub-collections and each see to one sub-collection. cError rate and fError rate parameters in table 1 are actually mean values.

Table 1. Values of each performance parameter

KIs	cKIs/all KIs(%)	cError rate(%)	fKIs/all KIs(%)	fError rate(%)
<500	13.4	3.35	2.4	0.951
1000	48.4	8.9	6.6	3.1
10000	50.6	8.55	6.2	3.37
>10000	49.9	8.75	6.4	3.29

In table 1, the first cError rate and fError rate are much smaller. It's because the first collection are mainly provided by teachers and realm experts, and the fifty students are top students. Our cError rate is a bit dim, but it is amended by the procedure of selecting candidate KIs to put into the KB. The cError rate is rather optimistic from table 1. More experiments show that the fError rate is among (0.9, 4), actually the worst one is 3.49%.

Fig.4. describes the correlation of learners' number and several parameters and their growth. This case greatly encouraged students' learning, though many of the KIs from the learners are incorrect and incomplete. Lots of other students are introduced to this system participating collaborative learning. Experiments show that KIs provided by students are increasing, and cKIs selected rate is increasing too. Remarkably, fKIs' rate of rise goes up quickly.

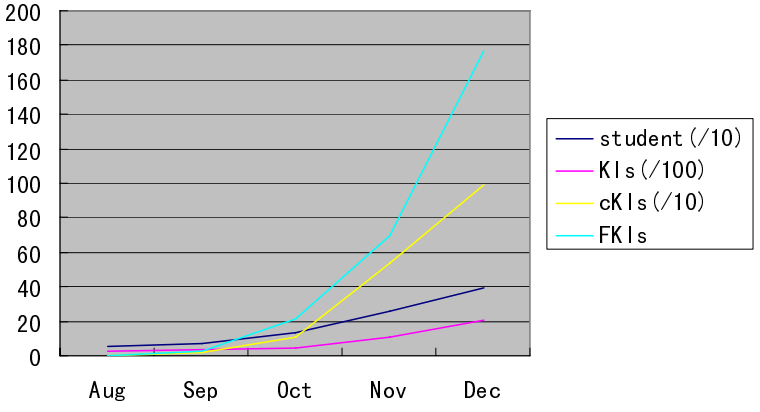

Fig. 4. The affects of learner number increase to each parameter

6 Conclusions

In this study, a collaborative e-learning system with KI appraising mechanism is presented, which allows students learning from each other, and hence the learning performance of the students can be improved by an aspiring and aggressive collaborative learning environment. Students in this system are not only encouraged by the system's appraising mechanism, but also by other students' approval.

Our KI ranking mechanism based on PageRank technique contributes a lot to the system, but some of the parameters should be much more choosey in order to improve our performance. In the near future, we will upgrade our server and DBMS to allow more students using this system, and get more accurate data to improve our system.

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Summarization on the Data Mining Application Research in Chinese Education

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Abstract. The application of data mining in the field of education is useful, which can help to improve the teaching quality, make scientific management decision. This paper details the data mining application research in Chinese education through relevant literature by retrieval. It analyses the research status in China from several sides as follow, statistical number, the study trend, the specialty background, the research hotspot and research approach. At last, this paper discusses the problems exiting in this research literatures.

Keywords: Data Mining, Application Research in Chinese Education, Literature Research.

1 Introduction

Data mining, also known as Knowledge-Discovery in Databases (KDD), refers to the process of sorting through large amounts of data and picking out relevant information. It is usually used by business intelligence organizations, and financial analysts, but is increasingly being used in the sciences to extract information from the enormous data sets generated by modern experimental and observational methods. It has been described as "the nontrivial extraction of implicit, previously unknown, and potentially useful information from data"[1] and "the science of extracting useful information from large data sets or databases."[2] Data mining in relation to enterprise resource planning is the statistical and logical analysis of large sets of transaction data, looking for patterns that can aid decision making [3].

As we know, to making a scientist decision, the people need data, information and knowledge. Data is raw and does not have meaning of itself. In computer parlance, a spreadsheet generally starts out by holding data. Information is data that has been given meaning by way of relational connection. This "meaning" can be useful, but does not have to be. In computer parlance, a relational database makes information from the data stored within it. Knowledge is the appropriate collection of information, such that it's intent is to be useful. Knowledge is a deterministic process [4].

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There are many analysts who could perform the task of extracting useful information from recorded data, but the increasing volume of data in modern business and science calls for computer-based approaches. As data sets have grown in size and complexity, there has been a shift away from direct hands-on data analysis toward indirect, automatic data analysis using more complex and sophisticated tools. The modern technologies of computers, networks, and sensors have made data collection and organization much easier. However, the captured data needs to be converted into information and knowledge to become useful. Data mining is the entire process of applying computer-based methodology, including new techniques for knowledge discovery, to data [5].

In China, e-learning gains an increasing popularity in college education and business training. With the application of computer technology in school, many digital information management systems have been implemented in the management. The design and implementation of web-based education systems have grown exponentially in the last years. These systems accumulate a vast amount of information which is very valuable in analyzing students' grade and behavior and to assist authors in detecting possible errors, shortcomings and improvements. However, due to the vast quantities of data these systems can generate daily, it is very difficult to manage manually, and authors demand tools which assist them in this task, preferably on a continuous basis. A very promising area to attain this objective is the use of data mining [6].

Data mining techniques are well acknowledged in banking, retail and many other commercial service sectors for their power helping to understand consumer individuality and improve individualized services. But the application in Chinese education is so late and seldom. This paper attempts to retrieve all papers about the research of data mining application in Chinese education and come to some useful conclusion. This paper is organized as follows. In section 1, we introduce briefly the data mining and present the problems which in the e-learning and the answering—to using data mining in education, section 2 introduces the state-of-the-art research in the fields of education at abroad, section 3 describes detailed the condition research in China from server aspects and draws some tables and figures to showing our conclusion, section 4 concludes this paper and discuss our future work.

2 The State-of the-Art of EDM

In the preface to the Educational Data Mining (EDM) Workshop at ITS 2006, educational data mining is defined as "the process of converting raw data from educational systems to useful information that can be used to inform design decisions and answer research questions"[7]. This paper uses the term of EDM later.

EDM uses same methods and producer as in other fields. But these data come on the one hand from traditional face-to-face classroom environments such as special education, primary education, higher education, etc. and on the other hand from computer-based education as well as web-based education such as learning management systems, web-based adaptive hypermedia systems and intelligent tutoring systems. Learning environments and, more broadly, educational activities accumulate a vast amount of data which is very valuable for analyzing students' behavior and could create a gold mine of educational data.[8]

There are so many organizations, experts, collages and so on begin to focus to on the research of EDM. Romero's & Ventura's have published a summarizes research papers about educational data mining a paper over the recent 10 years (1995-2005)[9].

In the last years, the numbers of contributions in this area have grown, both in both in international conferences, such as International Conference on Computers in Education, International Conference on Web-based Learning(ICWL), World Conference on Open Learning and Distance Education(ICDE), International Conference on Adaptive Hypermedia and Adaptive Web-based Systems(AH), International Conference on User Modeling(UM), International Conference on Intelligent Tutoring Systems(ITS), Pacific-Asia Conference on Knowledge Discovery and Data Mining(PAKDD), Genetic and Evolutionary Computation Conference(GECCO) and so on and in scientific journals, such as International Journal on E-Learning, IEEE Education, Computers & Education, Journal of Educational Technology Systems, Journal of Interactive Learning Research, User Modeling and User-Adapted Interaction, etc..

Researchers have begun to investigate various data mining methods to help teachers improve e-learning systems. These methods allow them to discover new knowledge based on students' usage data. The same idea has already been successfully applied in e-commerce systems and is now very popular.

There are many specific educational data mining, statistical and visualization tools that provide mining algorithms, filtering and visualization techniques, have been developed to help educators in analyzing the different aspects of the learning process. Romero's & Ventura's (2007) review summarizes research papers about educational data mining lists some tools, such as EPRules((Education Prediction Rules,2003 ExtendingAHA,),TADA-Ed(Tool for Advanced Data Analysis in Education,2005), BNT-SM (Bayes Net Toolbox for Student Modeling)[10], DataShop[11] and so on.

An International Working Group on Educational Data Mining have been organized, it has its own website[12], and continued to held many workshops at many conferences which include the AIED (2007, 2005), EC-TEL (2007), ICALT (2007), UM (2007), AAAI (2006, 2005), and ITS (2006, 2004, 2000) conferences before 2008.

In China, more and more people begin to concern the data mining in education. The following is our surveys the application of data mining to Chinese education, such as traditional educational, instructional management, distance learning, web-based courses, and adaptive and intelligent web-based educational systems and so on.

3 The Surveys about Application of Data Mining in Chinese Education

As mentioned above, Romero's & Ventura's have surveyed educational data mining from 1995 to 2005, which resources are these papers from proceedings of international conferences and the workshop.

In this paper, we want to analyze these papers published on the Chinese until 2007. The author has accessed the Chinese National Knowledge Infrastructure(CNKI) website[13], which is the most important and has the biggest data sets about research papers, and retrieve the literatures from three database including "the database Chinese journal Full Text", "the database Chinese doctor's thesis" and "the database Chinese master's thesis". For retrieving the papers about EDM, we enter some relevant

keywords and their group these keyword included *Data Mining*, *Educational*, *instructional, student(s)* and *learning*. After getting rid of the overlap and irrelevant literatures, there are about 156 pieces of literatures, including 37 pieces of master thesis and 1 doctor thesis. Table1 shows the retrieval results and the published time and number. As shown in Table 1, there are four keywords. We list tow kinds number for every subject, one is the number of papers in Journal or proceedings, the other lists. The unique doctor thesis's name was *Study of Data Mining Based Assessment of Distance Learning*,2005 published.

Generally, the master or doctor's thesis systemly introduce new methods, ideas , application tools and so on , which have some creative method, idea of system. So it is help to survey the research content, research system for us. So , the master or doctor's thesis are our research objects too.

Table 1. Statistic of Literal Number

Time	Subject Keyword (Data Ming and)							
	Instructional		Student		Educational		Learning	
2001	1	0	0	0	0	0	0	0
2002	1	0	0	0	2	0	1	0
2003	5	1	1	1	3	0	1	0
2004	10	1	4	1	2	1	1	1
2005	13	6	1	0	12	1	3	2
2006	20	6	11	4	16	2	0	0
2007	29	8	9	3	16	0	2	0

3.1 The Distribution by Year

The author draws the research trend according to the number in Table 1, which is shown as Fig.1. The dashed shows the total documents, the other three lines show the trend of retrieved results about "Instructional", "Student" and "Educational". As shown in Fig.1, We can know that, before 2001, there were no research documents about Data mining application in Chinese education, the research documents increased continually and rapidly from 2002. It illuminated the researching trend of data mining application in Chinese education.

Form the figure, we can get one conclusion that is data mining in education is a young research domain.

3.2 Statistic about Authors' Background

During read these papers retrieved, we find an interesting phenomena which is these authors have different profession such as teacher, student, researcher, the manager of educational administration, the decision-maker of college and so on. We also focus on these authors' specialty, including computer, pedagogy, educational technology, and educational management and so on. Before do these, we think that there should many educational organization and experts to do the data mining in Education, but the result is different to us. So, we have a special statistic about the authors' background.

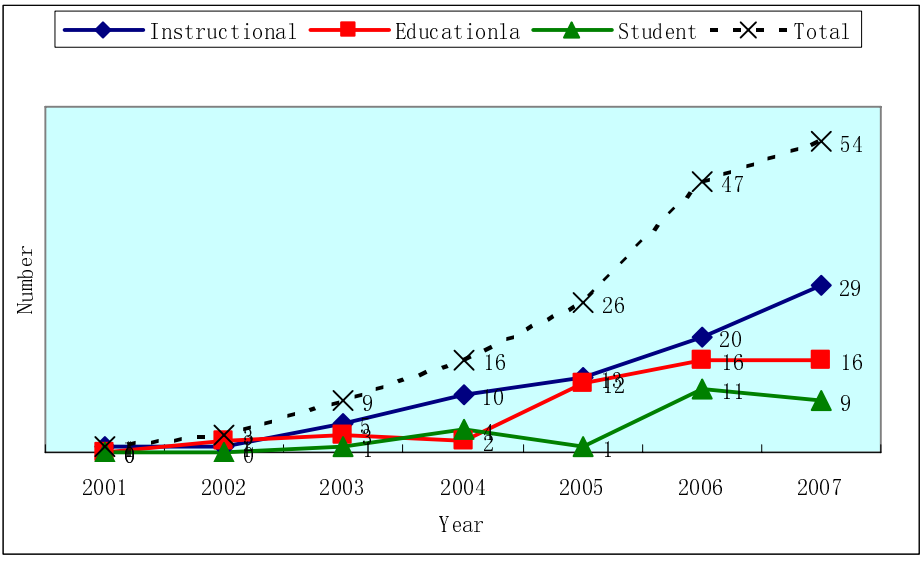

Fig. 1. The distribution of research literature by year

Because there are clear specialty list in the master and doctor's thesis , so we analyzed authors of 38 pieces of thesis, the result is shown in Fig. 2. From the figure, there are 85 percent authors had the foundation knowledge about computer, and rest authors had mathematic or educational knowledge.

From this figure, we can give one conclusion that data mining education is a realm of computer scientists, and it is little accessible for educators.

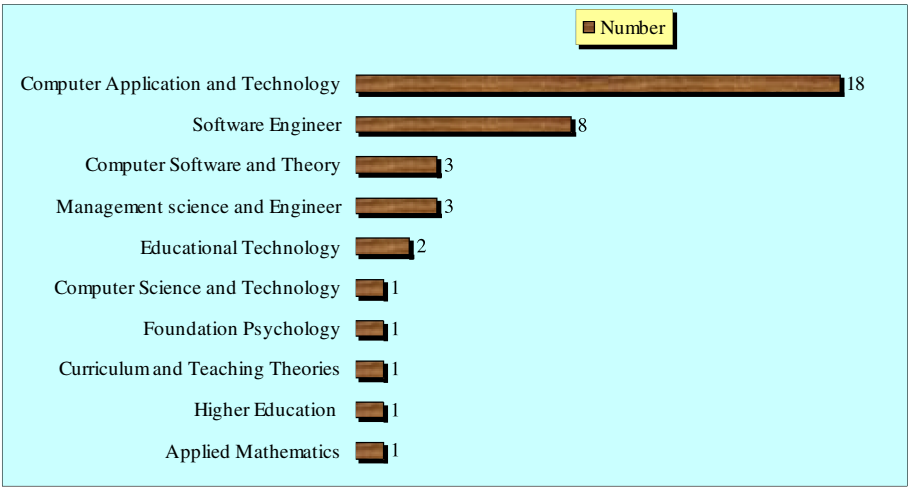

Fig. 2. The specialty distribution of master thesis author

The conclusion is suit for the development of data mining. Although data mining is a relatively new term, the technology is not. Data mining is a crossing science, which includes many theories and technique of other areas, such as database, artificial intelligence, computer science, machine learning, statistics and so on.

3.3 Survey of Research Content

As mentioned above, In China, e-learning gains an increasing popularity in college education and business training and there are many kinds of data. Data mining techniques can be applied: statistics and visualization; clustering, classification and outlier detection; association rule mining and pattern mining; and text mining.[9]

These data come from different source, such as information management system, traditional classroom, web log, intelligent instruction system and so on. According to the application area of data mining in education, we categories some learning contents as follow in the paper: instructional evaluation, educational administration management, analyses of record, students' information, distance learning, intelligent instruction and learning, personalized learning. The survey is shown as Table 2.

Table 2. The survey of research content

Keyword		Article Number
Data Mining	Distance Learning	35
	Students' Information	31
	Personalized Learning	20
	Instruction Evaluation	19
	Intelligent Instruction and learning	13
	Analyses of Record	8
	Educational Administration Management	6

From Table 2, we can see that the application in distance learning is the most popular. Distance learning consists of techniques and methods providing access to educational programs for students who are separated by time and space from lecturers. E-learning systems are lack of a closer student–educator relationship (one to one). Currently, web-based education is the most used and it allows students to conveniently learn via the Internet. For example, Web-based courseware can be viewed as a gateway to a variety of Web educational materials related to specific topics or educational goals. These web-based education courses and platform can normally record the student's accesses in web logs that provide a raw trace of the learners' navigation on the site. And these navigation information are help for assess the learner's of learning progress, understand learner's hobbies, perform the structure of the web-based courses and so on.

Students' information means the data come from traditional classroom. Adopting data mining technology to analysis the school teaching database, the useful information retrieved can help teaching staff to arrange their teaching work efficiently, to monitor and co-operate with departments and schools effectively, and help students to make grunt achievements.[14] Using data mining to mine knowledge in education databases, and to discover the association among different elements in education system in university, which provides a scientific basis for college management and decision making.[15]

Many papers describes how to use data mining to develop the intelligent learning system, such as Zhao, Juxue et al. designed a DM- based intelligent learning system (DMBILS), which uses data mining to analyze learner's characters like learning style and give good suggestion for their learning next.[16] Intelligent question answering system based on data mining is designed, which can classify the question in database exactly, the user question can orientated more quickly, and the better answer can be gotten exactly from database. [17]

In face, personalized learning is a part of distance learning, but it emphasizes the adaptive mechanism, which is an important idea of ITS (Intelligent Tutoring System), so we list it lonely in the paper. Data mining is used to design The personalized learning navigation system (PLNS), it is used to mine and analysis of the current user data, such as web log, to get the knowledge framework of the user, then, according to the whole knowledge space, we can make the complementary action to the user knowledge framework and provide the observed studying resources to the user.[18]

Despite the use for teaching or learning, another application of data mining in education is for educational administration management. It includes a lot of data, such as the information of student, teacher and the management department, the all courses information of the school, it is helpful to fulfill instructional management flounces. We refer it to courses management in the paper.

The instruction evaluation and the analyses of record are parts of educational administration management too. In this paper, the instruction evaluation is oriented to the teachers and the analyzes of record is oriented to the students.

3.4 The Survey of Data Mining Approach

Databases are rich with hidden information that can be used for intelligent decision making [19]. For getting useful information and knowledge, we need use data proceeding techniques and data mining techniques. These techniques includes many foundational algorithms, such as association rules, decision trees, artificial neural networks, genetic algorithms, clustering analysis, instance-based learning, Bayesian algorithms, rough set, and statistics analysis. Text mining and web mining are typical application of data mining, but they have their own objects and stepwise, we include them as two approaches in the paper.

