Client – Server System for Control of Virtual Instruments as Web Based Teaching Tools

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Abstract - **In the paper are discussed the basically characteristics of the digital devices from type DAQ cards and the possibility for their programmed management with the graphical language for programming of LabVIEW.**
A client - server system for management of virtual digital devices as web based teaching aids is presented.
An application at executing optical experiments is considered.
Keywords – **digital devices, virtual devices, optical experiment, web based teaching aids**

I. Introduction

A virtual instrumentation system is a software that is used by the user to develop a computerized test and measurement system [1]. Virtual instrument is composed of the following blocks: Sensor module; Sensor interface; Information systems interface; Processing module; Database interface; User interface.
Virtual instrumentation is an interdisciplinary field that merges sensing, hardware, and software technologies in order to create flexible and sophisticated instruments for control and monitoring applications. The work with virtual instruments realizes with virtual graphical programming language LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) of National Instruments [2]. All the codes in LabVIEW are constructed and saved in graphical structures. LabVIEW itself does not contain text-based codes, it can conveniently call text-based functions or subroutines programmed by other languages such as C, C++, MATLAB. and SciLab. The heart of LabVIEW is the graphical programming language – “G language”. G includes extensive libraries of functions for many programming tasks. Programs written using G are also called virtual instruments (VI).VI consists of three parts: front panel, block diagram, and subprogram.

The purpose of the web-based teaching tools (WBTT), discussed in [3], is not to imitate traditional learning but to add to all existing forms of training new resources for exercises, that activate self-dependent work and creative decision of the submitted problems.

This system is inextricably bound up with pages for helping, which direct the students for finding the correct way for deciding of the problems. So, the interaction between learner and the teaching material is submitted on a new high level. Psychological basis of designing of the web-based teaching tools is given in [4], [5].

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II. Purpose

To be presented client - server system for management of virtual digital devices as web based teaching aids.

To be discussed the basically characteristics of the digital devices from type DAQ, cards and the possibility for their programmed management with the graphical language for programming of LabVIEW.

To be expanded the area of applicability of the system for web-based training tools (WBTT) formulated in [3], [4] and [5], by supplementing with elements of client servers system (CS) for management the virtual digital devices (virtual instruments VI).

To present applications of a client servers system (CS) for control VI at executing optical experiments, as too and at preparation of virtual exercises as addition to WBTT.

III. Virtual Digital Devices and Communications

A. Sort of interface cards

Key components of PC-based instruments are the interface cards, which are of kinds: General-purpose interface bus card (GPIB), Data acquisition card (DAQ) and Digital signal processing card (DSP) [6].

The GPIB has three different methods to signal the end of a data transfer: hardware line, end of string, and byte count.

Hardware Line: This is the most preferred method. In this mode, the GPIB includes a hardware line (EOI) that can be asserted with the last data byte. End of String: In this method, a specific end-of-string (EOS) character is placed at the end of the data string itself. Byte Count: In this method, the listener counts the hand-shaken bytes and stops reading when the listener reaches a byte count limit. In the former, there are two GPIB-based instruments: a GPIB-based digital oscilloscope and a GPIB-based digital signal generator.

The advantage of using DAQ cards over the GPIB interface is that for a GPIB based device, the device itself must be equipped with a processing unit to process events concerned with the GPIB protocol, whereas for a DAQ-based device, this processing is done by the PC. On the other hand, the DAQ-based device must have transducers that convert various kinds of continuous physical signals to digital signals. Typical transducers include thermocouples, strain gauges, microphones, potentiometers, or any other device that supplies a voltage within the input range of the DAQ board.

DSP cards have some common features: they involve significant mathematical operations such as for multiplying and adding signals; they deal with real-time signals and they need to produce a response within a certain time.

DSP technology is used in a wide variety of applications such as communication, digital TV, radar, audio, sensor, fax, multimedia processing and process control.

