2006-96: VIDEOCONFERENCE TEACHING FOR APPLIED ENGINEERING TECHNOLOGY STUDENTS

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Videoconference Teaching for Applied Engineering Technology Students

Abstract

The development of a fully-interactive videoconference teaching facility for Applied Engineering Technology (AET) students is described in this work. This facility will provide greater program delivery flexibility by offering a non-traditional educational approach that expands student's horizons. The new facility will allow all AET students at Drexel, as well as students at remote locations, to participate in the same educational and training process. By expanding training opportunities to students who might not otherwise take advantage of them, due to distance and time, this facility helps reduce the shortage of trained specialists in applied electrical, mechanical, and manufacturing technology. The videoconference teaching courses will be designed for undergraduate AET students and may also be taken by other undergraduate/graduate students at Drexel or by the students of other universities and community colleges who have fulfilled the necessary prerequisites and desire to pursue a BS degree in AET. The inter-institutional class sessions will be carried out utilizing Internet II-based resources providing increased bandwidth for use with high-end video and test equipment of Drexel's AET electrical, electronics, and manufacturing laboratories. Through remote operation, expensive equipment of the AET laboratories, such as the electronics laboratory, nondestructive evaluation of materials laboratory, and web-enabled robotic assembly station, will be accessible to institutions that cannot afford the equipment directly and which do not have faculty with sufficient expertise and training in these specific AET areas.

Introduction

The main objective of the proposed project is to develop a videoconference teaching facility for Applied Engineering Technology (AET) students, which will provide greater program delivery flexibility and offer non-traditional educational segments that expand student's horizons [1, 2, 3]. One of the major goals of the AET program is to introduce students to the experimental principles and concepts of AET by applying contemporary skills and knowledge in a variety of positions based on industry needs. To achieve this goal, Goodwin College of Professional Studies is in the process of expanding and upgrading its educational facilities including development of a fully-interactive videoconference teaching facility. This facility will allow all AET students at Drexel, as well as students at remote locations, to be involved in the same educational and training process. By expanding training opportunities to students who might not otherwise take advantage of them, due to distance and time, this facility helps reduce the shortage of trained specialists in applied electrical, mechanical, and manufacturing technology. Key factors in the development process include creation of the classrooms and educational laboratories that can significantly contribute to the development of technologically literate students and workforce that will be in great demand not only in the tri-state area but also nationwide.

Project Description

The fully-interactive videoconference teaching courses will be designed for undergraduate AET students and may also be taken by other undergraduate/graduate students at Drexel or by the students of other universities and community colleges who have fulfilled the necessary prerequisites and desire to pursue a BS degree in AET. This approach will provide an excellent introduction to Drexel's AET laboratories for the undergraduates and facilitate the development of network-based teamwork that will allow the project/laboratory to proceed without the constant supervision of the faculty advisor[4]. The inter-institutional class sessions will be carried out utilizing Internet II-based access to high-end video and test equipment of Drexel's AET laboratories for other universities and community colleges. Students involved in the "live" interaction with other participants will share in small group discussions, share documents, collaborate, and fully engage in the videoconferencing experience via Internet II. The implications of fully-interactive videoconference teaching are far-reaching as it relates to distance delivery of real-time interactive instruction between any remote sites subscribing to Internet II services using Internet Protocol (IP) networks, which can support high-speed transmission, guaranteed bandwidth, and real-time communications. This protocol allows users to reserve bandwidth on the network from one computer to another and to send a single stream of information to multiple recipients.

The Goodwin College is in the process of developing a new educational laboratory for electrical engineering and electronics to serve primarily students pursuing a B.S. degree in Applied Engineering Technology. The state of the art facilities are also designed to serve working individuals interested in improving their skills, as well as those seeking knowledge for professional advancement. Currently, there are three laboratories under development that will utilize fully-interactive videoconference teaching:

1. **The electronics laboratory**. The primary goal of this laboratory is to introduce students to the fundamentals of DC/AC circuit analysis, analog and digital electronics, and fundamentals of microprocessors. The students will gain hands-on laboratory experience using both conventional measurement equipment and electronic trainers (ELVIS) developed by National Instruments (Figure 1).

