

Free Access Remote Controlled Laboratory on the Internet

VÁRADINÉ SZARKA Angéla

Department of Electrical and Electronic Engineering

University of Miskolc

Egyetemváros, H3515 Miskolc, Hungary, E-mail: elkvsza@uni-miskolc.hu

Abstract – Nowadays the remote controlled industrial systems have more and more importance. Use of the internet has become general and the Ethernet cabling has been entirely spread in the industry. This paper presents the possibilities provided by the Ethernet in the measurement technology, through simple examples. The remote controllable laboratory has free access for all Internet users, it is developed to introduce users into the practical use of most sophisticated remote controlled measurement systems. The hardware is built on compact Fieldpoint system while the software is developed in LabVIEW. It provides not only visualisation of measurements for users, but also active participation in control of the equipment. The system is used mostly in engineering education although it is suitable for presentation of the virtual technology to any Internet user interested in the subject.

Keywords: virtual instrumentation, Ethernet, remote control, FieldPoint

I. INTRODUCTION

Remote controlled systems in all areas of our life rapidly develop and spread. Internet has more and more importance in our official and private activities, including education. E-learning and e-teaching is a comfortable and economical way of education, but to make it more effective, development of new teaching methods is required. Traditional seminars and laboratory practices in some areas can be substituted with different computerised simulations and in some areas can be done through the Internet using remote control and measurement. [1]. From the other side this technology can be very important point in industrial cost reduction.

To study this new technology Department of Electrical and Electronic Engineering at University of Miskolc has developed a virtual laboratory with support of the Regional Knowledge Centre. This free accessible remote controllable laboratory serves the blended education from one side and it demonstrates possibilities of the Ethernet network-based industrial measurement systems to all users through an open for all web site, from the other. In this “laboratory” users can study different sensor applications and analyse electronic circuits while they can experience possibilities of the remote controlling.

As the laboratory can be accessed and used absolutely free for all Internet users, one of the most important requirements of the safe operation is determination of permissions given to the Internet users, determination of those functions which freely can be used without any danger to the laboratory equipment, and development of the most reliable protection methods of the system [2].

What kind of problems developers must face when a usual Internet user is allowed to control real laboratory equipment?

Most of the users will handle the system as acceptable: they will enter the system, use it by instructions and close down the system at the end of the use switching off the equipment. But the system must be prepared also for those users, who make some mistake in use or also for unexpected system errors. For example (not a whole list):

- User enters into the system, uses resources but does not do anything – leaves the computer switched on and goes for relaxation, smoking, etc. In this case nobody else can use the laboratory, but all the equipment is staying switched on.

- User does not close down the system as required and all the equipment remains switched on.

- User gives contradictory commands to the system (for example user sets the analogue input module to the current measurement while the equipment is connected to measure voltage)

To exclude these dangerous situations the user software must be very carefully designed and tested.

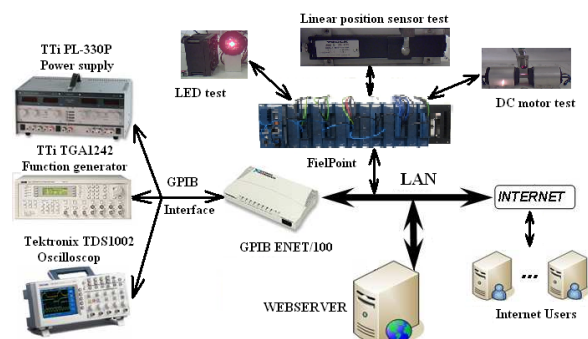


Figure 1. Network structure of Virtual Laboratory at the Department of Electrical and Electronic Engineering at the University of Miskolc

Laboratory is built on basis of GPIB and FieldPoint system. It includes controllable instruments and modules, server is connected to the system on LAN, and 3 different experiments can be performed, as seen on Fig.1.

In this system the virtual world meets the real world and the interface between them is the control software. Software is developed in LabVIEW, which provides suitable visualisation possibilities for user interface and also provides a simple way for network connections programming with its Web Publishing Tool package [3].

The system has limited user access possibility, because one hardware can be controlled by one user. Only one user at a time can have the control permission, all the other users connected to the system can only follow and observe the operation of the system.

For setting up the virtual laboratory a complex information technology system must be developed.

