MEASUREMENT SCIENCE REVIEW

Theoretical Problems of Measurement

Measurement in Biomedicine

Measurement of Physical Quantities

Web based platform for distance training
On Electrical Measurements course

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Abstract. This paper presents a Web based platform for distance learning. The platform is used in the course "Electrical Measurements" at Faculty of Electrical Engineering in Zagreb, Croatia. The paper describes the design of the FER Internet Laboratory, and experimental setup of Web based experiment. The suggested design offers a possibility to teach or present high precision experiments using expensive or sensitive equipment that is unavailable in sufficient quantities to serve large number of students.

Keywords: distance learning, web-based remote laboratory, LabVIEW

1. Introduction

Laboratories, which can be found in all engineering and science programs, are essential part of education training. Laboratories bring the course theory alive. In that way, students can see how unexpected events can affect measurements in a real world. Unfortunately, electric and electronic measurement laboratories are not widespread, mainly due to their costs. This makes difficult the practical education of students and engineers, especially in the fields of quality control, test engineering and metrology.

Due to rapid diffusion of Internet and the constantly growing number of institutions and persons that can be connected to the network, distance learning is becoming more and more frequent. The creation of remote laboratories that allow students to perform measurement experiments over the Internet, using the virtual electrical instruments, proves to be an essential issue during the realization of distance learning projects.

In education, but also in research and design, engineers and scientists demand rapid development and prototyping capabilities. With virtual instrument tools, you can quickly develop a program, take measurements from an instrument to test a prototype, and analyze results, all in a fraction of the time required to build tests with traditional methods.

LabVIEW is an effective tool that can be used to teach the functional principles of devices, conducting measurement methods and experiments. It can also be used to develop web-based remote laboratory system. For this discussion, a remote laboratory can be defined as an experiment, demonstration or a process running locally on a LabVIEW platform, but with the ability to be monitored and controlled over the Internet from within a Web browser.

The simplest case of the remote laboratory is an experiment (a group of real instruments and electrical circuits) that is connected to the computer through standard interface (DAQ, GPIB, RS232, parallel, etc) and with the host computer connected to the network. The client side can be any computer connected to the Internet running a simple Web browser. Once connected, the client will be able to see the same front panel as on the local computer hosting the experiment and also will have the same program functionality.

2. Basics of FER Internet Laboratory platform

Most of the laboratory measurement exercises has been planned to realize with National Instruments LabVIEW software. Laboratory experiments had to be accessible locally, in the laboratory room, but also over the network. Therefore, it was the first step during the realization of FER Internet Laboratory [1] to create a system capable to share these experiments over the Internet.

LabVIEW has it's own solution for these problems – Remote Panel feature, requiring the client side to have special LabVIEW's Run-Time Environment previously installed [2]. Also, Remote Panel feature does not provide some kind of advanced user access control and auditing, and also there is no solution for integrating several experiments into one web portal.

