Remote Access Laboratory in Physics - “Enlightening the Light”

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Abstract— **We developed a Remote Access Laboratory on Physics for middle school pupils. The selected area was optics and the question addressed was: how colours shown by objects are influenced by incident light? Our objects were a red apple, a lemon and two billiards balls (one black and another white). We directed to the objects three lamps, each one with a filter of a primary colour (red, green and blue). These lamps could be, at a distance, individually or simultaneously switched on.**

Index Terms— **Distance learning, Physics, Remote Access Laboratory.**

I. Introduction

During the last decade, computer networks have increased tremendously, allowing pedagogical methodologies like Electronic-learning or Distance learning [1]. Even in presential learning, the use of information and communication technologies has been encouraged. It is now common to find simulations, virtual laboratories, computer games, etc., which are used by schools.

We will describe the hardware of a remote laboratory developed by us, named “Enlightening the light”. This laboratory allows pupils to access an optics experiment around the clock, avoiding therefore some limitations of a traditional laboratory [2-4]. The only requirement is a computer with a broad band connection and the active X control “LabVIEW run time engine”. We also created several support materials which allow a pedagogically adequate use of our laboratory.

II. The Remote Access Laboratory

Our remote laboratory may be found at:

http://nautilus.fis.uc.pt/cec/lar/sara

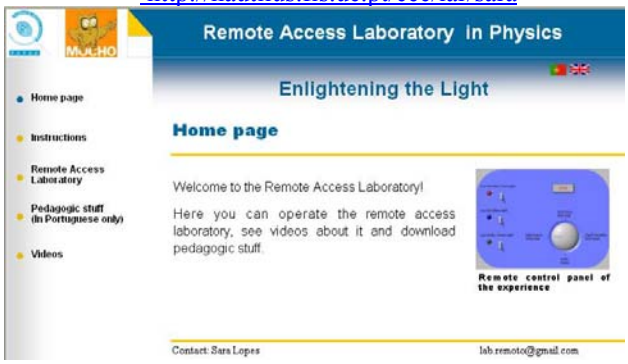

Figure 1. Initial webpage of our remote laboratory

This site contains instructions, a link to the remote laboratory, some educational materials (only in Portuguese, for the time being), and two videos: one showing the physical laboratory and the other teaching how to manipulate the laboratory.

The chosen area is taught in the Portuguese educational system to pupils in middle schools (8th year) so the pupils are around 13 years old. With this laboratory they can study the influence of different radiations in four different objects. Under white radiation they appear to be white (white ball), black (black ball), red (red apple) and yellow (lemon). All these objects are placed in a disc that rotates due to a step motor.

For illuminating the objects we used three halogen lamps, each one with a primary light colour filter. Therefore, one lamp emits red radiation, the second blue radiation and the third green radiation. All the lamps are controlled independently so that they may be switched on in various ways.

III. Construction and Materials

A. Laboratory schematic

We can define a remote access laboratory as an experiment which is implemented in a traditional laboratory but can be accessed and manipulated remotely from anywhere. This is only possible if the laboratory may be controlled by a computer. To create our remote laboratory we need to control remotely the three lamps and the step motor.

To implement the control and communication between the computer, lamps and step motor, we used a control board. This is connected to computer by a RS232 interface and has the capability to control a step motor and three controllable outputs.

To broadcast the video images over the Internet we used a high sensitive webcam connected to a computer. Fig. 2 shows the block diagram used to create our remote laboratory.