B. Using of DAQ devices

As en example of DAQ device we'll use Lab-PC-1200 board, from National Instruments[7]. The board is a low-cost, high-performance ADC (analog to digital converter). It allows DMA, interrupts, and base I/O addresses to be assigned by the system to avoid resource conflicts with other boards in the system. This board is designed for high-performance data acquisition and control for applications in laboratory testing.

The use of DAQ-based systems is normally accompanied by a set of driver software, which spares the user from complicated hardware-related interface configurations and handling such as those dealing with special protocols and other software layers. Specifically, drivers are at the following three levels.

- Hardware Level: This gives support at the lowest level, including that for connections, signal conditioning, acquisition plug-in cards (A/D multifunction types), and RS-485, RS-232, parallel, and other communication ports on the PC.

- NI-DAQ Driver Software: This gives support at the medium level and serves as the connecting link between the hardware level and the application software at the top level.

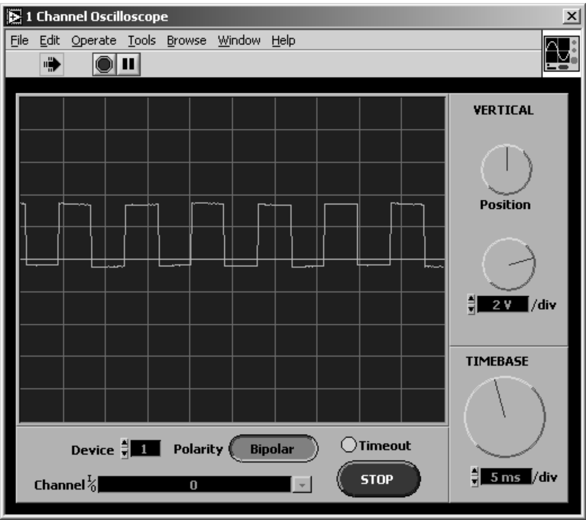

Fig. 1 Front panel of one-channel oscilloscope

- Application Software. This language-independent top level allows development environments such as LabVIEW, LabWindows/VCI, Visual Basic, Excel VBA, and C++ to access the hardware level effectively.

An one-channel oscilloscope realized with control of LabVIEW is example of applied software. The front panel is given on Fig.1 and appropriate scheme of the control is given on Fig.2. This represents one virtual instrument. One special element can noticed on Fig.2, that is another VI device – one-channel scope. The front panel of this device is given on Fig.3 and its scheme is given on Fig.4.

