REMOTED PHYSICAL EXPERIMENT DIRECTED VIA INTERNET

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Abstract

The paper presents the first step to the building of a distant experiment, in the framework of remove physical laboratory directed via internet. It deals with the measurements of the basic characteristics of electrical voltage source. The individual parts of arrangement were realized by the ISES kit, that is able to command the measuring procedures and to transform the corresponding values via computer.

Key words

physical experiment, electrical source, electromotive force, applied voltage, internal resistance, ISES kit, remote laboratory, internet

Introduction

Remote real laboratory is a modern device of current cognition, representing a new strategy of current e-learning [2]. Therefore, there exists a growing application of it in education, including the teaching process at the universities, too.

Also our department participates in the preparation of remote experiments – in the framework of international cooperation. Department of Physics IMS has prepared the experiment *Measurements of the Characteristics of DC-Voltage Source*. Essential part of related works, that is describing the operation of this task by means of the local computer, has been described in the article [1]. Here we are presenting the current state of the problem over all the world and giving a more detailed description of the experimental set ISES (International School Education System [3]); this appliance is forming the basis of the operating of all Czech and Slovak remove tasks (see, for example [4] or [5]), including our

one. We have described this experiment in local control with the connection of a competent computer situated in a laboratory room.

Since that time we have made the further progress. The complete device had been connected to the internet network so that users can remotely control the experiment. In this article we describe the principle of operation of such device when operating over the internet.

Performance of ISES KIT

ISES is an open system working under Windows operating system with all its advantages (multitasking and OLE - Object Linking and Embedding). The system is composed of an interface card, a set of variable modules and sensing elements, and a service graphical and evaluation software. The computer interface card, with the inputs and outputs and plug-in slots for modules, provides an easy way of interfacing to virtually any PC compatible computer. The card is the 12-bit analog-digital digital-analog, sample and hold with a maximum sampling frequency of 100 kHz. The ISES modules are easily interchangeable, their presence and adjusted range is automatically sensed by the computer, with the automatic calibration. The system is equipped with modules as e.g.: voltage ($\pm$ 5 mV$\div$ 10 V), current ($\pm$ 0.5 mA$\div$1A), resistance, capacitance, temperature (-20 °C $\div$ +120 °C), microphone, deviation sensing unit, adjustable preamplifier, light stop, current booster, relay switch, pressure meter and many others. The service program enables the simultaneous measurement of 10 different channels (8 analog and 2 binary) and to use 4 output channels. All these modules are fully programmable, using the programming panel. The data are depicted both in analog or digital form on variable number of panels, with depicted quantities either those measured by modules or their combinations (addition, subtraction, product, quotient etc.). The software provides data processing (integration, differentiation, fitting, approximation etc.) [6].

The main requirement was the compiling of the control program by the arbitrary user on the copy-paste principle of the prefabricated building blocks with only very limited knowledge of the rules of web pages creation using suitable editor at hand. This software kit, transforming the computer controlling the experiment to the web server, is ISES WEB Control consisting of:

1. Ready made packages for automatic creation of the sub servers (Image Server, Measure Server, HTTP Relay Server),
2. The prefabricated programs segments for the client web pages creation (view of the experiment, experiment controls, graphs, data digital displays and others),
3. The prefabricated Java applets for the transfer of image and data [7].
   The working principles of the RE are then based on the server computer with the ISES measuring system, with built in Image Server, Measure Server and HTTP Relay Server. Server generates web pages with built in Java applets controlling the experiment and data transfer and sends them to the client computer. On the client computer the web pages are then created comprising:
   - Control keys and bars for the control of outputs,
   - Applets for measuring and digital displaying of input values,
   - Applets for graphic displaying of input values,
   - Applets for the transmission of measured values into the client computer,
   - Applets for the image transmission from a WEB,
   - Applets for the image transmission from a WEB camera, etc. [8].

Measuring procedures

The web address of the task is *http://remotelab.mtf.stuba.sk:83/ises*. The installation of the compilation language Java is necessary for user for correct compatibility of the computer with experiment (as it is warned in the title-page). Web page is presented in two languages – Slovak and English. Now we are dealing with English mutation.