We read and arrange the approaches used in these retrieved paper, and draw Fig. 3 as follow:

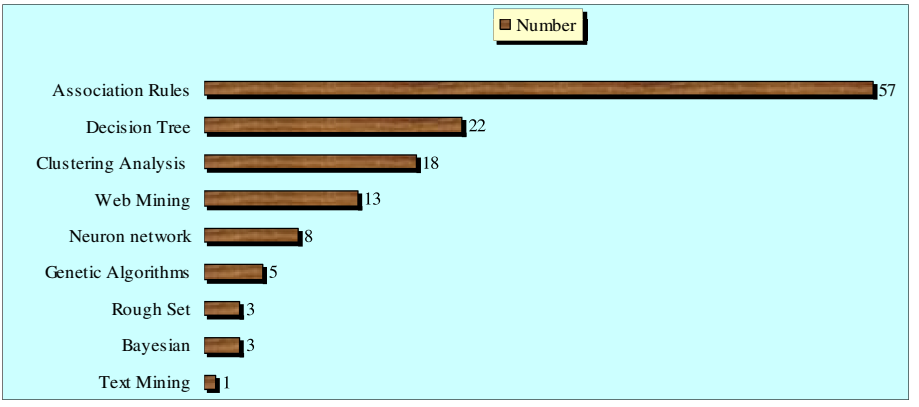

Fig. 3. The distribution of data mining approaches

From Fig. 3, we can get a conclusion that the mature and traditional algorithms is used more. An association rule is a popular and well researched method for discovering interesting relations between variables in large databases. Association rule is used in the assessing of teaching and is used to find the association between teacher's qualification, age, title and their instructional quantity. Association rules is used in the personalized learning, which mines the association of learner's trace and their learning characters.

Decision trees are powerful and popular tools for classification and prediction [20], which is used in analysis of students' record and find the relation between their grade and their learning quantity in classroom [21].

Clustering is a division of data into groups of similar objects. Each group, called cluster, consists of objects that are similar between themselves and dissimilar to objects of other groups.[22] Clustering analysis can be used in the grouping. In e-learning, Cooperative learning become more and more popular in schools and many teachers explores them in the classroom, but which grouping strategy is best, how to group is suitable. Clustering analysis support some science data for us.

Web mining and text mining are the application of data mining techniques to discover patterns from the web and the text. They need some algorithms mentioned above. Web mining is used in web-based course and web-based educational system. There are three kinds, one is usage mining - the process to analyze and discover interesting patterns of user's usage on the web, one is content mining - the process to discover useful information from the content of a web page, the other is structure mining - the process of using the graph theory to analyze the node and connection structure of a web site (Cooley, Mobasher & Srivastava, 1997).The web logs are the main source for web mining.

Text mining can work with unstructured or semi-structured data sets such as emails, full-text documents, HTML files, etc. So, it is an important process for web mining.[23]

We retrieved a poll website and get a poll named "*Data Mining Methods (Mar 2007)*", the question is "Data mining/analytic methods you used frequently in the past 12 months." There are 203 voters provided their answers, which is shown in Table 3 [24].

Because the later is not only the data mining in education, it has more detail and new methods. But there is a similarity, the traditional methods are used more.

Table 3. The poll of Data mining/analytic methods you used frequently in the past 12 months

Data mining/analytic methods	Results
Decision Trees/Rules (127)	62.6%
Regression (104)	51.2%
Clustering (102)	50.2%
Statistics (descriptive) (94)	46.3%
Visualization (66)	32.5%
Association rules (53)	26.1%
Sequence/Time series analysis (35)	17.2%
Neural Nets (35)	17.2%
SVM (32)	15.8%
Bayesian (32)	15.8%
Boosting (30)	14.8%
Nearest Neighbor (26)	12.8%
Hybrid methods (24)	11.8%
Other (23)	11.3%
Genetic algorithms (23)	11.3%
Bagging (22)	10.8%

4 Conclusion

Data mining in education is an upcoming field related to several well-established areas of research including e-learning, adaptive hypermedia, intelligent tutoring systems, web mining, data mining, etc [19].

4.1 Research Status

More and more organizations and researchers focus on the data mining application research on education in China, particularly the researcher with computer background. The subjects of application study related to education include evaluation, students' information, E-learning, instructional management and so on. All of above have large amounts data, it can supply a gap of traditional statistic approach use data mining in the analysis and Mining more implicit knowledge. The research result would provide scientist data for making correct decision. Researchers used different data mining approaches, but it would be more efficient to compound several approach or ameliorate the existing approach, which could overcome their limitation and improve the precision and reliability.

4.2 Existing Problems

(1) Low Research Level
About 80 percent of these literature introduced one or multiple approach and applied it or them in the educational practice, the author had not analysis the approach could solve which matter from theory, and had not prove the approach feasibility through computer simulation.

(2) Seldom Supported by Research Program and Fund
In all retrieval literature, there are only 15 pieces of document had been supported by the research program and fund, for example National Natural science fund, the science and technology research program of Ministry of Education of China, the Emphasis Subject of Educational Scientist Plan and so on. The number is so little than the number of all literature. Organization and researcher would pay more attention to the application research of data mining in the field of education. [25-28]

(3) Low Application Range
About 98 percent amount these literature applied data mining in higher school, only one paper, which subject was "Data Mining Application Research in Education Activity of Middle School", had definitely applied data mining in middle school. But in fact, the recommence of China basic education need more science and implicit data. The data mining would help to make rational decision.

In a brief, it is an important way that the manager and teacher use the result of data mining during the process, which help staffs to make scientific decision to improve instruction.

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Medical Imagistic Database Query for Educational Purpose

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Abstract. The paper presents original query modalities on a multimedia database that stores medical images and the associated information, for educational goal. So, a modern and efficient system for professional accomplishment is offered to the medical superior education (including residents, young specialists, family doctors and medical assistants). Specialists can update the medical image database with images acquired from different patients in the diagnosis and treatment process. A series of alphanumerical information: diagnosis, treatment and patient evolution can be added for each image. The database can be browsed, simply text-based queried or content-based queried using colour and texture characteristics automatically extracted from medical images at their loading in the database. An original element is the presence of a topic map based on a part of MeSH thesaurus, the part that includes the medical diagnosis names. The student can navigate through topic map depending on its interest subject, having in this way big advantages. He does not have to be familiar with the logic of the database, he will learn about the semantic context, in which a collection and its single items are embedded and he may find useful items he would not have expected to find in the beginning. Also, semantic queries against the multimedia database can be automatically launched with the help of the topic map. All these access paths can be combined for retrieving the interest information. Using content-based visual query with other access methods on a teaching image database allows students to see images and associated information from database in a simple and direct manner. This method stimulates learning, by comparing similar cases along with their particularities, or by comparing cases that are visually similar, but with different diagnoses.

Keywords: medical e-learning, medical image database, content-based visual query, topic maps, color feature, texture feature.

1 Introduction

Nowadays, in the medical superior education, there is a series of problems about also the confidentiality of the medical act, and the direct interaction of the student and patient. So, in conformity to the law, the information about the patient's disease is strictly confidential, and his examination by the student or the diagnosis and therapeutic practices can be realized only with his explicit accept.

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In this way, there is an evident limitation of the student's access to the information coming from the classic medical education. In the developed countries the problem was solved by means of e-learning solutions. So, in many prestigious European and US universities, the very known "patient's bed residential stages" evolved from the beginning of the third faculty year, are almost to be canceled, due to some real problems about the medical services: big risk for nosocomial infections (the big number of persons that are in cliniques), big risk for medical errors and implicitly big expenses with malpractice assurances (the medical practices committed by students or young doctors finished sometimes with grave complications), problems about confidentiality of the medical act and the respect of the patient's rights to intimacy, the limitation of the patient's resting and recuperation time by the presence of the students' groups, the limitation of medical performance of the groups leaders by dissolving their activity between the didactic and medical duties.

Although it can not definitively renounce to the direct transfer of the knowledge from professor to student during the stages hours, the electronic learning solution solves the above enumerated problems and offers multiple advantages like: the facile information access, a better storage of the didactic material, the curricula harmonization between universities, personalized instruction, informational content standardization, real time access to qualitative information resources, the hybrid learning being an ideal solution for medical domain.

Due to all these advantages medical e-learning has become more and more important and more frequently used in the last decade [1], [2], [3], [6], [7]. The technological development and the Internet contributed to the development of e-learning resources, repositories and digital libraries for access to e-learning materials were established (MedEdPortal, Association of American Medical Colleges, End of Life/Palliative Resource Center, The Health Education Assets Library, Multimedia Educational Resource for Learning and Online Teaching, International Virtual Medical School) [10].

The accomplished studies, including those focusing on medical domain, indicated that the students substantially appreciate the e-learning method, due to the facilities offered (easy access to materials, navigation, interactivity, friendly interfaces), but they don't consider it as a replacement of the traditional learning which has other advantages [8].

The introduction of the multimedia components (text, images, sound, video, graphics, animation) for the improvement of the learning content led to the necessity of the concept which precedes even the Internet, i.e. the multimedia learning. Both teachers and students consider that the multimedia learning improves the process of teaching and learning [10].

In the medical learning process, the courses in traditional or electronic format are accompanied in many cases by a series of images. For example, at a gastroenterology course, for the presentation of the ulcer diagnosis, the teacher presents to the students images that are relevant for this diagnosis, highlighting the changes in color, texture or shape of the sick tissue, in comparison to a health one.

In general, the presented images number is minimal. Accordingly, the existence of a database with medical images that could be collected by the teacher in the process of patients' diagnosis and investigation raises considerable the variety of communicated knowledge.

The paper presents innovating modalities for querying a database with medical images for educational goal. It is proposed the combination of classic query methods with original methods like content-based visual query and topic maps for semantic searching and browsing. The classic method is based on text. For example, the student introduces a diagnosis and all the images from the database with the corresponding diagnosis will be returned.

A modern query method is content-based visual query. In this case keywords or other texts are not used. The query uses the characteristics extracted from images (for example color and texture). This type of query is implemented taking into account the whole image, or only parts of it (regions). In the first case the name of the query is content-based image query. It will find in the database all the images that are significantly similar to the query image. In the second case, the name of the query is content-based region query. It needs to be selected one or several regions used as query regions and it searches in the database all the images that contain the selected regions. In this case it is necessary to have an automated region extraction algorithm for images, using certain characteristics (for example color) [13], [17].

A topic map based on a thesaurus with medical terms will be used also as browsing tool for student, allowing him to browse the image collection, and as a means to enable semantic searches.

The student will be able to combine different access options, which is supposed to be the most successful approach in image retrieval. Using content-based visual query with other access methods to medical image database allows students to see images and associated information in a simple and direct manner. They only have to select a query image and find similar ones. The student is stimulated to learn, by comparing similar cases or by comparing cases that are visually similar, but with different diagnostics [15].

This database with medical images and the modern and combined access possibilities can be used in the education process by the medicine students and by any physician who wants to improve his knowledge for establishing a correct diagnosis based on imagistic investigation, which is frequently used in patient's diagnosis.

2 The Medical Image Database

Further on, this paper presents the way in which a medical image library is managed for educational purposes. This implies the insertion of images and the launch into execution of some pre-processing algorithms for extracting information related to color and texture. Thus the images are prepared for the next stage, which is that of content-based query by color and texture.

2.1 Database Structure and Management

The system offers professors the possibility to insert new images in the database, together with their relevant information, namely: path and name of the image file, the diagnosis, as well as supplementary information that include specialists' observation regarding the disease and the way in which it is illustrated by image, treatment and evolution.

For realizing the content-based visual query, all the images loaded in the database are automatically processed in two steps:

1. the extraction of color feature
2. the extraction of texture feature

2.2 The Extraction of Color Feature

The images are pre-processed, namely they are transformed from the RGB color space to HSV color space and quantized to 166 colors, being thus prepared for a future query. The HSV color space is preferred, for its properties (compactness, completeness, naturalness and uniformity), which allow it to be proper for usage in the content-based visual retrieval [13], [17].

For the quantization of the HSV color space, the solution with 166 colors was chosen. Because the hue represents the most important color feature, it needs the finest quantization. In the circle that represents the colors, the primary colors red, green and blue are separated by 120 degrees. A circular quantization with 20 degree step separates sufficiently the colors. The saturation and the value are each quantized to three levels. The quantization produces 18 hues, 3 saturations, 3 values and 4 greys, that means 166 distinct colors in the HSV color space. The color information from the image is represented by means of the color histogram and by the binary color set. The color information is stored in the database as a vector with 166 values and it is used furthermore in the content-based image query and content-based region query [13].

The dissimilitude between the query and target image is computed using the histogram intersection [13], [17]:

$$d_{q,t} = 1 - \frac{\sum_{m=0}^{M-1} \min(h_q[m], h_t[m])}{\min(|h_q|, |h_t|)} \tag{1}$$

2.3 The Extraction of Texture Feature

Together with color, texture is a powerful characteristic of an image, which is present in nature and in medical images also. Thus, a disease can be indicated by changes in the color and texture of a tissue [15].

There are many techniques used for texture extraction, but there is not any certain method that can be considered the most appropriate, this depending on the application and the type of images taken into account. The effectuated studies on medical images indicated that among the most representative methods of texture detection are the Gabor representations, reason for which it was chosen for extracting the colour texture feature from medical images in the database [15].

In the case of Gabor filters, starting from the representation of the HSV colour space, the colour in complex can be represented [14], [16]:

$$b(x, y) = S(x, y) \cdot e^{iH(x, y)} \tag{2}$$

The computation of the Gabor characteristics for the image represented in the HS-complex space is similar to the one for the monochromatic Gabor characteristics, because the combination of colour channels is done before filtering [14], [16]:

$$C_{f,\varphi} = (\sum_{x,y} (FFT^{-1}\{P(u, v) \cdot M_{f,\varphi}(u, v)\}))^2 \quad (3)$$

The Gabor characteristics vector is created using the value $C_{f,\varphi}$ computed for 3 scales and 4 orientations [16], [18]:

$$f = (C_{0,0}, C_{0,1}, \ldots, C_{2,3}) \quad (4)$$

So the texture feature is represented for each image as a 12-dimension vector stored in the database.

The dissimilitude between the texture characteristics of the query image Q and the target image T is defined by the metric [14], [16]:

$$D^2(Q,T) = \sum_f \sum_\varphi d_{f\varphi}(Q,T), where\ d_{f\varphi} = (f^Q - f^T)^2 \quad (5)$$

3 Topic Maps

Topic maps define a model for semantic structuring of knowledge networks. Represent a solution for organizing and accessing large information pools, providing a bridge between knowledge management and information management domains. Topic maps represent a powerful tool for modeling semantic structures (associations) between any kinds of things (topics), which are linked to any kind of documents (occurrences) [5], [9].

Manual topic map population may require lots of resources: time, money and humans. As a result it is posed the problem of the self-population of topic maps. The available resources that can act as a source of input to auto-population are identified: ontology, relational or object-oriented database, metadata about resources, index glossary, thesaurus, data dictionary, document structures and link structures or unstructured documents [5].

It can be observed among these resources, the presence of thesaurus and XML, which are used for the design and self- population of topic maps, solution adopted by us also.

When converting a thesaurus to a topic map, the thesaurus provides the topics and some basic associations: the superclass-subclass association, synonyms and related terms.

In this software tool for medical learning, it is used a thesaurus that was designed based on MeSH that is the National Library of Medicine's controlled vocabulary thesaurus. It consists of sets of terms naming descriptors in a hierarchical structure that permits searching at various levels of specificity. At the most general level of the hierarchical structure there are very broad headings such as ``Diseases". More specific headings are found at more narrow levels of the eleven-level hierarchy, such as ``Duodenal Ulcer" [4]. Taking into account that the most important information associated to medical images is the diagnosis, and the retrieval is based on this criterion,

we used from the MeSH thesaurus only the “Diseases” part that defines the medical terms used in the diagnosis process.

The MeSH thesaurus is used by NLM for indexing articles from 4,800 of the world's leading biomedical journals for the MEDLINE/PubMED® database. It is also used for the NLM-produced database that includes cataloging of books, documents, and audiovisuals acquired by the Library. Search queries use MeSH vocabulary to find items on a desired topic. The Medical Subject Headings Section staff continually revises and updates the MeSH vocabulary. MeSH, in machine-readable form, is provided at no charge via electronic means [4].

This thesaurus served as a fundament for the construction of the topic map. Starting from the information offered by MeSH, it is obtained an xtm file that contains the structure of the topic map that presents only details for digestive diseases.

Of course the extension of the topic maps for other pathologies or categories of medical terms can be easily realized. Also, we specify that only some information from thesaurus will be used in topic map: term name that represents a topic, unique identifier, synonym, and the type relationships category-subcategory.

It is defined a topic class "disease" that is the base class for other topics.

For this topic is used the following xtm representation:

```
<topic id = "disease">
</topic>
```

Each disease will constitute a topic of the topic maps and has the following xtm representation:

```
<topic id = “Unique ID”>  // UID taken from  MeSH
   <instanceOf>
      <topicRef  xlink:href = “#disease”/>  // heritage from class “disease”
   </instanceOf>
 // MeSH Heading from MeSH
  <baseName>
    <baseNameString>” MeSH Heading”</baseNameString>/
  < /baseName>
// Entry Terms din MeSH
<occurrence>
   <resourceData>Entry Term 1</resourceData>
   <resourceData>Entry Term 2</resourceData>
    ……..
</occurrence>
</topic>
```

Because a disease category can contain also many diseases, between topics can appear relationships of the type category-subcategory.

For a relationship the following representation xtm is proposed:

```
<association>
  <instanceOf>
        <topicRef  xlink:href = “#Part-Whole”/>
  </instanceOf>
<member>
```

```
  <roleSpec>
    <topicRef xlink:href = "#Whole"/>
  </roleSpec>
  <topicRef xlink:href = "# Unique ID "/>
    // for example  Unique ID for Gastrointestinal Diseases
</member>
<member>
  <roleSpec>
    <topicRef xlink:href = "#Part"/>
  </roleSpec>
  <topicRef xlink:href = "#Unique ID 1"/>
     // for example  Unique ID for  Biliary Tract Diseases
</member>
<member>
  <roleSpec>
    <topicRef xlink:href = "#Part"/>
  </roleSpec>
  <topicRef xlink:href = "# Unique ID 2"/>
    // for example  Unique ID for Digestive System Abnormalities
</member>

<member>
  <roleSpec>
    <topicRef xlink:href = "#Part"/>
  </roleSpec>
  <topicRef xlink:href = "# Unique ID 3"/>
  // for example  Unique ID for  Digestive System Fistula
</member>
.....
</association>
```

The topic map can be used as a navigation tool for the student, but also as an instrument to enable semantic searches. He can navigate through topic map depending on its interest subject, bringing in this way big advantages. He does not have to be familiar with the logic of the database, he will learn about the semantic context, in which a collection and its single items are embedded and he may find useful items he would not have expected to find in the beginning.