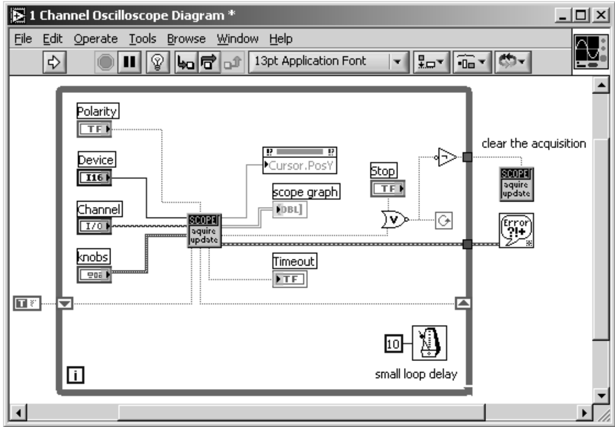

Fig. 2 Scheme of one-channel oscilloscope

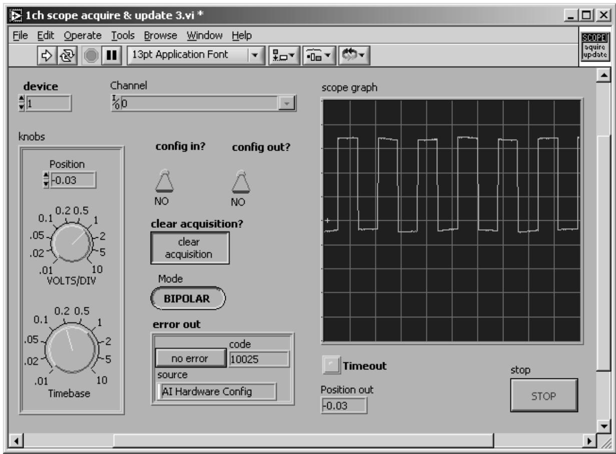

Fig. 3 Front panel of used sub-control for oscilloscope

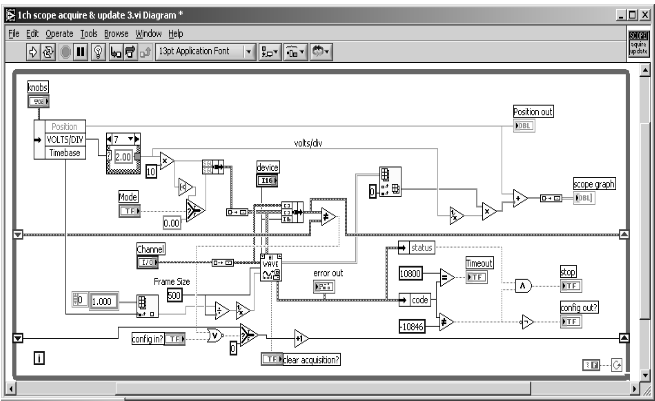

Fig. 4 Scheme of sub-control representing oscilloscope

C. How works with nonstandard devices

In some cases it is necessary to work on lower level because it is possible that the device can not be identified as standard device from LabVIEW. The communications between hardware devices and given module from higher level can become through writing and reading in so called hardware ports or hardware registers.

Writing and reading on referenced ports stand basically by assembler's commands in and out.

Example of part of such program:

```
PUSH    AX
PUSH    BX
PUSH    CX
PUSH    DX
MOV     DX, basis + 0Ah; Port C
IN      AL, DX
```

Through build controls in LabVIEW for writing and reading in input-output ports makes easier access and in higher level

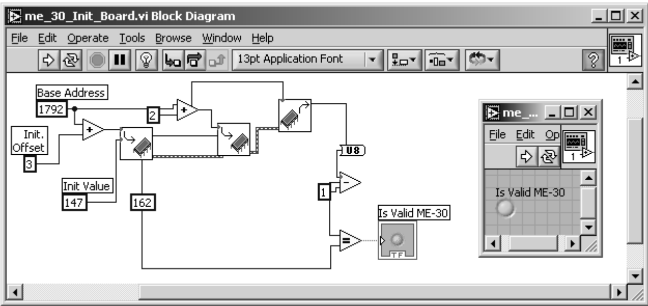

Fig. 5: Initialization and validation of ME-30

In this example it is demonstrated how LabVIEW can initialize and validate "Meilhaus ME-30" DAQ device. This can be done through the hardware registers (or hardware ports). The hardware registers are strictly defined for all available devices. If we have necessary information for the registers and how to use them, we can implement low level algorithms and organize them into drivers.

The basis in examined example is validation, through that determines whether given device is correctly mounted. At first should pass to address 0x700 + 3 the value 0x92. That tunes the device in regime for work. Writing the value 0xA2 on port 0x700 + 2 follows. The idea is to waiting

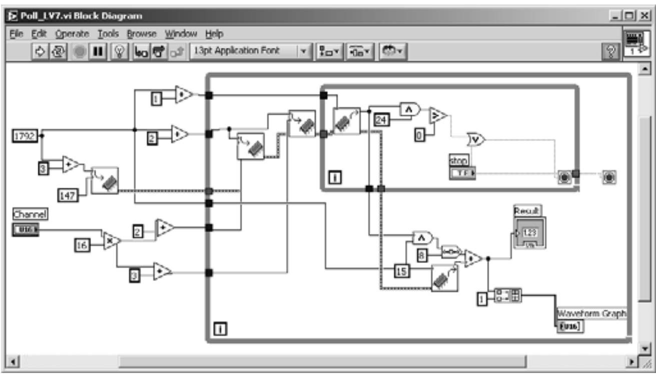

Fig. 6: Obtaining of the array of values responding to analogue input from ME-30

such that we were writing, be reading in the next moment from such address One program written on LabVIEW for initialization and validation of ME-30 is given on Fig. 5.