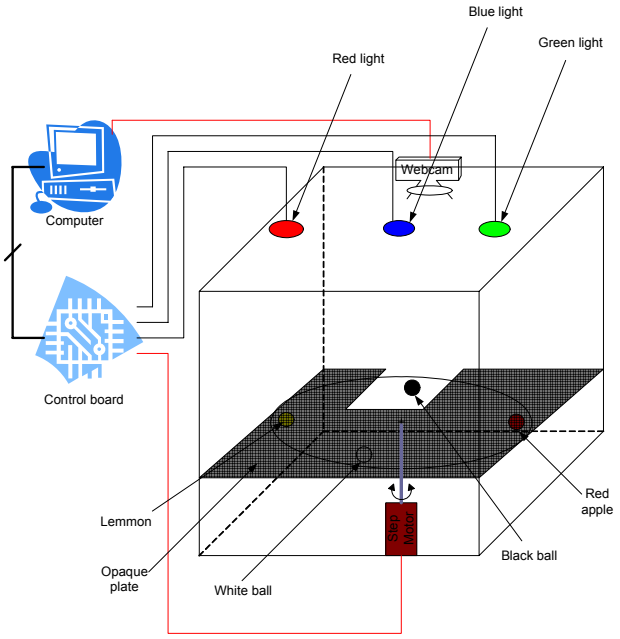

Figure 2. Diagram of the experimental set-up.

The four objects are placed in a disc that rotates by action of the step motor. Over that disc there is an opaque plate with a hole so that only the object below the hole is visible. The user can select the object and the light or lights which are switched on.

The remote front panel of this laboratory is a user friendly interface. When the controls are actuated they send signals from the computer to the control board. Those signals tell to the board the operation which should be done. The instructions can be: move the step motor to a specific position (making visible the selected object) or switch this or that light.

To avoid external light, all components must be placed in a black box

B. Used technologies

To control and manipulate the laboratory we used LabVIEW [5-6]. This software allows to create a remote front panel with a simple interface. This software also allows the interaction with board and creating a webpage with the front panel imbedded.

The block diagram, created with LabVIEW is shown in Fig.3.

The blocks located at left of block diagram are used to initialize the communications between the board and the computer. Inside the *while cycle*, there are the commands to control the lights (blocks in the bottom of the *while cycle*) and the step motor (blocks in the top of the *while cycle*). Inside the cycle there is a time delay to avoid the data overflow sent to board, which may cause strange board operations.

With LabVIEW we also created a webpage with the front panel.

All remote laboratories need to have real time images of the experiment being performed. To broadcast the results, a Java applet was imbedded in the webpage created with LabVIEW.

We used a USB webcam to acquire real time images of the experiment and a low-cost imaging software to imbed the webcam images in the web page.

C. Look of the remote laboratory

One essential requirement of our remote laboratory was that the whole experiment takes place inside a black box, where no external light enters. So, we constructed such a box to place all components (Fig.4).

The screen look of the experiment is quite simple (Fig. 5).

