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DESIGN AND DEVELOPMENT OF A DIDACTIC AN INNOVATIVE DASHBOARD FOR HOME AUTOMATION TEACHING USING LABVIEW PROGRAMMING ENVIRONMENT

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ABSTRACT

Domotics as a branch of automation has achieved remarkable advances in recent years, due to the enormous development of telecommunications that has allowed improving and complementing services of this type of solutions. It is necessary in the electronic engineering programs of the universities, to develop methods and strategies that facilitate the teaching of these subjects in a practical way, so that the student learns by doing. This article describes the development of a didactic dashboard for the teaching of domotics; integrated by sensors, actuators and a computer control interface to facilitate the execution of laboratory practices aimed at solving problems of comfort, safety and energy management at home in an interactive way. In order to verify the usefulness of the domotic dashboard in the teaching-learning process, a survey was applied to a group of teachers and students in Universidad de la Costa in Barranquilla, Colombia, showing that the board can become a useful resource for domotics learning.

Keywords: experimental environments, teachers and laboratories tools automatic, interactive tools, virtual and remote laboratories, teachers practices, education in control.

INTRODUCTION

Domotics is the set of systems to automate different installations of a home (Acampora & Loia, 2005; Bonino, Castellina, & Corno, 2008; Miori, Tarrini, Manca, & Tolomei, 2006; Morón Fernández, 2016; Zaccaria, 2007). Domotics applications seek to provide short and long term benefits in economic saving, welfare and prevention of domestic risks, efficiently taking advantage of natural resources such as sunlight (Balasubramanian & Cellatoglu, 2008; Moro Vallina, 2011; Shewale & Bari, 2015; Toledano, 2004). Integration of domotic technologies applied to the control and automation on buildings of tertiary or industrial sector, hospitals, hotels, universities, residential buildings, offices, and shopping centers is called immotic (Gutiérrez Suanzes, 2015; Millán-Anglés, Garcia-Santos, Jiménez-Leube, & Higuera-Rincón, 2014). Domotics systems can be composed of comfort, security and energy management subsystems (Huidobro Moya & Millán Tejedor, 2010; Kovatsch, Weiss, & Guinard, 2010).

Domotics is a branch in the line of deepening automation and control of any electronic engineering program. To link home automation in the teaching-learning process, resources are needed that bring the student closer to the needs of the household and thus develop the skills to address them, involving the use of actuators and sensors for these solutions, as well as elements that allow an approach to costs and recovery rates in this type of projects (Ovallos Gazabón, Villalobos Toro, De La Hoz Escorcia, & Maldonado Perez, 2016; Ovallos-Gazabon, De La Hoz-Escorcia, & Maldonado-Perez, 2015; Simancas-García, Meléndez-Pertuz, Sánchez-Dams, & Vélez-Zapata, 2016; Viloria & Parody, 2016; Zamora, 2011)

The aim of this project was to provide a tool that facilitates the teaching-learning process of home automation at the Universidad de la Costa. For this, a didactic board was developed to simulates a residential domotic system. This offers the possibility of developing exercises based on problems raised, related to management of sensors in a house, meeting requirements from the point of view of comfort, security and energy management.

Teaching of domotics in engineering

Problem-based learning (PBL) approach emerges as a response to the highly changing conditions of environment and even more in areas related to electronics and aspects such as automation and industrial communications(Betancourt Correa, 2006; Granado, Marín, & Pérez, 2016; Páez Logreira, Zabala Campo, & Zamora Musa, 2016). This approach allows the student to visualize phenomena and to participle actively, thus generating a multiperspective construction of knowledge, which is necessary to solve complex problems in engineering (Zamora, 2011). According to Dale´s Pyramid (Lalley & Miller, 2007), more participation represent more perceived level of learning (Figure 1).

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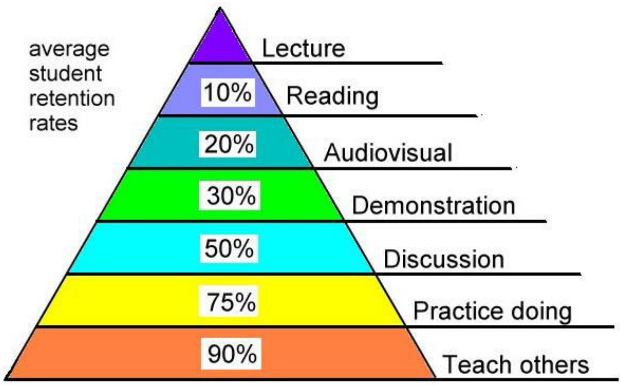

Figure-1. Dale's learning pyramid.

