Web Based Real Time Laboratory Applications of Analog and Digital Communication Courses with LabVIEW Access

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Abstract—Developments in scientific and technical area cause to use new methods and techniques in education, as is the case in all fields. Especially, the internet contributes a variety of new methods to design virtual and real time laboratory applications in education.
In this study, a real time virtual laboratory is designed and implemented for analog and digital communications laboratory experiments by using LabVIEW program for Marmara University Electronics-Communication Department. In this application, students can access the virtual laboratory web site and perform their experiments without any limitation of time and location so as the students can observe the signals by changing the parameters of the experiment and evaluate the results.

Keywords—Virtual laboratory, LabVIEW, Modulation Techniques.

I. INTRODUCTION

EDUCATION has a big importance in the development of societies. For this purpose, various methods have been developed to improve the learning process. The technological researches and developments provide new concepts in education [5]. Especially internet facilities present new approaches and methods to design virtual and real time laboratory applications for education purposes. Laboratory work is an important part of the course, in which the students can practice what they have learned in classes, which helps them to reinforce the learning of the concepts.

Facilities of the laboratories in educational institutions are generally insufficient when the number of students is considered. The implementation of a laboratory to meet the requirements cost too much. For this reason, virtual laboratories (VL) have become an alternative to the traditional laboratories. Students can get access to the experiments without time and location limitations in virtual laboratories that enable students to set up parameters to run experiments from a remote location and repeat the experiments, as they need

Another advantage of VL is setting up various experiments using software intensively but with a few pieces of equipment.

High-level programming languages such as MATLAB, LabVIEW and many others are used for VL applications. Among these, LabVIEW is widely used and it is used in this work, too.

LabVIEW software provides an active and controllable interface for test, measurement, instrument control, data processing and data analysis applications [3]. By using LabVIEW program, both virtual instruments can be designed and the devices can be controlled via GPIB, RS232 or VXI interface [1]. Additionally, with TCP/IP standard, users can get access to the applications via Internet. In this way, a VL has been set up to provide an environment for both physical experiments and simulations.

This study describes a web based virtual laboratory whose purpose is to provide a tool to be used as a teaching aid in analog and digital communications course. We present a web based VL on Amplitude Modulation (AM), Pulse Code Modulation (PCM), Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK) experiments by using LabVIEW program. If LabVIEW program has not been installed in the user's computer, to conduct and to perform experiments, the user needs to install LabVIEW Run Time Engine by clicking the relevant link on the web page. For performing the experiments in an efficient way, theoretical concepts and the procedures of real time and virtual applications related to experiments are given on the web page. The instruments in the VL are controlled by using GPIB interface. In order to design a web page and laboratory applications, TCP/IP, LabVIEW, .NET programs are used.
In order to store students' information and registration data, Microsoft Access has been used.

In Section II, the typical user interface is described to show experiment results and to change experiment parameters (input signal form, frequency, sampling time, etc.). Section III describes the hardware and software system architecture and finally, conclusions are drawn in Section IV.

II. USER INTERFACE

A. Control Panels

Our study contains both computer-simulated applications and real time applications. The front panels of the real time applications have been presented here. The front panels of real time applications of AM, PCM, ASK, FSK and PSK which are designed by using LabVIEW program are shown below.

