Physics Experiments at the UNEDLabs Portal

http://dx.doi.org/10.3991/ijoe.v8iS1.1945

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***Abstract*—UNEDLabs is a web portal based on a free, modern, open source, and well-known learning management system: Moodle. This portal joins two theme networks of virtual and remote laboratories (one for Control Engineering and another one for Physics, named AutomatL@bs and FisL@bs, respectively) together. AutomatL@bs has been operative for five years now. Following AutomatL@bs' scheme, FisL@bs was created as a network of remote and virtual laboratories for physics university education via the Internet to offer students the possibility of performing hands-on experiences in different fields of physics in two ways: simulation and real remote operation. Now, both FisL@bs and AutomatL@bs join together (while maintaining their independency) into an unique new web portal called UNEDLabs. This work focuses on this new web environment and gives a detailed account of a novel way in Physics to let distance learning students gain practical experience autonomously. This paper explains how the new portal works and the software tools used for creating it. In addition, it also describes the physics experiments which are already operative.**

***Index Terms*—Distance learning, Physics, Virtual labs, Remote labs, Web-based experimentation.**

I. INTRODUCTION

UNEDLabs is an ongoing UNED project addressed to distance learning in the context of the European Space for Higher Education. UNEDLabs offers to UNED students a structured set of virtual labs (VLs) and remote labs (RLs) belonging to the official curricula of the Physics (FisL@bs) and Computer Sciences (AutomatL@bs) degrees. And it also offers to the instructors a tool (vrlab plugin) and procedure for easily integrating the laboratories in the learning management system (LMS) web environment. The experiments in UNEDLabs are simulations and real experiments and can be accessed remotely through the official portal where documentation, theory, protocol tasks and tests are also available. All these experimentation resources are accompanied by e-learning resources such as documentation, collaborative and social tools (forums and other communication channels with students and instructors), a private files repository, a calendar that marks the deadlines for the activities and so on.

Every web-lab requires different materials and hardware tools. In order to reduce costs, simplify the construction, and provide a user-friendly impression to students, some of them were built using LEGO Mindstorms pieces, which is a nice solution for teaching/learning courses [1] when a limited budget is one of the restrictions to design the experimental setup. Other setups are being made up using aluminium pieces, stepper motors and controllers, force sensors, circuit elements, and so on. Either way, all the hardware is always controlled using LabView, a graphical programming language specifically designed for developing instrumentation, diagnostics, and data acquisition systems [2], or in Matlab.

Figure 1. Portal logo UNEDLabs

FisL@bs began working as an independent portal with two of the experiments mentioned above [3]. Now, this paper presents a new and much more complete and powerful portal. This work gives a description of 1) the new web portal and its features and 2) the experiences with the simulations corresponding to the labs and their didactical setups and the interactivity offered by their remote control.

II. UNEDLABS: THE WEB-BASED EXPERIMENTATION ENVIRONMENT

The UNEDLabs portal uses the well-proven structure of AutomatLabs and FisLabs for the creation and deployment of VLs and RLs. This methodology is based on a client-server architecture and on Easy Java Simulations (EJS) and LabView or Matlab. TCP/IP is the communication protocol for exchanging data between the client and the server. The graphic user interface (GUI) to remotely experiment with these laboratories is an applet, created with EJS, an authoring tool written in Java that helps to create interactive simulations in Java, mainly for teaching and learning purposes [4]. It is a tool designed to work at a high conceptual level, letting programmers concentrate most of their time and efforts on the scientific aspects of the simulation. The VLs corresponding to each remote experiment are also programmed using EJS.

Our e-learning portal organizes the access of users to available experimentation modules and simplifies the organization of user groups. It also offers notification services by email, instant messaging inside the online portal, news, forums, etc. allowing the interaction and the collaboration among students (and teachers/students). The website provides all the necessary theoretical documentation like practical guides, tasks protocols, instructions manuals or any other kind of information needed to satisfactorily perform a remote experimentation session in an autonomous way. Fig. 2 shows a caption of the aspect of the portal (FisL@bs) when a student access to the course where the VLs and RLs are offered.