METHODOLOGY

Four phases were developed. Phase I. Identification of variables, review of the literature and recognition of the needs of a house with respect to energy management, safety and comfort was developed. As a result, the list of domotic needs of a basic household and the housing risk plan with the proposed location of the sensors was obtained. In Phase II, hardware development, the board was develop according to the identified monitoring and control variables. Phase III. software development. Its objective was to implement supervisory software to control the autonomous board, generating the domotic control software and the user interface to interact with the board. And Phase IV. Verification was carried out through a survey to verify the board as a resource for the learning of domotics with students of Electronic Engineering Program at the Universidad de la Costa, Barranquilla-Colombia. In the same way, a quick user guide and laboratory practices with problems related to the comfort, safety and energy management of a home were made.

Products from National Instrument (NI) were selected as development platform. Labview® software was used for the handling of variables and the design of the interface due to its adaptability in the development of engineering projects (Hamed, 2012; Karhe, Patil, & Patil, 2013; Patil, Karhe, & Patil, 2013; Strack, Suárez, Di Mauro, & Jacob, 2014). The graphical programming environment makes Labview® user-friendly for the programmer, which is a decisive aspect in its selection, given that the target users are undergraduate students, where visual aspect plays an important role. For the data acquisition, management and monitoring of the electronic peripherals, the USB-6009 NI card is used. The acquisition card is connected to a computer running the programs developed in Labview (called virtual instruments, VI), in order to interact with the domotics board.

RESULTS

The main result of the project is the domotic board fully operational, with guidelines to develop laboratory practices oriented to solve problems in home automation.

Board description

In order to determine the constitutive stages of the board, the revision of the literature and the home automation needs of a basic household were taken into account. After this review, the needs for energy management, safety and comfort were established in Table-1.

Table-1. Basic home automation needs oriented to energy management, security and comfort.

CATEGORY	NEED AUTOMATION
Energy Management	Control of electric charges Power Consumption
Security	Gas leak Smoke alarm Intruder alert security camera
Comfort	Ambient temperature control Control of the lighting (dimmer)

Based on these needs, the sensors and actuators to be used in the board were determined. Table-2.

Table-2. Sensors and actuators to be used on the board.

KIND	CATEGORY	DESCRIPTION
Sensors	Smoke	Ss-770-lrc
	Gas	MQ2
	Presence	Passive Infrared
	Opening	Magnetic switch
	Temperature	LM35
	illumination	Photocell
	Current	ECS1030-L72
	Voltage	Transformer AC 6V
	Camera	FaceCam300
Actuators	Light bulbs	110 V AV
	Fan	Centrifuge of PC 12V
	Siren	Buzzer 5V
	Outlet	Outlet with separate switches
	Bulb	Halogen 110V AC
	Solenoid valve	Washer water standard. 110V AC

A typical risk plan was defined for the proposed building, represented in the home automation panel and on this, the selected sensors were located, after reviewing the characteristics of the same. Presence, smoke, magnetic and gas sensors were used. Figure-2.

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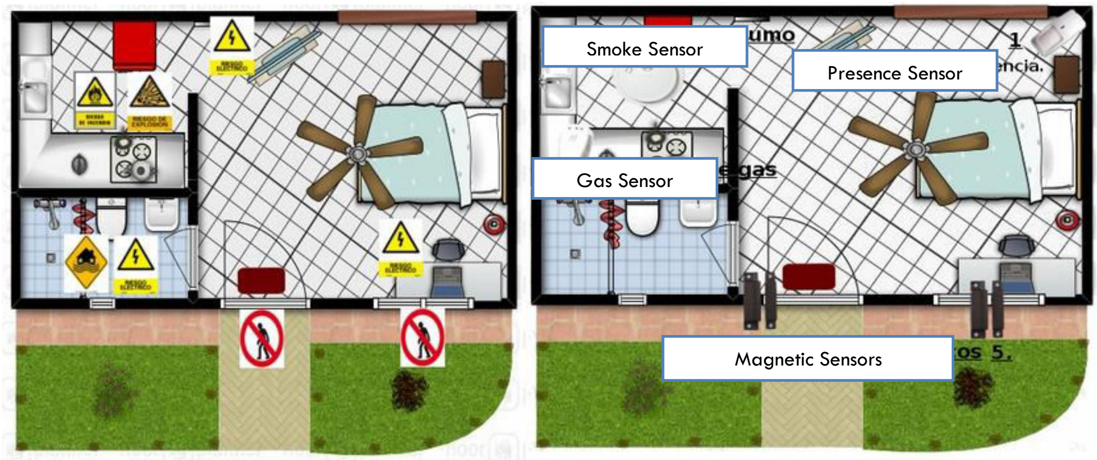

Figure-2. Risk plan and sensor arrangement.