After clicking on the address, the following sub-page will appear (Fig. 1):
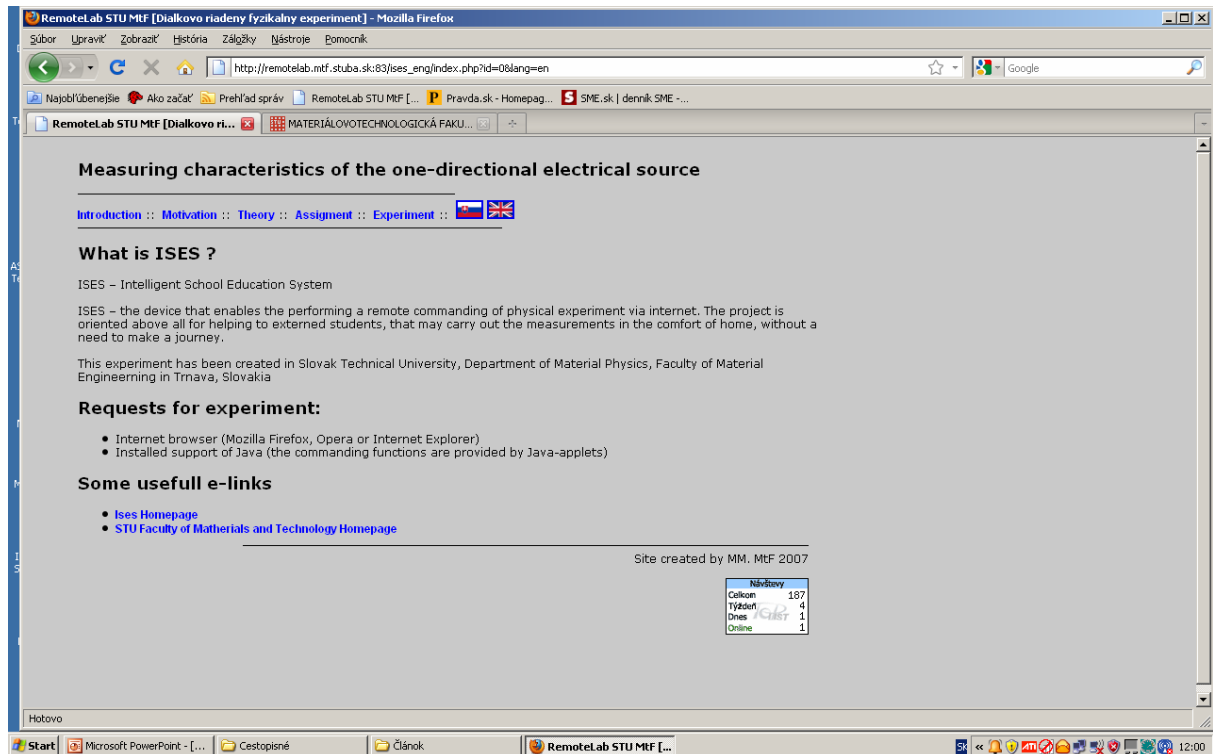