Figure 1. AET electronics laboratory.

Using the fully-interactive videoconference teaching facility during the laboratory sessions, the experience of performing the experiment will be essentially the same for students in the room with the instrument as for students sitting at remote locations on the other side of the world, since equipment is completely computer controlled and the output data analysis is performed via computer. The experiments are controlled by the LabVIEW virtual instrument (*V I*) (Figure 2). Collected data is then transferred to the computer also under control of LabVIEW *VI* and saved for future processing.

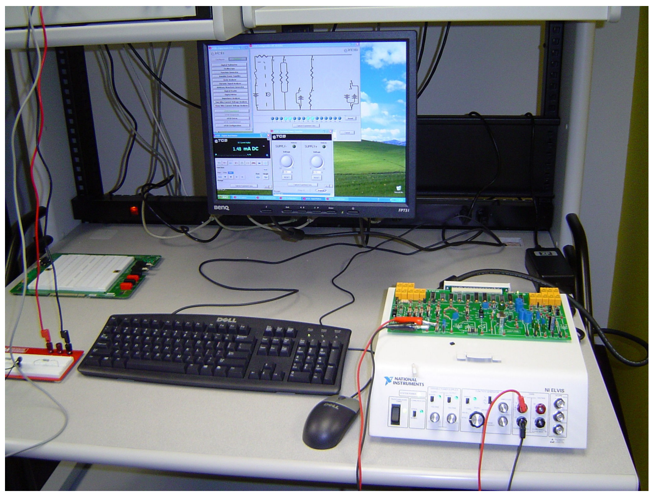

Figure 2. LabVIEW controller for electronics laboratory

2. **Nondestructive Evaluation of Materials (NDE) Laboratory**. The need for a large number of practical engineers with background in service and quality control analysis of industrial processes, over the next decade, has been clearly outlined [5, 6, 7]. The NDE laboratory being developed, provides a mechanism for giving undergraduate AET students direct, hands-on experience, with quality control analysis in various manufacturing fields, such as inspection of aircraft wing sections, in-process testing to determine the thickness and bond quality of a carbide wafer bonded to the top of a steel valve after grinding, rocket motor inspection, small diameter tube inspection, and transportable large-diameter tube inspection [8, 9, 10]. Students who complete the course will gain an understanding of the use of ultrasonic NDE equipment, tools for ultrasonic imaging, and electronic measurement equipment. They will gain hands-on experience with some of the tools available for inspection of products and equipment and will carry out experiments on their own. Students at remote locations will be able to utilize Internet access to

Drexel's high-end equipment [9, 10]. During the laboratory sessions, the transducer positioning system is completely computer controlled (Figure 3) and the output image and analysis of the image are performed via the computer.