On Fig. 7 we have program's diagram that reads data from analog input of DAQ card ME-30. Here we have two inserted cycles. The first gives at beginning what is expectable channel for that is reading the numeric analogue. The second cycle works for heaping the definite numeric value from side of ME-30. After receiving definite two-bytes number, it is leading to program output. The output can be as indicator of received value so graph in the time.

IV. REMOTE ACCESS OF THE CLIENT

When one program in LabView is composed this can published easily in Internet. This denotes that it gives the opportunity the users of the system to observe or even to remote control the front-panel. For achieving of this is necessary that the laboratory computer has access to Internet. If it is, selects the menu Tools/Web Publishing and wizard opens, that helps for publishing of the front panel.

On Fig. 7 is presented image of the front panel of two-channel oscilloscope, received in client's browser.

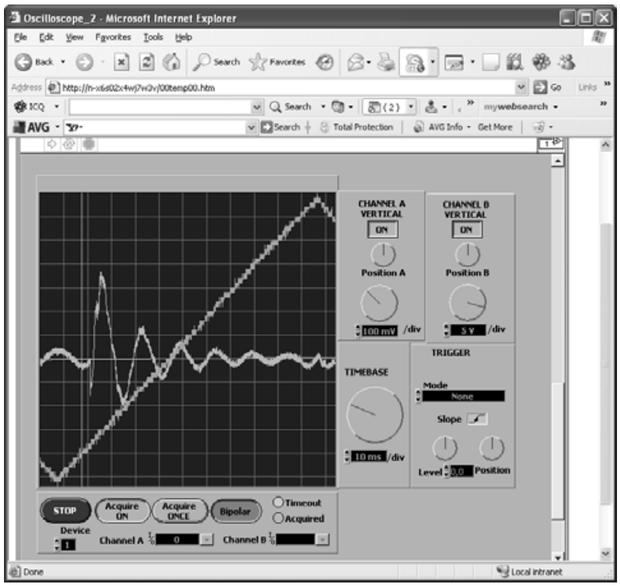

Fig. 7: Image of the front panel of two-channel oscilloscope, received in client's browser

V. SCHEME OF THE SYSTEM

The system for student's teaching WBTT is added with new elements according to scheme on Fig.8. For the application of the system at organization of optical

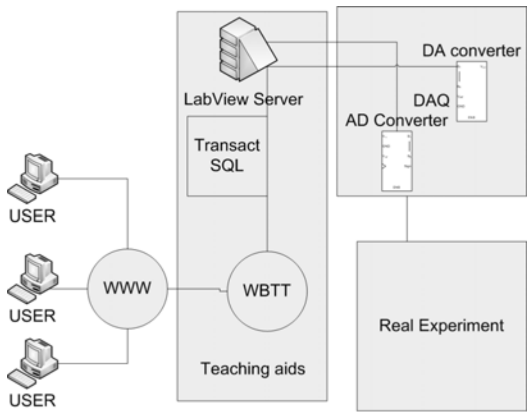

Fig. 8: Scheme of extended system WBTT

experiments the data base of type Transact SQL is used for storing the data from the experiments. Data, name of the student which implements the experiment and data that are digital signals are stored for each experiment.

Through the system gives ability for student's receiving of graphical information for the experiment in the appearance on Fig. 7.

VI. Application in Optics

We examine experiments in which parameters of Michelson’s interferometer are measuring with two-rays interferention (Fig. 9).