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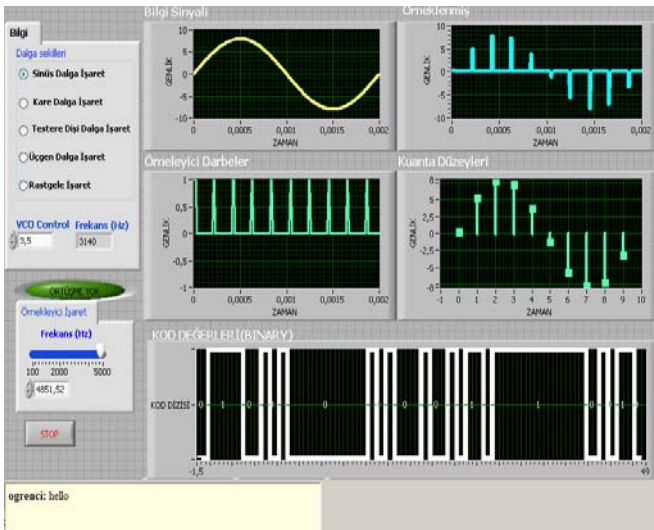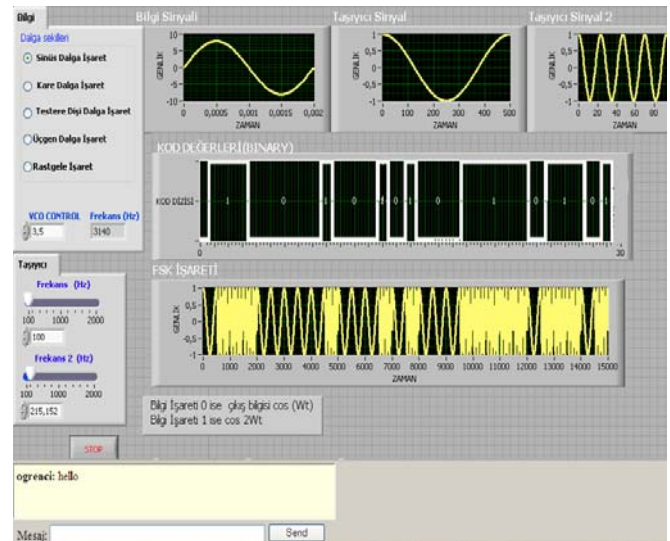Vol:1, No:5, 2007

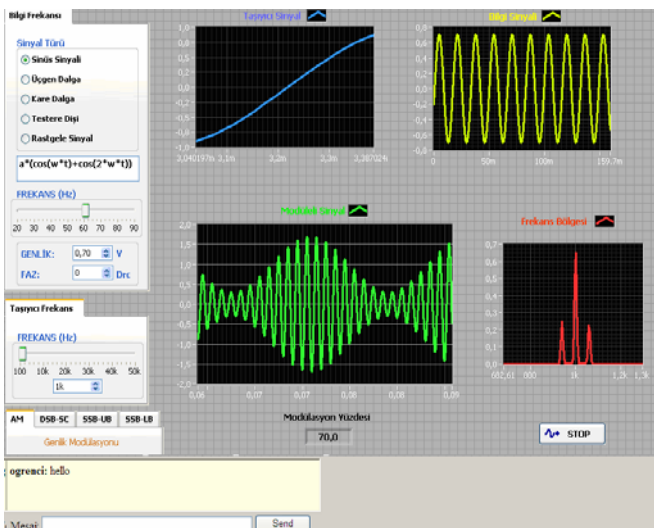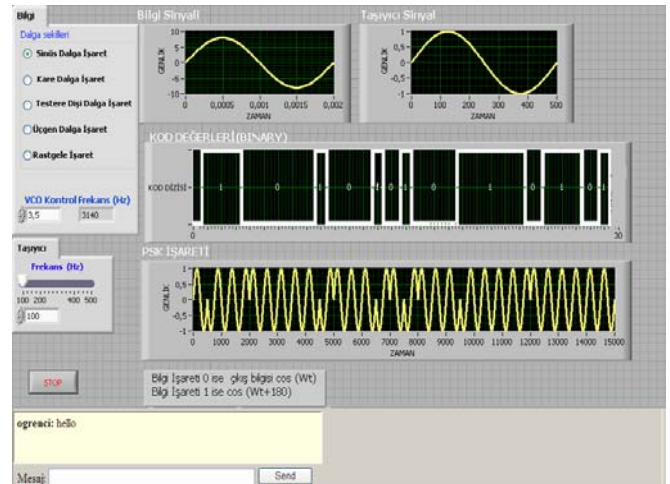Fig. 1 PCM Front Panel