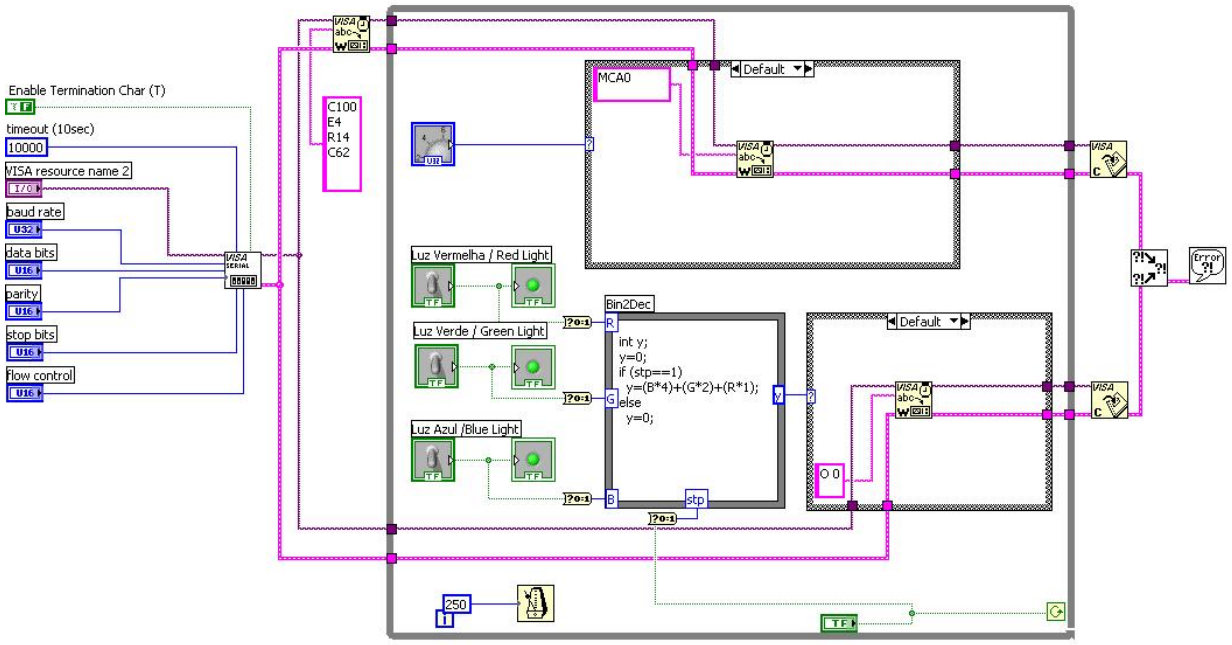

Figure 3. LabVIEW Block Diagram

Figure 4. Experimental set-up.

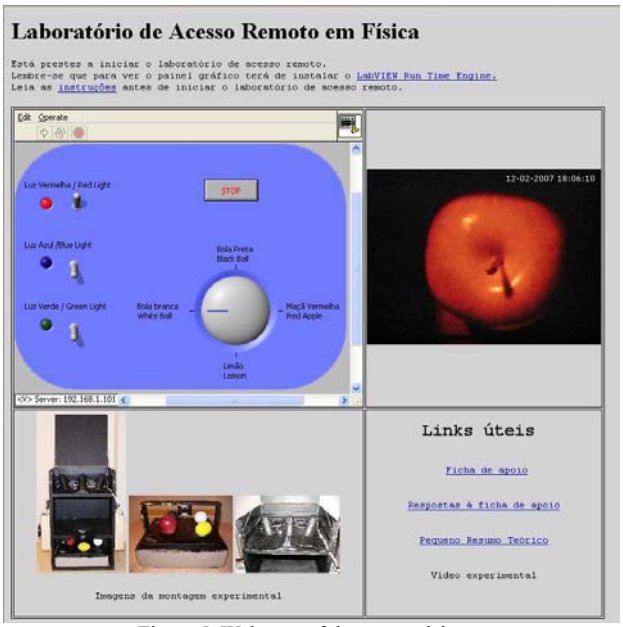

Figure 5. Webpage of the remote laboratory

IV. Conclusions

The main advantage of the remote access laboratories is that they can be used 24 hours a day, 365 days a year. The users of this kind of laboratory only need to have a broad band Internet connection.

There are many remote access laboratories in different areas of knowledge, but most of them are based on knowledge at university level. We aimed that young people observe and arrive at their own conclusions.

Our remote laboratory is not supposed to substitute the traditional laboratory but to complement it. It is an additional pedagogical resource.

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References

[1] Hua, J., Ganz, A. (2003) Web enabled remote laboratory (R-LAB) framework. 33rd ASEE/IEEE Frontiers in Education. Boulder, USA.

[2] Leleve, A., Benmohamed, H., Prevot, P., and Meyer, C. Remote laboratory towards an integrated training system. http://www.ictt.insa-lyon.fr/leleve/Documents/2003/ithet03.pdf#search=%22%22remote%20laboratory%20towards%20an%20integrated%20training%20system%22%22 last access 21/09/2006

[3] Bencomo, S. D. (2004).Control learning: present and future. Annual Reviews in Control, 28, 115-136.

[4] Alhalabi, B., Marcovitz, D., Hamza, K., and Petrie, M. (2000). Remote labs: an innovative leap in the Word of distance education. SCI 2000 / ISAS 2000. Orlando, USA.

[5] Distance-learning Remote Laboratories using LabVIEW. National Instruments. Download from: http://zone.ni.com/devzone/cda/tut/p/id/3301 last access in 26/10/2006

[6] Distance learning solutions guide. National Instruments. Download from: http://www.ni.com/pdf/academic/us/distance_learning.pdf last access 26/10/2006

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