Interactive E-Lab Systems

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INTRODUCTION

Most distance learning development programs are focused on online lectures, tutorials, and assessment. A practical training system that allows instruments to be monitored and controlled over the Internet leaves a lot of room to be studied. This training system can easily be turned into an online experiment that allows students at remote locations to control and obtain real-time measurements or experimental data (Tan & Soh, 2001).

Actually, some students like to read books to gain knowledge while others prefer to better understand theories through experiment (Whelan, 1997; Chu, 1999). Both of these knowledge-based and investigative types of learning styles have profound and different effects on the delivery and acceptance of engineering education.

The teaching of engineering subjects is bound to include a variety of rules, theorems, and devices that involve primarily knowledge-based learning and must be understood by the students. At the same time, students must also learn how to apply the learned knowledge through problem solving and design exercises (Ericksen & Kim, 1998). This provides another good reason to support remote-access practical work for this Web-based or virtual teaching system. A study at East Carolina University also found that a virtual laboratory helps students to understand the concept and theory of those online courses (Yang, 1999).

DIFFERENT KINDS OF E-LABS

There are an increasing number of virtual laboratories provided by universities or distance learning institutes (Tan & Soh, 2001). A virtual laboratory developed by using a simple matrix assembly Java applet provides an instrument simulator that forms a powerful auxiliary didactic tool to give students a basic idea of the instruments, control, and operation (Cabell, Rencis, & Grandin, 1997). Another Web-based interactive laboratory for basic electronic circuits using simulation was carried out at Robert Gordon University, Aberdeen (Masson, 1997). The simulation provides a representation of a system or process and allows the user to manipulate this model by changing parameters and examining the effects of these changes. It offers the advantages of repeated testing of alternatives, accessibility, reduced disruption and risk, pre-installation testing, and increased speed, as well as the obvious benefits of exploration and investigation of problem-solving skills.

The advantage of using simulation is reflected by the microprocessor development system at Griffith University (Edwards, 1999). Because a real, standalone microprocessor development system is associated with relatively high capital costs and complex modes of operation, implementation of software simulation means that each student has easy access to their own development system.

Another objective of a virtual laboratory is to provide remote hands-on lab activities to enhance online courses. Ko et al. (2000) create a virtual laboratory system using real-time video capture of an actual oscilloscope display rather than simulating the oscilloscope display on the client. The use of the mouse to turn the control buttons and knobs of the oscilloscope has been implemented so that a more realistic feel of the instrument is provided. Similarly, another laboratory running remotely via a Web interface allows users to conduct experiments in the Control Engineering Laboratory at Oregon State University (Shor & Bhandari, 1998). The Bytronic Process Control Unit at Case Western Reserve University can also be accessed remotely via the Internet (Shaheen, Loparo & Buchner, 1998).

Sharing resources is another strong point of controlling laboratories via the Internet (Henry, 1998). At the University of Tennessee, equipment of the Chemical Engineering Department can be shared by other engineering schools since introducing a Web-based laboratory. One thousand first-year under-

graduate engineering students also can experience a Web-based oscilloscope experiment at the National University of Singapore (Ko et al., 2000). This increase of utilization rate of equipment via Internet compared with the traditional laboratory also provides more learning opportunities for students with scheduling conflicts (Henry, 1998).

An online experiment for students at remote locations to control and obtain real-time experimental data was developed based on a funded consultancy project on virtual instruments (Chu, 2004). The intention of this Web-based laboratory package is to make the experiment more interactive, attractive, and easily accessed. Online video, which provides better visual impact of what is going on at the remote site, is sent to a user through a real-time video server. Background knowledge is included for easy access to the theory behind the experiment and gives an overview of the operation of the remote-controlled software used in this remote laboratory. Multimedia elements including sound, video, and animation are added for better explanation and easier understanding of the software and the basic theory for this remote laboratory.

Compared with a traditional laboratory, the virtual laboratory is particular useful when some experiments involve equipment that may cause harmful effects to human beings. The laser virtual laboratory developed by the Physics Department of Dalhousie University (Paton, 1999) shows how to perform real-time dangerous laser laboratory experiments with the help of commanding equipment through the Internet.

COMMON COMPONENTS OF E-LAB

Background Information

All necessary basic concepts and theories tailor-made to perform the corresponding laboratory can be found in the background section. This saves students' time to find related information for supporting them to conduct the laboratory experiment in different sources or locations.

Multimedia Explanation and Demonstration

In traditional laboratories, teachers usually explain the content of the laboratory in words prior to beginning. The multimedia explanation and demonstration section provides a similar function but with the help of multimedia technology, they are more interesting and easier to understand.

Download Section for Lab Sheet, Data Sheet and Shareware Simulator

During a traditional laboratory experiment, the laboratory tables are messy with lab sheets, databook, and equipment. To solve this problem, this section provides an all-in-one location to obtain updated lab sheets, a utility program (e.g., Adobe Acrobat), and simulation software (e.g., EasySim, MMLogic).

Remote Laboratory

This section may be divided into two types – software simulation and a real-time remote laboratory. For the simulation part, the predefined animation clips are used to give an idea of what is going on in some practical circuits. Different combination of inputs can be selected on the left-hand side of the screen.

For real time Web-based laboratories, equipment is well prepared for users to do at remote sites. As it is real-time controlled, this Web-based remote laboratory can allow only one pre-registered student to access for control, while other users can only monitor the result transmitted from the Webcam.

Remote Monitoring

A Webcam may be implemented for monitoring the whole process. As the delay introduced by the video server and the related infrastructure is very small for the current broadband Internet access, this gives the user a real-life feeling of what is going on at the remote site. Only the resolution of the Webcam prevents