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REAL AND REMOTE LABORATORIES IN EDUCATION

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ABSTRACT: One of the most important areas in the education of students is the laboratory realization of various technical subjects. The institutions are faced the burden of large numbers of students and the high costs of laboratory equipment and staff. In many cases, on top of the afore-mentioned problems comes the lack of space. The most appropriate solution is to develop a laboratory in a given place, this could in an industrial environment, as well, and then in real time establish access via the internet and with user interface and visualization enable two-way data exchange. This way only practice has to be organized, parameter setting, real time running can be achieved any given day or time, and from any location. The already established laboratories are capable of operating as distance laboratories if expanded with internet. At the Institute of Informatics of the University of Szeged the establishment of a distant laboratory has been started. This article shows the development of the server and user interface, and presents its use with a step motor. Since the web server is equipped with standard serial connection, it is suitable for connecting other laboratory instruments, as well, thus for the development of any further practices the internet part does not need to be designed again.
KEYWORDS: Remote control, distant laboratory, education of students

❖ INTRODUCTION

It is important that students have experience with microcontrollers. These requirements give for a university with the challenge of establishing in the sufficient laboratory establishment. Other important factors are also the large number of students in the education process, the sometimes limited laboratory space and the financial possibility of the universities.

In an effective way we can use existing Embedded System Laboratory (LAN with PC-s) together with other techniques from the web (Internet) and microcontroller trainer boards. Solutions over the internet open the possibilities for the distance learning. Open source distance learning software gives for the lecturers and students the chance for the distance administration, literature access, rapid and constantly updating the materials, renovation and use of tests. Main standing-point in laboratory-making is the following points: low level investment, using extant pieces of equipment together with the improvement of educational effectiveness. Including trainer boards and the internet in the laboratories does not change the old functions of the Laboratory. This paper presents a project to enhance the embedded system education of students. Some courses provide preliminary knowledge for students who selected microcontroller/microprocessor based classes.

In some obligatory and eligible courses students involve the design and development of microcontroller based technologies, for example in Robotics, Autonomous systems and Mechatronics. These courses include both lecture and laboratory components. In some cases in other courses students do interdisciplinary projects, or diploma works, also using microcontroller applications. Interfacing techniques of embedded systems require some physical and also electrical knowledge from students in microcontroller – external equipment connections. Students must know some electrical lows of electrical engineering: common grounds, voltage/current limitations, noise shielding, timing (delaying) problems. Other courses deal with physical/electrical questions, but the experience is, that a course on microcontrollers needs to remind students of these basics.

Also, we do not forget the mechanical interfacing aspects. This field is always imperfect in educational process of students.

❖ DISTANCE EDUCATION

Remote operation and control of the Embedded System Laboratory opens great potentials in distance learning. Educational institutes independent from geographical limitations (distributed

laboratories) will integrate material and knowledge potentials into a virtual but very realistic form, a complete unit, in the common educational space. The interactive video link connects two or more laboratories, so the instructor from one laboratory guides all students in the common educational space. Students from far-away workstations can operate through the internet with various remote laboratory equipments 24 hours on 7 days a week. Integrated web-learning environments seem to become more and more accepted. Our College's remote course is basically the traditional one with the big difference that it is remotely accessible over the internet.

❖ GENERAL DESCRIPTION OF THE SYSTEM

The general scheme of the application architecture is shown in Figure 1. In this system the software and hardware elements are split into two main blocks: local area (client side) where the user works, and remote area where the whole real system with control elements are located (Laboratory).

The elements of systems are:

- ❖ Local area: PC computer with Internet connection and HTTP 4.0 client application,
- ❖ Remote area: Internet connection, Web-server, Experimental board, real hardware (stepper motor) and image capture system.

The control software communication is RS 232 serial communication. End-user (client) can have access to the process and run step-motor application in real time using TCP/IP. The user can change different parameters: number of steps, direction (left or right) and RUN/STOP status.