II. OBJECTIVE AND METHODOLOGY

The virtual laboratory at the Department of Electrical and Electronic Engineering at the University of Miskolc includes the following subsystems:

- Control and measurement of inductive linear distance sensor
- Control and measurement of power LEDs
- Control and measurement of small DC motor-generator system

The system includes a web-camera in order to make experiments more spectacular for users. The web-camera is connected to a stepper motor to make possible turning it to the user defined experiment. The stepper motor is controlled by FieldPoint analogue output module.

System integration included the following development steps:

- Development of the circuits to be controlled and measured
- Development of measurement circuit with network interface
- Development of software for Internet use
- Testing the safe and reliable operation of the system.

A. Central Control System of the Laboratory

The National Instruments compact FieldPoint system is a flexible measurement and control system, built from modules. Modules are switched into cascade and connected to each other through the local bus connector. The 35 mm DN rail ensures fix positioning and safe connection of the modules [3].

The system must include an intelligent network controller, which is the central part of the system. This controller has its own IP address and it is connected to the LAN on the RJ-45 Ethernet port. It also has a serial connector (RS232) to make direct connection to the PC [4]. There are several status indicators on the controller

giving information on the operation of the module. The modules are connected in cascade through its bases.

6 modules are used in the laboratory's system, as follows:

- Two analogue input modules: used for measurement of voltage, current, speed of rotation, temperature, light intensity signals
- Analogue output module: Voltage generator for control of linear distance sensor's actuator movement, LED light intensity, DC motor voltage supply or the load of the motor and stepper motor of the web-camera.
- Counter/timer module with count inputs, gates and outputs
- Relay module can switch 24V or 230V
- Resistance Temperature Detection module is used with RTD sensors in LED and motor experiments.

B. Power supply of the system

Internet laboratory requires special design of the power supply system. As the laboratory is being switched on whole working days continuously, a safe and economic solution should be developed. In order to avoid unnecessary powering, a remote controlled central DC power supply is used for the start-up. When a user is connecting to the laboratory, the server computer sends a signal on GPIB bus to the controllable power supply to switch the central relays on and to make main powers connected [5]. Laboratory includes many different sensors and actuators, requiring different power supplies, therefore different AC/DC and DC/DC converters are used as shown on Fig. 2.

Relay system is designed to make connected only necessary powers, so when a user enters for example into the LEDs test, only the FieldPoint and hardware of the LEDs test will be powered. Also the webcam's stepper motor is powered for the time while it is turning to one or other experiment.

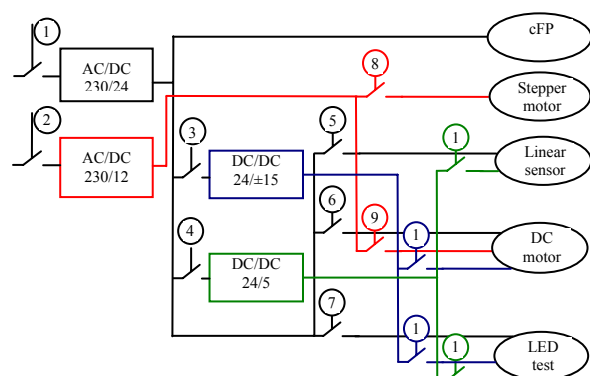


Figure 2. Power supply system of the laboratory

C. User interface for system administrator

The system administrator has permission to control all functions of the connected modules, he/she has

possibility to download control program to the Fieldpoint controller or to change IP address of the controller. The only administrator can change the module functions (for example switch between the voltage or current measurement), change measurement range, or change relay module's settings.

III. MEASUREMENT EXAMPLES WITH THE FIELDPOINT SYSTEM

Interface for the Internet users is developed with strict safety limitations and with dynamic switching possibility between the measurements. The software of FieldPoint contains three measurements:

1. Testing a linear position sensor;
2. Testing a small DC motor;
3. Testing power LEDs.

All the three tests include signals to be controlled by the Internet user through the analogue output and relay modules of the FieldPoint and signals measured by different sensors on the analogue inputs of the FieldPoint. Block diagram (Fig. 3.) shows structure of the system.