Fig. 4 FSK Front Panel

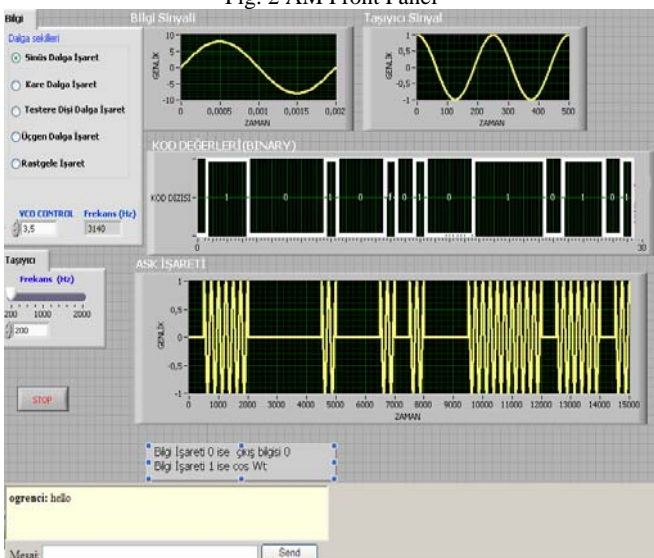Fig. 2 AM Front Panel

Fig. 5 PSK Front Panel

The front panels called "user interfaces" are designed as authentically as possible. The front panels of these applications that contain two sections such as the control buttons on the left and input-output waveforms of the experiments on the right are designed in a simple and intelligible structure.

The frequency of sample impulses (PCM), carrier frequencies (ASK, FSK, PSK, AM) are changed as virtual and the frequency of message signals are changed as real time by using control buttons. So students can change the message signals in real time via voltage controlled circuit (VCO) by controlling the connected devices. The measured results from the instruments are brought to the user through the same interface.

There are five types of signals such as sinusoidal, square, triangle, saw tooth and random on the message signal part. In addition, the front panels display message signal, sample impulses, carrier signals as input and AM modulated signal, PCM code sequence, ASK, FSK, PSK signals as output.

Fig. 3 ASK Front Panel

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The experiments can be stopped at any time by pressing the stop button located at the bottom of the left side of the front panel.

B. Web Site

In this study, a web site is designed to perform Analog and Digital Communication experiments via internet. The web site contains the theoretical information of experiments and virtual and real time experiment steps. The aim of these web pages is to give some information about the experiment. Any interested user can get access to these documents freely and install these documents without logging on at the same time without interrupting the experiment. To conduct and perform the experiment, students need to have web browser and LabVIEW Run Time Engine.

In Fig. 6, the home page of web site is shown.

The necessary steps for conducting and performing the experiment are given as follows,

- Students can choose the experiment from the buttons
- Username and password for authentication is requested from the user when the user clicks to the experiment link.

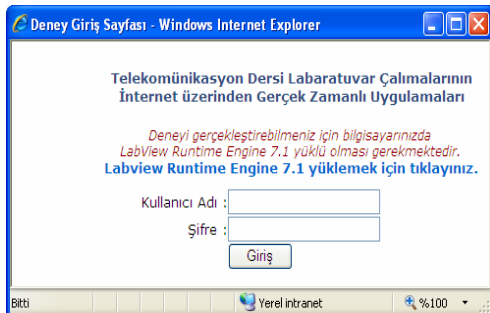Fig. 6 Home Page

The user input page is shown in Fig. 7.

Fig. 7 Application Input Page

- After a successful log on to the session, the user interface for controlling the instruments and performing the experiment will appear.
- Students can now change the experiment parameters such as the control voltage of VCO circuit to get message frequency, sampling frequency and carrier frequency and obtain the results.
- While the student is performing the experiment, the teacher may observe the experiment simultaneously and talk to the student through the developed chat page.
- Students are allocated 15 minutes and the session can be terminated by the user any time or after a default time limit of 15 minutes.

In Fig. 8, the student application page is shown.

Because of the fact that, students are able to perform the device control in the experiment as well, the web site allows to access only one student at the time.

