NetMeeting as a Distance Learning Tool for Electronics

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Abstract

This paper will focus on the electronics laboratory and the problem of distance education with a "hands on" subject. Electronic Workbench[1] has been used with Microsoft's NetMeeting[2] achieving marginal success. Discussion will include the need for "hands on" in the laboratory, the possibility of a laboratory done without "hands on", a method of one-on-one instruction from a remote site, and problems with NetMeeting in this application.

Introduction

The electronics laboratory is a place where experiments are done to support theory previously learned. The intent of the laboratory is to provide the time and resources to make mistakes and clarify concepts. An exercise that does not allow for a mistake may not be asking enough questions. A demonstration is often used to present a concept where safety requires that no mistakes are made. When the student is in a power laboratory and the question is one of motor control or three-phase power, safety requires that mistakes do not happen. One professor teaching power constructed a three-phase simulator[3] so that the students could work with 20 volt, three-phase. Obviously, the intent is to allow the student the possibility of error and thus of education. In a laboratory situation, mistakes must be an option since they are major contributors to our education.

The Situation

Mistake recovery needs to be available to the student. The student found lost in the maze of a laboratory procedure that he does not understand is not learning what was desired. A laboratory instructor / professor needs to be available and conscious of the student conditions. Time is valuable and particularly so in the technical fields. The students do not have time to learn all that is desirable and some material must be cut from a program in order that the student graduate. Wasting time in a poorly run laboratory can be very frustrating to both instructors and students. Making the laboratory too easy for the student removes some of the challenge and potential learning. Students do not want easy, they want achievable. Laboratory exercises should be challenging, clearly stated, and cover theory already presented or understood.

To accomplish this, instructors typically require that students work problems covering theory before the laboratory exercise is attempted. My best success with a basic laboratory has been to use homework problems and then a hands on laboratory exercise. With the advanced laboratory students, problems are used for basic theory, then a simulator is added, and then the hands on laboratory is completed. This sequence agrees with work done by Nejad[13] where he concludes that "students learned electronics circuitry concepts more when they utilized actual electronics components and then used computer simulations, ...". My experience and others[5] indicate that basic level electronics students have difficulty connecting the simulator and homework to the hardware solution. Advanced laboratory students use the simulator without being required to do so because, it is easier to use a simulator to set up a complex solution than it is to build hardware that will not work.

The Problem

How is a challenging, clearly stated, exercise conducted that allows for mistakes and recovery while using distance learning techniques? With this one situation (distance) we have the added problem of no hands on equipment and no error recovery mechanism (an instructor). The laboratory environment has a high demand for individualized attention[4] and we have removed the major source of attention. We have also removed the hardware, one of the elements of basic electronics education.

The Plan

Sophomore level students were used after they had completed four laboratories. By this time the students were working with Electronic Workbench and I expected the simulation / hardware connection could be made. The laboratory instructor was available on a NetMeeting link. The problem was a pre-lab exercise that was to be accomplished from a site remote from the electronics laboratory. The student would link to a computer running Electronic Workbench and NetMeeting, construct a circuit, show the desired measured values, and print the result in the lab. If a problem arose, the instructor could be called to the computer after which text would be used to answer questions. The students were expected to use any computer having Internet access during the instructors office hours for their exercise so that the instructor would be available. Since Electronic Workbench was already running on the lab computer, the student did not need to restrict himself to computers having the desired electronic simulation package.

The Simulator

The addition of the simulator has been attempted in the last few years because; first, it is available and secondly, it works in some situations. Electronic Workbench (EWB) has been used successfully by a highschool teacher[5] to allow the student to see the solution before an attempt is made to build it. EWB is a workbench simulation that cost the student $50 if purchased in lots of five. The simulation includes RLC, op-amps, discrete components, and basic logic chips. DC motors are available, steppers and AC motors with single and three phase power are not. A simulation has been done on EWB to represent a stepper[6] motor. I received a request from a student to include a PLC module with ladder logic but that is not yet available.

Remote Control

Remote control laboratories[7] will work without student presence. By using a computer controlled experiment station, the student can control the experiment as well from a remote computer as can be done from the computer itself. Sound and video transmission is necessary to insure safety and to make sure it doesn't seem like just another simulation. This results in a hardware laboratory that has a limited number of responses available. Speed can be adjusted and robots can be controlled. Only one operator can participate at a time and most unplanned mistakes cannot happen. It is not possible to plan for everything a student may try. Safety requires that some changes cannot be allowed in an experiment unless the instructor is close at hand. The requirement of a computer controlled experiment is that it be configured and the solution is achievable. The requirement for a more challenging lab is that the parts to perform the experiment are in the room. One of the groups using a remote-controlled experiment required that the student perform a pre-experiment connections lab to insure that the student could actually assemble the laboratory if given the opportunity. This allows the instructor to separate the aspect of setup and operation. The student would assemble his hardware at one location but be unable to operate the system until it was his time slot with the actual operational hardware. The assembly was more of a plug-in simulation. This procedure doesn't allow enough mistakes although it is useful for safety considerations. For example, a power lab could be setup with an easy to build socket, wood and paint prop. The students would use the mockup to plug in appropriate power. That would be the test that allowed them access to an actual power lab where they could control voltage and current and take recordings of torque and rpm.

Remote Software

NetMeeting[2], Pcanywhere[8], CuSeeMe[9], Phonefree[10], ICQ[11], and Freetell[12] are all programs built around the idea of PC to PC communications. Control of a remote PC can be done with NetMeeting and Pcanywhere. The other programs allow for or assist in control of audio and video transmissions from PC to PC. Because NetMeeting also includes the audio / video in the same package, it was the primary focus of my research.