Architecture of domotics system

With this distribution, hardware required for the solution was selected. NI USB 6009 card was established as the data acquisition device with centralized processing in PC for easy manipulation and changes, due to its characteristics, capacity and availability, as well as its integration with Labview®. Figure-3.

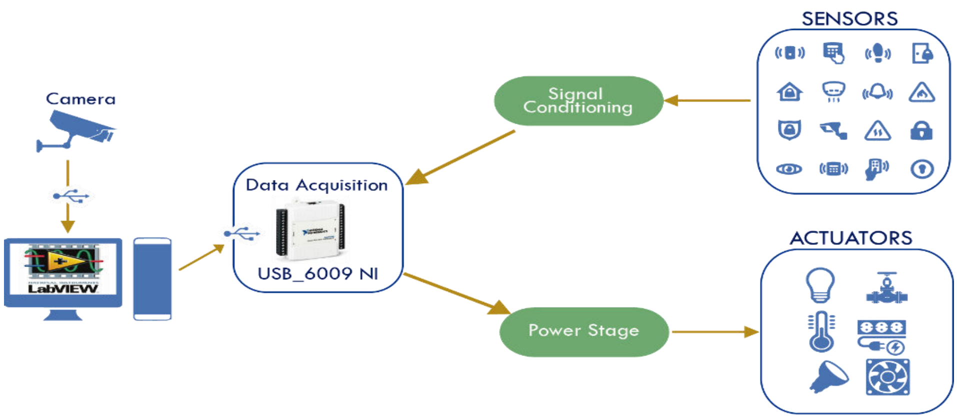

Figure-3. Home automation system architecture.

The board allows handling of electrical loads like lights, outlets and a fan. The system also has a surveillance webcam that sends photos to an e-mail previously include in the configuration when an intrusion is detected. A buzzer was integrated to alert if required as a means of alert. The board has dimensions of 110 cm high, 90 cm wide and 35 cm deep. Figure-4.

Figure-4. Final appearance of home automation system.

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Interface for home automation panel control

To facilitate the board handling, the interface shows the house plane. The user on this screen can manually control all variables, such as turning on / off lights, fan speed, temperature display and control, and the power consumed by loads in Watt units, and stopping the application. Figure-5.

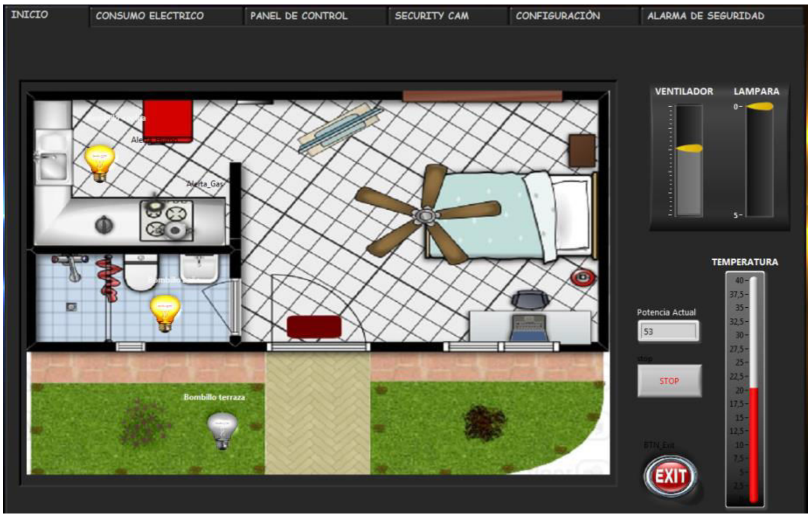

Figure-5. Home screen from interface for handling domotics panel.