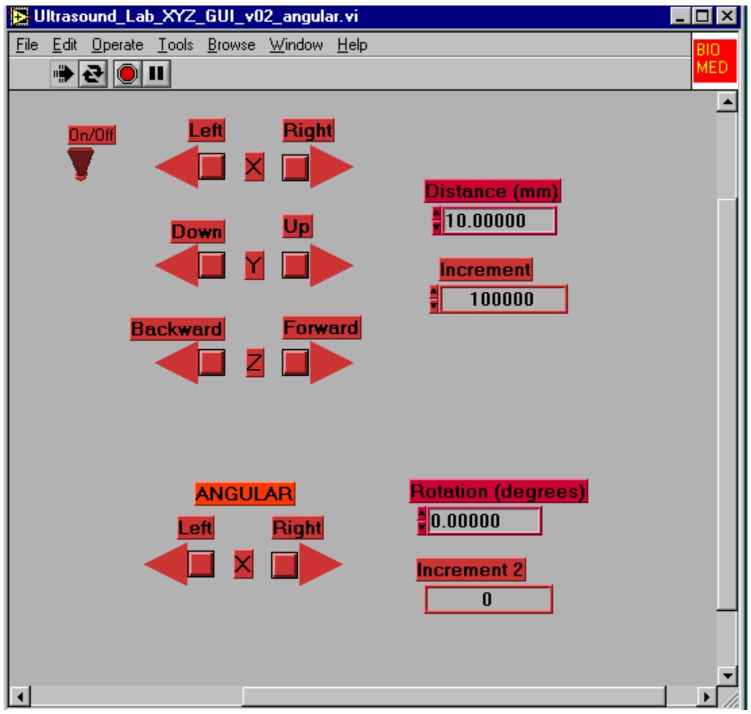

Figure 3. LabVIEW controller for NDE Laboratory

3. Web-enabled robotic assembly station. The first course, MET 205 Robotics & Mechatronics, was offered in the spring of 2005. Students were engaged in weekly experiments using state-of-the-art equipment. The goal of the experiments was to use the Internet as the communications link for manufacturing applications [11, 12, 13]. Experiments utilized four Yamaha robots for pick & place operations, a machine vision system for part inspection, web cameras for monitoring, and two PCs that allow the emulation of control programs. Students programmed, debugged, uploaded, tested, and remotely controlled the robots over the Internet (Figure 4). During the laboratory sessions, the web cameras sent image sequences to the remote users, providing visual feedback to the students. The experiments demonstrated the integration of computer, sensors, micro switches, and Internet-based automation technologies in modern manufacturing systems, using an Internet PLC (programmable logic controller). The series of experiments enabled students to understand how computer and Internet-based technologies can streamline dispersed, remotely-operated manufacturing systems. The most important pedagogical goal is to educate students about Internet-based automation and control of robotics.

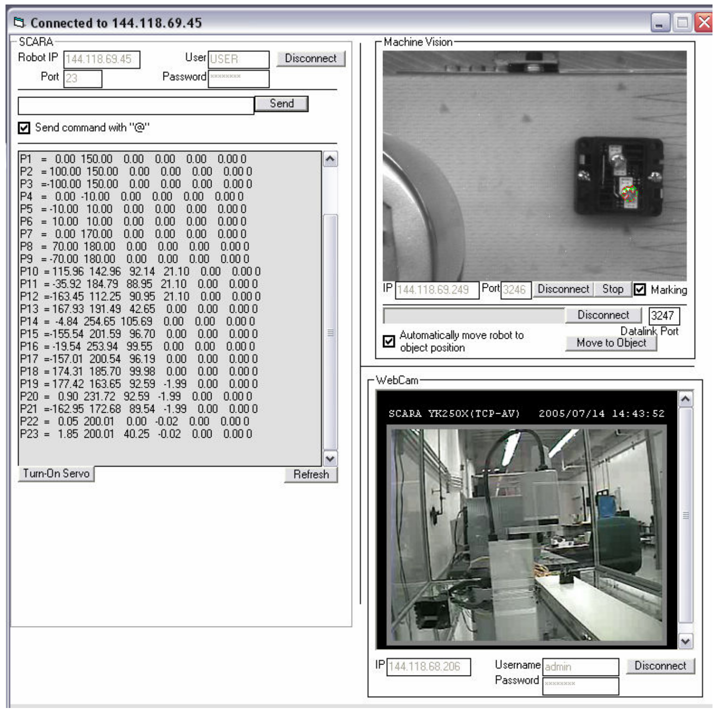

Figure 4. Snapshot of the VB application for remote control of SCARA robot, machine vision and web camera.

The Ethernet unit is an optional device for connecting the robot controller over the Internet. The communications protocol utilizes TCP/IP (*Transmission Control Protocol/Internet Protocol*), which is a standard Internet Protocol, so that PCs with Internet access can exchange data with the robot controller (Figure 5).

