Chapter 41
A LabVIEW-Based Remote Laboratory:
Architecture and Implementation

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ABSTRACT

Current technology enables the remote access of equipment and instruments via the Internet. While more and more remote control solutions have been applied to industry via Local Area Networks (LANs), Wide Area Networks (WANs), and the Internet, there exist requirements for the applications of such technologies in the academic environment (Salzmann, Latchman, Gillet, and Crisalle, 2003). One typical application of remote control solutions is the development of a remote virtual laboratory. The development of a remote-laboratory facility will enable participation in laboratory experiences by distance students. The ability to offer remote students lab experiences is vital to effective learning in the areas of engineering and technology. This chapter introduces a LabVIEW-based remote wet process control laboratory developed for manufacturing automation courses. The system architecture, hardware integration, hardware and software interfacing, programming tools, lab development based on the system, and future enhancement are demonstrated and discussed in the chapter.

INTRODUCTION

As distance learning has progressed from basic television broadcasting into web-based Internet telecasting, it has become a very effective teaching tool (Kozono, Akiyama and Shimomura, 2002). Laboratory experiences are important for engineering and technology students to reinforce theories and concepts presented in class lectures. The development of a remote-laboratory facility will enable participation in laboratory experiences by distance students. The ability to offer remote students these lab experiences is vital to effective learning. The development of a remote

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virtual laboratory is also motivated by the fact that presently, as never before, the demand for access to the laboratory facilities is growing rapidly in engineering and technology colleges. Being able to make the laboratory infrastructure accessible as virtual laboratories, available 24 hours a day and 7 days a week, goes far in addressing these challenges, and would also contribute to lowering the costs of operating laboratories. Additionally, remote virtual laboratories will provide the opportunity for students to explore the advanced technologies used in manufacturing remote control/monitor systems, and therefore, to prepare them for their future careers.

This chapter introduces a LabVIEW-based remote process control system, which is established to provide web based online virtual laboratory for an online computer-integrated manufacturing course. The physical setup of the system includes a wet process system, a FieldPoint control system with a NI cFP-2000 intelligent controller and eight I/O modules, a desktop computer, an Ethernet hub, and an Internet DLink camera. The wet process system is composed of three water tanks, pumps, discrete valves, continuous valves, temperature sensors, level sensors, and pressure transmitters. The software used for the system interfacing is LabVIEW 8.0 from National Instruments and the HyperText Markup Language (HTML). The desktop computer works as a control server as well as a web server for the system, providing a local interface for system control and maintenance and a remote interface for students to control and monitor the wet process through the Internet. The desktop computer, the intelligent controller, and the Internet camera communicate with each other through the Ethernet hub, and also connect to the Internet. All the sensors, valves, and pumps in the wet process system are wired to the I/O modules of the intelligent controller. Details of the system wiring will be examined later in this chapter. This system has been used in the lab of a computer-integrated manufacturing course for graduate students in the Manufacturing Technology option of the Technology Management program. Students are introduced to system integration, process control, LabVIEW FieldPoint programming, and the development of web-based manufacturing applications by involvement in the lab activities through the Internet.

This chapter explores the integration of the mechatronic equipment, computer software, and networking techniques to achieve a remotely controllable system. It demonstrates the development of a LabVIEW-based FieldPoint control system for a virtual laboratory. The implementation of the laboratory, future enhancement, and related researches are discussed in this chapter.

BACKGROUND

As in engineering and technology fields, the laboratory experiences associated with a technology curriculum are vital to understanding concepts (Saygin & Kahraman, 2004). They are also typically limited to a short group session each week due to time and space constraints. Increasingly practical and popular distance courses are hard-pressed to provide realistic lab experience at all. Simulation, which has seen increased use in education, is an especially valuable tool when it precedes instruction, but does not provide the problem-solving realism of actual hands-on experience (Deniz, Bulancak & Ozcan, 2003). Completing a project by remote operation of real equipment more nearly replicates problem solving as it would occur in the workplace and lends itself to teaching the processes and practice that are involved in true experimentation (Cooper, Donnelly & Ferreira, 2002).

With the rapid developments of computer networks and Internet technologies along with dramatic improvements in the processing power of personal computers, remote virtual laboratories are now a reality. In the early 1990's, the first remotely shared control system laboratory was proposed in the 1991 American Society of Engineering Educa-