Extending the control of remote laboratories using domotic devices

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Abstract — **Currently, technology is being applied in several domains to facilitate people's lives. Smart homes represent a proof of this tendency, providing several tools so users can easy their daily tasks. These homes are automated by the use of domotic devices that enable controlling their functionalities (e.g. lights, blinds, etc.). Today, companies are developing several devices, and new solutions and studies are still appearing, evidencing the continuous interest of the research community in this domain. This alerted us for the possibility of applying domotic devices in education, namely by proposing an extension to remote laboratory infrastructures that provide students the ability of controlling real experiments through the internet. Hence, taking into consideration the amount of domotic devices in the market, together with remote experiments' requirements, lead us to purpose the use of those devices for controlling the power infrastructure and the environment conditions of remote laboratories. This paper starts by an overview about smart homes and related technology, and finishes proposing a new remote laboratory infrastructure.**

Index Terms - **Remote Experimentation, Remote Laboratories, Smart Homes, Domotics.**

I. INTRODUCTION

During the last decades technology is changing, with new and better tools and devices that may be applied in several domains of our society. If at the beginning those were focused on improving the production output and management issues in companies, more recently technology is being adopted for directly improving people's lives, facilitating their daily tasks. For that purpose, in the last two decades the concept of smart homes appeared, that basically comprehends the ability for automating, in a smart way, a home, e.g. controlling eating and lighting conditions, multimedia devices etc.. Currently, several companies are developing products (sensors and actuators) supported on standards, for implementing smart and automated environments. Those products, usually named domotic devices, are connected through wired or wireless buses enabling them to talk with each other acting (actuators) according to specific sensed environment conditions (sensors). Furthermore, the ability that internet provides for transferring data from distant places, alerted companies for the opportunity of developing products for remotely interacting with domotic devices using mobile phones, smart phones, PDAs, etc.. Comfort, security and entertainment are people requirements that currently are being fulfilled by smart homes. Additionally, some of the adopted technology (the domotic technology) gather principles and facilities that can also be applied to other domains, namely in education.

Educational domain is already supported on several technologies, as proofed by the E-learning concept. Basically, this concept is related with the adoption of technological tools and resources for facilitating the teaching and learning processes. Virtual Learning Environments (VLE) are very well known tools that are being applied in several courses, providing students and teachers with management resources for delivering and organizing pedagogical contents. However, common VLEs do not allow the conduction of laboratory experiments required in Sciences and Engineering (S&E) courses. Then, during the middle 90s, appeared the Remote Experimentation concept as an extension of the E-learning. This concept comprehends the adoption of remote laboratories providing students and teachers the ability to interact with real laboratory experiments using a simple device connected to the internet. Students and teachers are now able to remotely conduct experiments in a similar way as they do with a traditional laboratory, supported by remote laboratory infrastructures. Presently, these infrastructures are implemented using several and distinct technologies, creating difficulties for their standardization. Furthermore, they usually comprehend several devices (web server, instrumentation server and several Instruments and Modules (I&M)), some of them expensive, bringing features not required for some experiments. Hence, for facilitating developments, reducing expenses and promoting collaboration among institutions, a recent proposal suggested the replacement of some of those devices, namely the instrumentation server plus the I&M, by a simple FPGA-based board [1]. The idea is to develop all the I&M using hardware description languages (e.g. Verilog and VHDL) following the IEEE 1451.0 Std. that defines a set of operating modes and interfaces for controlling sensors and actuators [2]. Once developed, they will be able to be included inside the FPGA, enabling the reconfiguration of the laboratory infrastructure.

In spite of the advantages this solution brings, if the environment conditions and the power management are required to control, specific modules should be developed. So, establishing a parallelism with the features that domotic devices bring to smart homes, together with remote experiment requirements, alerted us for the possibility of adopting domotic devices in remote laboratory infrastructures. As represented in figure 1, it will be possible to join two distinct domains (smart/automated homes with Remote Experimentation). This way, commercial products (which are standardized domotic solutions) can be easily implemented in remote laboratory infrastructures without further developments.