National Instruments also offers LabVIEW Internet Toolkit that was found to be partially suitable for our purpose. It provides flexibility and easy implementation of serving LabVIEW's VIs images [3] over the network, but for our purposes lacks adequate user access control/auditing, reservation and it cannot integrate several experiment hosting computers into one web-learning portal.
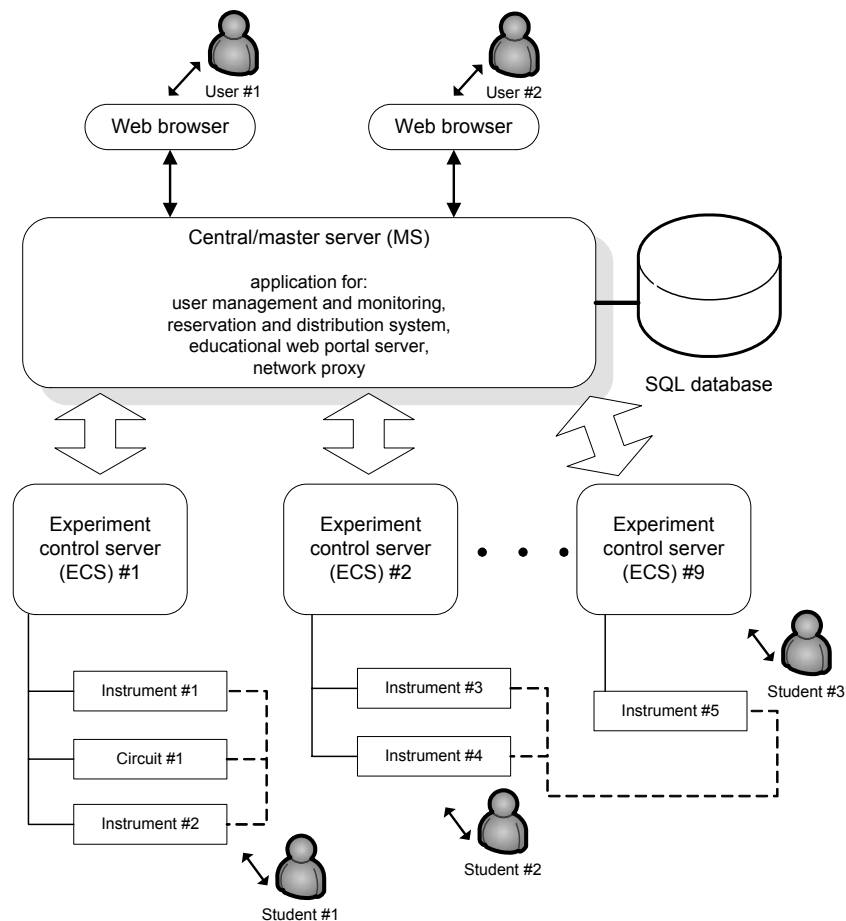

Fig 1. Concept of FER Internet Laboratory shows data and communication flow between users and measurement hardware.

To suitably face these problems, it was necessary to create a special web application that is capable of identifying visitors, giving them appropriate rights, reservation of resources and experiments. A brief representation of realized laboratory control solution is shown in Fig. 1.

3. Platform design

To coordinate the different users on the network and connect them to the appropriate measurement hardware, the FER Internet Laboratory uses a central (master) server (MS) and several decentralized experiment control servers (ECS). Experiment control servers are placed in their own intranet for security reasons (but that is not necessary) and are connected to the outside world via master server which acts as a network proxy server. In addition, a specific module controls the overall laboratory system. A specific scheduling system placed on MS manages the catalogue of available experiments (instrumentation) and redirects user requests to the first available ECS (see Fig. 1). The requestor finally gains control of an experiment that is running in LabVIEW VI (on an ECS) without any need for installing LabVIEW environment in his or her computer.

A MS is the only machine that is directly accessible through the Internet, while other ECS's are not visible directly to the clients. They are accessible only through a web application, which authenticates users, gives them the right to run experiments and monitors every user action.

Every ECS is placed in a student measurement laboratory or in some special laboratory and is connected to a set of instruments and circuits through one or more interface cards. The GPIB (IEEE 488) interface is used to connect other compatible instruments to the ECS. Software that controls experiments is LabVIEW, with installed LabVIEW Internet toolkit on every ECS.

When an ECS in laboratory is occupied with students working on some experiment, that experiment is not available through the web portal. When the ECS is available, and LabVIEW environment for hosting that experiment is ready, MS allows some user to access that experiment over the network. In addition, the user may book certain experimental setups in advance.

All user data, the reservation data and the hardware device data are stored in a MySQL database. The web portal and content management system was created in PHP scripting language. This concept allows a flexible extension of new devices and experiments. Key advantage of this concept is that the user only needs a web browser without any need of downloading applets and installing run time environments of any kind.

4. Example of an experiment setup

A number of laboratories around the world are using simple DVM method for comparison of standard resistors. Since they were introduced to the market, the high-precision 8 ½ digit voltmeters have been extensively used even for the most precise measurements. For establishing internal traceability for standard resistors ranging from 1 mΩ to 100 MΩ a method of comparison with the nominal ratio 1:1 and 1:10 have been developed at FER, using two digital voltmeters (DVM) with 8 ½ digits, (Hewlett Packard model 3458A)[4]. Two voltmeters are used, one parallel to each resistor. Each of DVMs designated as HP1 and HP2 is measuring voltage drop across one resistor.

