Chapter 20
E-Learning in Engineering Education:
Design of a Collaborative Advanced Remote Access Laboratory

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ABSTRACT

Attaining excellence in technical education is a worthy challenge to any life goal. Distance learning opportunities make these goals easier to reach with added quality. Distance learning in engineering education is possible only through successful implementations of remote laboratories in a learning-by-doing environment. This paper presents one such technology to carry out laboratory experiments from remote locations. The technology is demonstrated by handling the web interface, which supports the remote experimentation on communication circuits, power system and an embedded board. The implemented system environment facilitates users to perform the experiment remotely and efficiently using only a commonly available, user-friendly web browser. It describes the ongoing research in this area exploiting current telematics techniques, which supports remote experimentation with real hardware via the Internet.

LABORATORY

Distance learning, a stand-alone approach, has grown tremendously in the past several years. Advancement in Internet technology facilitates to undertake hands-on distance learning course work in an online environment. One of the important components of the distance learning in technical education is the virtual laboratory tools integrated to perform real hardware tasks in real time. At the core of the remote laboratory lies the

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concept of collaborative learning, where the tools and equipments used in the learning process may be distributed over several geographical locations. This technology would enable the sharing of expensive hardware and provide opportunities for all to experiment with such hardware. Further such environments provide opportunities for collaborative learning and research to enhance the quality of outcomes.

Literature reveals that there have been successful implementations of remote laboratories on electric and electronic circuits (Gustavsson, 2003; Fernandez, Kinguti, & Ramirez-Fernandez, 2002), control systems (Swamy, Kuljaca, & Lewis, 2002), embedded systems (Zubia, Angulo, Hermandez, & Orduna, 2008), power electronics (Hurley & Lee, 2005) *etc*. Development of independent remote experiments using the General purpose Interface Bus (GPIB) instruments and a graphical programming tool such as LabVIEW makes possible the remote access of laboratory resources through the Internet with minimum web-interface design complexity. Ko et al. (2001) present a web based virtual laboratory on a frequency modulation experiment wherein remote users are able to gain access to actual physical apparatus using LabVIEW and through Java applet programming. A distant Laboratory using LabVIEW by Tan, Lee, and Leu (2000) describes an experiment on real-time modeling and control of a pilot-scale DC servomotor.

The idea of remote laboratories has attracted learners to study of electrical drives control theory and practice. Hurley and Lee (2005) present the use of simulation tools iPES (Interactive Power Electronics Seminar) & PSpice for pre-laboratory assignments on power circuits and remote laboratory experiment on a dc-dc buck converter using LabVIEW and GPIB interface. Lin (2006) describes the measurement of power system harmonics using graphical programming tool LabVIEW. Li and Khan (2005) illustrated the use of IT tools in the remote hardware experiments for control and measure various parameters online. Grimoni (2007) uses of Hall Effect transducers in the design of mini power system model to measure electrical parameters.

Accelerated developments in electronics and computers, embedded systems play an important role in engineering applications. Callaghan, Harkin, McGinnity, and Maguire (2006) present a client-server architecture for distant access to an integrated learning environment for remote experimentation on embedded systems, where web-based e-learning approaches are complemented by utilizing existing on-campus resources. Gilibert et al. (2006) presented an application virtualization which manages the microcontroller system for remote laboratory experiments. The simulation programs are widely used to learn the basic functionalities, but real experiments are essential to design an engineering application utilizing the built-in features available with the microcontroller.

Computer network technologies support collaborative learning among globally distributed users by thus providing space flexibility that distance education offers. More recent developments show the integration of collaborative learning tools with remote experimentation which enhances web-learning in lab-supported courses. McLoughlin and Lee (2007) present a Web 2.0 based social software and the choices and constraints to build pedagogical models for effective learning. LabVIEW virtual instrumentation and Learning Management System (LMS) tool provide an ideal platform for developing instructional curriculum and for conducting scientific experiments (Uran, Hercog, & Jezenik, 2007).

This paper presents a novel web-interface design for engineering laboratory experiments consisting of a communication circuit, a power circuit and an embedded board employing collaborative learning techniques. The objective is to bring experiments of different disciplines of electrical engineering on to the same platform using a common frame work. The emphasis is on the design of computer-interfaces for a range of hardware experiments to support educational