Fig. 1 *The title-page*

This window is also identical with the sub-page *Introduction.*

We shall not deal with the site of *Theory* at this time, because of it has been described in detail in the article [1]. The following items *Motivation* and *Assignment* have the forms been imaged in the next site on Fig. 2 and 3:
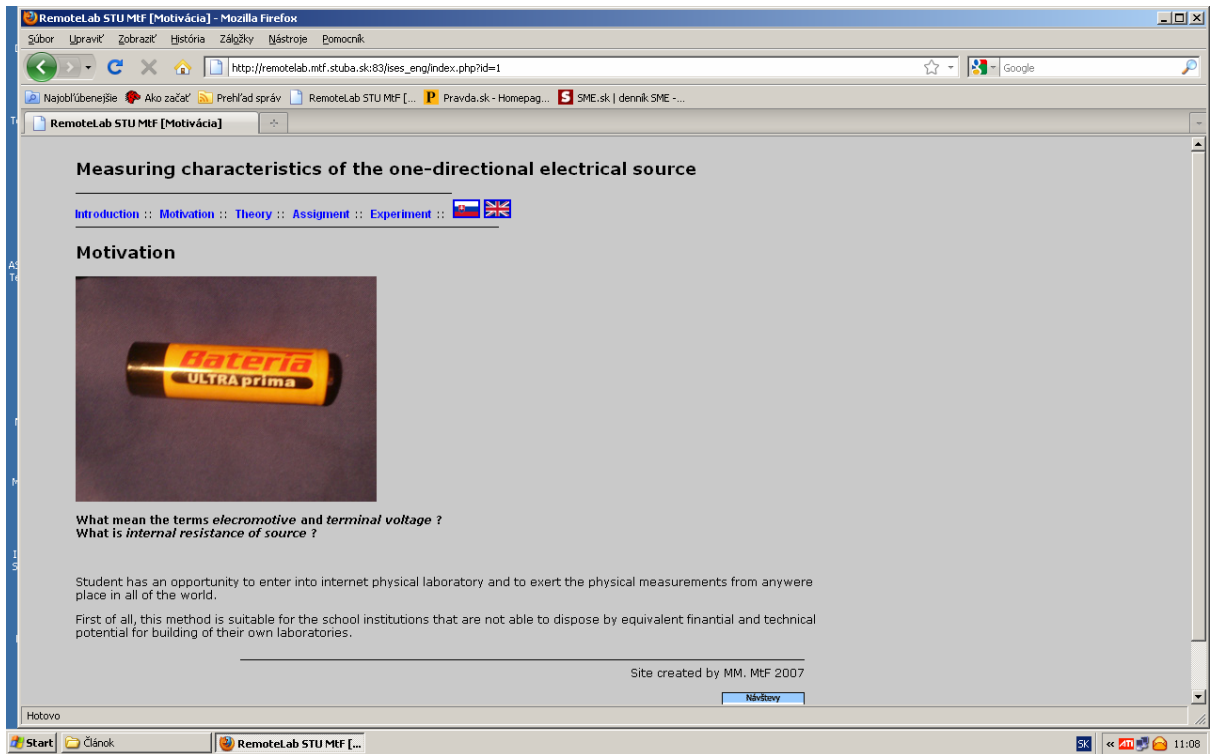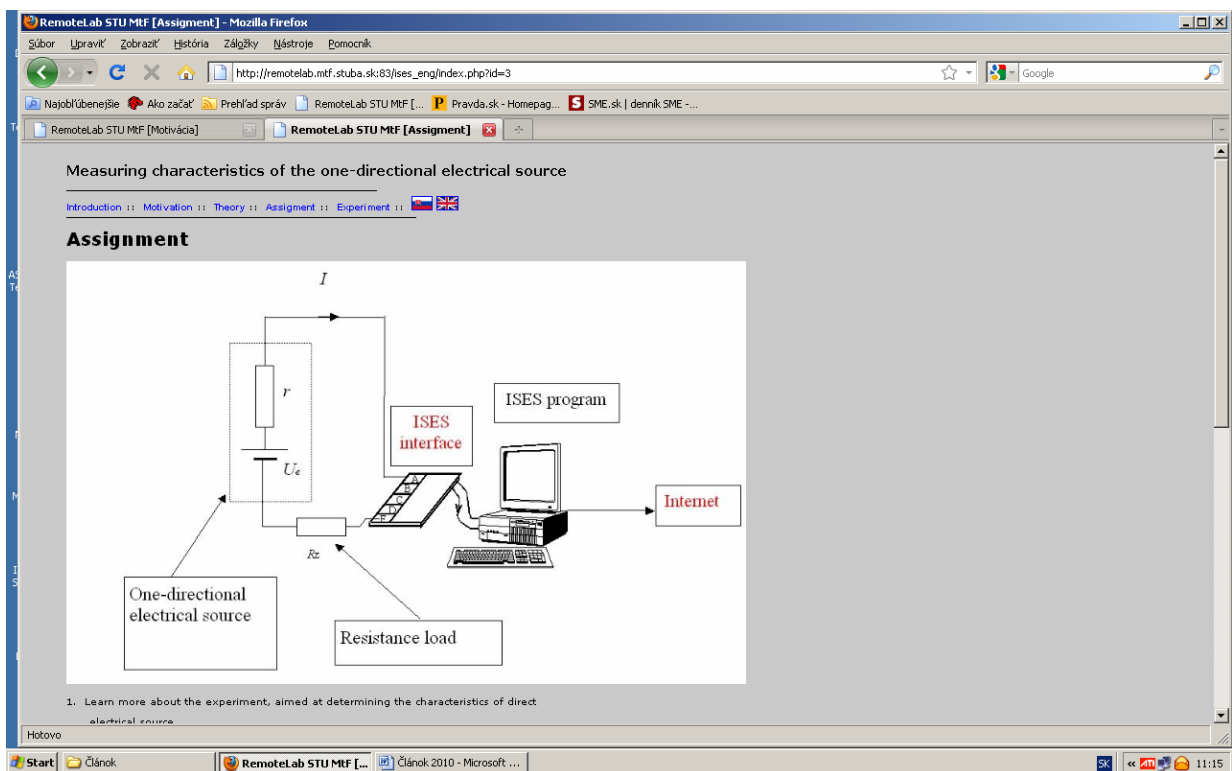
Fig. 2 The page **Motivation**