NetMeeting configuration is relatively simple. Log on to the web site and download the exe file for NetMeeting setup. Run the NetMeeting file. After the program has been installed. Test the operation. Use the tool's menu and click on options. Select the option: <u>not</u> to include your name on the directory, to accept calls automatically, and <u>not</u> to connect you to a server automatically at startup.

NetMeeting is currently a very good way for people from all over the world to communicate. They can send voice, video, and text anywhere at no cost. My graduate assistant uses similar technology to talk to her family in China. However, the servers and the communications lines are saturated. If you include your name on the directory, someone will log on with you and want to talk. If you attempt to log on to a server at the start of the program, you must wait for the connection to fail before you can proceed. Your students should call you directly via your IP address. That avoids non-business calls. The student machines should not be configured to accept calls automatically. The instructors machine should accept calls so that you can work in your office without being required to acknowledge a call. The calls are only accepted if you have NetMeeting running. In this way, the students will never get an "unable to connect" when you have stepped out for a moment but plan to work with them if they call.

Get your IP address by going to start, settings, control panels, network, configuration, TCP/IP, properties, IP address. Write down and distribute it to your students. It is a four-part number consisting of sets of three digits separated by periods. This is your Internet address and allows the student to contact you directly just like a phone number.

From the opening screen of NetMeeting, select “Call” or “Call Advanced”, from the top menus. Fill in the blank lines with the address (your IP address) and the method TCP/IP. TCP/IP is a protocol that requires the sender to establish a destination before data packets are sent on the net. It is possible that university security may not allow communication from some addresses or through some ports. You should talk to university computing services before you spend significant time on this. See what they have for a plan and how they suggest you accomplish your link. If hackers have not hit your university, there may not be an access problem. If the university has been hit, the firewall and security will be added concerns within your distance learning problem.

If you turn the audio and video off in the options’ menu, you can speed up your data transfer. None of my computers have cameras or microphones so the chat window was used for text communication. The camera is required for applications that require visual feedback of controlled devices. Since this is control of a simulation, no cameras are necessary unless you want to see each other. Voice would be nice but the student machine would need a microphone for it to work.

Operation

Start the instructors computer, start Electronic Workbench, start NetMeeting. Set NetMeeting with the directory off and auto-answer on. When a student calls in, NetMeeting will show who it is and indicate who has control and if anyone is sharing any programs. To allow another person to operate your program, you must press the “share” button at the top of the NetMeeting screen. If you want to use the instructor’s EWB program, the instructor must press the share (EWB) button. If the student wants to show the instructor something on his computer, the student must press the share button and select the program to be shared. Now both computers will show the same program. The student will be able to show the application and problem as it exists.

If the student or instructor wants to give up control of his computer so that the other can use the mouse pointer, the “collaborate” button must be pressed. Collaboration allows everyone connected to operate the shared application. When a person presses their mouse button, all pointers and control will follow the actions of that mouse. To get control, an operator must press his mouse button. Only one person can control the mouse at a time. Collaboration has many warnings attached. Collaboration allows another person to take control of your computer. They then have access to all shared programs. If you share a word processor and the remote user types a letter, saves the file, and prints the result, the computer with the word processor on it will retain the file and its printer will print the paper. If the instructor shares his EWB, the student can make a circuit and print the result on the instructor's printer. If the instructor shares his desktop or grade book, anyone calling in can gain access to his total machine or student grades. Do not share what you don't want available on the street.

Conclusions

The intent was to assist the beginning students by providing a method of one-on-one contact with the instructor. Electronic Workbench was presented as a simulator to be used in preparation for a laboratory. NetMeeting was tested as a method of gaining laboratory / instructor access from outside.

This was not a good fit for a beginning student. There is too much technology for the student to get through before his question can be solved. As a laboratory exercise, the problem is good experience. As a help session, there was too much confusion for the beginner.

Second and third semester electronics students do not have a problem using Electronic Workbench. Beginning students are still beginners until after that first semester. I plan to force the usage of EWB with my beginning electronics class. The students use it as a problem not as a source of solutions.

NetMeeting was an educational experience. I had security, setup, and resource problems. NetMeeting was blocked by our university firewall. It is considered a security risk. If a student was off campus, NetMeeting would not be allowed access because the firewall blocks its port address. None of my students could connect to the laboratory PC from off campus. It will save time if you have the security / access conversation with university services at the start. We have had some discussion about using LabView as the remote software link but the questions of security and port address are still unknown.

The setup of a machine that will run Electronic Workbench and can be called and accessed from an outside computer requires that EWB is running and the share and collaborate buttons are pressed on NetMeeting each time a new session starts. If you expect to set up the machine and leave it unattended, you need to dedicate another computer to call and stay on line with the EWB computer. If all visitors drop off, NetMeeting goes back to its default no share mode and the instructor must be there to allow callers access.

Remote EWB has the potential to swamp the PC. All of the laboratory circuits were simple. If a larger file was loaded and control was attempted from another computer, it is possible for the PC to get so far behind in the screen update process that the operator with mouse control does not know where the mouse pointer is on his screen. I ran multiple 486-150's and Pentium-166's in my lab so that I could see all of the screens at the same time. The computer screen that was running the program (EWB) would always show up-to-date information. The mouse pointer was jumpy but followed the movements of the controlling mouse. Other PC's that were attempting to follow the action, were jumpy or stopped. If the screen display of a large sample circuit was moved, all PC's except the one running EWB would freeze while trying to update a circuit image. It is important that only simple motion is attempted by a remote operator. Let the operator of the PC in use make any large changes. Don't try to reposition the whole screen from a remote PC.

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