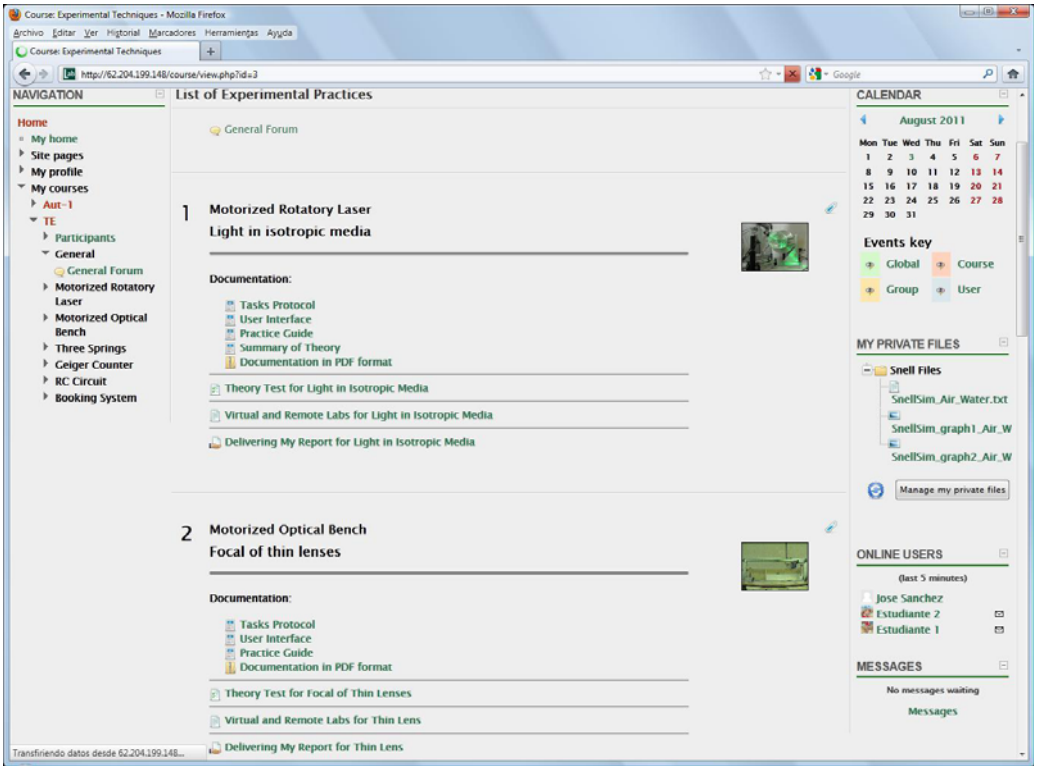

Figure 2. The FisL@bs portal

Thanks to the use of Moodle, the web environment also can suggest or impose a sequence of tasks or activities that students should carry out during an experimental session. The tasks can be of two types: Firstly, the tasks which students must carry out before performing the experiments in the real plant. This work should be done with a GUI that allows students to work in simulation mode.

The aim of this first step is to get an adequate previous insight about the process. This way, students will reduce the time spent in the activities that work over the real plant. The access in remote mode should not be allowed until the student has completed the tasks in simulation mode. Once the student's work in simulation mode has been evaluated by the teaching staff, the access in remote mode can be granted. Another important task that must be taken into account is the management of students and their assessments as well as the uploading of reports and the tracking of them. Also, a personal online file repository for students where the data collected during their experimentation sessions is stored. Finally, an automatic booking system is included in FisL@bs for scheduling the access to the physical resources of the laboratory for the RLs can only be used by one person at the same time. Therefore, a special application has been created to take care about the scheduling of these hardware resources.

The Physics labs available at UNEDLabs are:

- The laws of reflection and refraction of light, validity of Gauss' approximation, limiting angle… (Optics)
- Determination of the focal length of a thin lens by two different methods (Optics)
- Hooke's Law (Elasticity)
- RC circuits (Electricity and Magnetism)
- Laws of radioactive decays (Radioactivity)
- Electrostatic potentials (Electricity and Magnetism)
- Simple pendulum (Mechanics)
- Fresnel's equations (Optics)

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This work was supported by Calouste Gulbenkian Foundation, Lisbon, Portugal. It is a description of a demonstration given during 1st Experiment@ International Conference, 17/18 November 2011 in Lisbon, Portugal. Manuscript received 01 December 2011. Published as resubmitted by the authors 20 January 2012.