

Web Based Remote Access Microcontroller Laboratory

H. Çimen, İ. Yabanova, M. Nartkaya, and S. M. Çinar

Abstract—This paper presents a web based remote access microcontroller laboratory. Because of accelerated development in electronics and computer technologies, microcontroller-based devices and appliances are found in all aspects of our daily life. Before the implementation of remote access microcontroller laboratory an experiment set is developed by teaching staff for training microcontrollers. Requirement of technical teaching and industrial applications are considered when experiment set is designed. Students can make the experiments by connecting to the experiment set which is connected to the computer that set as the web server. The students can program the microcontroller, can control digital and analog inputs and can observe experiment. Laboratory experiment web page can be accessed via www.elab.aku.edu.tr address.

Keywords—Embedded systems education, distance learning, internet-based control, remote microcontroller laboratory.

I. INTRODUCTION

BECAUSE of accelerated development in electronics and computer technologies, microcontroller-based devices and appliances are found in all aspects of our daily life. Microcontrollers play an important role in many areas ie; motor control devices, electricity home instruments, security systems, elevator control systems, illumination control systems and belt conveyor systems [1]. Nowadays microcontroller education and microcontroller experiment set design are still under interest [2, 3, 4, 5]. Therefore microcontroller education is became a vital course of the electric-electronic engineering education. Laboratory experiments play important role efficient learning in technical and engineering education [6]. For this reason before the implementation of remote access microcontroller laboratory an experiment set is developed by teaching staff for training microcontrollers. Requirement of technical teaching and industrial applications are considered when experiment set is designed. Experiment set is based on PIC 16F877 microcontroller. The PIC 16F877 microcontroller

has built-in features such as ADC, USART and PWM units and this controller has enough I/O ports for industrial applications. Moreover, this microcontroller is inexpensive, widely used and accepted in the industry. But economic pressures on universities and the emergence of new technologies have spurred the creation of new systems for engineering education, in particular simulations and remote access laboratory systems. Many educators advocates simulation for economic reasons, space and time considerations and many educators advocates hands-on laboratories for engineering students should be exposed to real environments [7]. Using simulation programs are preferable to understand basic nature of microcontrollers but real microcontroller experiments are necessary to make sure programs on the microcontrollers are working efficiently [8]. As an alternative remote access laboratories have appeared. Remote access laboratories are require minimal space, time and can be rapidly configured and run over the web similar to simulations [7]. Students can make the experiments by connecting to the experiment set which is connected to the computer that set as the web server. The system wants from students a user ID and a password. The students who have not membership can access to the site as doing the needed membership processes on the related page. The one who enters to the system first will be the moderator of the experiment and 10 minute duration will be assigned for experiment. The other users can only observe the experiment and discuss with others by using the chat tool. The user who is timed up will be automatically logged out the system. After that next user will have the moderator of the experiment by the system. The experiment moderator will be able to program the microcontroller by clicking on the “Program” button after sending the hex file, which has been written and compiled previously, to the web server using the upload tool on the page. In order to do all the operation, client user never needs a software or hardware but web browser software. With this implemented study, a possibility for making microcontroller experiments independent from the time and place has been obtained for the students.

H.Çimen University of Afyon Kocatepe, Technical Education Faculty, Department of Electric 03200 Afyonkarahisar, Turkey (phone: +90 272 228 13 11 – 363; fax: +90 272 228 13 19; e-mail: hcimen@aku.edu.tr).

İ. Yabanova University of Afyon Kocatepe, Technical Education Faculty, Department of Electric 03200 Afyonkarahisar, Turkey (e-mail: iyabanova@aku.edu.tr).

M. Nartkaya University of Afyon Kocatepe, Technical Education Faculty, Department of Electric 03200 Afyonkarahisar, Turkey (e-mail: nartkaya@aku.edu.tr).

S. M. Çinar University of Afyon Kocatepe, Technical Education Faculty, Department of Electric 03200 Afyonkarahisar, Turkey (e-mail: smcinar@aku.edu.tr).