National Instruments have developed Dynamic Link Library (DLL) to control the LabVIEW applications from different programming platforms (Visual Basic, C++, C#). By using this DLL, VIs can be integrated to the .NET applications easily.

In order to add or erase experiments, update the current experiments and disable / enable the system, an administrator page is designed in web site as shown in Fig. 8.
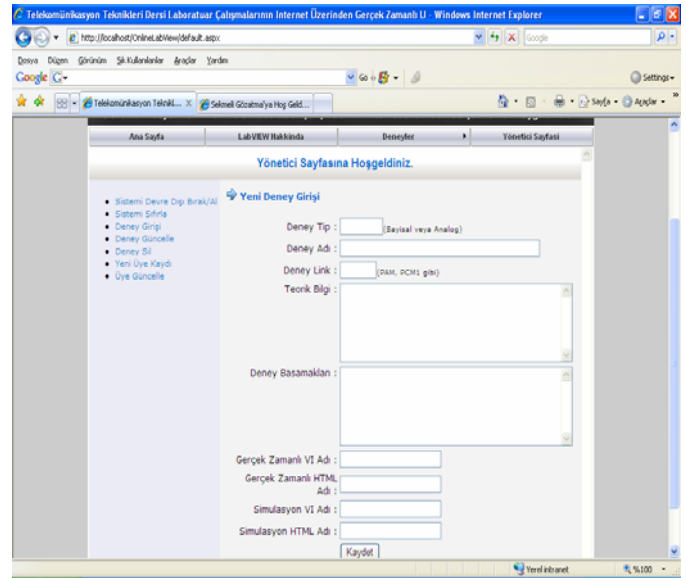

Fig. 8 Administrator Page

III. SYSTEM ARCHITECTURE

A. Hardware System

The hardware system and its components of the real time Analog and Digital Communication experiments is shown in Fig. 9. In this structure, Laboratory PC which includes GPIB and Ethernet Interfaces is called as a server PC. It works as the main controller. By using Voltage Controlled Oscillator (VCO) as shown in Fig. 10, a message signal has been

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obtained for experiments. The input signal of VCO is controlled by the DC power supply with GPIB and the output signal of VCO circuit is measured with digital multimeter and then sent back to the Laboratory PC through the GPIB. This measured signal is applied to the system as a message frequency.
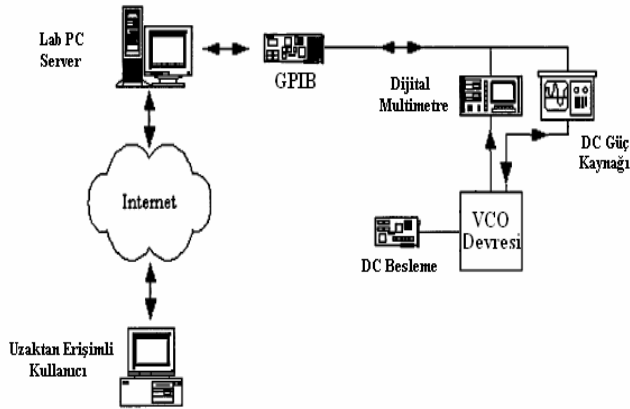

Fig. 9 Hardware Structure of Application

VCO circuit converts the voltage between 3,5 to 5,5V to the frequency between 1,6 to 11 kHz.
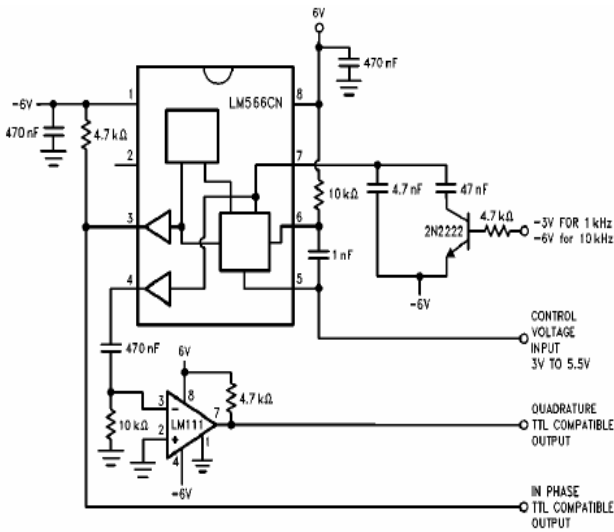

Fig. 10 VCO circuit

LabVIEW is adopted to implement local instrument control. On the basis of the GPIB port number assigned to the instrument, the commands are transferred through the GPIB card and cable to the corresponding instrument which implements the commands and executes the actions.

