

EASY TO USE REMOTE EXPERIMENTS WITHOUT LABORATORY SYSTEMS

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Abstract

Remote experiments during natural science education start to actively take part in e-learning, thus helping transform it into a new integrated e-learning. They are most often performed using universal measurement systems (ISES, LabVIEW etc.). However, trying to start with remote experiments using these systems is prudent just for those teachers, who already have such systems in their possession and do not need to acquire them just to start with the remote experiments. Our contribution aims to demonstrate remote experiments using simple and readily available resources (standard laboratory equipment, multimeters etc.) and the RS232C or USB interface. The next demonstration will show an experiment, where we will measure temperature, humidity, noise level and illuminance using merely a commercial environmental multimeter without any of the above –mentioned measuring systems. And at last we will demonstrate a remote experiment, again without the measuring systems, performing the Franck-Hertz experiment on the Phywe set. It is possible to connect this highly specialized and financially demanding experiment to the internet using just the ISES WEB Control as a remote experiment, accessible online by anyone from anywhere. The main component of these remote experiments using just the usual equipment and measuring tools and the RS232C interface is our universal ISES WEB Control software kit.

Keywords

Remote experiment, ISES laboratory system, ISES WEB Control software kit, RS232C, USB.

Introduction

Remote experiments first appeared around 10 years ago as initial attempts to unconventionally use the internet, some of them were [ISES], [SCHAUER at al.], [LILA PROJECT], [Remote experiments portal], [GRUBER at al.] and others. Those pioneers employed the blinking LED diodes, railroad models, simple robots etc. Each of those remote experiments was an original.

Remote experiments with measurement systems

At the time the ISES measurement system kit (created in 1985) has already been relatively widely used for the classic local experiments using the computer, just like other systems (LabVIEW, Phywe etc.) e.g. [MA, NICKERSON], [GOME]. In 2002, ISES, as one of the first measuring systems to do so, came up with the ISES WEB Control special software kit [LUSTIG, DVOŘÁK], which enabled even non-programmers to construct even complex experiment controls on a HTML page just by combining applets. This made it possible to not only measure but also to control the experiment and to export the measured data etc. Samples of those remote experiments can be found at <http://www.ises.info> or <http://www.eEdu.eu> where MFF-UK Praha, UTB Zlín, PedF Trnava, UKF Nitra, PšF Olomouc, PedF Brno etc. have combined their experiments, which used the ISES system as the basis. (Note: These remote experiments are of the “Control” type, they enable you to DIRECT and CONTROL

the experiments. Only the ISES and LabVIEW systems can be used to perform them, as, aside from input, they have both analogue and digital output from controls. Measuring systems such as Vernier or Pasco have only measurement input and do not support remote experiments).

Creating remote experiments using the ISES and ISES Web Control is easy even for non-programmers, but it always requires that the whole ISES system [SCHAUER at al.] be available.

Remote experiments without measurement systems

This time we shall demonstrate, which need no universal measurement systems (ISES, LabVIEW etc.), merely the standard laboratory equipment multimeters, stepper motors or environmental measurement devices etc. What these devices have in common are the RS232C or USB-COM interfaces. Many pieces of laboratory equipment (on pic. 1 are multimeter UT61E (for cca 2.000,- Kč), environmental multimeter DT2232 (for cca 1.000,- Kč), laboratory voltage source SPS12010 (source of 0-20V/10A, for cca 6.000,- Kč). To create this remote experiment you need only the mentioned devices and the ISES Web Control software kit with the correct plug-ins (for cca 3.000,- Kč). (Note 1: The prices mentioned here are so that you can picture how cheap it is to create a set of remote experiments using just the standard laboratory equipment. Note 2: It is possible to use any other pieces of laboratory equipment, provided it has the RS232C).



Fig. 1: Laboratory equipment – for example UT61E multimeter, SPS12010 laboratory voltage source, DT2232 environmental multimeter (all equipped with the RS232C interface) – convenient for creating remote experiments.

1. Electrotechnical measurement remote experiments using standard laboratory equipment

We shall describe the creation of a particular remote experiment, for example measuring the VA characteristic of a LED diode. For this experiment we require a controlled voltage source (for example 0 V to 5 V), we shall use the SPS12010 laboratory source, then we will have to measure the electric current flowing through the diode and the voltage on the diode. For this we shall use two pieces of the UT61E multimeter. The core of the didactic experiment is the LED diode itself. The aim of the experiment is to measure the VA characteristic of the LED diode. How to set up the experiment and the devices is surely clear. The measuring devices will be connected to a computer using the RS232C cable or the USB-RS232C adapter

Now we shall transform this local experiment into a remote experiment. To do this we need components of the ISES Web Control software kit. We will choose applets (buttons and a scroll bar to control the SPS12010 laboratory voltage source), numeral and XY graphical display of measured values of voltage and current on the diode. Then we will add applets for

choice of measurements and exporting the measured values. We put this all into an empty HTML page like a puzzle, without the need of understanding the HTML code, it is richly equipped with commentaries and the user makes mostly graphical and aesthetic modifications. This way we created the main control WWW page for the experiment.