The hierarchical structure of the descriptors from MeSH thesaurus, that has also multiple relationships between the medical terms, and each term may dispose by a series of synonyms, can not be properly visualized only by means of a topic map that offers to the student the opportunity to understand exactly these things. There are many examples of successfully using of topic maps in e-learning [11], [12].

In figure 1 there is an example of relationships between the descriptors from MeSH thesaurus, and in figure 2 it can be observed a part from the topic map, constructed for a much coherent visualization of this medical terminology.

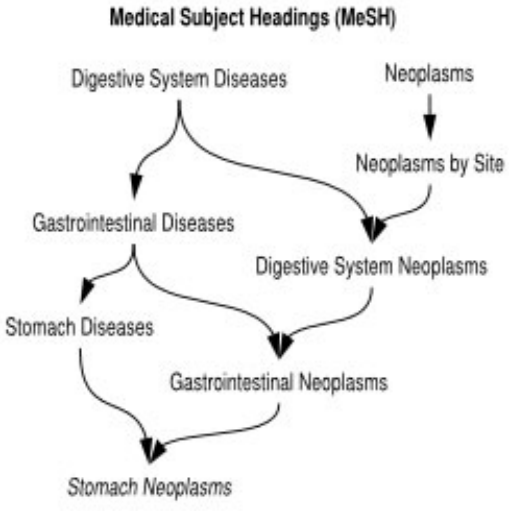

Fig. 1. MeSH – an example from this hierarchy

4 The Medical Image Database Access

For visualizing the information from multimedia database, based on different criteria, the student has the following access possibilities:

1. Traditional search can be effectuated as text-based search.
For example, the student introduces a diagnosis and the images included in the specified diagnosis will be returned from database.

2. A more modern solution is that of an imagistic database query based on content.
This supposes that there are not keywords or other textual information, but only an image is chosen from database, and the system will return a number of images similar with the query image taking into consideration the following characteristics: color, texture or shape automatically extracted [13], [17]. Also, for every image, detailed information is displayed.

Content-based visual query is a searching method based on similarity. It will return images visually similar with the query image, with the same diagnosis or different diagnosis. For computing the dissimilitude between a query and a target image from database, the color characteristic (represented by a 166 values vector) and the texture characteristic (represented by a 12 values vector), in equal weights were considered. The color dissimilitude is calculated using the equation 1, and the texture vectors dissimilitude using the equation 5. The overall distance between the query and target image is the average of these two values. The images are displayed to the student in the ascending order of the computed dissimilitude.

The student can analyze a lot of images from the same diagnosis, he can see the changes in color, texture or shape of the seek tissue reflected in the image. The

content-based visual query offers to the student a variety of options, raises his curiosity, because the student can select any image from the database and the query response can be different because the database is permanently updated.

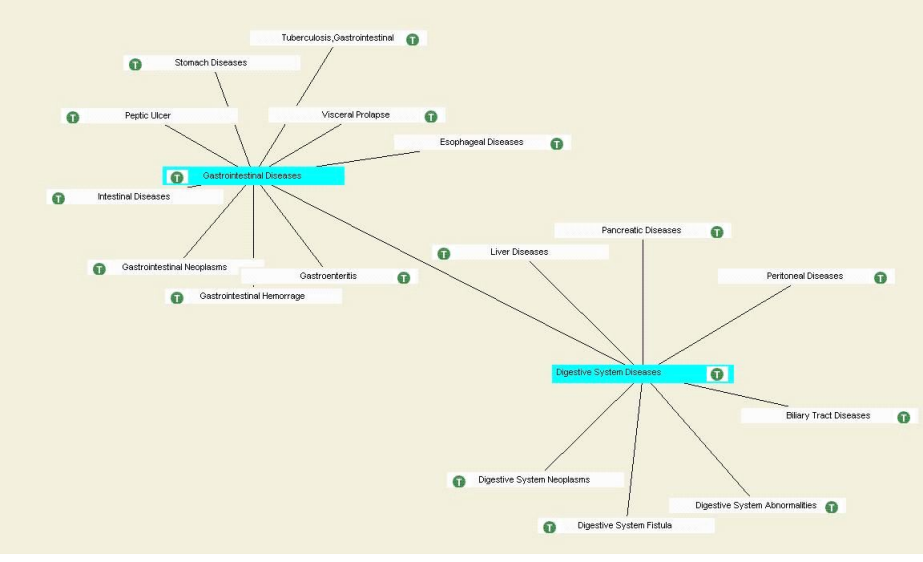

Fig. 2. Extract from the topic map

3. Semantic search and browsing

It is realized with the aid of the topic map. In our topic map, since the occurrences are stored in the database, every topic will be defined as a database query. This query may be simple: the topic "peptic ulcer", for example, will initiate a query for "peptic ulcer" in the diagnosis field of the table Images in the database. Consequently, every relevant image of "peptic ulcer" will be retrieved.

The database search can be done in two ways:

– **Using a Single Topic**. In this case a Select command with the general form is executed:

```
SELECT * FROM image where diagnosis="topic"
```

Example:

```
Select * FROM image where diagnosis="peptic ulcer"
```

– **Using the Topic and All his Synonyms**, if there are, and the Select command has the following form:

```
SELECT diagnosis FROM image where diagnosis="topic1"
or diagnosis="topic2" or…
```

Example:

```
Select * FROM image where diagnosis="peptic ulcer" or
diagnosis="gastroduodenal ulcer' or diagnosis=" marginal
ulcer"
```

The second query modality is very useful in the learning process, because the images are introduced in the database by different specialists, and for diagnosis they can use synonyms, very known in the medical language, but less known by students.

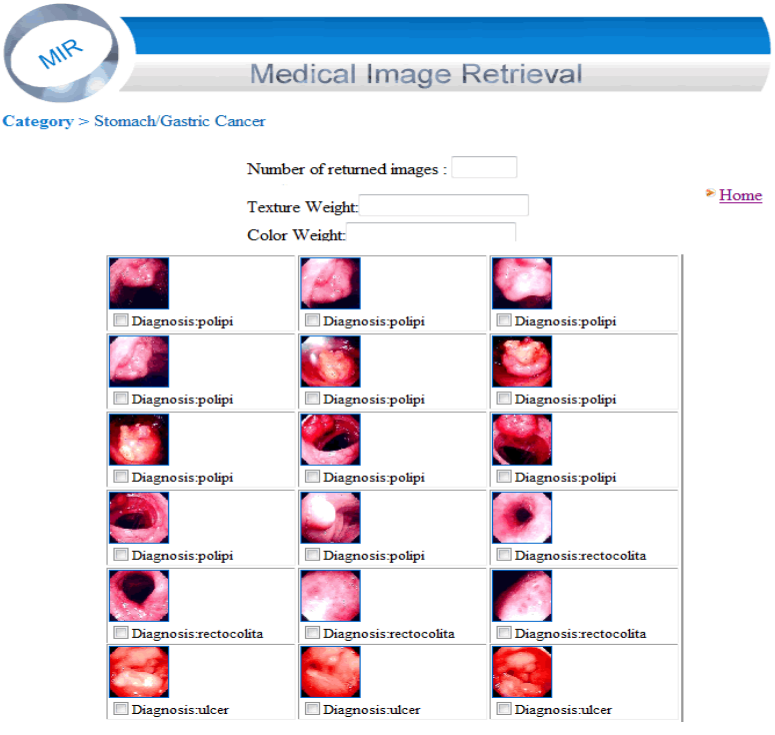

Fig. 3. The window for content-based visual query on medical imagistic database

These access paths to the medical imagistic database can be combined, the results being useful to the student in the learning process. There are presented some possible scenarios. For example, the student can select a certain diagnosis. There are displayed the corresponding images from that diagnosis and their afferent information. From the image set, the student can choose one and launch the content-based visual query on color and texture characteristics. As result the first 10 images from the database that are most similar to the image query will be displayed. The user can compare the images visually similar that belong to the same diagnosis, but also the images that are not visually similar from the point of view of color and texture, but that belong to the same diagnosis. In the first case the images are ascending displayed by dissimilitude, in the second case the images are descending displayed (figure 3).

Another scenario is the following. The student browses the topic map, learning about the hierarchical structure of diagnosis, and he decides to launch a query that uses the synonyms. As result, all the images corresponding to synonym diagnosis will be displayed. On the returned images set the content-based visual query can be executed.

5 Conclusions

This paper presents the benefit of using the multimedia components in the medical e-learning. The multimedia component represents a database with real medical images that come from the medical practice, being collected with different medical tools used for patient's investigation. These images are associated to different alphanumeric and numeric data that helped to establish a correct diagnosis.

Taking into account that the diagnosis is the most important information associated to images, we use the MeSH thesaurus that has as a component the medical diagnosis hierarchy, and also relationships between these and their synonyms. For visualizing this hierarchy in an educational way capable to offer also contextual information, a topic map based on MeSH thesaurus is used.

The database can be browsed, simply text-based queried or content-based queried taking into account the color and texture characteristics automatically extracted from images when they are loaded in the database. With the help of the topic map, the semantic query on database can be automatically launched. All these access paths can be combined for retrieving the interest information.

The medical imagistic collection used in the training processes help to increase the students' ability to find the correct diagnosis and to choose between very similar images as color and texture, but that are included in different diagnosis, reducing the probability for the future physician to establish a wrong diagnosis, which may have serious consequences on patient's health.

Our goal is to offer to the superior medical education (including residences, young specialists, family doctors and medical assistants) a modern and efficient system for professional accomplishment.

The solution of teaching using a medical imagistic database is used in parallel with traditional techniques at the University of Medicine and Pharmacy at disciplines like gastroenterology. The students found it attractive, innovative, and with big advantages in raising the level of knowledge achieved.

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Integrating IRT to Estimate Learning Ability with S-P Chart in Web Based Learning Environment

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Abstract. E-learning provides people a convenient and efficient way for learning things. But is no appropriate way to estimate and diagnose students in e-learning environment. Sato's student-problem chart is one of the analysis methods for diagnosing students learning conditions. For learning ability estimation issue, Item Response Theory which plays an important role in modern mental test theory is applied. We integrate these two theories to propose a combination methodology try to solve the estimation and diagnostic issues in e-learning environment. A web-based assist system is provided as well. Experimental data is collected with forty sophomore students studying "Business Data Communication" class in Taiwan. We illustrated the method to observe and estimate the variation of learner's ability. This methodology and system could make some valuable contribution in e-learning environment.

1 Introduction

E-learning provides people a convenient and efficient way for learning things. Web based learning is one of the popular way to for people to access learning material at any time, any place. Web based learning supports teachers teaching and students learning easily with web page. However web based learning did not provide well methods for assessing learners. In traditional education, the teacher can change his/her lecturing style or content flexibly to maximize the teaching quality with students' response face to face. On the country, teachers recorded and prepared their teaching materials before classes begin then it will be published on the Internet. Teachers have less time to predict students' learning ability thoroughly before the web class begins. Briefly, it is hard for teachers to modify the learning content or style immediately and flexibly in the web based learning environment. Estimate learners ability is a significant issue in web teaching. How to assist the instructor estimate the learner's ability and analyze the learning records accurately, which provides precious information to adjust the learning contents or learning sequencing more appropriately. Assessment measures and analyzes student performance and learning skill. It also replies feedback to the teacher and student which documents growth or provides directives to improve future performance, is significant to learning and development. Formative assessment

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plays the role to guide student instruction and learning, diagnose skill or knowledge gaps, measure progress and evaluate instruction. In daily use, teachers apply formative assessment to determine what concepts require more teaching and what teaching techniques or strategies require modification. After a period of learning days, teachers use the result to evaluate instruction strategies and curriculum. Teachers can make some adjustments for better student performance. Assessment focuses on the gap between students performance and instruction goal. Formative assessment which is beneficial to apply on web based learning to gather the learning information could adapt the teaching or the learning to meet the needs of the learner.

The related work section describes Sato's S-P Chart analysis and Item Response Theory we use in our methodology and system, some related studies are discussed as well. After related work section, the main methodology is presented, it delineates how to integrate S-P Chart and IRT to diagnose students and estimate their learning abilities. An assist system is discussed in web based assist system section. Experiment discussion section records the results of our study. Finally, a brief conclusion and future work is drawn.

2 Related Works

2.1 Sato's Student-Problem Chart (S-P Chart)

The Student-Problem Chart (S-P Chart) is proposed by scholar Takahiro Sato in '70s [1]. The S-P Chart is a graphical analysis tool to represent the relationship between students and the response situations of answering some problems by these students. The main purpose of the S-P Chart is to obtain the diagnosis materials of each student when they study. Teachers can provide better study counseling to each student according to these analyzed materials. There are numbered indices used in S-P chart. Including disparity index, homogeneity index, caution index for student (CS), and caution index for problem (CP). With these indices, teachers are able to diagnose students' learning conditions, instructive achievement, and problem quality [2, 3].

The S-P Chart is a two dimensional table as Table 1. The rows represent the students and the columns are problems of an exam. It shows the relation between the students and the problems. When N students answer n problems, we can get the 'Original S-P Chart' with N×n matrix. How can it be used? When No. X student answers No. Y problem correctly, the corresponding cell (row: No. X; column: No. Y) is marked as '1'. On the other hand, if the student failed the problem, the corresponding cell is marked as '0'. Consequently, the value of each S-P Chart's cell is either '0' or '1.' After all the student exam results are recorded, students and problems are sorted the number of 1's from high to low. The sorted upper-left triangle in the SP table should be filled with 1's because it is believed that students who have good grade should answer simple questions correctly. Students with higher scores appear in the upper part of the sorted table. And problems correctly answered by more students appear in the left part of the sorted table. It is abnormal when 0's show up in the upper-left triangle of the sorted SP table and 1's appear in the lower-right triangle of the table. For instance, there are 10 students attend an examination with 10 problems. The response situation is shown in Table 1. After we sort all students in row and all

problems in column with scores and correct number of each problem. In addition, we can draw the S-curve (solid line) and P-curve (dotted line) as shown in Table 2 [3]. The bold line represents the overlap of these two curves.

Table 1. Original S-P Chart with 10 students and 10 problems

	Problems										
Students	1	2	3	4	5	6	7	8	9	10	correct
1	0	1	0	1	1	0	1	1	1	0	6
2	0	1	1	1	1	1	1	1	1	1	9
3	1	1	0	1	1	1	1	1	1	1	9
4	0	1	1	1	1	0	1	1	1	1	8
5	1	1	1	1	1	1	1	1	1	1	10
6	1	1	1	1	1	1	0	1	1	1	9
7	0	1	1	1	1	1	0	1	1	1	8
8	1	1	1	1	1	0	1	1	1	1	9
9	1	1	1	1	1	0	1	1	1	1	9
10	1	1	1	1	0	0	1	1	1	0	7
num	6	10	8	10	9	5	8	10	10	8	

Table 2. Sorted S-P Chart with 10 students and 10 problems

	Problems											
Students	2	4	8	9	5	3	7	10	1	6	correct	percentage
5	1	1	1	1	1	1	1	1	1	1	10	1
2	1	1	1	1	1	1	1	1	0	1	9	.9
3	1	1	1	1	1	0	1	1	1	1	9	.9
6	1	1	1	1	1	1	0	1	1	1	9	.9
8	1	1	1	1	1	1	1	1	1	0	9	.9
9	1	1	1	1	1	1	1	1	1	0	9	.9
4	1	1	1	1	1	1	1	1	0	0	8	.8
7	1	1	1	1	1	1	0	1	0	1	8	.8
10	1	1	1	1	0	1	1	0	1	0	7	.7
1	1	1	1	1	1	0	1	0	0	0	6	.6
num	10	10	10	10	9	8	8	8	6	5		
percentage	1	1	1	1	.9	.8	.8	.8	.6	.5		

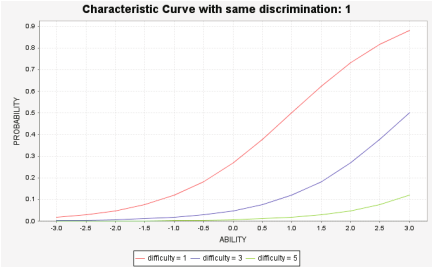
There are many researches apply S-P Chart for analysis issue, such as S-P Chart software implementation [4] and for educational measurements [5, 6,7]. Other studies like, Kazuo Yamanoi [8] used Microsoft Excel to implement the SP table. The tool is useful and user-friendly. It can draw the S-curve and the P-curve easily. However the results are analyzed by human, not by computer. Dai et al [9] discovered some significant things: 1) the class-based analysis unit of the S-P chart; 2) the diagnosis of students' learning outcome in regards to S-P chart; 3) the diagnosis of test item quality according to S-P chart; 4) the forecast of students' placement; 5)facilitation to the analysis and testing the test quality of the related subjects test bank; 6) an blend tool to construct the web-based test. Chen et al. [10] incorporated the response time, the difficulty index, and the discriminatory index of each test item into an S-P model during the analysis. Moreover, Chen et al. [11] implemented an online assessment feedback mechanism into SCORM 2004 content package.

2.2 Item Response Theory

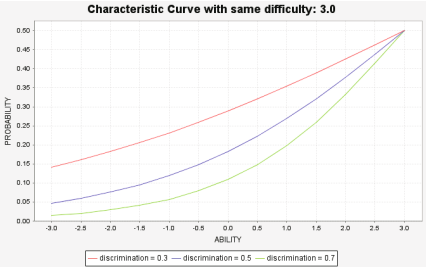
Item Response Theory (IRT) is often referred to as latent trait theory, strong true score theory, or modern mental test theory and is distinguished from Classical test theory [12]. Theoretically, IRT is based on two concepts. 1) The possibility of one student who answered the individual question can be predict or explain by one set of factors. 2) The relation of the possibility of one student who answered the individual question and the set of factors can be explained by a continuous increasing equation called item characteristic curve.

The definition of item characteristic curve is the possibility when the student answered the question correct. When the item characteristic curve is high means the

possibility when the student answered the question correct high. In IRT theorem, each question has only one item characteristic curve which is composed of one or more parameters to describe the question's characteristics. Therefore, item characteristic curve will be different when we apply different parameter equations. For instance, we pick three items (problems) and one-parameter model for the example. In the left hand side of Fig. 1., it represents three item characteristic curves of same discrimination of 1 and distinct difficulties of [1, 3 and 5]. On the other side, it also represents three item characteristic curves with same difficulty of 3 and distinct discriminations of 0.3, 0.5 and 0.7.



(a) Same discrimination of 1 with distinct difficulties



(b) Same difficulty of 3 with distinct discriminations

Fig. 1. Item characteristic curves with one-parameter model

Logistic Function is the formula to represent characteristic curve of each item in IRT. We can show the formula as follow [12].

$$P(\theta) = \frac{1}{1+e^{-a(\theta-b)}} \tag{1}$$

where:

e is the constant 2.718.
b is the difficulty parameter, typical value have $-3 \leqq b \leqq 3$.
a is the discrimination parameter, typical value have $-2.8 \leqq a \leqq 2.8$.
$L = a(\theta - b)$ is the logistic deviate (logic) and θ is an ability level.

