

# Building an Interactive E-Lab

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## INTRODUCTION

There has been an increasing emphasis on enhancing students' practical experience acquiring from the 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. A practical training system that allows instruments to be monitored and controlled over the Internet leaves plenty of room to be studied. This training system can easily be turned into 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 understand theories deeper through experiment (Chu, 1999; Whelan, 1997). 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 in East Carolina University also finds that a virtual laboratory helps students to understand the concept and theory of those online courses (Yang, 1999).

## BACKGROUND: REVIEW OF E-LAB

Many virtual laboratory systems are provided by universities or distance-learning institutes (Tan & Soh, 2001). A 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, preinstallation testing, and increased speed, as well as the obvious benefits of exploration and investigation of problem-solving skills. Another 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).

The advantage of using simulation is reflected by the microprocessor development system in Griffith University (Edwards, 1999). As real standalone microprocessor development system is 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.

Sharing resources is another strong point to control laboratory via the Internet (Henry, 1998). At University of Tennessee, equipment of the chemical department can be shared by other engineering schools after introducing Web-based laboratory. One thousand first-year undergraduate engineering students also experience 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 traditional laboratory has another effect to provide more learning opportunities for students with scheduling conflicts (Henry, 1998).

Another objective of 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. Similarly, 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 also be accessed remotely via the Internet (Shaheen, Loparo, & Buchner, 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 about virtual instrument (Chu, 2004). The intention of this Web-based laboratory package is to make the experiment more interactive, attractive, and easily to be accessed. Online video, which is for better visual impact of what is going on in the remote site, is sent to the user through a real-time video server. Background knowledge is included for easily accessing 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.

Comparing with traditional laboratory, virtual laboratory is particularly useful when experiment involves 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 with the help of commanding equipment through the Internet.

## MAIN FOCUS: INTRODUCTION TO ELVIS

The National Instruments Educational Laboratory Virtual Instrumentation Suite (ELVIS) (Figure 1) is a LabVIEW-based design and prototype environment for university science and engineering laboratories originally conceptualized by Paul Dixon of the Cal State Physics Department (Paton, 2004). ELVIS consists of LabVIEW-based virtual instruments, a multifunction data acquisition (DAQ) device, and a bench-top workstation and prototype board. This three-part combination provides a ready-to-use suite of instruments required in most educational laboratories. Because the system relies on LabVIEW, it delivers the flexibility required to provide complete data acquisition and prototyping capabilities; the system is ideal for academic course work ranging from lower-division classes to advanced project-based curriculum.

ELVIS was designed to function as a three-part system. The ELVIS workstation interfaces with LabVIEW software and a National Instruments data acquisition device to perform measurements and transmit signals. Both LabVIEW and a data acquisition device are required for the ELVIS to operate, due to the workstation's dependency on these components to make measurements and send control signals. The integration of these three parts makes ELVIS a powerful, highly customizable measurement and experimentation platform.

The ELVIS workstation functions with the DAQ system and LabVIEW to take readings of physical

Figure 1. ELVIS system



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