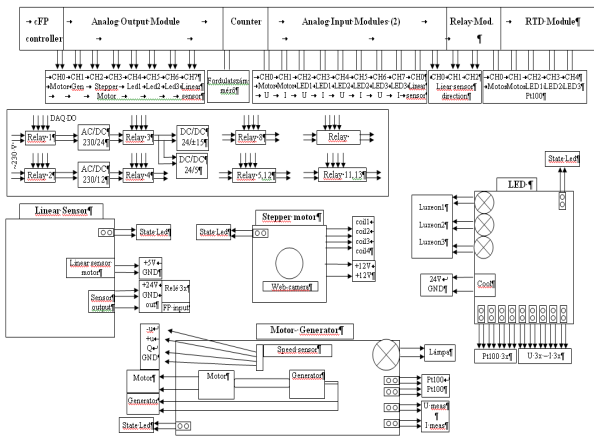


Figure 3. Block diagram of the Internet laboratory

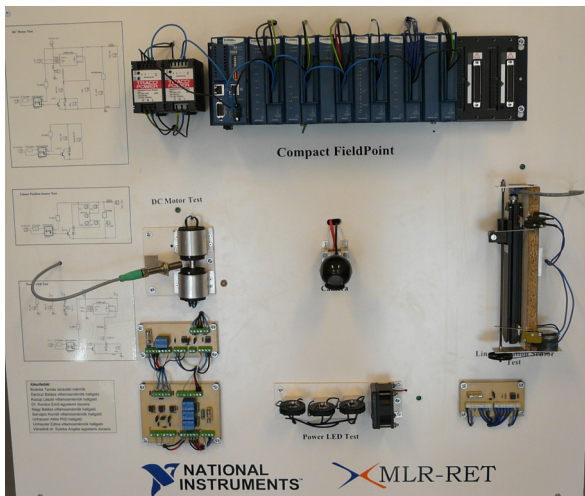


Figure 4. Demonstration board of the laboratory

On the Fig. 4. practical realization of the system is shown. FieldPoint is on the upper side of the demonstration board, the linear sensor test is on the right side, power LEDs test is on the bottom side; motor test is on the left side, and the Web-camera is in the middle to make possible to “see” all the three experiments.

A. Linear position sensor test

Parameters to be controlled:

- Movement direction
- Speed of movement

Parameters to be measured:

- Position of the sensor

The inductive linear position sensor has 100 mm measuring range and it can be positioned with a 3 V DC motor. The motor is controlled by the relay module to both directions and the speed via analogue output of the FieldPoint. The output signal of the sensor is in the range of 4-20 mA, which is measured on the current input of the FP-AI module. According to the actual value of the sensor the relay can be controlled to drive the motor to both or only one direction, because if the sensor reaches one of the end-positions, the motor can be switched on to move the sensor only to the opposite direction. The measurement is visualised through a webcam to make it more attractive for studying (Fig. 5.).

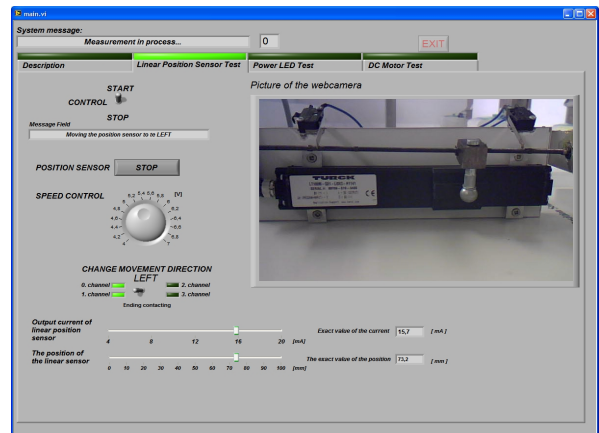


Figure 5. Linear sensor with motor control and user interface of FieldPoint system

B. DC motor test

Parameters to be controlled:

- Voltage level of supply
- Load

Parameters to be measured:

- Supply voltage
- Current of the motor
- Speed of rotation
- Temperature of the motor

Parameters to be calculated:

- Power
- Torque

The DC motor is connected to a similar DC generator for providing controllable load to the motor. Hall-effect transducers are used for current and voltage detection, a Pt100 resistance for temperature detection, and an encoder for revolution detection. Internet user can control supply voltage of the motor and can change load of the motor using the generator. Software provides possibility of characteristics measurement [6][7]. Power excited by the generator is dissipated on a lamp, making the experiment more spectacular for users (Fig. 6.).

