

## Chapter 2.17

# Using Virtual Instrument to Develop a Real-Time Web-Based Laboratory

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### **ABSTRACT**

In this study, an online experiment was developed for sub-degree students at remote locations to control and obtain real-time measurements or experimental data. Online video is set up for better visual impact of what is going on in the remote site. The intention of this Web-based laboratory package is to make the experiment more interactive, attractive, and easily accessed. Background knowledge is included for better understanding of 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 software as well as basic theory for this remote laboratory. This remote equipment control and monitor was

added as a supplement laboratory to a class of engineering students. Positive feedback from students was obtained through questionnaires and interviews. These results throw light on doing remote laboratory through the Internet and direction for improvement.

### **INTRODUCTION**

Most distance learning development programs are focused on online lectures and tutorials. 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, there has been an increasing emphasis on student experience in higher education, focusing not only on the development of academic and intellectual capabilities and subject knowledge, but also on the development of skills to equip students for employability (Noble, 1999). Also, some students like to read books while others prefer to experiment (Whelan, 1997; Chu, 2000). 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, which involve primarily knowledge-based learning, and must be understood by the students. But 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. Study at East Carolina University also finds that the virtual laboratory helps students understand the concept and theory of those online courses (Yang, 1999).

There are an increasing number of virtual laboratories provided by universities and distance learning institutes (Tan & Soh, 2001). A virtual laboratory developed by using a simple matrix assembly Java applet provides an instrument simulator which forms a powerful auxiliary didactic tool to give students a basic idea of the instruments, control and operation (Cabell, Rencis & Grandin, 1997). Another laboratory running remotely via a Web interface allows user to conduct experiment in the Control Engineering Laboratory at Oregon State University (Shor & Bhandari, 1998). The Bytronic Process Control unit at Case Western Reserve University can be accessed remotely via the Internet (Shaheen, Loparo & Buchner, 1998).

Comparing with the traditional laboratory, the virtual laboratory is particular useful when some experiment involving equipment 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 a real-time dangerous laser experiment with the help of commanding equipment through the Internet.

Another objective of a virtual laboratory is to provide remote hands-on lab activities to enhance online courses. Ko (Ko, et al., 2000) creates a virtual laboratory system using real-time video capture of 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.

Sharing resources is another strong point to control laboratory via the Internet (Henry, 1998). At the University of Tennessee, equipment of the chemical department can be shared by other engineering schools after introducing a Web-based laboratory. One thousand first-year undergraduate engineering students also experience the Web-based oscilloscope experiment at the National University of Singapore (Ko et al., 2000). This increase of utilization rate of equipment via the Internet compared with traditional laboratory has another effect—to provide more learning opportunities for students with scheduling conflicts (Henry, 1998).

Funded by the Hong Kong Industry Department, a consultancy project concerning a virtual instrument from Hong Kong University of Science and Technology was given to the Hong Kong Institute of Vocational Education (Tsing Yi). This study was based on the result of this cooperative industrial project to further develop an online experiment for students at remote locations to control and obtain real-time experimental data.

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