Laboratory guides

With the user interface fully developed, user guide and laboratory practices were elaborated. The purpose of user's guide is to verify operation of sensors and actuators in the board, seeking to provide a quick configuration in a introductory way in use of the tool to user. Proposed labs practices try to simulate real-world scenarios and involve the student in solves using signals from the sensors with the VI of Labview and propose alternative solutions for some type of situation raised in terms of energy management, safety and comfort.

Verification

In order to verify the home automation board use and performance in the academic field, practical activities were included in electronic laboratories in which the students and teachers had to interact with the domotics board. Subsequently, an instrument aimed primarily at identifying the users' perception in criteria like assimilation, effectiveness, applicability and satisfaction was applied. The results are presented in Figure-6.

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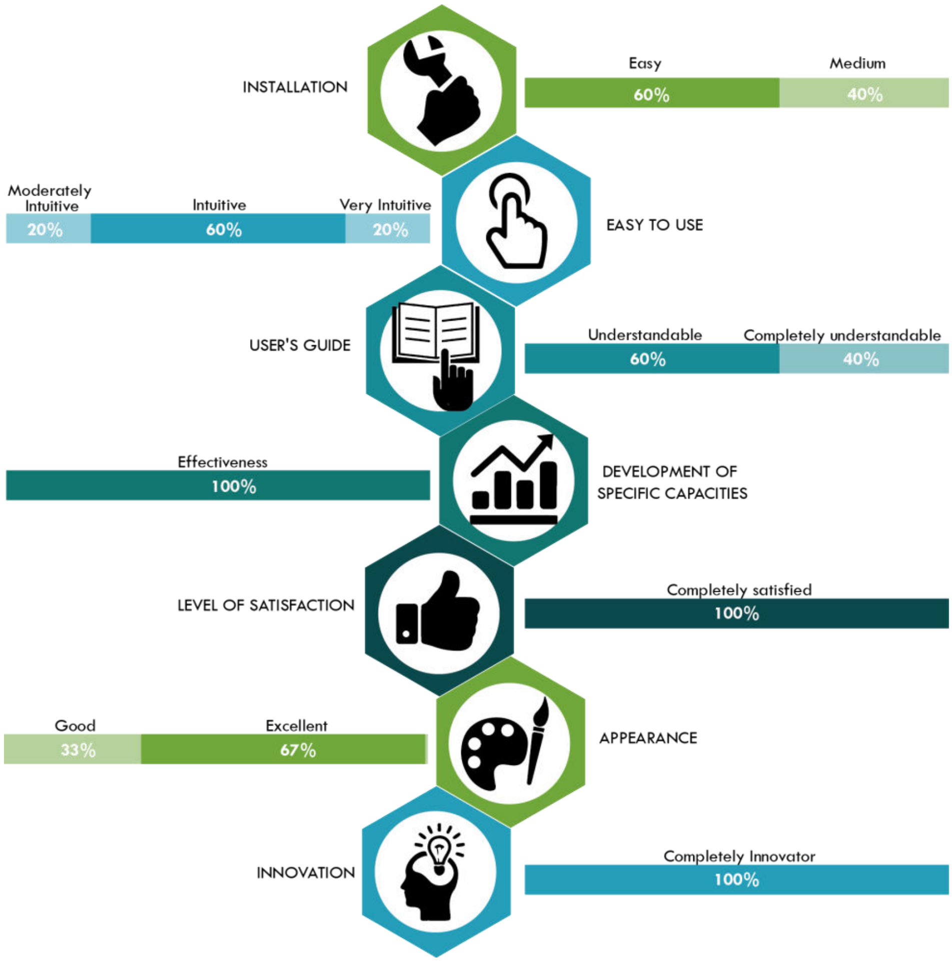

Figure-6. Results of post-use verification of home automation board.

CONCLUSIONS

The development of home automation board and the laboratory practices formulated, are considered an important contribution at academic and pedagogical level, being a technological advance in local and national context with commercial possibilities and a gateway to business opportunities.

The interaction of students and teachers with the interface made in Labview®, highlights the ease of manipulation and enables the development of applications in the domotics. On the other hand, students were shown that Labview® is not only based on monitoring and analysis of signals at industrial level, but can be used for developments related to other topics, such as simulation of safety elements, comfort and energy management in a home. The laboratory guides, practices and user guide, allowed to identify through the survey carried out that the didactic board constitutes an important tool for the learning of home automation in electronic engineering.

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