Now we need to activate all the required server components of the ISES Web Control software kit on the side of the server with the experiment. It requires a WWW server (we use for example Nginx.exe), then further we need a special measurement server (MeasureServer.exe with components needed for particular laboratory devices) and further it would be prudent to have a webcam to observe the experiment online, to do this, we run Videoserver.exe. This way the experiment is running on the server side.

On the client side it is up to us to connect to the address of the remote experiment (you can try <http://kdt-19.karlov.mff.cuni.cz>) anytime from anywhere. How does one connect to a remote experiment? It has been described many times, so we shall do it telegraphically here. To connect to a remote experiment, you require an internet browser like Internet Explorer, Firefox, Opera etc. Further you need to have Java installed on your computer, preferably the latest version. (Note: There have been several Java upgrades last year, so it is prudent to install the latest (freely available from www.java.com). Enter the address of the remote experiment into the address bar – for example <http://kdt-19.karlov.mff.cuni.cz> and wait for the experiment to run. Not all of the applets may load at the same time, so a refresh of the page (F5) may be needed, perhaps even several times, until all the applets have loaded (grey buttons will change into active buttons). After the latest Java update a message may appear asking, whether we wish to activate the applets. Confirm the activation. All the applets required for the experiments should become active. Now we can work with a scrollbar and change the voltage between 0 V and 5 V. This way we can delineate the entire VA characteristic. If we wish to measure the entire VA characteristic automatically, we just need to press the Start-Auto button. If we are going to export the data, we need to press Start record, perform the experiment and press Stop record. Then by pressing the Export values button we generate a new HTML page displaying the measured values. Then by employing the copy and paste maneuver we move the data to the desired processing software (Word, Excel etc.), the measured values are in an ASCII format and so it is possible to import them into any known software. We can then leave the experiment by closing the internet browser used.

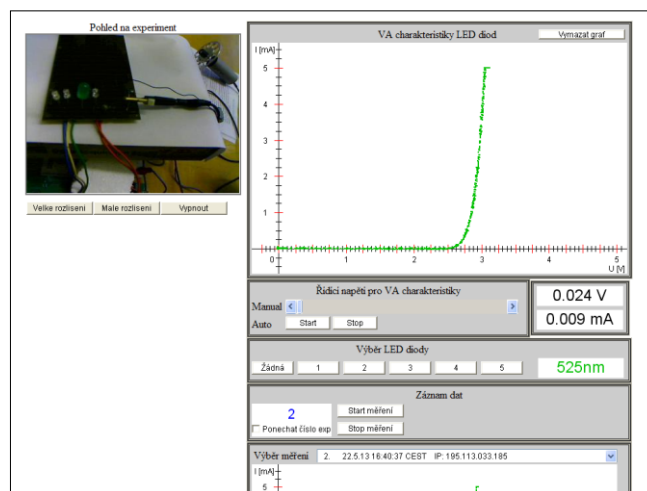


Fig. 2: Example of the graphic interface of the LED diode VA characteristic remote experiment. (<http://kdt-19.karlov.mff.cuni.cz>), instrumentalization: 1x power supply SPS12010, 2x multimeter UT61E.

2. Remote experiments using the environmental multimeter

The DT2232 Multimeter is not so well known, unassuming and cheap, however, it is a very remarkable multimeter used to measure temperature, humidity, noise level and illuminance. It is equipped with the usual RS232C interface for connecting to a computer. We have prepared a special plug-in for our ISES Web Control software kit for this device. With this plug-in this standard device becomes a remote instrument for both long- and short-term, either graphical or digital recording of temperature, humidity, noise and illuminance levels. Data is persistently stored and available for viewing or exportation of the chosen period of time. Picture 3 shows us an example of the graphic interface of a long-term recording of outdoor illuminance levels.

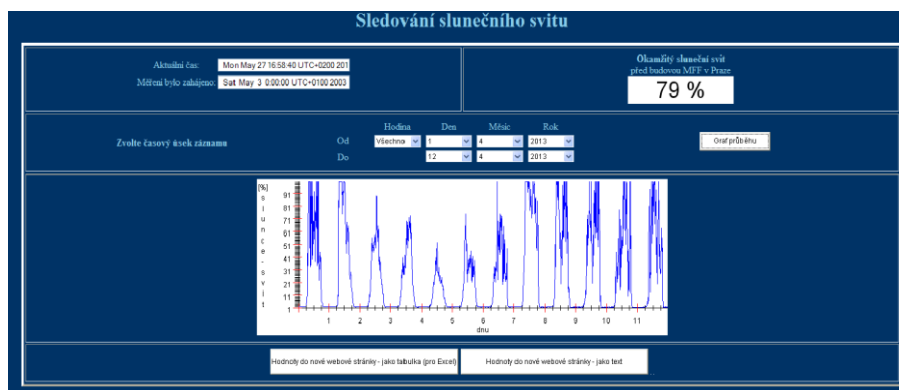


Fig. 3: Example of the graphic interface of the remote experiment using the DT2232 Multimeter to monitor sunlight/illuminance (partially at <http://kdt-16.karlov.mff.cuni.cz>), instrumentalization: 1x DT2232

Monitoring noise levels is yet another attractive experiment. You can measure noise levels in your street during the day and at night or measure noise levels inside the classroom etc.