However, there are some special models in basic logistic function, including:

(1). One-parameter logistic model: One-Parameter logistic model ignores the discrimination of item, and set the discrimination of each item to 1. In this model we can transform the basic logistic function into the formula below [12].

$$P(\theta) = \frac{1}{1+e^{-a(\theta-b)}} = \frac{1}{1+e^{-1(\theta-b)}} \tag{2}$$

(2). Two-parameter logistic model: Two-Parameter logistic function considers both the discrimination and difficulty of item. And its logistic function is the original type of logistic function. (3). Three-parameter logistic model: besides the discrimination and difficulty of item, Three-Parameter logistic function also considers the guessing

factor when people answer the item. The parameter c is the probability of getting the item correct by guessing. After we add the guessing factor into the original logistic function, we get the tree-parameter logistic function as shown [12].

$$P(\theta) = c + (1-c)\frac{1}{1+e^{-a(\theta-b)}} \tag{3}$$

The parameter c has a theoretical range of $0 \leqq c \leqq 1.0$, but in practice, values above 0.35 are not considered acceptable [12], hence the range $0 \leqq c \leqq 0.35$ are used here.

IRT always comes with Computerized Adaptive Testing (CAT). Adaptive testing is used in computer administrated tests to dynamically estimate the examinee level, such as Graduate Record Examination (GRE) and the Test of English as a Foreign Language (TOEFL) [13]. However, this kind of technique is appropriate for testing, not for detecting problem's quality. IRT works when there is a need to determine a student's level of knowledge, but not measuring the student's knowledge in every concept or level in the course. This paper proposes a combinative methodology. With Sato's student-problem chart, it will diagnose students' learning conditions, and problem quality. It will also estimate students' learning abilities with item response theory.

3 Data Analysis Methodology

In this section, we illustrated our method to estimates the learner's ability with forty sophomore students studying "Business Data Communication" class in Taiwan. Table 3 represents the sorted S-P Chart, S-curve (solid line) and P-curve (dotted line). We are able to diagnose students' learning conditions easily with it. We can reduce the number of miscellaneous tasks involved in educational assessment; and spend more time on guidance and teaching tasks, which can improve student learning effectiveness, teaching quality. However, we also need to know the progression of each student when we apply S-P Chart. Following is learning ability estimation of each student.

Estimating learner's ability is not easy. In most cases, teachers are used to estimate learner ability with the score. However, the questions which have different difficulty and discrimination in the exam sheet, students have the same score might have ability. In order to estimate learner ability, we apply item response theory to estimate each item. We apply two-parameter logistic model to get the $P(\theta)$ which is the probability that an examinee with that ability will give a correct answer to the item. The $P(\theta)$ range is $0 \leqq P(\theta) \leqq 1$. In order to get the item difficulty index and item discrimination index, we choose Kelly's method. In 1939, Prof. Kelly indicated that the best percentage is 27%, and the acceptable percentage is 25-33% 14. We tried to define the percentage 25% in this paper and our system. Following is how we compute item discrimination index in steps.

Table 3. Sorted S-P Chart of 40 students and 20 problems in Chapter 4 & 5 of "Business Data Communication"

	7	19	8	10	9	16	13	1	20	17	14	15	4	3	6	12	11	5	18	2	
B09510016	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510054	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510074	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510088	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510090	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510098	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510106	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510208	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
B09510002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	19
B09510030	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	19
B09510038	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	19
B09510104	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	19
B09310005	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	19
B09510066	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	19
B09510204	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	19
B09510018	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	18
B09510026	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	18
B09510040	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	18
B09510046	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	18
B09510050	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	18
B09510206	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	18
B09510010	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	17
B09510056	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	17
B09510060	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	17
B09510076	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	17
B09510108	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	17
B09510064	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	17
B09510028	1	1	1	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	1	1	16
B09510094	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	16
B09510202	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1	1	16
B09510006	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	1	1	15
B09510022	1	1	1	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0	0	14
B09510044	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0	0	1	14
B09510078	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	1	1	14
B09510084	1	0	1	1	1	0	1	0	0	0	1	0	1	1	1	0	1	1	0	1	12
B09510012	1	1	1	1	1	1	0	0	1	1	0	0	1	0	0	1	1	1	0	0	12
B09510102	0	1	0	1	0	1	1	1	0	1	0	1	1	1	0	0	0	0	1	0	10
B09510052	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	1	0	0	9
B09510062	0	0	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	1	0	0	6
	38	38	37	37	36	35	35	34	34	34	34	33	33	33	33	32	32	32	30	27	

Step 1: Sort the students order according to the students' score in the exam.

Step 2: P_H is defined as the higher 25% of total students and P_L is defined as the lower 25% of total students.

Step 3: Count a student's correct answers and his/her percentage in the higher group and the lower group of each question.

Step 4: Calculate the item difficulty index for each problem P = (PH+PL)/2.

Step 5: Calculate the item discrimination index for each problem D = PH-PL.

Step 6: The following shows the information format we record.

In our experiment, there are twenty items in our exam. The discrimination index and difficulty are listed in Table 4. For example, student No.B09510028. We knew the discrimination index a＝0.4545 and difficulty index b＝0.7727 of item 1 in Table 4. Default learner ability θ is set 1. The calculation progress and the result of student No.B09510028 is shown from Table 5 to Table 8.

Table 4. the discrimination index and difficulty gathered in our exam

Item No.	*(a):Discrimination Index*	*(b):Difficulty Index*	*Item No.*	*(a):Discrimination Index*	*(b):Difficulty Index*
1	0.4545	0.7727	11	0.3636	0.7273
2	0.4545	0.6818	12	0.6364	0.6818
3	0.2727	0.8636	13	0.3636	0.8182
4	0.2727	0.8636	14	0.3636	0.8182
5	0.4545	0.7727	15	0.6364	0.6818
6	0.3636	0.8182	16	0.2727	0.8636
7	0.1818	0.9091	17	0.2727	0.8636
8	0.2727	0.8636	18	0.5455	0.7273
9	0.2727	0.8636	19	0.1818	0.9091
10	0.2727	0.8636	20	0.3636	0.8182

Then we put the parameters into the equation and get the P(θ) of item 1. In Table 4, we calculated 20 items for their P(θ).

$$P(\theta) = \frac{1}{1+e^{-a(\theta-b)}} = \frac{1}{1+2.718^{-0.4545*(1-0.7727)}} = 0.525804$$

The next step is to estimate learner's ability. The learner ability estimation equation is given as following.

$$\hat{\theta}_{s+1} = \hat{\theta}_s + \frac{\sum_{i=1}^{N} a_i[u_i - P_i(\hat{\theta}_s)]}{\sum_{i=1}^{N} a_i^2 P_i(\hat{\theta}_s) Q_i(\hat{\theta}_s)} \tag{4}$$

$\hat{\theta}_s$ is the estimated ability of the examinee with iteration s

a_i is the discrimination parameter of item i, i=1,2,….N

u_i is the response made by the examinee to item i:

u_i = 1 for a correct response

u_i = 0 for a wrong response

$P_i(\hat{\theta}_s)$ is the probability of correct response to item i, under the given item characteristic curve model, at ability level $\hat{\theta}_s$ within iteration s.

$Q_i(\hat{\theta}_s) = 1 - P_i(\hat{\theta}_s)$ is the probability of incorrect response to item i, under the given item characteristic curve model, at ability level $\hat{\theta}_s$ within iteration s.

We count Q(θ), a(u-P) and a*a(PQ) for item 1 below.

$Q(\theta) = 1 - P(\theta) = 1 - 0.525804 = 0.474196$

$a(u\text{-}P) = 0.4545 \times (1 - 0.525804) = 0.215543863$

$a*a(PQ) = 0.454 \times 0.454 \times (0.525804 \times 0.474196) = 0.51515$

With the same calculating progress, we got the result of 20 items for iteration 1 in Table 5. For the reason Δθs□0.001 is not equal to our limitation, the iteration would continue.

Table 5. ability estimation of student No.B09510028 iteration 1

item	u	P	Q	a(u-P)	a*a(PQ)	Δθs	θs+1
1	1	0.525	0.474	0.2155	0.051515	2.7078	3.7078
2	0	0.536	0.463	-0.2436	0.051384		
3	1	0.509	0.490	0.1338	0.018589		
4	1	0.509	0.490	0.1338	0.018589		
5	0	0.525	0.474	-0.2390	0.051515		
6	1	0.516	0.483	0.1758	0.033022		
7	1	0.504	0.495	0.0901	0.008264		
8	1	0.509	0.490	0.1338	0.018589		
9	1	0.509	0.490	0.1338	0.018589		
10	1	0.509	0.490	0.1338	0.018589		
11	1	0.524	0.475	0.1728	0.032977		
12	1	0.550	0.449	0.2860	0.100209		
13	1	0.516	0.483	0.1758	0.033022		
14	1	0.516	0.483	0.1758	0.033022		
15	1	0.550	0.449	0.2860	0.100209		
16	1	0.509	0.490	0.1338	0.018589		
17	1	0.509	0.490	0.1338	0.018589		
18	0	0.537	0.462	-0.2929	0.07397		
19	1	0.504	0.495	0.0901	0.008264		
20	1	0.516	0.483	0.1758	0.033022		
			SUM	2.0052	0.740514		

Table 6. ability estimation of student No.B09510028 iteration 4

item	u	P	Q	a(u-P)	a*a(PQ)	Δθs	θs+1
1	1	0.835	0.164	0.0749	0.028447	0.0003	4.3424
2	0	0.840	0.159	-0.3821	0.027663		
3	1	0.720	0.279	0.0761	0.014967		
4	1	0.720	0.279	0.0761	0.014967		
5	0	0.835	0.164	-0.3795	0.028447		
6	1	0.782	0.217	0.0790	0.02249		
7	1	0.651	0.348	0.0634	0.007509		
8	1	0.720	0.279	0.0761	0.014967		
9	1	0.720	0.279	0.0761	0.014967		
10	1	0.720	0.279	0.0761	0.014967		
11	1	0.788	0.211	0.0769	0.02207		
12	1	0.911	0.088	0.0564	0.032742		
13	1	0.782	0.217	0.0790	0.02249		
14	1	0.782	0.217	0.0790	0.02249		
15	1	0.911	0.088	0.0564	0.032742		
16	1	0.720	0.279	0.0761	0.014967		
17	1	0.720	0.279	0.0761	0.014967		
18	0	0.877	0.122	-0.4788	0.031914		
19	1	0.651	0.348	0.0634	0.007509		
20	1	0.782	0.217	0.0790	0.02249		
			SUM	0.0001	0.413772		
					0.643251		

We set $\Delta\theta s \leqq 0.001$ because the value of the adjustment is very small. Besides, we checked the standard error which is not greater than 1. The standard error is affected by the quantity of the test item. The more test items, the smaller standard error. We estimate 40 students' learning abilities in Table 7, there are nine students' abilities cannot be estimated. These students who answer all the items correct or wrong, are special cases in our equations. The learner ability is not an infinite sequence toward some limit; the Δθs will not converge smaller than 0.001. The standard error of Student B09510028 is 0.643251.

4 Web Based Assist System

According to the methodology has discussed in previous section. We propose a simple prototype system to help us to analysis collected data. We use PHP 4.4.5 and Dojo Toolkit 1.0.2 [15] for the JavaScript and AJAX library. Apache Web Server 2.0.59 for Http server, MySQL 5.0.27 for the database management system. We build a score-book system to help teachers to keep scores when having a quiz or examination in

semesters. In addition, it also assists teachers in analyzing students' learning conditions and estimating their learning abilities with S-P Chart and IRT. This system really reduces the computing time of normal paper work before.

Table 7. Experiment result of the learner ability

Student No.	$\Delta\theta_s$	θ_{s+1}	Standard Error→1/((a*a*(P*Q))^1/2)	Iterations
B09310005	0.000564086	7.228475628	0.425637762	5
B09510002	0.000464682	10.26309262	0.272959423	6
B09510004	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510006	0.000157018	4.128891681	0.661535659	4
B09510010	5.98903E-05	6.349052791	0.484351245	5
B09510012	8.18448E-06	3.374039583	0.725815834	4
B09510016	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510018	4.23338E-06	8.418639491	0.357142425	6
b09510022	7.85567E-05	3.92651486	0.678904942	3
B09510026	4.41257E-07	7.771627679	0.392841793	6
B09510028	0.000306072	4.342488819	0.643251499	4
B09510030	4.98357E-06	11.76500885	0.220233456	7
B09510038	0.000464682	10.26309262	0.272959423	6
B09510040	4.41257E-07	7.771627679	0.392841793	6
B09510044	1.64374E-07	4.810209551	0.60369427	5
B09510046	5.98903E-05	6.349052791	0.484351245	5
B09510050	0.000564086	7.228475628	0.425637762	5
B09510052	-4.18338E-08	0.394703485	0.859689607	3
B09510054	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510056	1.92367E-05	5.981935115	0.510988809	5
B09510060	5.64201E-07	5.06871674	0.582347424	5
B09510062	-2.61989E-08	0.517461764	0.86129777	3
B09510064	7.85567E-05	3.92651486	0.678904942	4
B09510066	0.000184305	6.760413351	0.455989303	5
B09510074	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510076	4.23338E-06	8.418639491	0.357142425	6
B09510078	3.82082E-05	3.733991289	0.695390875	4
B09510084	8.18448E-06	3.374039583	0.725815834	4
B09510088	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510090	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510094	0.000157018	4.128891681	0.661535659	4
B09510098	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510102	3.6612E-05	1.890880609	0.830933176	3
B09510104	4.25078E-05	9.218247684	0.317654426	6
B09510106	The$\Delta\theta_s$ will never converge smaller than 0.001.			
B09510108	5.64201E-07	5.06871674	0.582347424	5
B09510202	1.8763E-06	5.347459033	0.559848971	5
B09510204	0.000184305	6.760413351	0.455989303	5
B09510206	0.000564086	7.228475628	0.425637762	5
B09510208	The$\Delta\theta_s$ will never converge smaller than 0.001.			

Figure 2 is the snap shot of our proposed system. It can be divided into three parts, 1) upper part, 2) lower left part and 3) lower right part. Upper part is displayed when user logon system, Part 2 and part 3 are totally nothing and fill with blank. Part 1 shows all curriculums the user teaches or data recorded in tabbed button on top of the part 1. In Figure 2, there are three curriculums show on the page, including "Business data communication", "Operating system" and "Programming language". In

"Business data communication" tab, there are two classes take this program. And several quiz and examination were held before. When user choose the class and pick the assessment he/she want to analyze, all students attend that assessment will show on the lower left part.

As we can see in Figure 2, all users' id and scores can be listed in part 2 as common scorebook system. User can select examinees by selecting checkbox in front of each student. Detail records of examination of selected students will be displayed in the lower right part. Part 3 represents the original S-P Chart of selected assessment. In the same time, examinees' learning ability will be estimated by items' discrimination index, difficulty and IRT. As we discussed, there are several abilities cannot be estimated and filled with blank. That is because these students answer all the items correct, and it's a special cases in our experiment. On the top of part 3, user can check the sorted S-P Chart and reference the S-Curve and P-Curve as well.

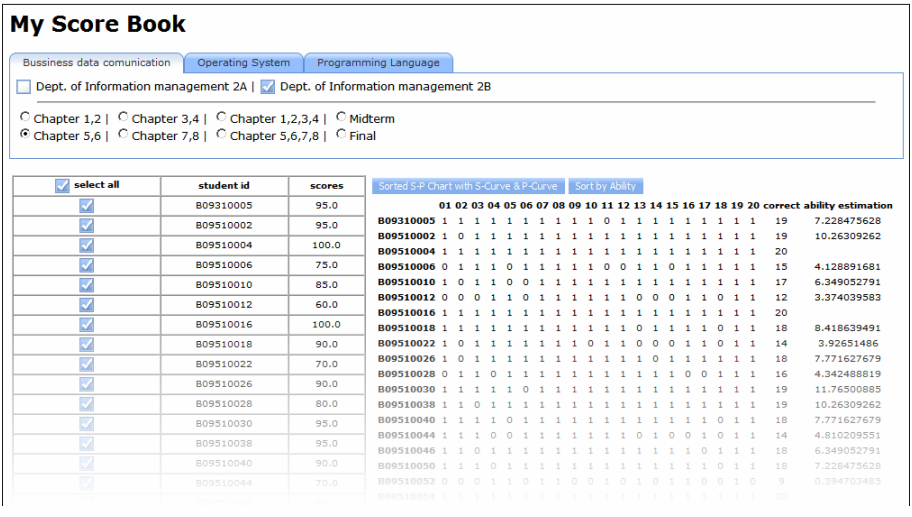


Fig. 2. Proposed scorebook system (prototype)

5 Experiment Discussion

In the experiment, we gave no feedback to class A students. They could know their test grade but couldn't know the problem which was wrong. So they should to find the wrong answer by their own. On the contrary, the students in class B students could get the information after the pretest. They knew the wrong answers that found it in correct chapters. The answer correct rate in class A and class B of pretest and posttest are shown in Fig. 3. Answer correct rate in Class A and Fig. 4.. Comparing the result from Fig. 3. Answer correct rate in Class A and Fig. 4. that could see the progress had obvious difference. With our system's support, class B had better academic performance than class A in all of the chapters.

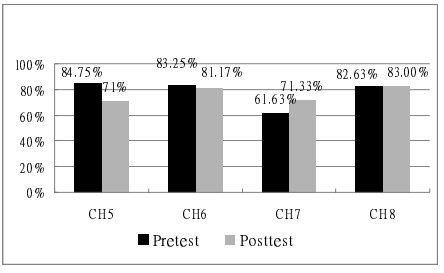


Fig. 3. Answer correct rate in Class A

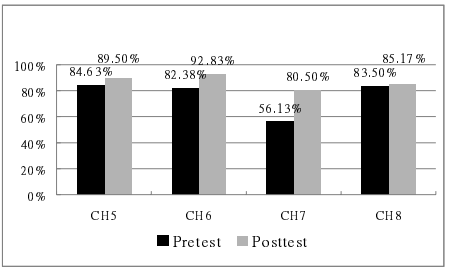


Fig. 4. Answer correct rate in Class B

The standard deviation is the most common measure of statistical dispersion, measuring how widely spread the values in a data set. The standard deviation is small which means many data points are close to the mean. In Table 8, the posttest standard deviation of class B is smaller than class A. In order to observe the standard deviation of two classes, we apply Table 9 which includes the quantity of students who answer correct questions. It was apparent the class B curve looks like normal distribution than class A in Figure 5. Additionally, class B academic performance is better than class A.

