Integration of Manufacturing Automation Laboratory Component with Distance Education

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Abstract

In the last two decades, there has been an increasing emphasis on manufacturing automation and flexible manufacturing work cells in order to increase the product quality and reduce inventory and there by increase the overall effectiveness and profits. Therefore, robot control and work cell programming is a highly demanding field in the industry. Due to this fact most students are keen to follow courses in robotics and manufacturing automation. This paper is about an ongoing research project for controlling a Robotic Work cell over the World Wide Web, which will provide students a greater access to the facilities in the manufacturing laboratories.

Introduction

The Internet is now providing a new and increasing important medium for distributing information world wide without time constraint, permitting information to be displayed numerically and graphically on any client platform. This has generated great impact to the way of "information/knowledge acquisition" as well as to the manufacturing/commerce automation. The ability to acquire information and even to control instruments/devices at fingertips over the Internet is becoming desirable not only to the professionals but also to the general public.

Thanks to the development of Internet Technology, distance learning and distance control of devices are emerging realities. Students nowadays can access information and receive education at home over the Internet. There have been many distance learning (web based) courses offered by academic institutions to benefit many students who might be constrained by distance and time. However, most web-based courses are "lecturing courses" that still cannot fulfill the need of engineering and technology education.

In engineering and technology programs, most courses have a laboratory component. The quality and availability of laboratory facilities are important factors to the quality of engineering and technology education. However, high-quality laboratories are very expensive to build and most

laboratories are only used part of the time by students due to time and/or distance constraints. Sharing laboratories among several academic institutes and allowing students to practice laboratory remotely without time and distance constraints would enhance the quality of education without much increase in the overall cost. Therefore, the functions offered by distance learning have to be extended to the real engineering laboratories whose physical process can be remote-controlled.

In the last two decades, there has been an increasing emphasis on manufacturing automation and flexible manufacturing work cells in order to increase the product quality reduce inventory and there by increase the overall effectiveness and profits. Therefore, robot control and work cell programming is a highly demanding field in the industry, which has the potential of gaining high, paid engineering and technology positions. Due to this fact most students are keen to follow courses in robotics and manufacturing automation and as explained earlier, vast majority of students are constrained by the distance and time in following these courses. Hence developing web based courses for this sort of subjects is an important step.

Software Development

In the planned web-based robotic lab we are using Visual Basic (VB), Active X, HTML, and ASP (Active Server Page) to build graphical interfaces to write the robot programs and a window based ladder logic program editor to upload/download ladder programs to/from Programmable Logic Controllers (PLC) that will serve as the cell controller in a robotic work cell setup. According to the planned research all a student has to do is to access the web-based robotic lab web site to start the client window at the press of a button. Following the instructions on the web page student can write robot and PLC programs online and upload them to the robot controller and PLC.

In order to verify students program it is necessary to have a simulation program, which will simulate the robot movement within the work cell. This simulation program will be developed as a different project with the help of graduate students.

As a safety measure, there has to be a lab technician in the physical lab in order to do a dry run of the program to make sure that the program written by the student will work as expected without errors. After checking the program, lab technician can give the rights to the students to run the program through the web site from his distance location. A similar process can be carried out for the complete work cell programming as well. With a web camera installed in the lab, the user can observe the live video of robot operations as well.

Laboratory Setup

Recently, robotics laboratory of Industrial Technology department at WVU Tech acquired two new industry standard robot arms and controllers. By utilizing these two new robot arms and existing Computer Numerically Controlled (CNC) machines of the department, we have set up a flexible manufacturing work cell and an assembly work cell. Figure 1 shows the manufacturing work cell and Figure 2 shows the assembly work cell. The manufacturing work cell consists of a CNC lathe machine, a CNC milling machine, a 5-axis articulated robot, proximity sensors and a

Programmable Logic Controller (PLC) as the cell controller. The assembly work cell consists of a SCARA Robot arm, two conveyors, proximity sensors and a PLC as the cell controller.

Figure 1: Manufacturing Work cell

Figure 2: Assembly Work cell

These manufacturing and assembly work cells will be connected to the World Wide Web as shown in Figure 3.

The graphical control interface is being written in Visual Basic (VB) programming language. VB is based on an event-driven programming model and supports a number of features that make it an excellent language for quickly creating full-featured solutions, taking advantage of the graphical user interface in Microsoft Windows. These features include data access, Active X technologies, Internet capabilities, rapid application development (RAD), etc. It can also use system-provided APIs or external DLL/OCX to extend its functionality. For instance, it is easy to use Winsock.ocx (Winsock control) to develop an Active X control in the ASP program that gives the Internet accessibility to the server and client.

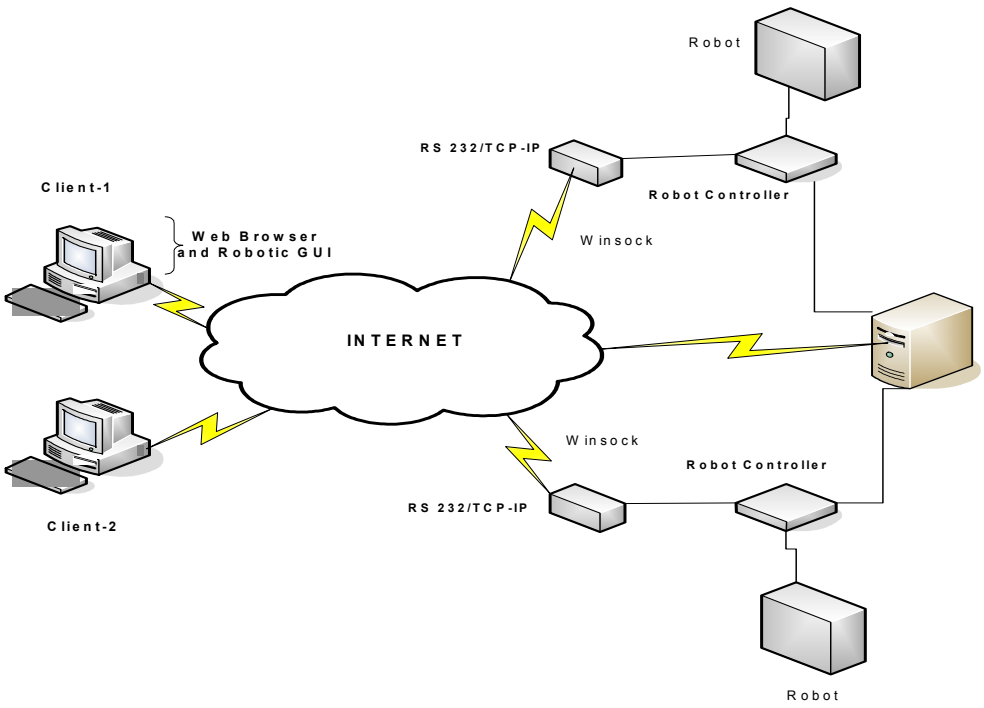

Figure 3: Planned Network Setup

Summary and Future Work

This paper is about the need and idea of developing web based manufacturing lab component for distance learning of engineering and technology. Three undergraduate students and two graduate students are working on this project. Currently these work cells are being used in teaching Robot programming and industrial automation to Industrial technology undergraduate students. It is planed to finish the implementation of above network setup before Fall 2005 semester. Completion of this networked lab will enhance the education facilities at WVU Tech. It will provide a test bed to start online courses on Robotics and automation. This new network setup will be used for Fall 2005 online classes as the laboratory component along with WebCT. Also, it is necessary to develop an assessment plan for the course delivery over the Internet using the web based lab component.

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