Spreading the VISIR remote lab along Argentina. The experience in Patagonia

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Abstract.
The learning of technical and science disciplines requires experimental and practical training. Hands-on labs are the natural scenarios where practical skills can be developed but, thanks to Information and Communication Technologies (ICT), virtual and remote labs can provide a framework where Science, Technology, Engineering and Mathematics (STEM) disciplines can also be developed. One of these remote labs is the Virtual Instruments System in Reality (VISIR), specially designed to practice in the area of analog electronics. This paper aims at describing how this remote lab is being used in the Universidad Nacional de la Patagonia San Juan Bosco (UNPSJB - Argentina), in the framework of the VISIR+[1] project funded by the Erasmus+ Program, one institution without previous experiences with remote labs.

1 Introduction

The Virtual Instrument Systems in Reality (VISIR) is a well-known remote lab that has been discussed many times in this conference and in many articles published in journals. Being designed and developed by Prof. Ingvar Gustavsson in Sweden almost 10 years ago [1], this remote lab has been set-up in different European institutions. University of Deusto was the first institution that purchased and deployed the VISIR outside Sweden, and it was followed by other universities in Spain, Austria and Portugal. After the expansion of the remote lab platform, the VISIR Consortium created

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around it aimed at sharing experiences and experiments using the VISIR as a learning tool which helps students and teachers to achieve the learning outcomes of subjects related to analogue electronics. With the goal of spreading the knowledge about the VISIR, the VISIR+ project was presented to ERASMUS+ European Union call, being finally accepted in July 2015 [2]. To fulfil that goal, European universities that have the experience of using the VISIR will transfer it to Latin American institutions, namely Higher Education Institutions with engineering careers/courses.

VISIR+ has two well-differenced well distinctive stages: during the first one, institutions from Latin America must deploy the physical elements, instruments and components of the VISIR remote lab. This stage is supported by staff from BTH (Sweden), the developers of the remote lab. In a second stage, the other European Universities involved in the project will help their Latin American partners to exploit the resources of the VISIR remote lab as a learning tool, sharing with them their experiences along these years.

This paper rather than being focused on describing the VISIR+ aims at exploring the results of the first training action that was held in Rosario (Argentina) in September, 2016. During this training action, staff from University of Deusto introduced the VISIR remote lab to more than 25 trainers, lecturers and professors from different parts of Argentina that were interested in discovering the possibilities offered by the VISIR. The sessions started with an introduction to remote lab as many of the attendants were novel in these environments.

The goal of this paper is to show not only the experiences during this training action, but also the first intensive use of the VISIR by lecturers and students from Universidad Nacional de la Patagonia San Juan Bosco (UNPSJB).

2 Scope of Training Action 2

One of the expected results of the project is a set of educational modules for engineering courses comprising the use of hands-on, simulated and remote labs, following an enquiry-based methodology. It implies the inclusion of the VISIR remote lab in theoretical and practical lessons with students, within a variety of courses related to electric and electronic circuits. In order to fulfill that objective, the project VISIR+ has two training actions in associated Latin American institutions partners of the Project.

The first training action in the framework of VISIR+ project took place at Facultad de Ciencias Exactas, Ingeniería y Agrimensura (FCEIA) from Universidad Nacional de Rosario (UNR) in September 2016. The training was developed during three days, combining oral presentations, workshops and practical activities with VISIR. The training sessions were led by two research professors of the Universidad de Deusto, who are experts in the use of VISIR, plus three UNR teachers who usually use remote laboratory practice in their subjects of Electronic Engineering courses. Also present was one researcher ~~of~~ from Instituto Rosario de Investigación en Ciencias de la Educación (IRICE), member of the VISIR+ project, with the aim of taking records of from the training sessions.

This training action at FCEIA targets all teachers with lecture duties in Engineering courses related to electric and electronic circuits, plus two representatives from each of the two UNR associated partners: Facultad Regional Rosario of the Universidad Tecnológica Nacional and Instituto Politécnico Superior of the UNR. As this training action was also considered one key moment for dissemination at a regional level, there were also invited academic authorities, PhD students and teachers from other institutions nearby UNR.

