A SMART LAYER FOR REMOTE LABORATORIES

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***Abstract* - Commonly, when a weblab is developed to support remote experiments in sciences and engineering courses, a particular hardware/software architecture is implemented. However, the existence of several technological solutions to implement those architectures difficults the emergence of a standard, both at hardware and software levels. While particular solutions are adopted assuming that only qualified people may implement a weblab, the control of the physical space and the power consumption are often forgotten. Since controlling these two previous aspects may increase the quality of the weblab hosting the remote experiments, this paper proposes the use of a new layer implemented by a domotic system bus with several devices (e.g. lights, power sockets, temperature sensors, and others) able to be controlled through the Internet. We also provide a brief proof-of-concept in the form of a weblab equipped with a simple domotic system usually implemented in smart houses. The added value to the remote experiment hosted at the weblab is also identified in terms of power savings and environment conditions.**

***Index Terms*—Remote Experimentation, Weblab, Domotic System, KNX.**

I. INTRODUCTION

Weblabs are used for educational purposes since the mid 90's. According to Aktan et al. [1], it was maybe in 1996 the first time an undergraduate weblab has been made fully accessible using networking tools. This solution contributed to the appearance of the Remote Experimentation concept, defined as a distance learning area that enables the remote control of real experiments using computers connected to the Internet. This remote access to labs, commonly used to support the practical work required in sciences and engineering courses, brought several advantages to education, like: a) users (teachers and students) may access resources not available locally, providing the accomplishment of experiments without any costs; b) experiments may be shared among institutions; c) equipment may be used more often; d) costs per student may be reduced; among others [2].

Due to all those advantages, already described in literature, nowadays there is a growing number of weblabs. Since those same labs require specific resources to enable a remote access, several solutions for harmonizing the software and hardware used for implementing them have already been proposed and described. However, the existence of many different technologies difficults the choice for a standard approach to implement a specific weblab both in terms of hardware and software. Usually, when a specific weblab is required, an immediate and particular technical solution is adopted for this development. Moreover, due to the specificity of each solution, usually only qualified people are able to develop one, which partially justifies that almost all weblabs fall into the engineering domain [3]. Thus, harmonization at hardware and software levels is an important aspect to take into consideration as to facilitate the construction of standard and well defined weblabs. If harmonization is followed, software/hardware modules used in each weblab may be reused on others. This will ease the creation of weblabs and promote its widespread use in the teaching and learning domain. Moreover, by following a standard architecture, other aspects may be considered during a weblab implementation, namely the environment of the physical space occupied by it and the power infrastructure. By controlling these two common aspects to all weblabs, further control facilities are given to remote users. They will be able to control the place where a specific experiment is running, like if they were in the place, contributing to approach the in-place lab facilities to weblabs. To implement these aspects in any weblab, we propose the adoption of a standard domotic system bus usually implemented in smart houses, which will ease the control of all the environment aspects encountered in any lab.

The rest of this paper is organized as follows: in the next section we discuss those same weblab requirements, namely issues concerning the control of the physical space (light incidence and temperature) and the power sockets where the lab devices are connected to; section 3 presents the use of a domotic system bus within a client-server architecture; and section 4 describes the solution adopted for our lab that enables remotely controlling two specific devices (a halogen lamp and a power socket). The paper ends with some considerations about the work already done and future directions.

II. ANALYSIS OF REQUIREMENTS

Each weblab requires a specific place to accommodate the apparatus, the measurement equipment and the servers. Usually, those places have characteristic light incidence, temperature and humidity conditions, containing all the equipment power supplied. Figure 1 illustrates a possible place to host a remote experiment, surrounded by several equipment also able to control remotely.

The necessity to adopt a weblab to support the practical work, 24 hours per day, 7 days per week, has consequences in the power consumption and in the results obtained from the experiments. Specific attention should be paid to the physical environment where an experiment is running, namely with the light and temperature conditions. Supposing that a weblab facility has direct sun light and visual feedback is required, then artificial lights are not mandatory, i.e. they are not required to be switched on during the day.