II. HARDWARE ARCHITECTURE

The experiment set is given in Fig. 1. Microcontroller-based experimental set has a lot of peripheral units such as PWM unit, Counter input, LCD module, Analog I/Os, Digital I/Os, Serial communication unit etc. The experiment set has a lot of components that students can come across in the real life applications. Many I/O units and several communication units are installed including five analog, eight digital, one counter

and six buttons as inputs; eight digital, one analog, one PWM and LCD as outputs, a serial communication unit and programming unit. Programming process is realized by a programming circuit embedded on the board. There is no need for any extra hardware for the programming.

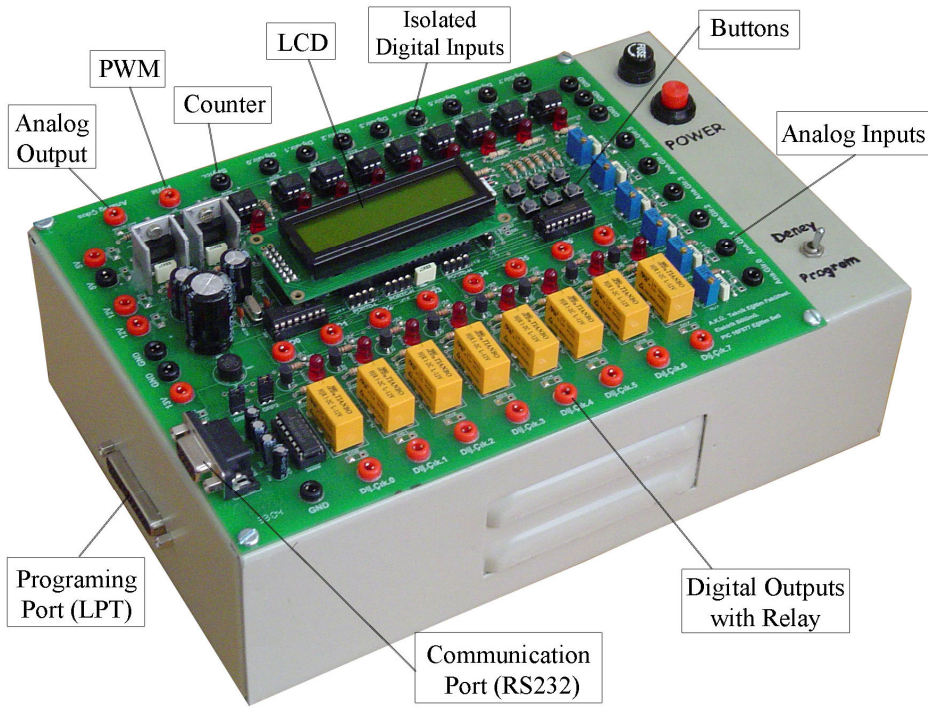


Fig. 1 Experiment Set

In Fig. 2 block scheme of the web based remote access microcontroller laboratory project is given. The clients can upload the program codes which they wrote and compiled previously to the experiment set connecting to the computer that set as the web server. After realizing the programming

process, experiment set's digital and analog inputs can be controlled by the circuit connected to serial port of the server. The experiments can be observed by the webcam connected to the server.