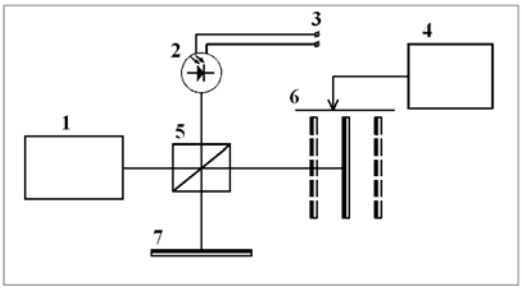

Fig.9 Scheme of Michelson’s interferometer: 1) laser; 2) photodiode; 3) Output to AD converter; 4) Signal generator that influence on PZT to set in motion movable looking-glass; 5) beam splitter; 6) movable looking-glass; 7) immovable looking-glass

Experiment 1: Measurement of displacement of movable looking-glass in Michelson’s interferometer.

The intensity of waves who are interfered is measured with constantly velocity of translational movement of the looking-glass. The velocity of the looking-glass gives on axis x in device for measuring. On Fig. 10 is presented front panel of virtual instrument – oscilloscope realized with DAQ cart PCI-1200. Interfered picture and the shifting of the looking-glass are got. By this measuring is displayed the interference picture between two rays.

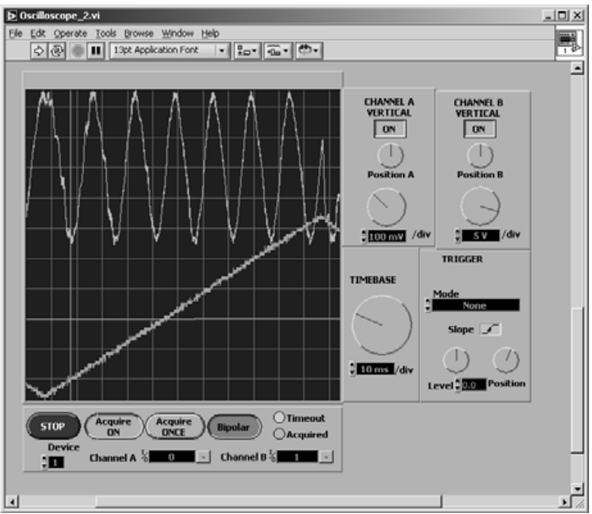

Fig. 10: Front panel of oscilloscope with depicted interference picture and shifting of the looking-glass

This experimental setup put into practice for precise measuring on little distance for evaluating of the quality of optical elements (looking-glasses, lens, prisms).

Experiment 2: Obtaining the graph of a function of the depth of penetration of the light in testing objects.

This experimental installation obtains as on the place of looking-glass number 5 puts the tested object (Fig. 1). The depth of light penetrating is measuring in examined pattern.

On Fig.7 is presented front panel of virtual instrument - oscilloscope realized with DAQ cart PCI-1200. The image is received in the browser of the client. The interference drawing and shifting of the looking-glass are obtained. Such measuring is used in the medicine for measurement the properties of tissues of the order of several μm .

Experiment 3: Measuring the degree of coherence at different polarization of the light coming from two shafts of light.

In the optical part of the system for measuring are added polarizers, which change the polarization of the two interference rays. The used laser is not polarized. Measuring of two-beam interference picture is carried out without and with polarization of the light. With this experiment can measure interference grade in dependence of sort and angle of polarization between two beam.

VII. Conclusion

The using of VI devices is an inexpensive method for realizing of experiments. The Vi devices as the card PCI-1200 substitute several expensive devices. The using of VI devices creates the ability for graphical programming through the understandable for the engineer G-language of LabVIEW.

Before the advent of the Web, such demonstrations were typically developed in isolation at scattered institutions using locally available software packages. With the Internet, the demonstration programs and files can be launched and made available to the entire world, allowing more students to have access without the need to waste time developing the software.

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