Table 8. The pretest and posttest in class A and class B

	Class A Standard deviation		Class B standard deviation	
Chapter	Pretest	Posttest	Pretest	Posttest
CH5	2.24	4.15	3.29	2.41
CH6	2.63	2.23	3.22	2.04
CH7	3.68	2.80	4.58	2.81
CH8	3.11	3.24	3.68	2.12

Table 9. Students who answer questions correct in class A and class B

Test items	Number of correct answer in class A	Number of correct answer in class B
0~30	1	0
31~35	2	2
36~40	9	3
41~45	7	6
46~50	5	8
51~54	17	12
55~59	14	9
60	0	0

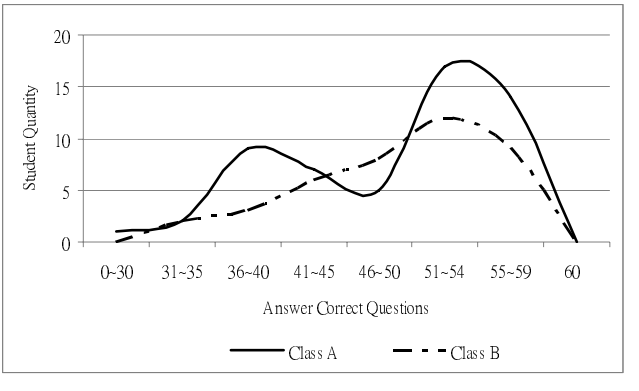


Fig. 5. Students who answer questions correct disparity curves in class A and class B

6 Conclusion and Future Work

Intelligent assessment technologies supports web based learning environment to provide students adaptive learning suggestions, give teachers hints to modify learning content and estimate the individual learner's ability to assist them maximize learning performance. In this paper, the methodology of estimating learning ability is discussed. We use Sato's Student-Problem Chart to diagnose students' learning conditions with assessments they attended. We analyze the examination result of the pretest, and the posttest, and discover the difference between experimental group and control group. We apply the Item Response theory to justify each learning abilities of every examinee. A prototype web based assist system to help us to compute collected data is proposed. For the system, we could build an on-line assessment system in the front-end, and in the back-end our propose system can play an important role for the analysis in the near future. For experiment, we will analyze the pretest and posttest of one class for the experimental group and control group. Find out the learning abilities variation to apply individual learning in e-learning environment. These experiment results will provide us a valuable example for the learning management system or tutoring system construction in the future.

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A New Approach for Education Information System's Compliance Test with the CELTS Standard Based Upon XML Processing Technology*

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Abstract. The paper designed a new system to test education information system's compliance with the national CELTS standard. The new system is composed of three loosely coupled components: the XML schema documents translated from the CELTS standard, the XML parsing and validating package and the program interface. The XML parsing and validating package is the heart of the system. It automatically parses the XML schema documents fed into the system, and then, builds up an internal data structure for the successive validating process. This approach is proved to be a great success, which decouples the XML schema documents and the XML data documents and makes the whole system more adaptable to the evolution of the CELTS standard.

Keywords: CELTS standard, XML schema, education information system.

1 Introduction

Every education institute has its own information system and every education information system has its own private information format. This raises an unnecessary hurdle between each two systems with different information formats. Therefore, interoperability among different education information systems is really a nightmare, even not impossible [1]. As internet becomes more reachable and public, cross-talk among education information systems is more necessary than ever before. But the private information format of each education information system has made this cross-talk nearly impossible! So, a national education information format standard comes onto our agenda, and the CELTS standard is just the right result [2]. This paper deals

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with the CELTS-3(LOM standard), CELTS-9(CP standard), CELTS-10(QTI standard), and CELTS-11(PAPI standard), total four sub-standards under the CELTS standard.

Today, XML becomes more popular. It is a nature choice for information interchange between different information systems. And the four sub-standards adopt this trend and use XML to ease the data exchange and sharing among different education information systems. The four sub-standards do not deal directly with the XML data, but rather, build up one standard XML data format in their own fields. However, the four sub-standards are in their nature language format and are not exact enough to ensure each education information system's compliance with the corresponding standard. Thus, the authors decided to translate each sub-standard from their own nature language format into XML schema document, while the old testing system adopts DTD to define their standards. XML schema is more accurate and expressible than DTD. And XML schema is also more expandable than DTD.

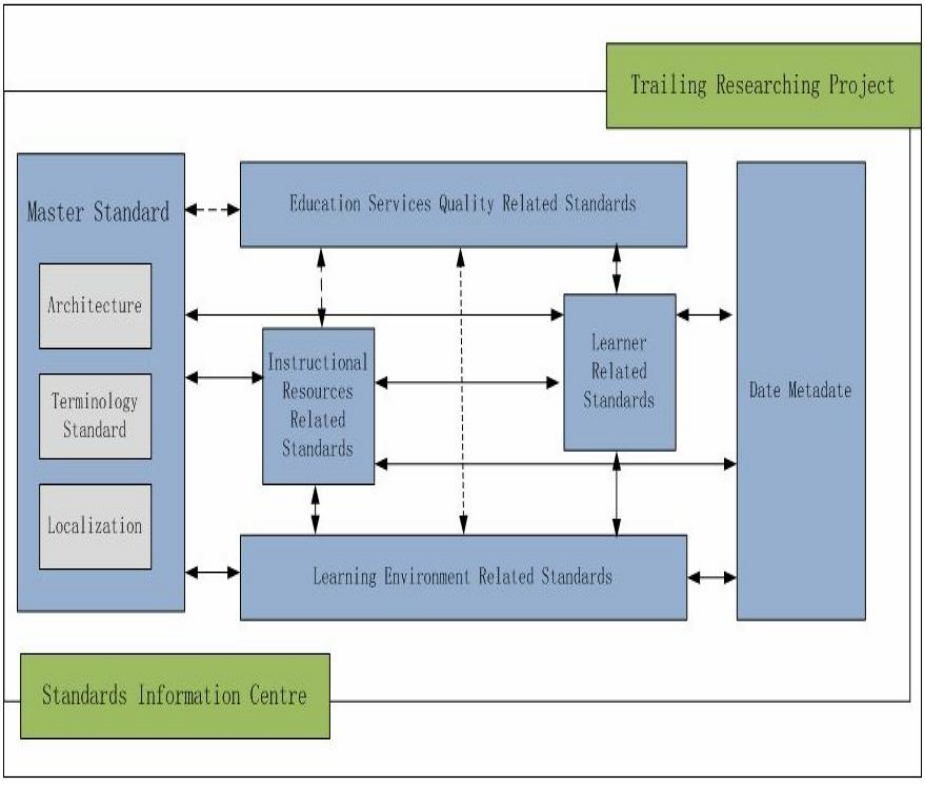

Fig. 1. CELTS Standard System [3]

The old testing system had a serious flaw: each DTD translated from the corresponding four sub-standards was built-in the system. In other words, the DTD and the testing system were tightly coupled, and the whole testing system would break easily

when the four sub-standards changed. The authors find out a clever method to decouple the standard and the testing system. That is, the authors write out an independent XML parsing and validating package, which automatically builds up an internal data structure from each XML schema document translated from the four sub-standards, and use this private data structure to validate the XML data document fed from each education information system. This innovation makes the whole testing system more rigorous and maintainable.

2 CELTS

Nowadays, the process of teaching informationization in our country encounters some problems, such as lacking of a unified standards and fighting each other. In order to solve the problems, Chinese E-Learning Technology Standardization Committee officially submits the first batch of Chinese E-Learning Technology Standards (CELTS). The CELTS standard system is as Fig. 1 illustrated.

Every sub-standard in the CELTS standard system has its own information model and several test points, so it is impossible to manual test the standard. Therefore, when a new standard is published, a new test tool will be developed in order to automatically test the new standard. The common CELTS test system model is as Fig. 2 illustrated.

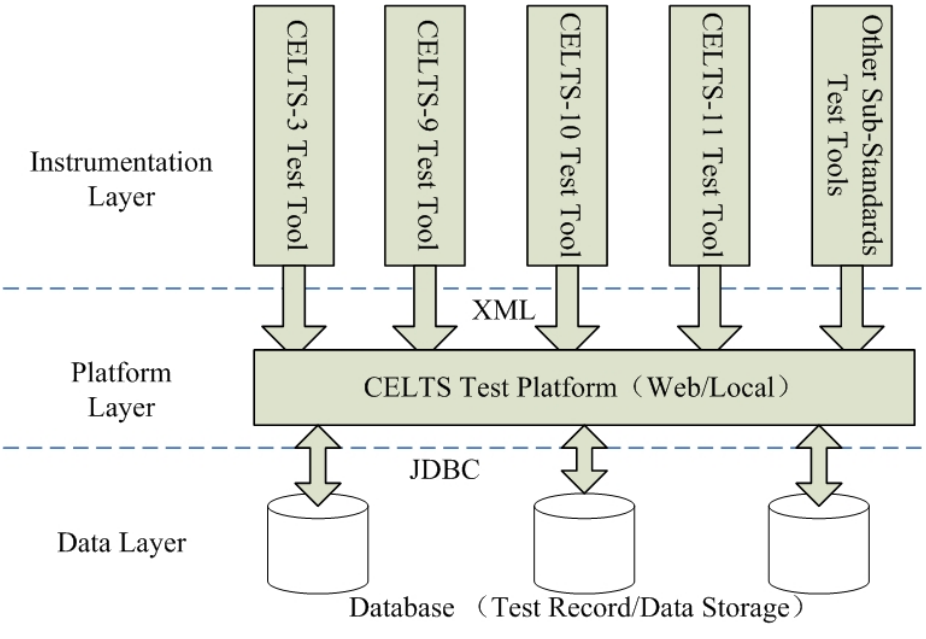

Fig. 2. Common CELTS Test System Model [3]

In order to support the numerous standard test items, common Celts test system adopts three layer construction models as shown in figure 2. The construction

includes instrumentation layer, platform layer and data layer. Instrumentation layer consists of the test tools of each sub-standard. Platform layer is a common and uniform Technology Platform which is composed of common services and operations for all test tools. Date layer is used for save test data and test records. [3]

Four sub-standards, include CELTS-3, CELTS-9, CELTS-10, CELTS-11 are involved in the test approach. The approach adopts XML technology instead of DTD to test education information system's compliance.

3 DTD and XML Schema

The Extensible Markup Language (XML) is a general-purpose specification for creating custom markup languages. It is classified as an extensible language because it allows its users to define their own elements. XML is originally designed to meet the challenges of large-scale electronic publishing. It is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere. Nowadays, its primary purpose is to facilitate the sharing of structured data across different information systems, particularly via the Internet, and it is used both to encode documents and to serialize data. [4]

XML follow the expandability, designability and verification from SGML (Standard Generalized Markup Language). The greatest virtue of XML is separating the content from the presentation. XML describes date through three separate departs, includes data files, XML mode (DTD or Schema) and style sheet. The introduction of DTD and XML schema is summarized as follows.

3.1 DTD

Document Type Definition (DTD) is one of several SGML and XML schema languages. It is the oldest schema format for XML. A DTD is principally used for the expression of a schema via a set of declarations that conform to a particular markup syntax and that describe a class or type in terms of constraints on the structure of that document.

A DTD specifies the syntax of an application of SGML or XML, such as the derivative language HTML or XHTML.It prescribe the logical organization of the document via element and attribute-list declarations. Due to its inclusion in the XML 1.0 standard, DTD support is general. But it is seen as limited for the following reasons:

1. It has no support for newer features of XML, most importantly namespaces.
2. It lacks expressiveness. Certain formal aspects of a XML document cannot be captured in a DTD.
3. It is not an unabridged structure of XML and uses non-XML syntax. So different resolvers and API are required for DTD and XML.

In light of this, the approach that the test system adopts DTD to define their standards is not really an idea one. The author adopts XML Schema, a newer XML schema language, to define the four sub-standards.

3.2 XML Schema

XML Schema is described as the successor of DTD. XSD (XML Schema Definition) are far more powerful than DTD in describing XML languages. They use a rich datatyping system, allow for more detailed constraints on an XML document's logical structure, and must be processed in a more robust validation framework. XSD also use an XML-based format, which makes it possible to use ordinary XML tools to help process them. XML Schema's merits are as follows. [5]

1. Consistency. XML Schema defines the structure of the document by using XML syntax rule and does not use other formalization languages. Therefore, the mode and the instance definition of XML come to meet each other.
2. Expandability. XML Schema extends DTD. It introduces date type and namespace. Moreover, it supports the quote from other XML Schemas.
3. Interchangeability. Different XML Schemas can achieve interconversion through specifically mapping mechanism in order to carry out data interchange.
4. Normative and accurately. XML Schema provides more complete and standard mechanism to constraint XML document and completes certain definitions which can't be defined in DTD.

Table 1. Different between DTD and XML Schema

	DTD	XML Schema
Data Type	Ten build-in data type such as CDATA, Enumerate, and NMTOKEN.	Thirty seven build-in data type and user-defined type
Element Order	Supporting node order of sub-elements description except the sub-elements are disorder.	Supporting node order of sub-elements description in all condition.
Namespace	Nonsupport	Support
API	DOM and SAX can't analyze the DTD document's content. Thereby, the constraints and declaration of elements, attitudes of DTD document can't be analyzed.	XML Schema is a XML document. It can be easily analyzed by DOM, SAX and JDom.
Database	DTD's limit data type can't finish the one to one mapping of relational database and can't describe most of data rule.	XML Schema basically satisfies the requirement of data description in relation schema.

3.3 Different between DTD and XML Schema

In comparison, it can be seen that XML Schema has more expressiveness than DTD. It can high-level supply the demand of application in different domains. The vantages of XML Schema can be summarized as follows. [6]

1. Lots of XML editors, API and XML resolvers can be directly applied in it without any alteration.
2. It is readability and flexibility due to the self-describing and expandability inherited from XML.
3. It can be operated and saved as the XML document. Therefore, it can be managed conveniently.
4. It makes the application system based on XML data exchange easier to transfer schema.
5. It is more accurate, expressible and expandable.
6. It has same validity verification mechanism as XML.
7. It is more suitable to describe the relational database then DTD owing to its further build-in data type.

Thus, in view of the vantages above, the authors decided to translate each substandard from their own nature language format into XML schema document to define their standards.

4 System Design

The testing system is divided into three independent components: XML schema documents (represented by the four box on the top left corner of figure 3), XML parsing and validating package (represented by the box in the center of the figure 3), and the program interface (represented by the ellipse at the bottom of the figure 3).

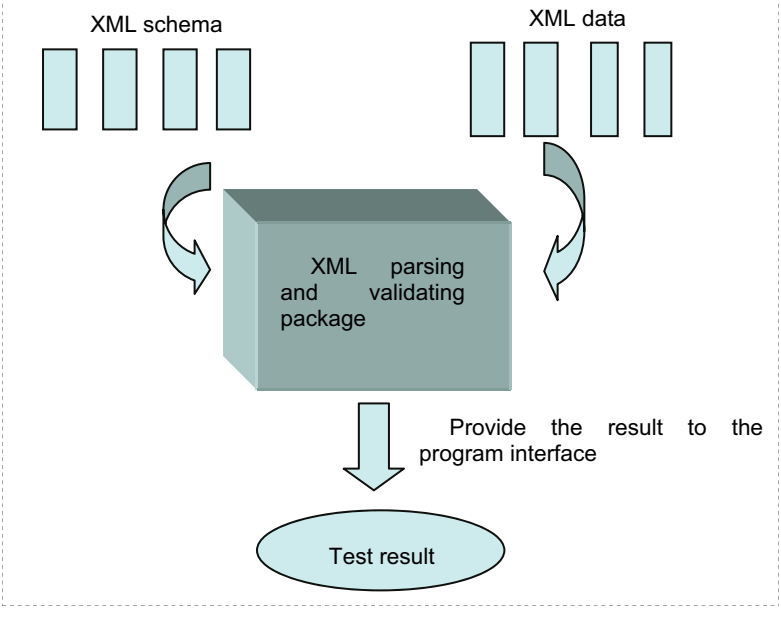

Fig. 3. System Design

4.1 XML Schema Documents

The XML schema documents are translated directly from the four CELTS sub-standards. They are in their own right. That is, you can modify the XML schema document when the corresponding CELTS sub-standard changes with little influence on the XML parsing and validating package. These XML schema documents also provide the accurate data for the XML parsing and validating package to build up their own private data structure. Therefore, the XML schema documents bridge the gap between the four CELTS sub-standards and the XML parsing and validating package.

The functionality of each component is detailed as follows.

4.2 XML Parsing and Validating Package

This package is the heart of the whole testing system. It has two main functions. One is to parse the XML schema documents as shown in the top left corner of the Figure 3. The other is to validate the XML data fed by the education information system to be tested as shown in the top right corner of the Figure 1.

XML schema document is itself in well-formed XML data format. So, the ordinary XML data parsing technology is well available to parse XML schema document. This package is built upon the DOM model to parse the XML schema document. But the DOM model does not recognize the metadata of XML schema. Thus, the authors have to deal with the metadata of XML schema themselves. Fortunately, the metadata of XML schema are not that difficult to deal with. The authors successfully build the functionality to recognize the metadata of XML schema into the package. With the DOM model and the metadata of XML schema recognized, the authors create an internal data structure to hold the information integrated from the DOM model and the metadata of XML schema. The XML data fed by education information system are validated against this private data structure. When the validation process ends, the validation information is also in a private format provided by the package.

This package directly parses the XML schema documents and prepares for successive validation process. This architecture fulfils the original goal to isolate the XML schema documents from the XML parsing and testing package. Therefore, the four CELTS sub-standards can evolve more easily with no influence on the XML parsing and validating package.

4.3 Program Interface

The testing system supports many different result presentation formats. The validation information obtained from the XML parsing and validating package is in its own private format. This information is really stuffed into the XML parsing and validating package and it is very easy to pull it out and convert it into tabular, html, excel, word and many other different formats, only if you provide the corresponding conversion code or third party software component .

5 Implementation

The whole testing system is a standalone desktop application written in Java. And the XML parsing and validating package is implemented completely in the XML processing technology built-in Java. This package is really a small component and has no dependence on other third-party software components.

6 Conclusion

This new approach upgrades the old testing system from the XML DTD to the XML schema technology, which makes the system more adaptable and expandable to the evolution of the four CELTS sub-standards. The authors translate all the four CELTS sub-standard into corresponding XML schema documents. A new innovation upon the old testing system is the decoupling of the XML schema from the system. This strategy is proved to be the right practice.

The authors develop an XML parsing and validating package based upon the DOM model built-in the JDK 1.4and later. The package has no dependence on any other third party software component. This makes it very easy to deploy the testing system. The authors also add the metadata of XML schema recognition functionality into the XML parsing and validating package. This provides the independence of the package from other parts of the testing system. The package also supports its own private information format to ease the conversion of the validation information into many other presentation formats.