Fig. 3 The page **Assignment**

The page *Assignment* also offers guidance on the measurement procedure:

1. Learn more about the experiment, aimed at determining the characteristics of DC- electrical source.
2. Perform the measurements of electromotive and terminal voltage of source with various resistive sizes of load resistance R_z.
3. Using the measured values of ε, U_s, R_z and I determine - on the basis of the relationship (3) - the value of internal resistance r of the source for each measurement, with following determining the arithmetic average.
4. Draw the graphical records of terminal voltage and current in the circuit on the load resistance. Identify the approximate value of the internal resistance of the source from the current dependence.
5. Discuss the size of power and efficiency of the source on the size of a resistive load.
6. Draw up a paper with the following points:
   a) Physical introduction.
   b) Description of the experiment and layout.
   c) Measuring procedure.
   d) Table of measured values of ε, U_s, I and R_z with the relevant calculation of the resistance r, including the arithmetic average.
   e) Graphical dependences: - terminal voltage U_s as a function of load resistance R_z,
   - current in the circuit I as a function of load resistance R_z, with the extrapolation estimate of r,
   - power P_e as a function of load resistance R_z,
   - efficiency η as a function of load resistance R_z.

The actual process of measurement can be made through site *Experiment*. When you click on it, the next sub-page will appear as in Fig. 4 (hand-commende regime) or in Fig. 5 (automatic regime).
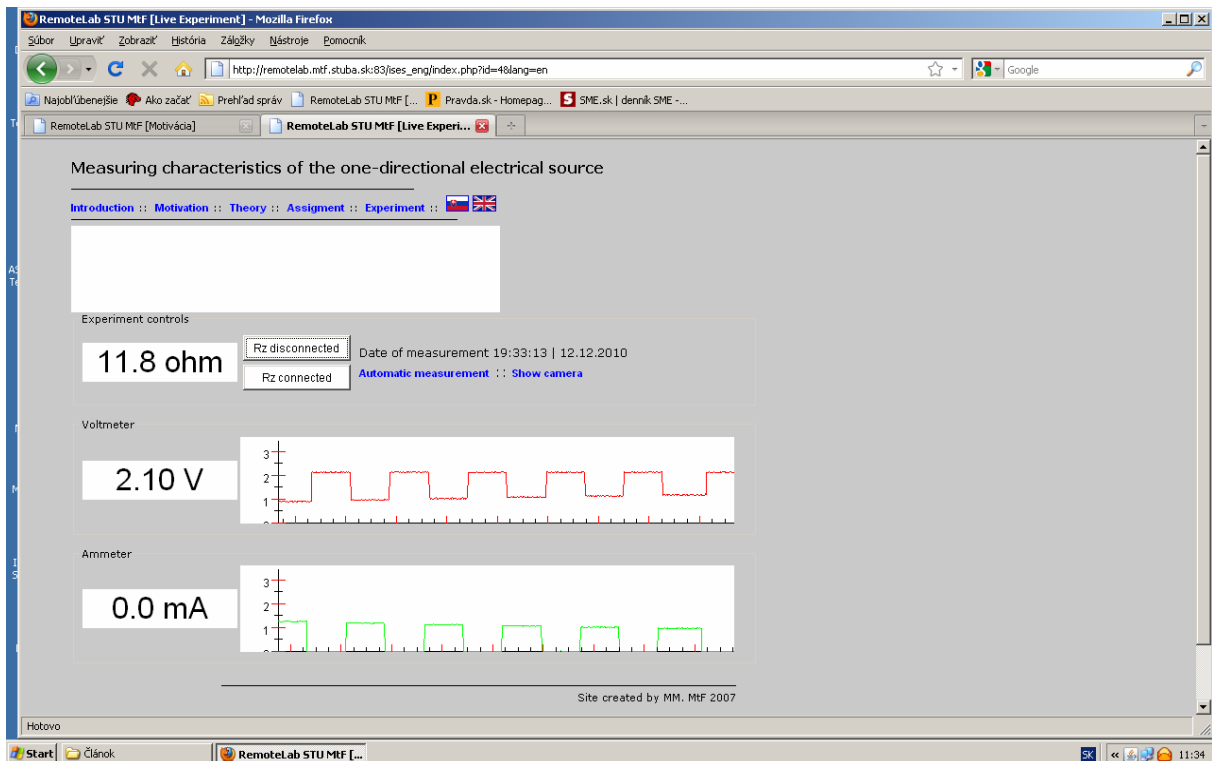