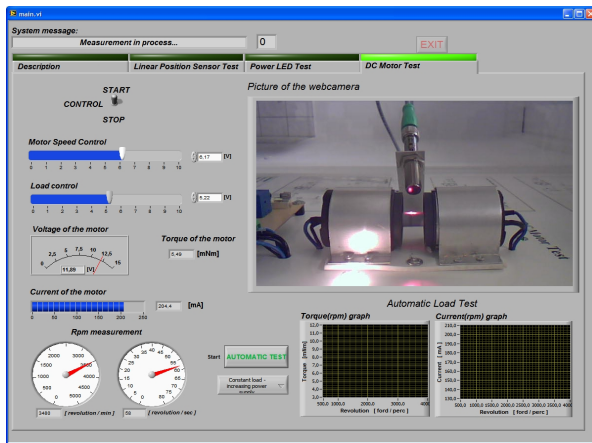


Figure 6. User interface of DC motor test

C. Test of 3 power LEDs

Parameters to be controlled:

- Light intensity of each LEDs individually
- Cooling fan switching on or off

Parameters to be measured:

- Supply voltage of each LEDs
- Current of each LEDs
- Summarised light intensity
- Temperature of each LEDs

Parameters to be calculated:

- Power of each LEDs

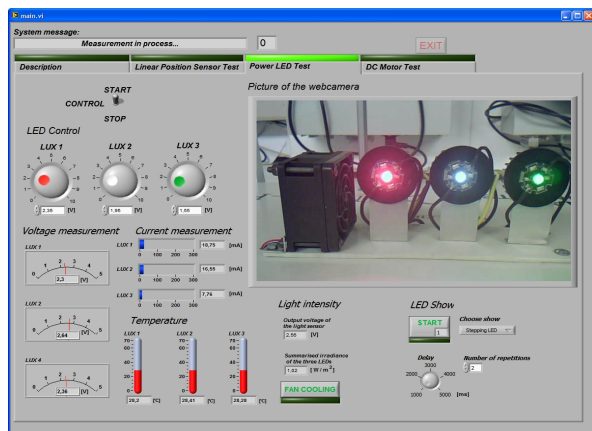


Figure 7. The three power LEDs and the cooling fan from the left side

Test includes 3 power LEDs of different colours: one red, one white and one green (Fig. 7.). Each LED is assembled onto a cooler. On the surface of each cooler a Pt100 RTD is mounted. A cooler fan can be switched on or switched off by the Internet user.

IV. CONCLUSIONS

The virtual laboratory developed at the University of Miskolc is not only an attractive tool of teaching measurement technology for students but also it has a practical importance for industry. In the today's globalised world engineers must often travel from one side of the globe to the other to check a system, to find an error in a system or to get information on the use or operation of a system. In many of these cases several parameters could be measured and/or controlled through the Internet without the need of individual presence. This method provides a cost effective solution for many distance and remote testing problems.

The laboratory can be controlled by one user at a time. After a defined time interval (usually 30 minutes) the server passes the control to the next queuing user. The laboratory operates on working days during teaching semesters of the University of Miskolc from 8.am until 4.pm. It can be tested through the following web site: <http://193.6.7.165/cFP.html>

ACKNOWLEDGEMENT

This publication is supported by European Union and European Social Funds financed project TÁMOP-4.2.1.B-09/1/KONV and by Hungarian National Office of Research and Technology financed Gábor Baross Programme

REFERENCES

- [1] *The Measurement and Automation Catalog* (2002), National Instruments, USA
- [2] Váradiné Sz. A.: *Remote Control of Intelligent Virtual Instrumentation using the Internet*. OGÉT 2005. Szatmárnémeti, Románia, pp.156-159.
- [3] *FieldPoint User Manual* (2002), National Instruments, USA
- [4] Kazup László, Unhauzer Attila, Szkárosi Szabolcs: *Application of Ethernet based industrial communication equipment*, Conference on Knowledge and Innovation, Miskolc, 2007. ISSN 1789-0284, pp 131-137
- [5] Unhauzer Attila, Kazup László, Szkárosi Szabolcs: *Development of GPIB based virtual laboratory* Conference on Knowledge and Innovation, Miskolc, 2007. ISSN 1789-0284, pp 137-147
- [6] Bátorfi R.: *Software solutions for effective and reliable on-line diagnostics*, XXII. microCAD International Scientific Conference, 19-20 March 2009, Miskolc, Hungary, pp 1-5, ISBN 978-963-661-866-9
- [7] Bátorfi R.: *Effect of Information Science Development on Research of Electrical Energetics*, XVII. Számokt – VIII. ENELKO Conference 2007, Romania, 2007 pp. 12-15.