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State of art, Initiatives and New challenges for Virtual and Remote Labs

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***Abstract*—until a few decades ago, face to face classrooms and hand-on laboratories were the common solution for teaching theory and practice. But, new e-Learning tools have emerged and learning methodologies such as blended and distance learning have taken an important space in learning initiatives. Among them are virtual and remote Labs which provide student with a learning environment where can carry out the experiments through Internet and acquire the needed skills to develop his future jobs. This paper describes the importance of virtual and remote labs and their usage in learning scenarios.**

Keywords-component; distance and blended learning, E-Learning, online experiments, virtual and remote Labs.

I. INTRODUCTION

The last few decades, have seen an advance in communication and computer networks, and the evolution of programming languages. New e-Learning tools have emerged and enabled the usage of learning methodologies such as blended and distance learning. Among these "new" e-Learning tools, we can emphasize virtual and remote Labs.

- Virtual Labs are software simulation programs which allow students to carry out experiment from their computer. These can classify as software laboratories and virtual web laboratories.
  - Software laboratories are stand-alone computer base programs that must install. They do not run over Internet.
  - Virtual web laboratories are applications installed in a web server and accessed over the Internet. Therefore, the students are able to access to them through a web browser from some PC with an Internet connection.
- Remote laboratories are systems which allow students to utilize real instruments over the Internet. In the majority of the cases, these are remote web laboratories where students can access to them through of a web browser [1-3].

This paper shows how different universities have developed these e-learning tools, their problems and advantages, and the necessity of integrate them in learning scenarios. This paper is focus on the use of virtual and remote lab in education.

II. USE OF VIRTUAL AND REMOTE LABS IN EDUCTION

A review of the current literature shows a great number of universities or organizations that have created their own virtual and remote laboratories to support life-long learning and students' autonomous learning activities in industrial fields such as: electronics and microelectronics, power electronics and electrical drives, chemistry, physic, and control and automation [4-7].

As it was just mentioned, a great number of universities are developing their own online laboratories, but many of these efforts lack a unity of design, involve considerable custom development and present integration issues. To solve this, several initiatives emerged in the last decade to provide shareable experiments. Among them, we can emphasize these:

- LabShare is led by the University of Technology, Sydney, and is a joint initiative of the Australian Technology Network: Curtin University of Technology, Queensland University of Technology, RMIT University, University of South Australia, and the University of Technology, Sydney [8]. This project aims to create a national network of shared remotely accessible Laboratories. This mean a greater number of high-quality laboratory-based educational experiments are available to university and high school students from anywhere in Australia and around the world.
- The WebLab-Deusto project is an open source project providing a web-based, experiment-agnostic, scalable software infrastructure, which permits the University of Deusto to offer several laboratories to its students through the Internet [9]. Some available online experiments are:
- The iLab Shared Architecture (ISA) implemented by the MIT to facilitate the rapid development of new web laboratories and to provide a mechanism for students from one university to use the experiments and the hardware instruments of another university [10].
- VISIR is an open source laboratory dedicated to remote experimentations on analog electronics [11]. Some of the online experiments provided are: function generator and oscilloscope use, DC circuits, AC circuits or MOS transistor characterization.

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- OCELOT (Open and Collaborative Environment for the Leverage of Online insTrumentation) is an open source and collaborative Online Laboratory framework and middleware. It is based on mixed reality and interactive multimedia. One of its core features is the multimodality of the W3C Widgets-based Graphic User Interface delivered to the learner. It is currently being implemented by Télécom Saint-Etienne (France) under LGPL (http://ocelot.ow2.org) [12].
- LiLa (stands for Library of Labs), a European eContentPlus project that promotes a portal of Online Labs resources and fosters exchanges on experiments among institutions [13]. To do this the using an e-learning standard named SCORM [14-15]. To do this, LiLa packs the remote laboratory in SCORM and use JavaScript to launch the experiments. Although this solution is able to use the laboratory, its main problem is that the exchange and storing of information between the SCORM package and of Lab is limited by the Javascript and the version of SCORM data model [16].

Although these initiatives allow sharing virtual and remote Labs from different universities, other main issue must be considered. Virtual and remote Labs need be executed along with learning activities as chat, forums, assessment, etc. Providing adequate learning scenarios.

Several possibilities can be considered to integrate virtual and remote Labs in learning scenarios

- For each Remote and virtual Lab is possible to create and implement a learning environment (content, chats, forums, assessments) around it. The main problem is this environment must be created by each new Lab once and again.
- It is possible to wrap some virtual and remote Labs in e-learning content standards as SCORM [14]. The main problem is that currently the interaction between the packaged Lab is limited by the JavaScript and the version of SCORM data model.
- It is possible to integrate the Labs in learning management systems. Well through an URL or creating a web service structure which allow a better interchange of data between the Lab and the LMS (Fig 7) [16-17].

These solutions are enabled and provide Labs with other learning tools, but, new ideas and e-learning standards such as smart devices, widgets, SCORM next generation and IMS-CC & LTI are getting stronger.

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