A NOVEL WEB-BASED ONLINE EXAMINATION SYSTEM FOR COMPUTER SCIENCE EDUCATION

Yuan Zhenming[1], Zhang Liang[2], Zhan Guohua[3]

Abstract *– Web-based Examination System is an effective solution for mass education evaluation. We have developed a novel online examination system based on a Browser/Server framework which carries out the examination and auto-grading for objective questions and operating questions, such as programming , operating Microsoft Windows , editing Microsoft Word , Excel and PowerPoint, etc. It has been successfully applied to the distance evaluation of basic operating skills of computer science, such as the course of computer skills in Universities and the nationwide examination for the high school graduates in Zhejiang Province, China.*

Index Terms *– Examination system, Auto-grading system, Web-based, DCOM*

1. INTRODUCTION

In China, the education for basic computer operating skills has been broadly launched. The skills include the operating of Windows, MS Office, Networking skills, etc., which are the foundation of a combination of different courses, as well as of electronic-government. Now, every undergraduate must pass the course of the Computer skills, while every civil servant must pass the corresponding Computer Operating Exams. Furthermore, the basic computer education in high schools is in process. Since the late 1990's, hundreds of thousands of people have taken part in different levels of computer education and testing in Zhejiang Province. It is necessary to build a Web-based learning and examination system for such a large number of people, as an effective solution to mass learning and evaluation of basic computer education.

Several Web-based learning and testing systems have been designed, such as WebCT[1], QUIZIT[2], ASSYST[3], and PILOT[4]. The most widely used question types of the Web-based examination system are objective tests and quizzes which assume simple answers that can be formally checked and easily evaluated online. The typical questions are limited to yes/no questions, multiple-choice/single-answer questions, multiple-choice/multiple-answer questions, and fill-in questions with a string and numeric answer.[5] Richer types of answers in these systems need to be graded manually by the course graders or the instructors. In addition, these systems do not support testing operating skills, such as Windows printer setup operation and Word editing, etc. in the client computer.

Our examination system for basic computer operating skills has the following characteristics: (1) The question types include not only objective questions, but also operating questions as Windows, MS Word, MS Excel, Internet skills, etc. (2) The goal of the learning and testing system is to train the practical skills. As a result, operating and testing in the actual environment of the client machine is the best learning method. (3) It is urgent to develop an automatic grading system which can grade the operating questions as well as the objective ones. However, the previous Web-based learning and testing system cannot support such functions.

We have developed a novel online examination system based on a Browser/Server framework using state-of-art computer technologies, which carries out the examinations for basic computer operating skills including objective tests, Visual Basic programming, Microsoft Windows operating , Word, Excel and PowerPoint editing, Internet and Email skills, etc. It has also implemented automatic grading online.

2. SYSTEM ARCHITECTURE

Our web-based examination system is a distributed collaborative system which is based on DCOM technology. It has four major components: the examination preparation system, the examination system, the examination monitor system and the auto-grading system.

- **The preparation system** is used to manage question storage, assign test ID and schedule the test. The question database is composed of the questions, a set of possible answers, the question types and other metadata, which are indexed by several factors, such as topics, keywords, complexity and difficulty, etc. The database is open to teachers, allowing them to add questions and answers by template.
- **The examination System** is a web-based testing interface for students, called WOES, which include the following key features: client side control, time control, security control and auto-installation. Benefiting from DCOM technology, the system can install and update itself conveniently, better than the C/S framework. Because the system is established on the Web, the systematic security faces a severe challenge. We

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guarantee the security by cryptography, real-time monitoring system and data transmission encryption. The cryptography is used to validate student identification before testing.

- **The real-time monitoring system** requires students not to leave the computer during the test by face tracking technology. The data transmission encryption system transmits the examination question and result in secret form through the network to the server. The examination monitor system is also the manager of the examination system, by which we can monitor the test processing, carry out test ID statistic and collect the answers, etc.
- **The auto-grading system** is designed by the fuzzy matching algorithm and the macro programming technology, which is seasoned with variable question types.

3. WEB-BASED ONLINE EXAMINATION SYSTEM

3.1 The aim of the examination system

As a universal examination system for the education of basic computer operation, it must meet the following requirements:[6]

1. A reasonable question storage, which must conform to the general outline of the exam.
2. A practical interface. There are two types of exam interfaces. One is the simulation, the other is the actual environment. The second scheme will give the student more flexibility because of the practical nature of computer skills.
3. A range of question types, such as objective questions, operating questions, design questions, information retrieval, group testing, etc.
4. A safety and reliable examination system.

3.2 The components of WOES

The Web based Online Examination System (WOES) is a multi-layer system which is composed of the Web Server, Database Server, WOES middleware Server, WOES client module and Browser, such as Internet Explorer. In this system, we use the Internet Information Server 4.0(IIS) as the Web Server, the Database Server is Microsoft SQL Server 7.0.

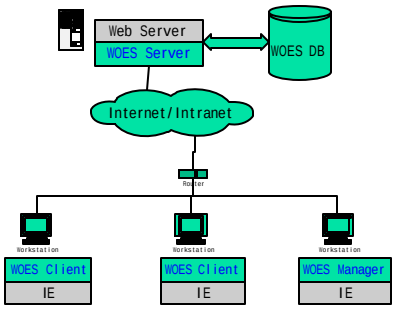

FIGURE 1
MULTI-LAYER WOES

The kernel of WOES is the WOES middleware Server and the WOES client module, which is designed according to Microsoft DCOM standards. DCOM is the binary COM object's extension jointing LAN, WAN and Internet, which can instance and bind objects over different network. It is an advanced network protocol used to cooperate with COM based components of two processes in different locations. The WOES middleware Server is a server-side component providing communication interfaces between WOES clients and the Web Server or Database Server. The WOES client is a client-side component which is called by the Browser to control the client computer and submit or receive information from the WOES Server. This technology guarantees the flexibility and the potential for extension of the test system. In addition, it allows access to local files, whereas in conventional systems, the IE security prevents such access.

