Chapter 16
Online Workbenches for the Deployment of Electronics Experiments

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ABSTRACT

The evidence that the field of online engineering has matured is overwhelming, particularly as indicated by the number of online laboratories in operation today. The objective of this chapter is to describe several solutions of online laboratories that were built based on the MIT NI-ELVIS iLab and the collaborative development efforts it has inspired. To this end, this chapter will describe the VISIR Platform (Virtual Systems in Reality), developed at the Blekinge Institute of Technology, Sweden, as another good example of an online workbench featuring flexible experiments. Work done at Carinthia University of Applied Sciences towards integrating VISIR-based labs on the iLab architecture will then be detailed as an indicator of future collaborative efforts.

INTRODUCTION

Laboratories are important elements in science, engineering and technical education. They allow for the application and testing of theoretical knowledge in practical learning situations. Actively working with experiments and problem solving helps learners acquire applicable knowledge that can be used in practical situations. As such, courses in the sciences and engineering consider laboratory experimentation to be an essential part of educating students. Experimentation and experience-based learning–learning by doing–is also performed in many other subject areas. For example, in economics, students lead virtual companies and compete on a simulated market. While there is a

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clear value in a traditional, hands-on laboratory experience, it is not always feasible. The costs associated with providing laboratory resources to students and the logistics of providing access can be prohibitive. This is particularly the case with laboratories that utilize limited resources or with students who may be performing their coursework remotely. In such cases, an online laboratory–a real laboratory that students can control remotely via the Internet–can provide students with a valuable practical experience that is complementary to available hands-on laboratories.

Online laboratories are important applications in the new domain of Online Engineering. Online Engineering can be defined as an interdisciplinary field utilizing the areas of engineering, computing and telematics; where specific engineering activities like programming, design, control, observation, measuring, sensing and maintenance are provided to both remote and local users in a live, interactive setting over a distributed network. The availability of high bandwidth Internet connections world-wide and other derivative capabilities in the areas of real-time communications and control have made the possibility of Online Engineering, as well as utilizing state-of-the art equipment in online laboratories across the globe a current reality.

Development and use of online laboratories has gained a significant amount of traction over the past decade with many institutions getting involved in such efforts. The MIT iLab Project has been active in this field with efforts directed towards the development of individual online laboratories as well as a distributed software architecture to support lab development and dissemination (Harward, 2008; Jiwaji, 2009; Soumare, 2009a). Over the lifetime of the project, iLabs addressing topics in electrical, nuclear and chemical engineering as well as electromagnetism, telecommunications and control systems have been developed. Recently, the MIT iLab Project has focused on developing iLabs based on the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI-ELVIS) platform (Jiwaji, 2009). The NI-ELVIS is a relatively inexpensive, small-footprint instrument containing a number of common electronics test and measurement tools intended for educators (National Instruments Corp., online). Leveraging iLabs together with the NI-ELVIS hardware platform enables a wide variety of electronics measurements to be made remotely without the burden of interfacing with many different pieces of individual lab instruments. This work has been adopted and extended by a number of collaborating institutions with iLabs and the NI-ELVIS forming a common development platform from which a broad set of online laboratories spanning a variety of engineering disciplines can be created.

One such institution is the Carinthia University of Applied Sciences (CUAS), which uses the iLab and NI-ELVIS combination as an avenue to learn about and develop other, more diverse iLabs. This includes electronics laboratories that leverage switching hardware to enable students to create and test Op-Amp based circuits with varying behaviors as well as an experiment allowing real-time control of a CPLD microcontroller device. An important aspect of the efforts at CUAS has been their work beyond the development of individual iLabs. In particular, recent efforts at CUAS have resulted in the integration of the iLabs architecture with laboratories based on the VISIR (Virtual Systems in Reality) platform.

The VISIR Project at Bleckinge Institute of Technology (BTH) in Sweden has focused on the development of online labs that provide a highly flexible experimentation environment to students. Using professional-grade electronics test and measurement equipment from National Instruments and an expandable switching architecture, a lab has been developed that allows students to construct circuits and analyze their behavior. This lab also features an intuitive graphical interface that allows students to construct circuits from a "bin" of parts by dragging and dropping them onto a virtual breadboard. With collaborative efforts from all three institutions, CUAS has taken this