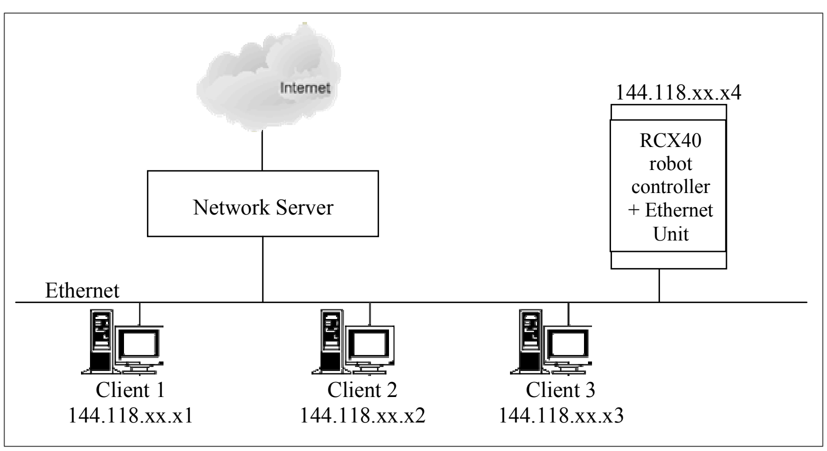

Figure 5. Connecting Controller to Internet with no server required.

The controller (RCX40) is connected to a computer (we would treat it as a server as it awaits for commands from user/client and sends them to the controller). The connection between the controller and the server is made by using RS 232C cable connected to the COM 1 port of the server. For viewing the workspace, a D-Link webcam which has Pan/Zoom/Tilt functions has been used. In addition to the custom built application programming interface (as illustrated in Figure 4), the VIP Window software developed by Yamaha Robotics was used for controlling the robot. The software enables to run the robot manually by typing specific destination points, or automatically by writing a program. The D-Link webcam can be accessed using Microsoft Internet Explorer by typing in the IP address of the camera. For security reason, the camera is password protected. It can be accessed in two modes: demonstration mode and complete access mode. In demonstration mode, features like Pan/Tilt/Zoom are disabled. The VIP Software on the server can be accessed from anywhere using Remote Desktop Connection (RDC), which is a built-in feature of windows XP operating system. All that is needed is the IP address of the server and a user account (which is created by the system administrator on the server). Once connected to the server using RDC, the client can run VIP Software and operate the robot in the same way as done when the controller is being directly operated from a Personal Computer (Figure 6).

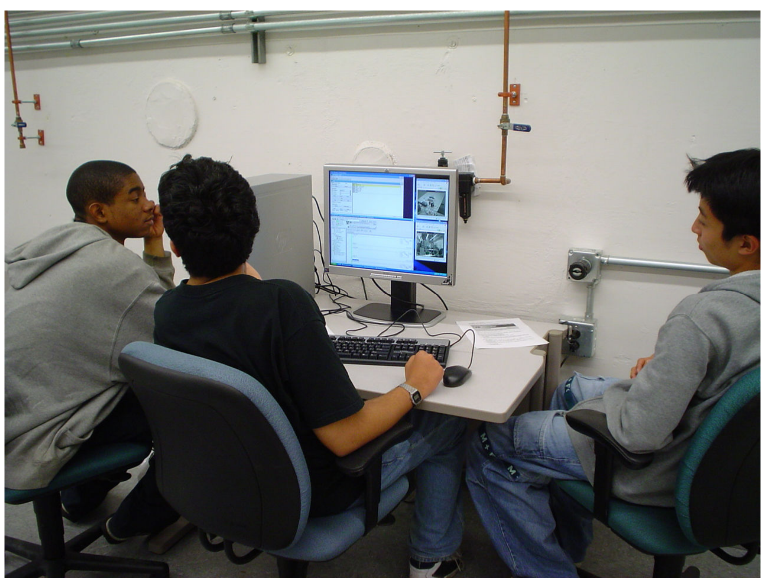

Figure 6. The robot is viewed simultaneously using the D-Link webcam.

Classroom Development and Testing

The laboratory exercises described above must be written and logistical issues resolved in order to test this mode of delivery with students. Through remote observation and operation, expensive equipment of the AET laboratories will be accessible to the Community Colleges that cannot afford the equipment directly and which do not have faculty with the expertise in specific AET areas. Fully-interactive videoconferencing will also be used for instruction when students take classes not offered at their school or when students cannot attend traditional classes.