The measurement process is automated by a personal computer equipped with GPIB-488 card for operating the voltmeters, and by a specially built PC controlled apparatus for changing the polarity of the current and changing the position of voltmeters. DVMs are connected with GPIB-488 bus to the PC computer.

The automated data acquisition has been developed using the LabVIEW. It offers the necessary flexibility to the operator, which includes measurement set-up, such as range, number of samples and duration of DVM integration time, builds the calibration database, performs the statistical analysis, and creates print-ready calibration report with all relevant data.
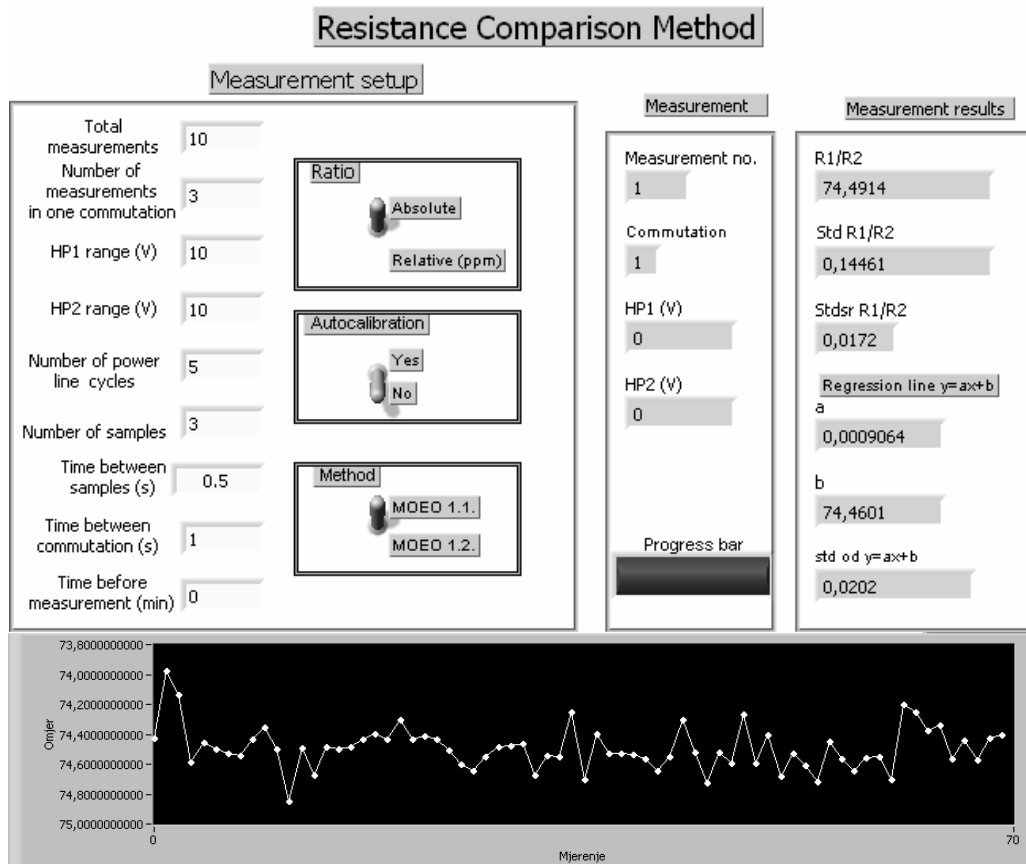
Fig. 2. Virtual front panel of resistance comparison method

As the resistance standards are placed in thermostated oil bath, they cannot be moved to student laboratory. Also, as there are only two 8 ½ digit multimeters available, the only possibility to present this high precision method to large number of students (over 500 students attends the course "Electrical Measurements") is through web-based remote laboratory experiment (see Fig. 2).

5. Conclusion

In this paper a technique for remote instrumentation management and distance training in electric measurement course has been presented. In future other solutions will be tried and more experiments will be added into the laboratory. Training on real measurement equipment is very helpful to test theoretical understanding of measuring the electrical quantities. The internet laboratory and virtual instruments cannot replace real measurements, but it can prepare students and technicians to make reliable measurements close to real life.

References

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