The program interface is also decoupled from the testing system. It is a great ease to plug in a different program interface into the system without breaking other parts. The program interface can also present the validation results in many different formats only if the right code or third-party software component is provided.

7 Recommendation

The four CELTS sub-standards are still not in their final stage at present. The testing system is sure to change according to the four CELS sub-standards. Since the PAPI sub-standard is more complete than the other three ones, this system has successfully been used to the PAPI sub-standard. As time goes on, the testing system will supports the other three sub-standards soon.

The XML parsing and validating package is not perfect, either. It can only recognize the element definition in the XML schema. When it comes to the attribute definition, it has nothing to do. But the system design in this paper is really a success. As the CELTS standard goes into its final stage, the XML parsing and validating package will be complete, too.

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Multimedia Instructional Design Corresponded to Cognitive Psychology

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Abstract. Multimedia extends the amount and type of information available to learners, but multimedia itself doesn't mean effective learning outcomes. A successful instruction needs to be designed with a great deal of consideration. And it is assumed that multimedia instruction messages that are designed in light of how the human mind works are more likely to lead to meaningful learning than those that are not. From years of empirical teaching experience in computer courses and series of teaching experiments, we conclude some multimedia instructional design strategies. Firstly, this paper introduces Mayer's Cognitive Theory of Multimedia Learning and Hede and Hede's integrated model of multimedia effects on learning. Then, it presents seven multimedia instructional design principles to create meaningful and effective learning materials based on some cognitive theories.

Keywords: Multimedia learning; Instructional design; Cognitive psychology; Working memory; Effective learning.

1 Introduction

As broadband becomes ubiquitous, interactive designers are increasingly called upon to incorporate multiple media and dynamic graphics into their work. It is prevalent for teachers to use multimedia coursewares in classes, and students to study with multimedia learning materials. Popular forms of multimedia instruction, such as online learning and the more inclusive computer-based training (CBT), have created many new possibilities for education. They provide new ways of delivering content, and they often promote learner-centered environments that can motivate students and add variety to learning. In this environment, instructional units are often accompanied by a liberal use of multimedia that is intended to add excitement to the lesson and hold the learner's attention.

However, visual and auditory components that are intended to stimulate rather than educate do not always make for sound instructional design in multimedia delivery and can quickly become counter-productive to learning. Though, presenting instruction in multiple media can be more effective than doing it through a single medium (such as text), what is important is combining media effectively, not merely adding media.[1]

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Educational materials that have been effectively designed will facilitate the achievement of desired learning outcomes for students. Effective design of multimedia materials relies on instructional design processes. It requires carefully combining media in well-reasoned ways. In this paper we assumed that multimedia instruction messages that are designed in light of how the human mind works are more likely to lead to meaningful learning than those that are not.[2][3]

Cognitive psychology is the branch of psychology that studies mental processes including how people think, perceive, remember, and learn. As part of the larger field of cognitive science, this branch of psychology is related to other disciplines including neuroscience, philosophy, and linguistics. The core focus of cognitive psychology is on how people acquire, process, and store information. There are numerous practical applications for cognitive research, such as ways to improve memory, how to increase decision-making accuracy, and how to structure educational curriculums to enhance learning.

2 What Is Multimedia?

Multimedia is the combination of various digital media types, such as text, images, sound, and video, into an integrated multisensory interactive application or presentation to convey a message or information to an audience.[4] It implies that the combination adds up to more than the elements by themselves, which we believe is the key quality of multimedia when it comes to learning. In any combinations or permutations of common media formats, the whole should be greater than the sum of the parts.

Undoubtablely, multimedia has the potential to extend the amount and type of information available to learners. Text, images, and sound can be combined to create materials that cater for several learning styles, and allow a degree of interactivity on the part of the student. “In the modern world, language is not the only important communicational system. Today images, symbols, graphs, diagrams, artefacts, and many other visual symbols are particularly significant” [5].

Multimedia can offer layers of beneficial resources, provide gratuitous information leading to frustration and overload, or anything in between. For example, online encyclopedias can provide links to videos and additional articles on specific topics of interest. News stories can reference links to audio commentaries, replays of video footage, and links to websites with additional resources. Online instruction can include explanations, links to resources, simulations, illustrations and photographs, and myriad types of activities that can also include multiple media. Too many resources and media, however, and the benefits get crowded out by the need to figure out what’s what.

A meta-analysis by Liao[6], examined 35 studies and concluded that multimedia-based instruction is superior to traditional instruction. However, it is notable that 10 of these 35 studies showed the opposite, namely, that traditional instruction is superior to multimedia. And these inconsistent learning outcomes from multimedia are likely due to the design of the instruction. It is crucial that the instructional design follow the learner-centered principle[7][8], and correspond to the learner’s cognitive mode.

3 Knowledge Acquisition

Learning is often viewed as information transfer from one person's head (an instructor or expert) into another's (the learner). Learners are thought to obtain information from an expert and add it to their own memory. A contrasting view is that learning requires people to personally integrate and make sense of new information while they are applying it in their daily lives.[1]

Consider the world of difference between merely being able to restate information and the ability to apply the information in the course of living and working. A great deal of instruction is aimed at rote memorization or superficial learning, but that approach doesn't go far enough. Complex skills and abilities that can be used in real life are the true goal of learning, not simply the ability to recall information.

Declarative knowledge is knowing about — the ability to state, list, match, describe, and so on. Procedural knowledge is knowing how — the ability to accomplish complex real-world skills. Copier technicians who can list the parts of the copier have declarative knowledge. Those who know how the parts work together and can use that understanding to troubleshoot a malfunction have procedural knowledge. Declarative knowledge is commonly part of procedural knowledge, but it isn't enough. Too often, instruction is developed at the declarative level, while actual tasks require people to work at a procedural level.

The purpose of effective instruction is to provide formal opportunities for complex skills and abilities (procedural knowledge) to develop. Instructional designers must be aware of the relationship between short term memory (also known as working memory) and long term memory in the human brain when designing instructional materials. Working memory has been shown in a number of studies to be a crucial factor of learning with educational multimedia. It is a theoretical construct within cognitive psychology that refers to the structures and processes used for temporarily storing and manipulating information, before it passed to long-term memory.

Cognitive Load Theory, as defined by Sweller,[9] states that optimum learning occurs in humans when the load on working memory is kept to a minimum to best facilitate the changes in long term memory. Working memory in humans can be likened to the RAM of the computer while long term memory can be likened to the CD-RW. As the processing load in the computer's RAM increases, transfer of information to and from the CD-RW slows.

4 Cognitive Theory of Multimedia Learning

Richard E. Mayer is Professor of Psychology at the University of California, Santa Barbara. For the past 17 years, he and his colleagues have been engaged in a sustained effort to construct an evidenced-based theory of multimedia learning that can guide the design of effective multimedia instructional messages.

Mayer defines a multimedia instructional message as the presentation consisting of words and pictures that is designed to foster meaningful learning. The words can include printed or spoken text and the pictures can include static graphics (such as

illustrations, maps, charts, and photos) and dynamic graphics (such as animation and video). Meaningful learning means deep understanding of the material, which includes attending to salient aspects of the presented material, retaining relevant information in both visual working memory and auditory working memory, organizing it into a coherent mental structure, and integrating it with relevant prior knowledge.[10] A framework for Mayer's cognitive theory of multimedia learning (CTML) is presented in Fig. 1.

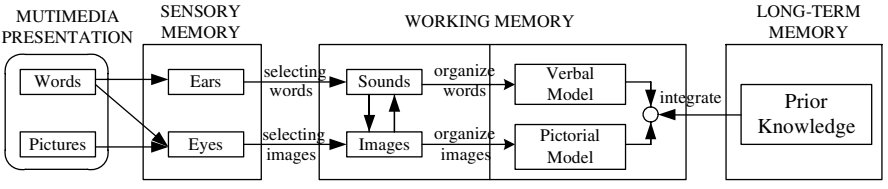

Fig. 1. Mayer's Cognitive Theory of Multimedia Learning

The CTML is based on three cognitive science principles of learning: dual channels, limited capacity, and knowledge construction[11]. First, humans are dual-channel processors, that is, people have separate channels for processing visual/pictorial information and auditory/verbal information (Paivio, 1986; Baddeley 1999). For example, animations are processed in the visual/pictorial channel and spoken words (i.e., narrations) are processed in the auditory/verbal channel. Second, humans are limited capacity processors, that is people are able to actively process only a small amount of information in each channel at any one time (Baddeley, 1999; Sweller, 1999). For example, learners may be able to mentally activate only about a sentence of the narration and about 10 seconds of the animation at any one time. Third, humans are knowledge constructing processor, so meaningful learning occurs when people attend to relevant incoming information, mentally organize the information in coherent structures, and mentally integrate it with other knowledge (Mayer, 2003; Wittrock, 1989). This process of active learning results in a meaningful learning outcome that can support problem-solving transfer.

As seen from figure 1, the CTML specifies five cognitive processes in multimedia learning: selecting relevant words from the presented text or narration, selecting relevant images from the presented illustrations, organizing the selected words into a coherent verbal representation, organizing selected images into a coherent pictorial representation, organizing selected images into a coherent pictorial representation, and integrating the pictorial and verbal representations and prior knowledge.

Mayer, Fennell, Farmer, and Campbell cite evidence that two important ways to promote meaningful learning in e-learning are to design activities that reduce cognitive load, which frees working memory capacity for deep cognitive processing during learning, and to increase the learner's interest, which encourages the learner to use this freed capacity for deep processing during learning.[12] Once again, interest can be stimulated simply by presenting the material in a visually appealing way, accompanied by lively and personable wording or narration.

5 Integrated Model of Multimedia Effects on Learning

The CTML aimed at how to use words and pictures to improve human learning. But the effectiveness of learning is not only limited to the presentation of learning materials, it is also related to the characteristics of the learners, or even more. Hede and Hede offer an integrated model[13] of the myriad factors that may affect the potential for learning from multimedia (Fig. 2). It has implications for designers who need to be aware of factors and their complex interactions in learner reaction to multimedia.

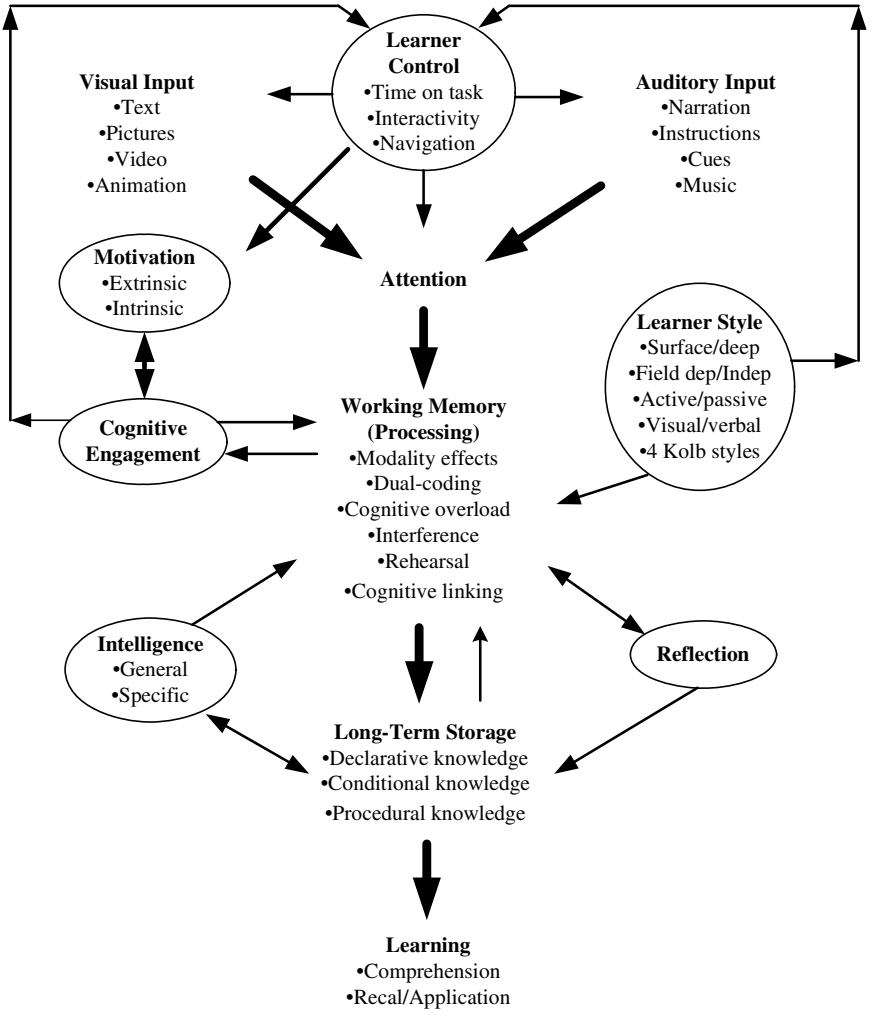

Fig. 2. Hede and Hede's integrated model of multimedia effects on learning

The model is comprised of 12 inter-related conceptual elements, each representing a theoretical construct, which can be operationalized as a variable. Learner style constitutes the independent variable, with learning as the dependent variable. The other elements are visual input, auditory input, learner control, attention, working memory, motivation, cognitive engagement, intelligence, reflection, and long-term storage, each of which is either an intervening or moderating variable or in some cases both. Designers need to be aware of the relationships among the many elements of the integrated mode if their multimedia products are to be fully effective as learning tools.

This model provides a 'road map' of the issues faced by instructional designers in the development of effective multimedia materials. The model suggests the following design guidelines: 1) create interfaces that conform to software standards and patterns; 2) create simple navigation with several modes of access; 3) provide multiple 'views' of information rather than static paths; 4) simplify simultaneous media presentation; 5) provide interface controls for media presentation. No single piece of software can hope to meet all the demands of the integrated model, but by taking into consideration the interplay and exchange of forces, more effective multimedia instruction can be designed and developed.

6 Multimedia Instructional Design Principles

Although multimedia offers designers enormous opportunities for making learning environments meaningful and effective, multimedia by itself does not assure a good learning environment. Multimedia that's effective in learning doesn't simply consist of using multiple media together, but combining media mindfully in ways that capitalize on the characteristics of each individual medium and extend and augment the learning experience.

Uses of multimedia vary, from practice to games to discovery learning. Designers should first determine what outcomes they are trying to achieve and then select elements well suited for these outcomes (for example, select audio to allow learner to hear differences in tone). Then they need to make sure that the multimedia elements are designed well and work well together. And for years of teaching experience and series of experiments, we conclude seven principles that designers could take into consideration. They are as follows:

6.1 Usability Principle

As software, multimedia inherits all of the design concerns of human-computer interaction.[14] Customisable interfaces provide a high level of learner control, but it is worth noting that there is some evidence that complex learner control functions can be counter-productive in terms of educational outcomes.[15] In designing effective instructional software, it is important to standardize software interface design as much as possible. Creating interfaces that conform to user expectations can reduce the overhead and learning demand of the software itself and allow learners focus on the material being presented. Ideally, therefore, it should not be necessary for learners to learn

the software in order to learn the target material. Usability patterns can provide the necessary tools for making low-level interaction design decisions.

6.2 Multimodality Principle

This draws from theories such as Baddely's (1986) theory of visual and auditory working memory subcomponents. It asserts that effective working memory capacity can be increased by using auditory and visual working memory together rather than using one or the other alone. The information that is directed at each channel, however, should be such that it can't be understood in isolation, but needs to be integrated with information in the other channel in order to be fully understood. For example, it is better to make use of two modes of representation rather than one in explaining a concept[16][17][18], and animation and narration is better than animation and on-screen text. When words and pictures are both presented, learners have the chance to construct verbal and visual cognitive representations and integrate them.

6.3 Contiguity Principle

The contiguity principle[19] states that better learning occurs when corresponding narration and animation are presented simultaneously, both temporally and spatially. Temporal contiguity means that corresponding words and pictures should be presented at the same time, while spatial contiguity means that corresponding words and pictures should be presented near rather than far from each other on a page or screen. In other words, don't place an important visual image on one page or frame, and then discuss it on a preceding or following page/frame without continuing to show the visual image.

Instructional split-attention occurs when learners are required to split their attention between and mentally integrate several sources of physically or temporally disparate information, where each source of information is essential for understanding the material. By eliminating the need to mentally integrate multiple sources of information, extraneous working memory, load is reduced, freeing resources for learning.

6.4 Coherence Principle

Learning is better when there is no superfluous text, graphics, or sound. Extraneous material such as irrelevant video, animation, pictures, narration, and sound hurt student learning.[20] Coherence principle states that all of these extraneous material should be excluded. This is consistent with the understanding that working memory is limited in its cognitive resources and so as not to overtax these precious resources, irrelevant materials should be excluded. This is where instructional designers who employ gaming technology should be careful.

6.5 Redundancy Principle

The redundancy effect occurs when information that can be fully understood in isolation, as either visual or auditory information, is presented to both channels as

essentially the same information.[21] Coordinating redundant information with essential information increase working memory load, witch interferes with the transfer of information to long-term memory. This is due to the fact that the visual pathway could be stuffed heavily with materials to be cognitively processed when in fact both the text and pictures are merely duplicating what they wish to convey in terms of information and understanding. Eliminating redundant information eliminates the requirement to coordinate multiple sources of information.

6.6 Pre-training Principle

People learn better from a multimedia presentation when they already know about the components in the presentation. If the learner doesn't understand the nature of each component, trying to construct a model of each component while trying to understand how they integrate with each other will quickly overload working memory.[2] It is better to do pre-training on each component so that the learners already possesses schemas for them before presenting material that requires the learner to integrate each component into larger schemas. This connects to the concept of chunking and building schemas. Learners have to create low level schemas about a concept, before they can combine them into larger, more complicated schemas.

6.7 Learner Control Principle

It is important to provide control mechanisms accommodated to the different abilities and styles of learners.[22] Better learning occurs when the pace of presentation is controlled by the learner, rather than by the program. Learners vary in the time needed to engage in the cognitive processes of selecting, organizing, and integrating incoming information, so they must have the ability to work at their own pace to slow or pause the presentation if necessary.

Linear presentation is useful, particularly for providing specific learning paths, but mechanisms such as searching and indices can provide especially effective alternatives for learners. Multiple views of information can be provided rather than assuming a single static information structure. This capacity allows for distinct styles of learning to be catered for, with separate views being provided of the same information. Similarly, the utilization of a variety of alternative media types permits information to be presented in ways that allow learners to focus on material that support their particular style of learning.

7 Conclusion

It would be easy to conclude that multimedia is always the way to go, but that's a stretch. The first consideration is whether you have the resources and skill sets needed to do it well. Designers need to select media only when it supports a learning need. It is far more effective to build well-executed single-media instructional materials than poorly executed multimedia.