During the Summer Term, necessary equipment, such as Kodak videoconference system Polycom VSX 7000 IP, Parkervision CameraMan 3-CCD digital broadcast camera system, three Hitachi 42" SVGA Plasma Displays, two Interactive SMART White-Boards 580, and Polycom Microphone System, was purchased. The hardware and software is being installed and set up. The core components of the fully-interactive videoconferencing system are the Parkervision Tracking Camera system for the instructor, which tracks instructor's movements very accurately, and the Interactive White-Board System, which can be shared from all endpoints. We have to develop effective presentation skills for fully-interactive videoconferencing to be sure that the speech is clear, loud enough to be heard in a regular situation, and slow enough to be easily understood, as well as effective and efficient white-board endpoint sharing rules. The lighting, as well as monitors, microphones, and interactive white- boards placement will be checked to ensure the best quality transmission and reception.

Some small scale piloting activities will be established to determine the effectiveness of IP-based videoconferencing-based instruction. The pilot will consist of a single consortium of Drexel's Goodwin College and Montgomery County Community College (MCCC), which both have Internet II services and comparable instructional delivery systems using Internet II Protocol (IP) networks. The class session will be taught by the Goodwin College's AET faculty to a full class at Drexel and participated in by a partial class of students at MCCC. During this session, the concept of fully-interactive IP-based videoconferencing of users at different locations will be tested to optimize the parameters and locations of the equipment installed. All necessary adjustments will be carried out by the network specialists of the Goodwin College and MCCC.

Already there has been significant progress in the development phase of this initiative as fully-interactive classroom sessions have taken place between Drexel's Goodwin College, Montgomery County Community College, and Burlington County Community College via Internet II. As part of these demonstration sessions, a remote laboratory was taught and participated in by the three endpoints mentioned above in the control of an articulating arm robot located at Montgomery County Community College. This laboratory session was conducted by an instructor at Montgomery County Community College and participated in by students at both Drexel's Goodwin College and Burlington County Community College. The fully-interactive instructional session and associated laboratory were remarkable successes, demonstrating great promise for continued development of courses and programs utilizing Internet II delivery.

Upon completion of the first stage of the pilot activity, the pilot sites will be invited to take part in large-scale piloting involving other participants. We anticipate testing this videoconference teaching approach in conjunction with some of the partners we have already collaborated with in the development of the AET degree, such as Delaware County Community College, Montgomery County Community College, Community College of Philadelphia, and Burlington County Community College, which have, or are working on obtaining, Internet II IP-based services. Their close partnership with Drexel allows such work on new concepts. Once fully developed, the fully-interactive videoconference teaching facility will allow the Goodwin College to consolidate and teach small classes spread across several Community Colleges reducing the cost of teaching and laboratory outfitting. For example, the consolidation of three sections would result in savings to the Goodwin College of approximately $6,000 per quarter in instructor pay, which would lead to an annual savings of about $24,000 per course. Another benefit of fully-interactive videoconference teaching is that the classroom sessions can be recorded and integrated with WebCT.

Conclusion

Fully-interactive videoconference course sessions will take place via Internet II-based access to instructors, students, and high-end equipment of Drexel's AET laboratories. Instructors will facilitate the lecture/laboratory course from a “host” class room/laboratory at Drexel to students located at remote classrooms. The fully-interactive videoconference room/laboratory will be equipped to monitor instructor’s motions and two-way audio and video interaction of students with the instructor and classmates at other locations. The developed fully-interactive videoconference teaching facility will have the potential to significantly impact AET education. Fully-interactive videoconference teaching will create infrastructure for remote access to high-end equipment via the Internet II, as well as provide experience in effective delivery of education through this modality. It will also create a model for incorporating leading edge concepts and technology in AET education into undergraduate research that can be utilized at other institutions and in other disciplines.

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