Fig. 4 *The page of the experimental dependencies, resulting from the hand-commanded changes of load resistance, realized by the clickings on the vessels Manual Measurements, and subsequently, on „R_z connected" and „R_z disconnected"*
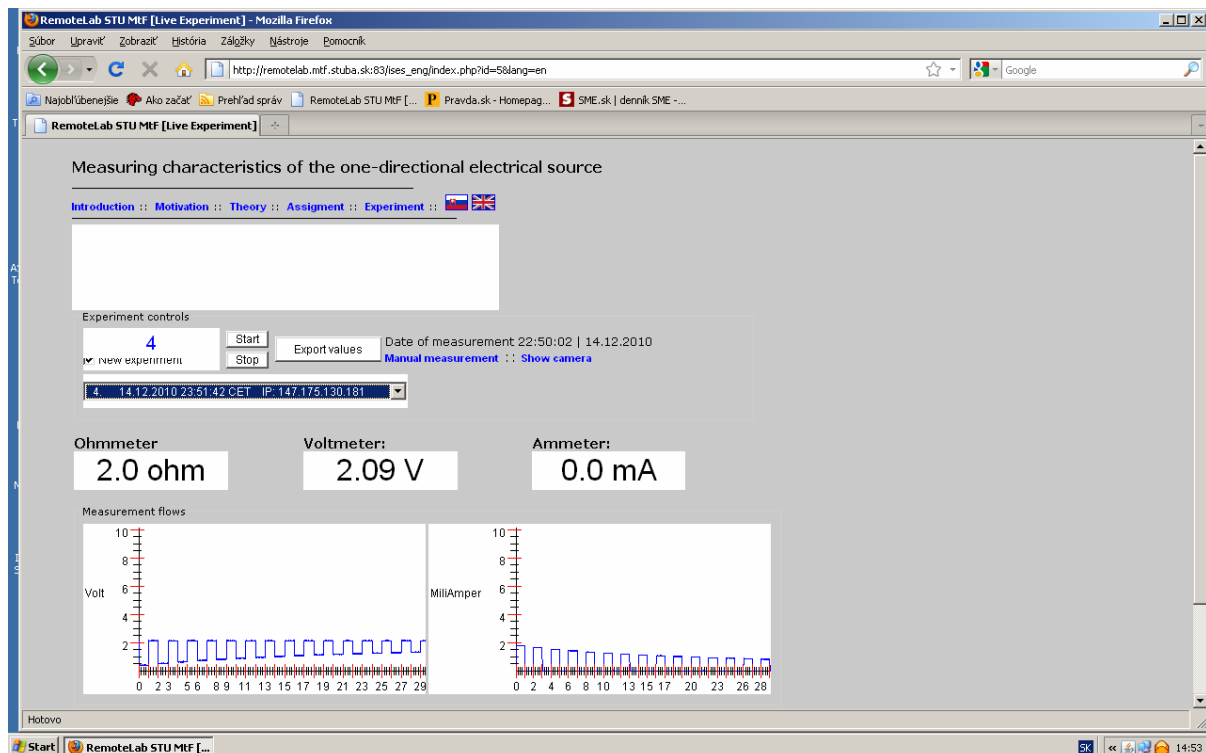
Fig. 5 *The page of automatical step regime of performance, when the load resistance is changed by clicking on the vessel „Automatic measurement"*