In designing instructional media, an awareness of the Working Memory construct can assist in ensuring that cognitive overload and dual-coding effects are avoided. Levels of existing learner expertise, computer-familiarity and several other factors all contribute to the overall effectiveness of educational multimedia. Instructional designers can have little control over the innate abilities of learners, but an awareness of their abilities and a detailed understanding of the characteristics of the targeted learners can provide a foundation for sound instructional design.

Well-designed multimedia helps learners build more accurate and effective mental models than they do from text alone. The exponential growth in computer-based training will precipitate increasing demand for effective learning design in multimedia instruction. Rather than relying on flashy special effects, it is important that instructional designers begin to work within an empirical framework of principles that are driven by the learner, rather than technology. Cognitive science provides a research-based foundation of theories that serve as a grounded starting point for this instruction, as well as further research.

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Study of Heterogeneous Distributed Resource Warehouse Semantic Retrieving Based on Multi-agent*

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Abstract. With the advent of the network education, multi-media information resources are used more and more widely, which normally require a large amount of the network memory space. It is the extremely challenge for further developing this kind of system (distributed resource warehouse). This paper aims to sort out some problems related during developing the distributed resource warehouse, and proposes an architecture for distributed resource retrieving based on multi-agent. Finally, this paper illustrates the process to fulfill heterogeneous resource selecting based on the same ontology by some simple examples.

Keywords: Heterogeneous Distributed Resource Warehouse, Semantic Retrieving, Multi-Agent, Ontology.

1 Introduction

Currently, with the network education developing, multi-media teaching resources such as audio frequency, video frequency are used widely. However multi-media information resources' memory space also increases swiftly and violently. Although high-capacity memory equipment has been developed, the insufficient memory space problems are still outstanding due to limited memory equipment space facing unceasingly growing multi-media resources. At the same time, with the fact that ceaselessness of web learning, many resource sites are presented in different ranks and different layers. As a result, the traditional ways to store resource have caused many problems. Therefore, building up virtual distributed teaching resource warehouse has become the effective solutions for education resources memory.

Subsistent distributed resource warehouses, no matter they designed with layers frame or upsides1, have a few problems. Follows are several mainly problems that restrict distributed resource warehouses' functions and development2.

1. Retrieving is not effective. In the process of retrieval, the different sites need frequent interaction among them, so there exists the bottleneck problem, which reduces the entire distributed resource warehouse retrieval efficiency.

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2. Currently, a lot of distributed resource warehouses are heterogeneous; every site owns its independent resource memory scheme and resource descriptive way, reducing the precision ration of selecting and the ration of recalling resources, which influence the entire resource warehouse retrieval effect.
3. “False” distribution. This problem is obvious in the distributed resource warehouse which adopting layers frame. To this kind of resource stations arranged on different layers of resource warehouse, resource retrieval and administration are all by host server, while every resource site can only carry out the resource memory, whose retrieval way is still centralized obviously.

Be short of the support of semantic-based resource selecting. At present, mostly using warehouse with distributed resources, the searching methods for resource are all resource keywords-based full text selecting, the same as the searching method of network searching engines, such as Google, Baidu. Distributed resource warehouse is a special domain resource aggregation. Even if resources are totally unrelated on formulation, there still exist possible contacts on semantic. Therefore, Semantic-based resource retrieval can drive development of distributed resource warehouses and expand their range of application.

Teaching resource warehouse is used broadest among using distributed resource warehouses. It affects most widely and shows highly solicitude3. Being aimed at the current development situation of distributed teaching resource warehouse, this paper proposes an architecture for distributed teaching resource semantic retrieving based on Agent and, it’s a basis frame that has been already applied to develop a few network courses of our school. With the development of our country’s economy and the rising of information, the selecting scheme building-up for distributed resources warehouse also surely have certain draw lessons meaning to the construction of other distributed resource warehouse.

The remainder of the paper is organized as follows: in Section 2, background and the related work are presented; in Section 3, the distributed resource architecture is given out; the semantic-oriented distributed resource retrieving process is proposed in Section 4, and conclusions and the future works are shown in Section 5.

2 Related Work and Areas

Semantic search is a key issue in integration of heterogeneous databases. Paper 4 presents the methodology to implement semantic search in BioDW, an integrated data warehouse. In BioDW, two important tables are constructed. Based on those tables, multifarious ways for semantic search have been provided and the corresponding entries in heterogeneous databases in terms of semantic can be expediently searched.

The generality of the RDF data model presents unique challenges to efficient storage, indexing and querying engines, and there are limitations in modeling RDF constructs. The RDFStore model5 is a new flexible indexing and query model. This model is tailored to RDF data and is designed around the Semantic Web from the ground up.

Retrieving useful information from a specific database is a basic computing task. However, traditional information retrieval techniques aren't suitable for some educational purposes. The proposed system in paper 6 exploits the fuzzy semantic cognition

concepts to design the retrieval mechanism. In their system, users can easily find the target bird by inputting the observed features, view its image, read its brief introduction, play its sound, and even take bird-life notes of it. The experimental results show that this model isn't only suitable for educational purpose but also easy to be modified for other domains.

In order to implement knowledge sharing between technical researchers, a new method 7 using techniques of semantic Web is proposed, which can retrieve reference metadata from varied documents. By way of pattern matching, it can get some metadata such as authors, titles, publishing date and journal name, and uses the OWL ontology description language to formulate the metadata, which assists the semantic searching in the next step.

Current agent-based approaches lack in intelligence of the system behavior. These systems8 either use metadata retrieval based on simple keyword search or exploit RDF schemas. Our contribution is the semantic retrieval of resources covering varying and dynamically changing thematic regions, and with the technology of multi-agent making searching process more flexible and intelligent.

Paper 9 presents a concept for information retrieval in the World Wide Web which satisfies both quality and efficiency. So-called domain experts acquire knowledge about specific domains. They use mobile agents to investigate the Web for documents relevant to their domain. By storing this knowledge, experts can answer future queries directly without any remote actions. Apparently, the lack of this method needs domain knowledge, and it is difficult to establish these knowledge libraries.

In the paper 10, an Information Retrieval Server Based on ontology and Multi-agent is presented, which integrates several kind of agents, such as interface agent, pre-process agent, management agent, information processing agent, and information searching agent with mobile ability. The system also uses ontologies to classify the domains of documents and assist user to normalize their queries. Using this system, dynamic changes of information on the Internet can he reflected timely, and the navigational ability of retrieving information can be improved. However, this system needs users' interest, and must pre-process the documents.

The search of decentralized multi-agent ontology-based system for information retrieval11 presents a catalog based system based upon data collection and harmonization from distributed fields of knowledge that enables the online search and discovery of information from different thematic regions. But their current systems and implementations permit search among only fixed areas of interest.

This section surveys the related areas of distributed heterogeneous information retrieval, multi-agent and ontology.

2.1 Distributed Information Retrieval

Approaches to querying distributed heterogeneous data sources, which may include traditional databases, knowledge bases, programs, Web pages, and data files, can be broadly categorized into the follows 12:

1. A lazy or on-demand approach, where information is extracted from the sources only when the queries are posed.
2. An eager or in-advance approach, where relevant information is extracted in advance in anticipation to queries and stored in a central repository.

It is obvious that a lazy approach incurs inefficiency and delay in query processing, especially when queries are issued multiple times. Each time when a query is issued, a system that employs a lazy approach has to decompose the queries into sub-queries and then translate, filter, and merge the results to generate the answer.

There are a variety of on-demand approaches that have been proposed for querying heterogeneous and distributed databases. The trend seems to be towards a federated approach. One example of such systems is Pegasus that addresses the semantic heterogeneity problem by requiring administrators to write specific programs that will reconcile semantic differences13.

The problems with the above approaches are (1) schema integration is usually difficult; (2) as soon as any of the information sources change or a new source is added, the process may have to be repeated.

2.2 Multi-agent

The term "agent" is difficult to be defined. Agents are often described as entities with attributes considered useful in a particular domain. Common agents usually have attributes of adaptively, autonomy, collaborative behaviour, inferential capability, "Knowledge-level" communication ability, mobility, personality, reactivity, and temporal continuity.

As seen from DAI (Distributed Artificial Intelligence), a multi-agent system is a loosely coupled network of problem-solver entities that work together to find answers to problems that are beyond the individual capabilities or knowledge of each entity. More recently, the term multi-agent system has been given a more general meaning, and it is now used for all types of systems composed of multiple autonomous components with the following characteristics14:

1. Each agent has incomplete capabilities to solve a problem.
2. There is no global system control.
3. Data is decentralized.
4. Computation is asynchronous.

One of the current factors (and arguably one of the more important ones) fostering MAS development is the increasing popularity of the Internet, which provides the basis for an open environment where agents interact with each other to reach their individual or shared goals. To interact in such an environment, agents need to overcome two problems: they must be able to find each other, and they must be able to interact.

2.3 Ontology

Ontology is defined as specification schemes for describing concepts and their relationships in a domain of discourse. It is important that agents not only have ontologies to conceptualize a domain, but also that they have ontologies with similar constructions. Such ontologies, when they exist, are called common ontologies. Once interacting agents have committed to a common ontology, it is expected that they will use this ontology to interpret communication interactions, thereby leading to mutual understanding and (ultimately) to predictable behaviours. Ontolingua15 is often mentioned in the literature as a system that provides a vocabulary for the definition of

reusable, portable and shareable ontologies. Ontolingua definitions are described using syntax and semantics similar to those of the Knowledge Interchange Format16, also known as KIF, which is a format to standardize knowledge representation schemes based on first-order logic. SUBRATA DAS presents an Agent-based Complex QUerying and Information Retrieval Engine (ACQUIRE) for large, heterogeneous, and distributed data sources17.This method improves the source retrieve using mobile agent, and our paper will further improve the effects to get help from agents, ontologies and facets.

3 Distributed Resource Warehouse Architecture Based on Multi-agent

Generally speaking, the distributed resource warehouse should have following fundamental characteristics:

1. It has a main site to provide the catalogue service for searching resources;
2. The different resource sites can carry out resource description and memory independently;
3. Resources in different sites can be searched by other sites and can be gained owing to certain conditions.

Being aimed to the fundamental characteristic of distributed resource warehouse, the building-up distributed resource warehouse should satisfy three requests as follows:

1. Each resource site is able to dynamically and independently to manage its own resources, including resource's addition, deletion and modification.
2. By the fact that a main site provides Yellow Pages service to all resource stations. Any resource site wants to join in the resource warehouse, it must register itself on the main site. The main site can count a list of a series of resource sites for these resource sites where it will go for searching its needful resources.
3. Among the resource sites, there is a business mechanism, so it must provide a fine resource transaction way to answer the frequently information interactive between resource sites.

Agent has some characteristics, such as autonomous, initiative, mobility18. However, in the multi-agent system, different Agents can represent different entities to interact and collaborate with other Agents, and the interaction or collaboration takes self-interests maximize as its target19. Because of these characteristics of multi-agent technology, this paper will draw support from multi-agent to construct the architecture for distributed resource warehouse to satisfy above-mentioned three requests. Figure 1 gives out the frame of distributed resource warehouse based on Agent.

This architecture takes multi-agent technology of Jade (Java Agent Development Framework) as its basis20. There are mainly two kinds of Agent used in this frame, Site Agent and Search Agent. While the Site Agent can also be divided into two kinds of Agent, respectively corresponding to main site’s Main Agent and every resource site’s Sub Agent. In the entire distributed resource warehouse, there must have a Main Agent to be responsible for all resource sites’ registration service and catalogue service, and it looks upon as an interactive bridge between resource sites. Each resource

site has a Sub Agent, which is responsible for the operations of resource's addition, deletion and modification. When receiving the retrieval request for resources from other sites, Sub Agent changes resource retrieval request information into a regulatory description, and responses the resource list satisfying the request; While some sites asking for resource, the Sub Agent can produce a Search Agent dynamically carrying out the resource retrieval in the entire resource warehouse, and its life cycle is a resource searching process. Follows will make a little explanation to Site Agent and Search Agent respectively.

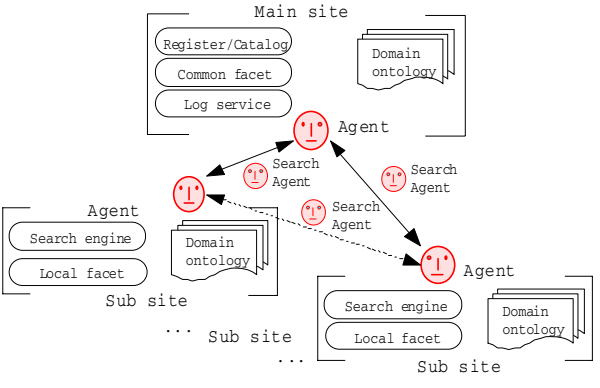

Fig. 1. Agent-based distributed resource warehouse architecture

3.1 Site Agent

In the designed distributed resource warehouse architecture, every resource site has a Sub Agent to be its core component. The Sub Agent does not leave the resource host, and it is mainly responsible for these operations as following:

1. Selecting information standardization. Since every resource site exists an isomerism in aspect, such as heterogeneous descriptions, in order to realize heterogeneous resource site information transition, the Sub Agent is asked to carry out a pretreatment first to consumer's retrieval information. In Figure 1, we can see that, every resource site has its own domain ontology21, and the main site has a common facet, while each resource site has a local facet. Before sending out a retrieval request, retrieval information that is described by local facet will be changed into retrieval information that is described by common facet; On the other hand, while Sub Agent receives retrieval information that is described by common facet, it will be transformed into retrieval information that is described by local facet;
2. Generating the Search Agent dynamically. In order to retrieve required target resource from distributed resource warehouse, the resource site should generate specifically Search Agent for some searching request and deliver it to the main site. The Search Agent needs to carry the target resource information for this searching, and it gains the resource site list that may own target resource, then it moves it to the target site for retrieval request.

3. In charge of the sites communication. Each Site Agent represents the site interactive with others, such as sending retrieval information and receiving the searching result; it is in charge of buffering memory various information and managing the message queue.
4. Catalogue and log service. Main Agent is responsible for renewing a catalogue and retrieval log. It is in charge of providing catalogue service and resource sites retrieval priority list for Search Agent.

3.2 Search Agent

An important problem that distributed resource searching needs to solve in the process of resource retrieval is the communication bottleneck as the information frequent interactive. For this purpose, the frame shown in Figure 1 designed the Search Agent to resolve the communication problem between sites. The resource site is required to produce a corresponding Search Agent for specifically retrieval; Figure 2 shows the running process of Search Agent taking a searching request for example.

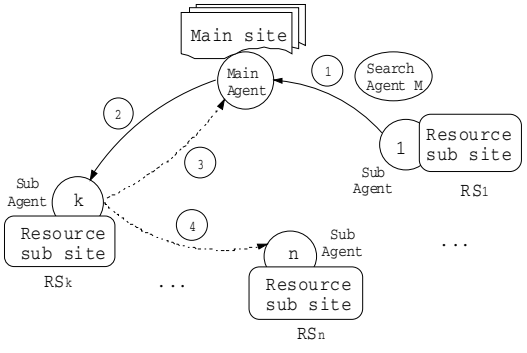

Fig. 2. Running process of Search Agent.

Assuming that resource site RS1 receives a request for resource retrieval, after that, Sub Agent of RS1 will create a Search Agent M, here M represents the resource site RS1 carrying out the resource retrieval. Follows are the running processes of M:

1. After M generating, it comes to the main site carrying the retrieval request firstly, and brings forward a retrieval request to Main Agent;
2. The Main Agent returns a resource searching site priority list to Search Agent. M decides its own route according to priority list, It firstly moves to the highest priority site RSk on this list;
3. M will interact and consult with RSk according to its own carry-over retrieval request conditions. If consulate and comparative result is successful, it will return the retrieving result to Main Agent, and go to step 5, or else it will execute step 4;
4. M moves to the next resource site on the list and continues to search resource until getting the target resource or getting the failure result after consulting with all resource sites on the list. If M arrives in the resource sub site according to resource

searching list, and finds that the resource sub site is busy now, (For example, the unresolved retrieval requests have reached the threshold value of RSn's searching request queue, and M satisfies its own searching request that needs to wait for some time.), it can move to next resource site on list, and chooses an appropriate time to access this resource site once again.

5. Main Agent returns the retrieval result to RS1's Sub Agent (including two result instances, success and failure) by Search Agent M, and finishes this searching process.

4 Oriented-Searching Distributed Resource Searching Process

Having found the Agent-based system architecture, this section will expound the distributed retrieval process with some simple examples under this architecture. So long as heterogeneous resource warehouses are based on the same ontology, this retrieval method can implement resource searching in all inner resource sites. The retrieval process is shown in Figure 3, and we take eight steps to illustrate the retrieval process.