In closing regarding the very remarkable commercial DT2232 device, which is capable of measuring the current levels of temperature, humidity, noise and illuminance, we would like to emphasize that just by utilizing the ISES Web Control software, this device becomes a remote measurement station for all these properties. It is possible to both view and download the recorded data via the WWW.

3. Remote experiments using the Franck-Hertz apparatus

The Franck-Hertz experiment didactic aid (the Phywe version can be found in many schools) is present in perhaps every university practice. It is a precise experiment, demonstrating the turning point between classic and quantum physics. The apparatus itself is very expensive (cca 150.000,- Kč), however, it is directly active only for a few minutes per practice. The controls involve only pushing the START button. The output is a data file, which is then examined using a computer. The students usually are not involved in the setup of the experiment, because the experiment is usually already prepared. This experiment is connected to the computer using the RS232C interface. We took this as a challenge and prepared a remote version of this experiment. Again we utilized the ISES Web Control software kit and added the plug-in for the Franck-Hertz apparatus. On picture 4 you can find the graphic interface for the Franck-Hertz experiment. You can connect to this interface using a web browser like Internet Explorer, Firefox or Opera etc. Here the experiment will also begin by pressing the START button. The experiment will run and the recorded data will be downloaded for further processing. A webcam aimed directly at the gas-filled tube will

provide us with a macroview of the neon layers. This way gives the user data in higher quality than just observing with the naked eye. This experiment shall demonstrate that there is little to no difference between the traditional and remote approaches – in both cases a computer will record the data! However, a remote experiment is accessible to anyone, anywhere, anytime.

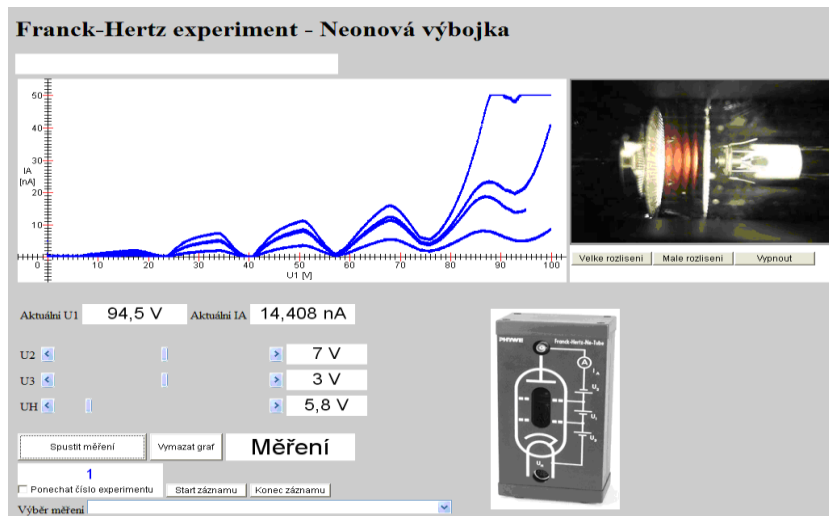


Fig. 4: Example of the graphic interface for the Franck-Hertz remote experiment using the Phywe apparatus (temporarily at <http://kdt-33.karlov.mff.cuni.cz>).

Conclusion

The aim of developing the interface for remote experiments utilizing standard laboratory equipment was to make creation of remote experiments more accessible even to users who do not have any universal measurement system available and still wish to begin with remote experiments. Of course, those wishing to create more complex remote experiments sets will probably try using the ISES system, which nowadays offers probably the highest number of options for control. ISES is equipped with 8 analogue inputs, 2 analogue outputs, 16 relays, 16 digital inputs/outputs and a multi-camera recording system. Furthermore, ISES/ISES Web Control is capable of remotely controlling 4 stepper motors with either rotary or linear motion, laboratory sources 0 to 40 V/0 to 20 A etc. New components are easy to add to the ISES Web Control simply in the form of new plug-ins.

Further details about the ISES system can be found at www.ises.info, for a list of non-stop running experiments visit <http://www.ises.info/index.php/cs/laboratory>, or for an overview visit <http://www.eEdu.eu>. To learn more about integrated e-learning or new trends in remote, virtual and traditional laboratories we recommend following publications: [SCHAUER at al.] and [LUSTIG].

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