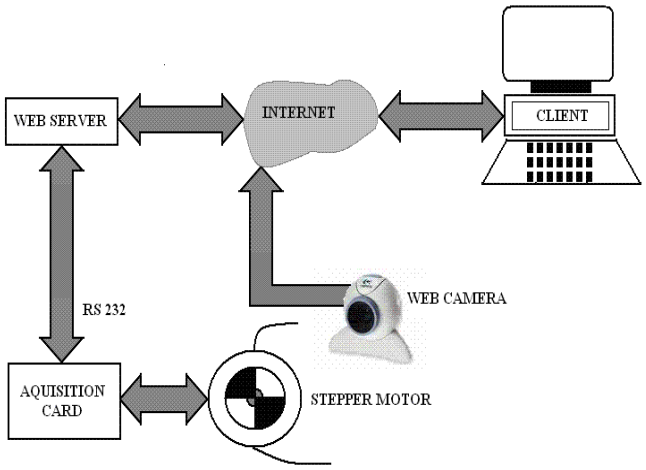

Fig.1. Schematic representation of the Distance Laboratory

❖ WEB-BASED STEPPER MOTOR ACQUISITION AND CONTROL SYSTEM

The world-wide-web gives method for information transmission. The web enables the control of stepper motor systems from anywhere in the world. The Real system is shown in Figure 2, Lantronix web-server board, self-made experimental printed circuit and stepper motor.

The first step in the starting the process is to turning-on of the web-camera. After the typing of IP address from web-camera into the browsers address-line the D-Link server sends trough the internet to the client a window with *login* and *password* requirements (Figure 3).

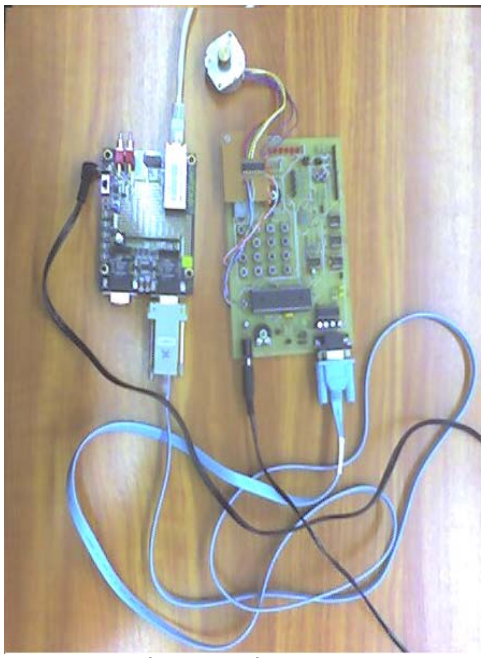

Fig.2. Real system

Fig.3. Login into the camera

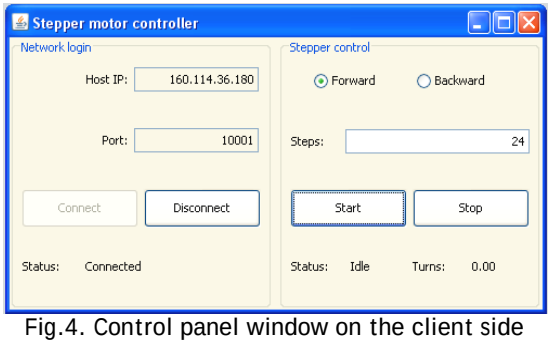

Fig.4. Control panel window on the client side

The web-server for the camera (D-Link) is integrated onto a circuit board that uses HTML. The second step is starting the example software, written in Java environment. The Client side network login and stepper control window is shown in Figure 4.

Fig.5. Real laboratory system in browser using camera picture

Lantronix web-server board needs IP address (160.114.36.180) and Port number (10001) and press the "Connect" button. The connection status is displayed on the bottom part of the window. In the right part of window, in this example there are two buttons for rotational direction (left or right), one stepper motor step is 15 degrees, so full rotation is 24 steps. All our activities are displayed in browser window (Figure 5).

❖ COMPARATION OF TWO TECHNICS

In the next table there are some advantages and disadvantages of real and remote laboratories:

Table 1. – comparation of two types of laboratories (rel and remote)

Properties	Real laboratory	Remote laboratory
Contact with system in real work	High-efficiency, full real connection	Indirect relationship, partly real work (programming, parameters)
Delay	There is no immediate response	Internet and internal network-dependent
Financial investment	Great, all exercises should be constructed separately	Smaller, limited to a specific laboratory practices should be established
Other equipment	No	Servers, software and webcams
Student Access	Only under the supervision of a pre-specified times, at night, Sundays and holidays no	7 days in week, 24 hours in day
Supervision	One or more persons	No
Maintenance	Yes	yes
Contribution to the cooperation between the institutions	Limited, it still must be organized	Constant, to be jointly developed curricula should be standardized in the laboratories

❖ CONCLUSION

This paper describes the first steps in building combined microcontroller/robotics distance laboratory for several courses in the teaching process of students via the Internet. Teaching microcontrollers for robotics and industry applications is feasible for compulsory courses as well as voluntary courses. This piece of laboratory equipment is also appropriate for other microcontroller applications. Applications of internet tools allow building very operative remote controlled laboratories for the teaching of mobile robots and industry control architecture.

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