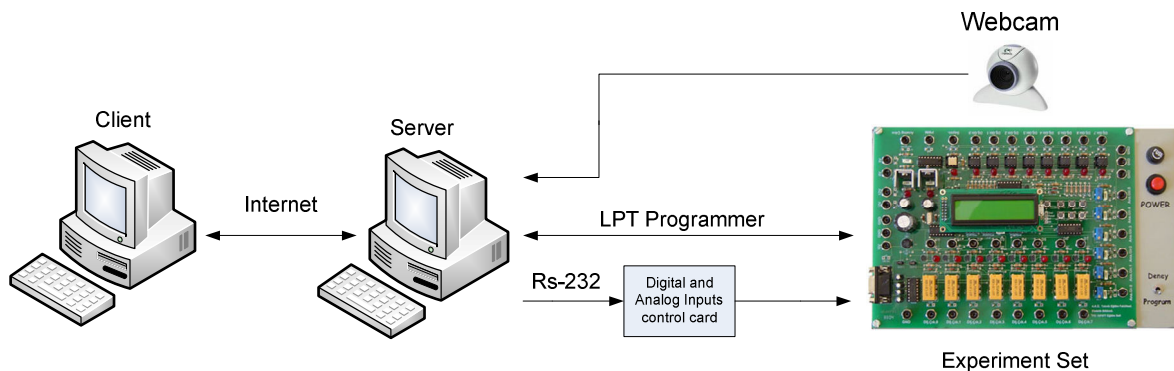


Fig. 2 Block Scheme of the Web Based Remote Access Microcontroller Laboratory

Furthermore several application modules selected from real life applications are designed to improve the skill of the students. These modules are four flat elevator, seven segment display, traffic lights, DC motor module and DC motor module is basically presented. DC motor's velocity, rotation and position can be controlled with this module. The module can be connected to the computer over serial port and suitable for computer controlled process. The DC motor has an encoder and so feedback control applications can be developed. In Fig. 3 DC motor module is given.

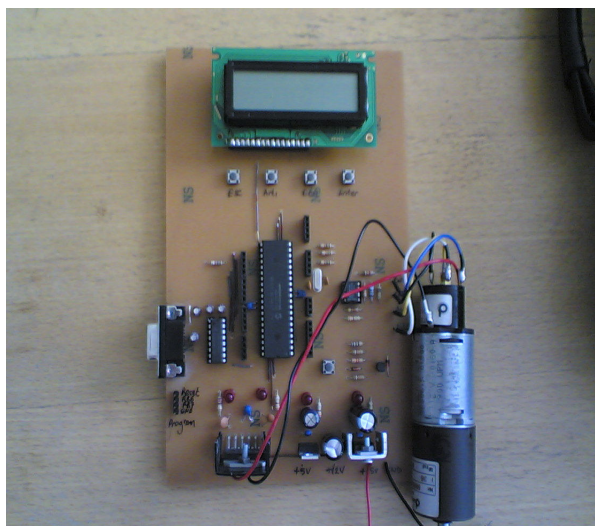


Fig. 3 DC Motor Module

III. SOFTWARE ARCHITECTURE

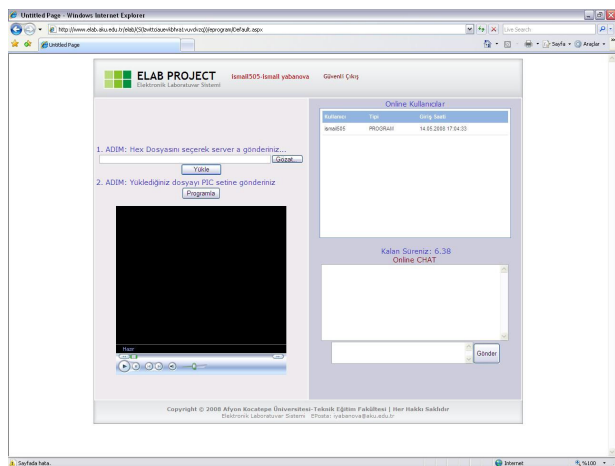


Fig. 4 Programmer main page

Web page has been developed by using C# programming language. The system wants from students a user ID and a password. The students who have not membership can access to the site as doing the needed membership processes on the related page. On the registration page, necessary information is requested from the users then the end of registration process, user ID and password are sent the user's email address. The one who enters to the system will be the moderator of the

experiment and 10 minute duration will be assigned for experiment. The other users can only observe the experiment and discuss with others by using the chat tool. The main page of the user who has authorization for programming is given in Fig. 4.

The main page of the user who has authorization for observation is given in Fig. 5. In this page file upload and programming buttons are disabled. On both of the pages, there are names of the online users, authorization type, login date, a chat tool which users can discuss the experiment results and a countdown timer for programmer's remaining time. In addition to this all the users can watch the experiment via webcam. The list of online users is refreshed at every 10 seconds. In order to avoid cutting the video stream, online users' list refresh process was made with AJAX. A page automatically opens and closes when experiment time is up to control digital and analog inputs of the experiment set. Programmer can control 8 digital inputs and 2 analog inputs of the experiment set via this page. This page is given in Fig. 6.