In Fig. 11, the set of the instrument located in a standard laboratory is shown.
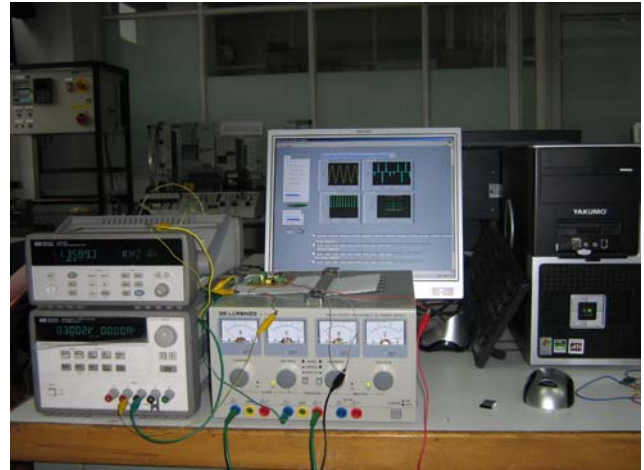

Fig. 11 Laboratory Appearance of Application

B. Block Diagram

The block diagrams are the main part of the experiments. Connections between the VI's, analog I/O are implemented under LabVIEW using the G programming language. Also programs are verified by using Formula node in the block diagram. The block diagrams of the experiments are shown below [Fig. 12, Fig. 13, Fig. 14].
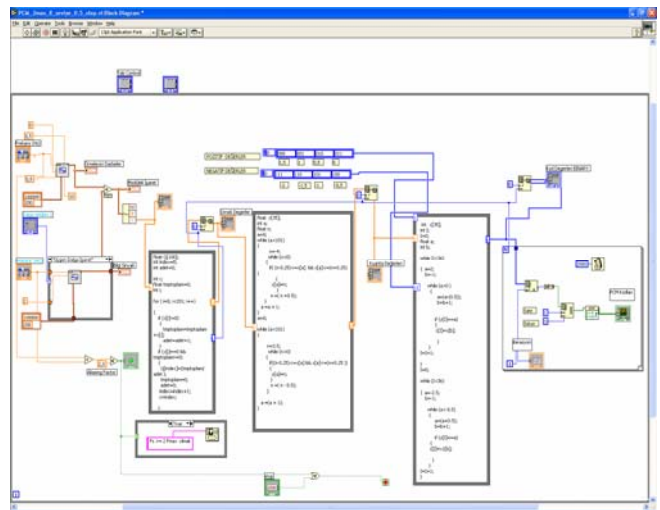

Fig. 12 PCM Block Diagram Structure (a=0,5, Q=8)

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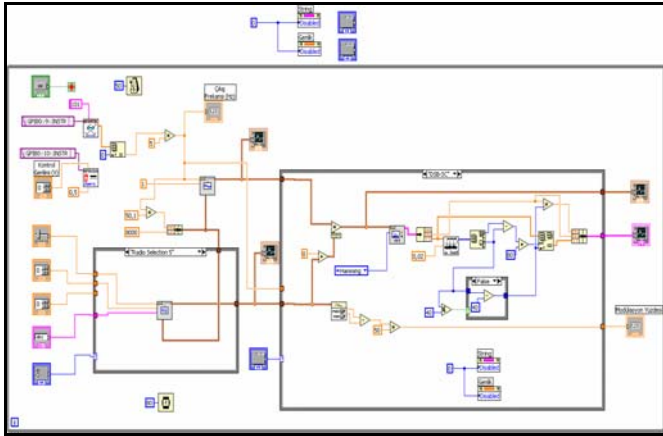Vol:1, No:5, 2007

