Spreading remote lab usage

A System – A Community – A Federation

Gustavo R. Alves, André Fidalgo, Arcelina Marques, Clara Viegas, Manuel C. Felgueiras, Ricardo Costa, Natércia Lima, Manuel Castro, Gabriel Díaz-Orueta, Elio San Cristobal Ruiz, Felix García-Loro, Javier García-Zubía, Unai Hernández-Jayo, Wlodek Kulesza, Ingvar Gustavsson, Andreas Pester, Danilo Zutin, Luis Schlichting, Golberi Ferreira, Daniel de Bona, Juarez B. da Silva, João B. Alves, Simone Biléssimo, Ana Pavani, Delberis Lima, Guilherme Temporão, Susana Marchisio, Sonia Concari, Federico Lerro, Rubén Fernández, Héctor Paz, Fernando Soria, Nival Almeida, Vanderli de Oliveira, María I. Pozzo, Elsa Dobboletta

The VISIR+ Project

Polytechnic of Porto, National Distance Education University, University of Deusto, Blekinge Institute of Technology, Carinthia University of Applied Sciences, Federal Institute of Santa Catarina, Federal University of Santa Catarina, Pontifical Catholic University of Rio de Janeiro, National University of Rosario, National University of Santiago del Estero, Brazilian Association for Engineering Education, Educational Sciences Research Institute of Rosario

gca@isep.ipp.pt

***Abstract*— Experiments have been at the heart of scientific development and education for centuries. From the outburst of Information and Communication Technologies, virtual and remote labs have added to hands-on labs a new conception of practical experience, especially in Science, Technology, Engineering and Mathematics education. This paper aims at describing the features of a remote lab named Virtual Instruments System in Reality, embedded in a community of practice and forming the spearhead of a federation of remote labs. More particularly, it discusses the advantages and disadvantages of remote labs over virtual labs as regards to scalability constraints and development and maintenance costs. Finally, it describes an actual implementation in an international community of practice of engineering schools forming the embryo of a first world wide federation of Virtual Instruments System in Reality nodes, under the framework of a project funded by the Erasmus+ Program.**

Keywords—engineering education; remote labs; VISIR; VISIR+[1]; Community of Practice, online labs federation

I. INTRODUCTION

Remote labs stand for physical apparatus connected to computer-controlled instruments able to be remotely accessed for carrying out real-world experiments. This definition leads to the expression "remote experimentation" which denotes the type of experiments that can be done in remote labs, in opposition to "virtual experiments", or "simulations", which can be done in "virtual labs". For a complete understanding, hands-on labs refer to physical spaces where users perform experiments by directly manipulating the instruments and/or apparatus under experimentation. The more recent expression "hybrid labs" refers to a sort of environment where parts of the apparatus under experimentation and/or the instruments connected to those apparatus are real, and other parts are modeled, i.e. correspond to mathematical and data models running on a computer. These two parts interact during the course of an experiment, hence the word "hybrid".

In historical terms, the value of experimentation in Science has long been recognized. For instance, the oldest Scientific Society in the world, the Royal Society, adopted the motto 'Nullius in verba' to "… *express the determination of its Fellows … to verify all statements by an appeal to facts determined by experiment*." [1]. This spirit has also long been part of the Education and Training process of both Scientists and Engineers, as reported by Feisel and Rosa in [2]. In particular, these authors trace back the value of combining theory and practice to the very first engineering school in the United States, the U.S. Military Academy, founded at West Point, N.Y. in 1802 [2, p. 122]. Although majorly focusing on the role of hands-on laboratories in Undergraduate Engineering Education, Feisel and Rosa also account for the provisions of both virtual and remote laboratories to that role.

The particular aspects of combining hands-on, simulated and remote laboratories into Science, Engineering, Technology and Mathematics (STEM) Education are well discussed in [3] and [4]. These papers also acknowledge virtual and remote labs to be the two most recent vertexes of this triangle, illustrated in figure 1. Froyd, Wankat, and Smith corroborate this statement by rightfully classifying simulations and remote labs as part of one of the five major shifts in 100 years of Engineering Education (EE), in particular of its 5th major shift, i.e. the influence of Information and Communication Technologies (ICT) in EE [5].

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