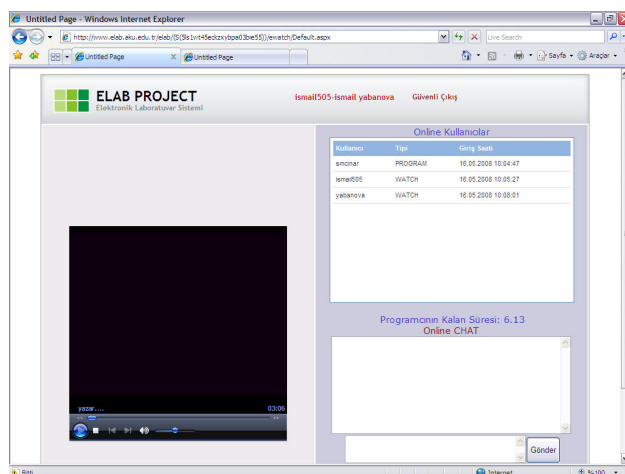


Fig. 5 Observer main page

The user who is timed up will be automatically logged out the system. After that next user will have the moderator of the experiment by the system. The experiment moderator will be able to program the microcontroller by clicking on the "Program" button after sending the hex file, which has been written and compiled previously, to the web server using the upload tool on the page. In order to do all the operation, client user never needs a software or hardware but web browser software.

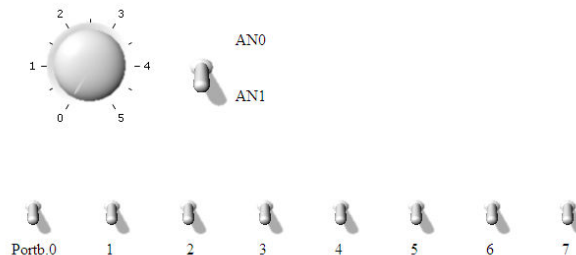


Fig. 6 Digital and Analog Inputs Control Page

IV. CONCLUSION

Consequently in this study a web based remote microcontroller laboratory is developed. With this implemented study, a possibility for making microcontroller experiments independent from the time and place has been obtained for the students. Thus increasing the programming skills of the students and making remote experiments have been obtained.

ACKNOWLEDGMENT

This study was sponsored by a project of Scientific Research Projects Commission of Afyon Kocatepe University (Project name: Internet based programmable systems laboratory, Project no: 06.TEF.09).

REFERENCES

- [1] H. Çimen, M. Nartkaya, İ. Yabanova, S.M. Çinar, "A New Microcontroller Experiment Set For Undergraduate Students", 4th International Forum on Engineering Education-Integrating Teaching& Reseach with Community Service, 2006
- [2] V. Giurgiutiu, J. Lyons, D. Rocheleau, W. Liu, "Mechatronics/microcontroller education for mechanical engineering students at the University of South Carolina", *Mechatronics*, Vol 15 (2005), pp.1025–1036.
- [3] B Weiss, G Gridling, M Proski, "A Case Study in Efficient Microcontroller Education, Vienna University of Technology", *Embedded Computing Systems Group E182-2*, 11 Oct. 2005, pp.1025–1036.
- [4] Martin-del-Brio, B. Bernal-Ruiz, C., "A software tool for teaching microcontroller system principles", *International Journal of Electrical Engineering Education*, Vol 36 (1999), pp. 279-286.
- [5] A.H.G. Al-Dhaheer, "Integrating hardware and software for the development of microcontroller-based systems", *Microprocessors and Microsystems*, Vol 25 (2001), pp. 317-328
- [6] Hercog, D., Gergic, B., Uran, S., Jezernik, K., "A DSP-Based Remote Control Laboratory", *Industrial Electronics, IEEE Transactions on* Volume 54, Issue 6, Dec. 2007 Page(s):3057 – 3068
- [7] Jeffrey V. Nickerson, James E. Corter, Sven K. Esche, Constantin Chassapis, "A model for evaluating the effectiveness of remote engineering laboratories and simulations in education", *Computers & Education*, Volume 49, Issue 3, November 2007, Pages 708-725
- [8] A.Kutlu, "Microlab: A web based remote microcontroller laboratory for engineering education", *International Journal of Engineering Education* Vol. 20 No. 5. pp 879-885, Ireland.

Hasan Çimen was born in Turkey in 1963. He is head of Electrical Department at Afyon Kocatepe University, Turkey, a position held since October 1998. He obtained MS degree from Marmara University, İstanbul in 1988. PhD degree from Sussex University, UK in 1998.