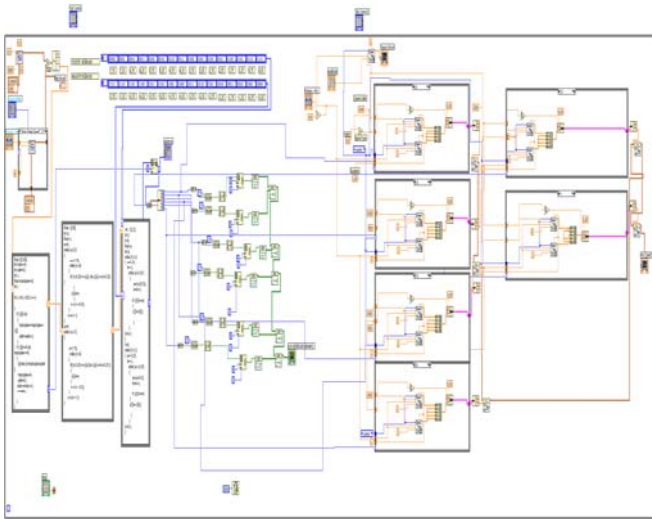Fig. 13 AM Block Diagram Structure

Fig. 14 ASK Block Diagram Structure

A block diagram of the PCM experiment given in Fig. 12 is summarized as follows. It contains four sections. In the first section, by using the signal generation VI's, the message and sampling frequency are generated. Then a program is written in Formula Node to select sample values. In the third section, in Formula node, a program is developed to allocate levels to the infinite range of amplitude of sample values of the analog signal using uniform quantization operator. This program is carried out quantization parameters (quantization step size a=1 and a=0,5, the quantization levels Q=8, 16, 32).

In the last section, encoding operation is performed by developing a program in Formula Node. In this step, each quantization level is expressed in a code. According to number of quantization levels, code word length (n) is selected 3, 4, 5 bits. n bits (0,1) code words are converted to Binary- Non-Return to Zero (B-NRZ) pulse sequences to transmit.

For the other experiments, similar block diagrams are developed.

IV. CONCLUSION

In this study, for supporting laboratory applications of students, a general methodology has been presented to create real time and virtual experiments of Analog and Digital Communication courses. In addition to this, this study not only supports the effective but also complete learning and provides a solution for distant technical education. The aim of these experiments is to study the frequency spectra of AM, DSB, SSB modulated signals and time spectra of PCM, ASK, FSK, PSK signal forms according to input parameters. These experiments are designed based on theoretical knowledge.

Various experiments corresponding to modulation techniques have been designed under LabVIEW program to real time and virtual applications. It is planned on to develop the demodulation applications of these experiments. This methodology can be extended to other communication system techniques too. Users can access the virtual laboratory at the Goztepe Campus of University of Marmara.

REFERENCES

[1]   C. C. Ko, B. M Chen, S. Hu, V.Ramakrishnan, C. D. Cheng, Y. Zhuang, & J.Chen, "A Web-Based Virtual Laboratory on a Frequency Modulation Experiment", IEEE Transactions on Systems Man. and Cybernetics, 2001, pp. 295-303.
[2]   K.W.E. Cheng, C. L Chan., N. C. Cheung, & D. Sutanto, "Virtual Laboratory Development for Teaching Power Electronics", Instıtude of Electrical and Electronics Engineers, 2002,pp.461-466.
[3]   M.L. Higa, D. M. Tawy, & S. M. Lord, "An Introduction to Labview Exercise for An Electronics Class", 32nd ASEE/IEEE Frontiers in Education Conferece, TID-13, 2002.
[4]   LabVIEW Manual , National Instruments, 2002.
[5]   A.B. Hasanul, A.I. Saliaman, " On – campus an Online Virtual Laboratory Experiments with LabVIEW", Southeast Con, 2006, pp. 325-330.