1. The consumer expresses the searching request described with location site's facet scheme, and sends the searching request to source resource site;
2. The source site's Sub Agent will do some pretreatment for consumer's request based on domain ontology. Pretreatment contains three steps: Firstly, Sub Agent transforms the request according to domain ontology, and gains the ontology-based searching request. During this conversion process, because the faceted classifications are independent mutually, any resource needs to establish the common conversion regulation according to its own local faceted classification and common facet classification locating on Main Site; Secondly, Sub Agent makes the retrieval request standardization .it examines the parts existing disaccords or conflict places among retrieval requests, even the request which will not be satisfied by any resource. For example, if consumer's retrieval request not only has the request of "a form that is doc ", but also has the request of "run by Real Player ", the conflict will be reasoned out apparently. In this process, many times interactive with the consumer may be required. Once the inconformity appears, it will inspire consumer to adjust searching information and try again. Thirdly, Sub Agent enriches and expands the resource's description and customer's retrieval request according to ontology knowledge. For example, making use of domain ontology, direction description information can reason out the indirection description information, which exists in resource or retrieval request. If consumer's retrieval conditions contain "a form that is doc ", Sub Agent can reason out the condition of "run by Microsoft Word" according to the relationship "Open With" between the instance "doc" and the instance "Microsoft Word". After pretreatment, we can get consumer's retrieval request description which is consistent, enough integrity and based on ontology, it can be understood by all resource sites sharing the same ontology;

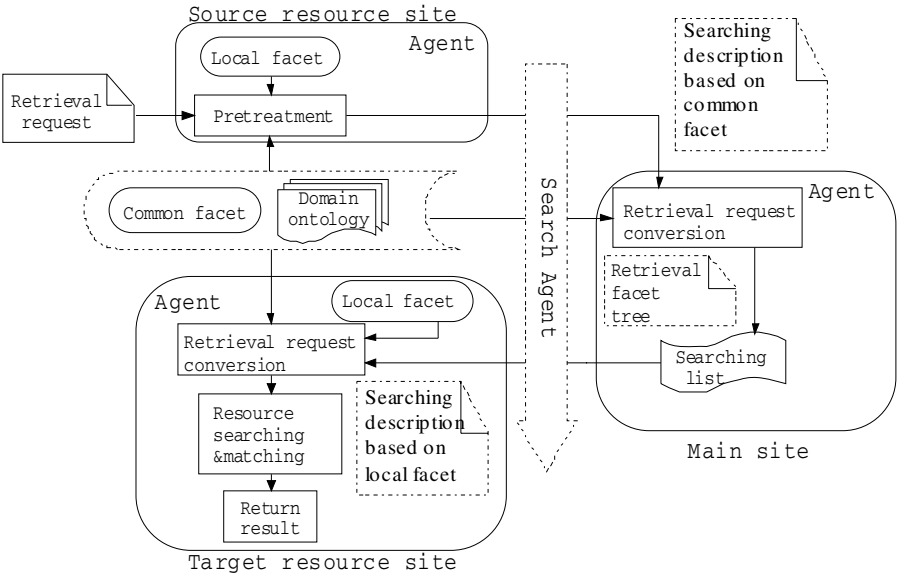

Fig. 3. Distributed resource retrieval process

3. Load this ontology-based searching description to Search Agent, and send it to Main Site from source site. Main Agent maps the searching request to retrieval facet tree according to its own local facet scheme. During the implement process, Main Site doesn't store any resource, and in order to improve the searching efficiency, this architecture defines Main Site's faceted classification as common faceted classification consisting with its domain ontology;
4. Main agent generates resource site searching priority list according to retrieval facet tree, and sends it to Search Agent;
5. Search Agent routes according to resource site searching priority list. When it arrives at target resource site, it gives the retrieval request described by common facet scheme to target resource site's Sub Agent. This Sub Agent gains the local retrieval facet tree mapped from its own local facet scheme.
6. Target site's Sub Agent searches the resource by matching the retrieval facet tree, and this retrieval method is called retrieving resource based on faceted classification22. Having found the retrieval result according to consumer's request, Sub Agent consults with Search Agent on resource transaction. If they can get the negotiation result in that given time, we called this searching process is successful, and go to step 8, or else execute step 7;
7. Search Agent moves to the next target site that is on the resource site retrieval priority list, and continues to execute step 6 and step 7 again until it searches all the listed sites;
8. Finally, Search Agent comes back to source resource site. If retrieval is successful, Search Agent gives the resource information selecting from target resource site to source site's Sub Agent. Or else, the Search Agent will send failure message to source site's Sub Agent. The retrieval process finishes here.

The ontology-based resource description and retrieval method make the resource description and consumer's retrieval be more semantic, therefore, it can improve entire resource warehouse retrieval effect. On the other hand, because domain knowledge is relatively stable, ontology share is easier among these resource sites, and the modification of domain ontology is easier to spread to other resource sites.

5 Conclusion and Future Works

The increase of web resource especially the web multi-media teaching resource puts forward much new demands for distributed resource warehouse. Under this background, this paper proposes an architecture based on multi-agent for distributed resource warehouse, and expounds the process of resource retrieval combining with semantic idea under this architecture. The main work of this paper to resource retrieval manifests two aspects. Firstly, by introducing multi-agent system, this paper sets up the framework based on multi-agent for distributed resource warehouses, and provides the foundation for the distributed resources retrieval and automatic transactions. Secondly, through the establishment of the domain ontology, the retrieval method combining ontology and facet not only achieves the single resource site retrieval based on semantic, but also establishes the interactive between heterogeneous distributed resource warehouse, so as to realize the heterogeneous distributed resource sites resource retrieval based on the semantic. This is only a little trial study to build distributed resource warehouses. We want to offer our pygmy effort to resolve the problem of network teaching resource memory by this study. There is still much uncompleted study for us. Building transaction module and strategies is our core study from now on.

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Technical Route for Remote Demonstration Teaching

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Abstract. It designs and realizes display mirror driver with Windows Driver Development Kit of Microsoft Corporation, and develops a remote demonstration teaching system associating with network technology, which actualize such functions as video capturing, network sending, remote receiving and playback.

Keywords: display mirror driver, demonstration teaching.

1 Introduction

Demonstration teaching, a kind of teaching method which has been proved to be effective in long-term practice, is usually used for testing the impartation of observation teaching and action skill in daily teaching of school. For example, difficult actions are often analyzed one by one, displayed in frozen images and then demonstrated together by video in physical education, so as to make it better for students to master those actions. Due to the progress of information technology, demonstration teaching recruits "virtual" method. As a result, students are so lucky that they can see those things which hardly take place or never happen in real life despite the fact that they may just exist on computer screens or in visions caused by laser holographical imaging. As the saying goes, "better to do than to say", so demonstration teaching is undoubtedly one of those most intuitionistic and acceptable methods for learners whatever the method is.

Information technology education contains much teaching contents requiring students to practice on their own or imitate operating procedures of their teachers. As for such stage, teaching is generally performed under LAN (local area network) in multimedia classroom. The teacher's computer acting as server locks students' computers acting as clients, and delivers what is displayed on the server to clients in the form of broadcast for students to observe.

Remote demonstration teaching mentioned herein means a teaching method which realizes remote and real-time observation with the help of information technology. It refers to a scheme and key realizing technology to realize remote demonstration and interactive teaching in the form of software under wide area network.

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2 Development of Remote Demonstration Teaching

Remote demonstration teaching is one kind of applications of mature remote monitoring technology into education. In the practice of remote teaching based on network, people employ IP network rather than peer-to-peer analog video cable to deliver video and other information concerning monitoring.

Network video teaching is adopted in some IT training, through which learners can see the teacher and PPT used for courses and hear the teacher's voice. Although videos are played slowly sometimes due to network broadband, the advantage of visible image of the teacher is more than the problem of mental feelings compared with conventional online display courses.

As for the practice of remote teaching in iatrology, surgery remote demonstration teaching, achieving distance and real-time observation of surgeries in virtue of monitoring equipment, has been applied for years. Its advantages include high real-time performance, intuitiveness and no disturbance to normal treatment, which promote two-way interactive communication between doctors in operating room and observers.

There are, however, some problems in those above methods more or less. For instance, students, unable to join in teachers' demonstration, are stander-bys wholly. They cannot act like apprentices in auto repair shops who can pass tools timely while observing their masters' actions. It is obvious that the teaching effect will be better if students can participate actively in teachers' operation process. And it is really regretted that details and operation process cannot be seen in demonstration teaching "broadcast lively" by camera.

3 Technical Method Adopted in This Paper

To make it convenient for developers to develop and extend external equipment driver, Microsoft provides a Driver Development Kit (DDK) which contains basic structure regulations of all the equipment drivers supported by Windows. Following these regulations, designers can optimize and rewrite existing driver and even project and achieve "virtual hardware" provided with specific functions as per their own requirements.

The inventor of this system, with the help of regulations for display card driver in DDK, designs a virtual display card driver, overloads and rewrites the function for reading and writing in display buffer region thereof. Thus, after successful installation of virtual display card (as shown in Fig. 1), the system, when inputting and displaying any information on the screen, will send the information to actual display card as well as virtual one. Therefore, virtual display card is able to realize the same operation of original display card of the system synchronously. Virtual display driver does not have to realize I/O command actually, but it has an opportunity to read directly image data of display buffer region, namely acquire screen images timely, which is different from the principle of common screen copy at all. Screen images obtained through screen copy are acquired regularly from the screen rather than from the computer memory. This method cannot achieve the interception of video images on the screen. On the contrary, one advantage of virtual display card is that it can get the very same "copy" of whatever text or video displayed on the screen.

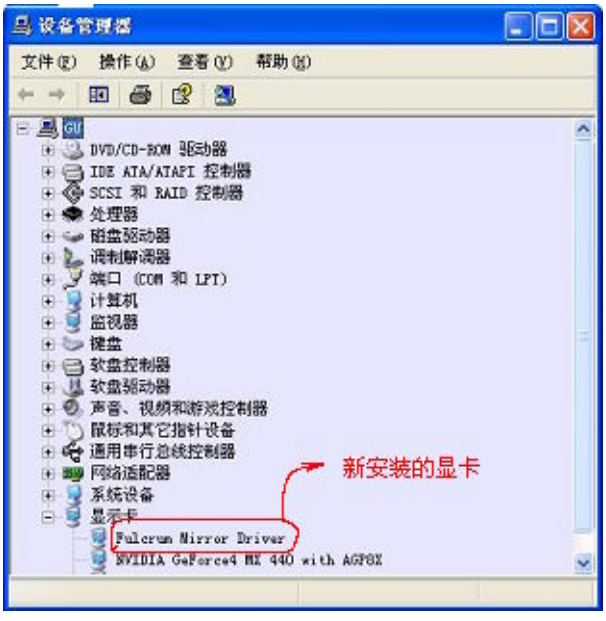

Fig. 1. Successful installation of virtual display card Fulcrum Mirror Driver

Normal display card will send the content obtained from display buffer region to display device, and at the same time virtual display card receives those screen images to be displayed. However, the modified virtual display card driver “snapshots” the screen and sends it to specified clients, and then the client program shows the information in the form of a picture after receiving it. As display card driver can get all the changes of screen output, all the information on the screen of the server may be viewed by the client with the permission of broadband. Remote demonstration teaching, thereby, is achieved. The above method is also a substitute for remote technology support of enterprises.

Fig. 2. The Desktop screen effect on the Server_side

Fig. 3. The screen effect on the Client_side

Fig.2 and Fig.3 reflects the relationship between the client and server-side clearly.

4 Detailed Design of the Scheme

In order to connect to and control over virtual display card correctly in the application need to know its name,the procedure in the display driver used the "EnumDisplayDevices" function to access the system, its original form:

```
BOOL EnumDisplayDevices
(
  LPCTSTR lpDevice,                    // device's name
  DWORD iDevNum,                       // display device
  PDISPLAY_DEVICE pDisplayDevice,      // information about device
  DWORD dwFlags                        // Reservations
);
```

Procedure should traverse display driver to find the Mirror Driver,like this:

```
while (result = EnumDisplayDevices (NULL,devNum ,&dispDevice,0))
{
  str=(const char *) dispDevice.DeviceString;  // get the Current device
  if (strcmp(str, driverName) == 0)
     break;
  devNum++;
}
```

and use "CreateDC" to create a description of form, this can really use the virtual display driver in application.

```
HDC hdc = CreateDC ("DISPLAY",          // the name of virtual display driver
                    deviceName,         // device's name
```

```
                    NULL,
                    NULL
                );
```

According to the principle of designed display driver, in the Mirror Driver need to achieve “DrvEscape function”, so that applications can call it. “DrvEscape” the core mode can directly access the hardware address, and this breakthrough the restrictions in the operating system because running on the user mode applications cannt access the the bottom hardware address. DrvEscape original form:

```
DrvEscape (
        SURFOBJ   *pso,   // Graphics interface objects
        ULONG      iEsc,   // Functionality mode option
        ULONG      cjIn,   // Reservations
        PVOID      pvIn,   // Rectangular screen memory address
        ULONG      cjOut,  // output data len
        PVOID      pvOut   // output address
         )
```

in the function of DrvEscape has a key function be called,that is: Screen2Buf which is the role of the copied entire screen image information directly into the memory buffer.

The operation flow designed for the whole system is shown in Fig. 4.

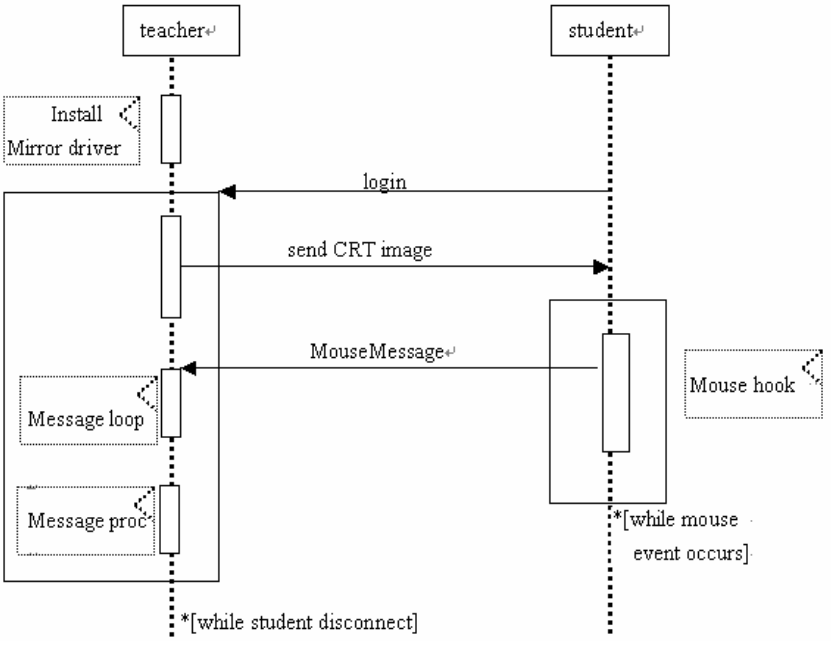

Fig. 4. Picture of system operation flow

The work flow of this remote demonstration teaching system is as follows: first, teacher terminal program inspects whether the virtual display card is successfully installed, if it is, and then it waits for the entry of student terminal. When the student terminal connects, it will send Ready signal to teacher terminal to tell the teacher terminal that it has been ready for receiving data. The teacher terminal sets up data buffer area according to the conditions of student terminal, if it is the first time to send data, then the display memory will be directly visited via virtual display card drive and the data in the display memory will be sent to student terminal; if not, then the system will obtain the area coordination which needs redrawing, display the resolution and position and read the corresponding data module from the display memory by simple calculation according to the current screen, then send it out. Student terminal will put the pictures together and display in the windows correctly according to the mode which the data was received.

In the teaching process, we could achieve the remote demonstration teaching by the application of this system. As shown in Fig. 5 and Fig. 6, the teacher terminal is demonstrating Visual C++ program design and the student terminal could receive the guide of teacher though network in real time.

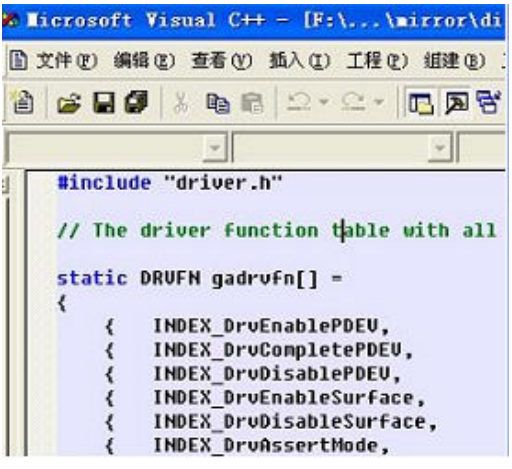

Fig. 5. Screen effect of teacher terminal

On the screen of student terminal, the information received is from teacher terminal and to be precise, which is a screen picture of teacher terminal. If the student participates in the teaching with mouse and keyboard, for example, when he clicks the menu items of the picture displayed on the current screen, he certainly wants to see the drop-down menu items to enjoy the effects that his participation produces. If the client terminal just receives the pictures transmitted from the server terminal, then there will not be anticipated reaction when the student clicks these pictures.

The techniques of hook program are needed in the application program for the necessary feedback effects in interactions of the student terminal. There are many hook programs can be used, the most familiar ones are keyboard hook and mouse hook. actually hook is a process of dealing with the message and it be hang to system by system calls. Whenever a specific message be sent, before it reach to purpose

window, procedures on the hook intercept and capture the message, hook function get control over it. Then hook function can process (change) the message or can continue deliver this information without any handle and can also force to end of the message transmission. For each type of hook in the system would be maintained in a kind of data strcture of stack, recently installed the hook on the stack's top, and the first to install the hook on the stack's bottom. Win32 system to achieve the hook, we must call the API function "SetWindowsHookEx" to install the hook function, this function of the prototype is:

HHOOK SetWindowsHookEx (int idHook, HOOKPROC lpfn, HINSTANCE hMod, DWORD dwThreadId), which, the first parameter is hook's type; the second parameter is the hook function address; parameter third is the function of the module and contains hook handler; the fourth parameter is monitor thread. If the designated identified threads, which is dedicated hook thread, if the parameter designated NULL, which is the global hook. The global hook function must be included in DLL (dynamic link library), and the threads can also contain special hook in the executable file. After the hook function get control and completion of the treatment the message, and you want to convey the message continue, it must call another API function "CallNextHookEx" to deliver the message. Hook's function can also discarded the message by returned TRUE and to prevent the transmission of message.

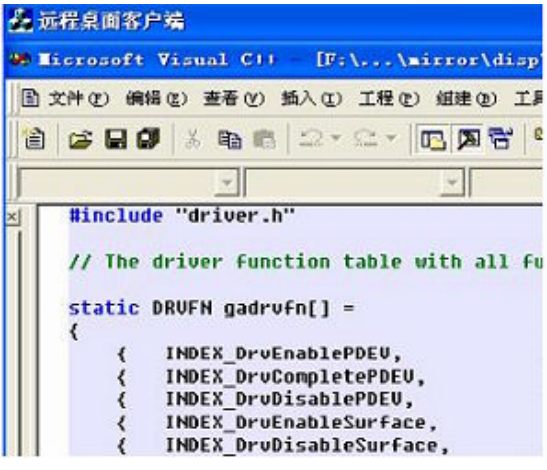

Fig. 6. Operation effect of student terminal

As mentioned in the above example, when a student clicks the menu in the picture with mouse, this action will be captured by the mouse hook which has no concern with specific windows and works at windows in background and the coordinate parameters are also obtained while mouse pressed at the very time. In hook program, this information captured will be sent to the teacher terminal after necessary handling like coordinate transformation, and the teacher terminal will, by itself, send a message that the mouse pressed at designated point to the corresponding windows with this information as the parameter, which will induce the running of the message handling function of the corresponding mouse in teacher terminal and cause the unfolding of the menu items, hence, any change of the picture on the screen of teacher's computer

will appear on the students' computers. Therefore, while a student is using mouse and keyboard on the computer in client terminal and participating in the interactive operation on the screen, he could see the anticipated content just as operating a same computer with the teacher.

5 Discussion

Although the system has primarily achieved the goal of remote teaching demonstration, many parts of it need improving. First, the network resource it occupies is much larger because the server transmits images to client terminal. Thus, compression is firstly needed while the virtual display card transmits data, otherwise the client terminal would be intermittent while the server terminal plays videos. Next, in physical teaching, there might be one-to-many. However, group sending function has not been designed yet in this system currently. Besides, once the system is modified to send data to more than one user at the same time, an additional multithreading coordinated controlled module should be added, or else the system might be in a mass when more than one student operates simultaneously.

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