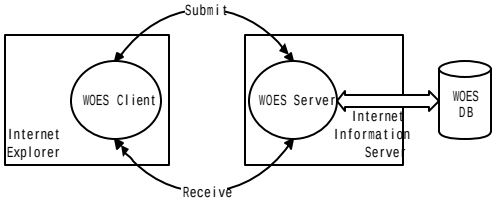

FIGURE 2
COMMUNICATION OF CLIENT AND SERVER

Benefiting from DCOM, the WOES clients can be downloaded or updated automatically from WOES middleware Server on the Internet. They can also move from one client to the other and communicate with the WOES Server. The system acts like an Agent society, which is a centralized Agent system controlled by only the WOES Server.

3.3 The key technologies of WOES

1. A user-friendly interface

We use browser as our user's interface. The Browser interface has a uniform and consistent user interface. Almost everyone is able to use it skillfully. Therefore it can

eliminate the differences of various exam systems and guarantee a fair test.

2. Simplified system maintenance

Since the system is based on Browser/Server architecture, the teacher can update the system or the question database or examine the student's database only in Server. It is not necessary to update the client system as the Client/Server must do.

3. Central examination management

Profiting from the central controlled system, the teacher can easily control the examination process, such as the beginning and end of the exam, collecting the answers and monitoring the students' conditions on the teacher's screen.

4. Security

The most severe difficulty which the B/S based system faces is security, because in principle the web-based examination system can be accessed on the Internet or WAN in a city.

- All the questions, materials and answers are transmitted in bits stream format after encoding, not in file format. It can ensure not only security in the transmission process, but also protect from invasion.
- When one student starts his test, the system will distribute him a password produced according to his client's hardware and operation system environment. It can prevent cribbers to login from other clients imitating this student.
- The newest method to prevent the distant student from leaving the client or is making use of face detection and recognition technology. Before the start of the exam, the student is asked to sit in front of the computer camera which can monitor the whole scene. Then the system will automatically recognize the student's face and his identification. As soon as the validation is performed, the student must stay in front of the camera until the exam is finished.

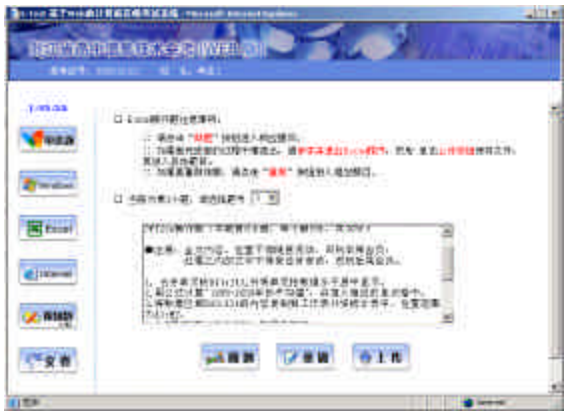

FIGURE 3
USER-FRIENDLY INTERFACE OF EXAMINATION SYSTEM

4. AUTO-GRADING SYSTEM

The auto-grading system can automatically grade the answers, which are collected from the examination system. It helps teachers to achieve the score with ease.

There are two types of the grading: objective questions and operating questions. Objective questions, such as choice questions, yes/no questions, and fill-in questions, can be graded effectively by accurate matching or fuzzy matching. But it is difficult to grade operating questions by simple matching technologies. A possible solution could be: (1) Reading the answer file directly and comparing it to the key file. But this is not practical because the format of Microsoft Office files is complicated. Another solution is: (2) grading by using the Office OLE object. This method is convenient and efficient, but it has a big disadvantage: the source code of the grading system is closely related to the concrete question, which results in a large amount of work when the questions are changed.

We propose a universalized grading system which is carried out on the basis of a database of key knowledge.

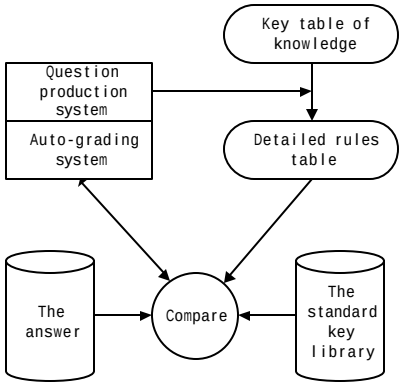

FIGURE 4
UNIVERSAL AUTO-GRADING SYSTEM

First, we extract all possible knowledge points and store them in a triple form: (key, value, location). Then we produce the question file by labeling the question point directly on it; the system will add the corresponding question key to the standard key library. So, the last process of auto-grading system is to compare the answer file with the standard key library. The auto-grading system also allows the teacher to add his/her own questions to our examination system.

5. CONCLUSION

We have developed an overall solution to the examination system for practical computer skills. It provides a user-friendly platform of various questions for the basic computer education in Universities, civil servant training and nationwide examination for high school graduates in Zhejiang Province, Hundreds of thousands of students and

teachers have used this system and agree that it has effectively raised the learning and testing efficiency.

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