As we can see from both of pictures, numeric values of quantities being measured are imaged in the little windows of Voltmeter, Ammeter and Ohmmeter. The time courses show the expected fact, that the applied voltage increases with increasing size of the load resistance, and that the current, in turn, decreases. From the measured values, we found the size of the internal resistance to be equal 10 Ω.

The clicking on the vessel *Export of values* can also display numerical readings. It remains a task for students to calculate an internal resistance of source, and to plot the dependences of the performance of consumer and the efficiency of source to the size of the load resistor.

Conclusions

The experiment being presented above belongs to the file of Czech and Slovak tasks, which set is constantly replenished. The filling of this task can be applied in teaching on physics lectures concerned with the topics on power supplies, as so as in the labs. It is suitable, too, as a filling work for physical collectives in secondary schools.

Remote real laboratories and multimedia-based teaching programs are helpful in conveying subject matter to students. The use of computers with laboratory interfaces allows real-time recording and graphing of physical quantities. They offer students a chance to take control over their learning and develop their skills at a self-determined rate.

References:

[1] KVETAN, K., RIEDLMAJER, R., MIZERA, M. Physical Control of Experiment by Using the Internet School Experimental System – ISES. In *Materials Science and Technology* [online]. 4/ 2010. pp. 22 –30. Dostupné na internete http://www.mtf.stuba.sk/generate_page.php?page_id=2450. ISSN 1335-9053

[2] WIEMAN, C., PERKIN, K. Transforming Physics Education. In *Physics Today*, 2005, Vol. 58, pp. 26 – 41.

[3] LUSTIG, F., DVOŘÁK, J. *ISES WEB Control, Software Kit for Simple Creation of Remote Experiments for ISES Teaching Tool Co.* PC-IN/OUT, (U Druhé Baterie 29, 162 00 Prague 6, Czech Republic)

[4] SCHAUER, F., KUŘITKA, I., LUSTIG, F. Creative Laboratory Experiments for Basic Physics Using Computer Data Collection and Evaluation Exemplified on the ISES system. In *Innovation 2006, World Innovations in Engineering Education and Research.* USA, iNEER Special Volume 2006, Virginia, U.S.A., pp. 305-312. ISBN 0-9741252-5-3

[5] OŽVOLDOVÁ, M., ČERŇANSKÝ, P., SCHAUER, F., LUSTIG, F. Internet Remote Physics Experiments in a Student Laboratory. In *Innovation 2006, World Innovations in Engineering Education and Research.* USA, iNEER Special Volume 2006, Virginia, U.S.A., pp. 297-305. ISBN 0-9741252-5-3

[6] SCHAUER, F., OŽVOLDOVÁ, M., LUSTIG, F. Real Remote Physics Experiments across Internet – Inherent Part of Integrated E- Learning. In *iJOE – International Journal of Online Engineering*, 2008, Vol. 4, No 2, pp. 52-55.

[7] OŽVOLDOVÁ, M., SCHAUER, F., LUSTIG, F., DEKAR, M. Real Remote Mass-Spring Laboratory Experiments across Internet-Inherent Part of E-Learning of Oscillations. In *iJOE – International journal of online engineering*, 2008, Vol 4, No 1.

[8] OŽVOLDOVÁ, M., SCHAUER, F., LUSTIG, F. Real Interactive Physics Experiments with Data Collection and Transfer Across Internet. In *MPTL12 -12th International Conference on Multimedia in Physics Teaching and Learning.* Institute of Experimental Physics University of Wrocław, 2007. Electronic Proceedings, http://mptl12.ifd.uni.wroc.pl/proceedings.html, Editor Ewa Debowska, http://mptl12.ifd.uni.wroc.pl/papers/15.pdf, 7 pp.