Three teachers from different Argentine Universities were also invited to participate in this training action. They were selected by Consejo Federal de Decanos de Ingeniería (CONFEDI). The participation of CONFEDI as an associated partner provides the conditions for creating an additional impact at the national level in Argentina. The three teachers attended the training sessions as regional coordinators of a project that CONFEDI is carrying out in Argentina~~,~~ to encourage the subsequent dissemination of the use of VISIR in the Engineering faculties. Belonging to this last target group, is the professor of the Universidad Nacional de la Patagonia San Juan Bosco, whose experience using VISIR is presented in this paper.

During this training action, staff from Universidad de Deusto introduced the VISIR remote lab to 26 trainers, lecturers and professors from different parts of Argentina that were interested in discovering the possibilities offered by the VISIR.

Fig. 1. Training Action at Universidad Nacional de Rosario (Argentina)

Due to some administrative delays related to the import process, UNR still lacked the necessary equipment to support training. This inconvenience was overcome by using the VISIR platform of Universidad de Deusto, via Internet.

The sessions started with an introduction to remote lab because many of the attendants were novel~~s~~ in these environments. The training program included aspects related with the design, implementation and the evaluation of educational modules with VISIR. In addition it included application examples selected from those available on Web Lab Deusto, to prove the adaptability of VISIR to different institutional cultures and its universality in terms of experiments with electric and electronic circuits. The teachers focused on both, technical and didactic aspects, especially in or-

der to scaffold student's learning and foster their autonomy, namely by allowing them to conduct real experiments over the Internet. Once the training was completed, and to encourage both the teachers' motivation on the use of VISIR and the immediate application of what was learned to the classroom context, attendees were asked to plan an educational activity using VISIR contextualizing the plan in their own subject, career and institution.

~~2.1~~ Immediate outputs of Training Action

A Satisfaction Questionnaire (SQ) was designed by the members of VISIR+ Project in charge of Qualitative research, from the Research Institute of Education Sciences (IRICE-CONICET) in Argentina and from the Instituto Politécnico do Porto (IPP) from Portugal. The SQ had a twofold objective: measuring the immediate impact of TA on target audience and evaluating possible scenarios for VISIR implementations in HE institutions. The SQ was given to the 19 TA participants at UNR and the questions focused on three main aspects of the TA: (1) the workshop (objectives and time allotted) and the lecturers (interaction with participants); (2) the use of technological equipment, i.e. VISIR Lab, as regards the didactic implications and practical use; and (3) the participant's expectations on TA2. All questions were presented in the form of statements and a Likert scale from 1 to 5, being *(1) Unsatisfactory* and (*5) Excellent*. Table 1 below sums up the results.

	Workshop	**Technological Equipment**	**Participants expectations**
Excellent	48.17%	6%	47%
Highly satisfactory	43.83%	26%	43%
Above average	8.00%	68%	10%

Table 1: TA impact/outcomes

Most participants scored the workshop as excellent (48.17%) and highly satisfactory (43.83%). Only 8% found the workshop above average. The evaluation of the workshop included the overt explanation of the TA objectives, the time allotted, the instructors' participation and the extent to which technological equipment had enhanced the effectiveness of teaching and learning. As regards the actual use of the technological equipment, namely VISIR Remote Lab, the answers ranged from too easy to use (i.e. excellent) 6%, easy to use (i.e. highly satisfactory) 26%, and just right (i.e. above average) 68%. Finally, TA met participants' expectations by 47% as excellent, 43% as highly satisfactory and 10% above average.

An open question was also included in the SQ in order to provide a qualitative perspective to the evaluation by eliciting reflection on positive and negative aspects of the whole experience. Three main categories aroused from the reading of participants answers: equipment potential, clear presentation, time. Most of the participants argued that the training action raised awareness about the potential of VISIR equipment not only by presenting the possibilities of actual use in the classroom but also by giv-

ing participants the chance to experiment during the sessions. Secondly, most participants pointed out the presentation approach facilitated their understanding of VISIR technical and pedagogical use. Finally, participants referred to the need of more time to extend the TA experience: the schedule was constrained to some slots for actual connection to VISIR via University of Deusto WebLab which participants considered limited.

3 Early use of the VISIR in Patagonia

One of the participants of TA which took place at UNR from Universidad Nacional de la Patagonia *San Juan Bosco* (UNPSJB) in Comodoro Rivadavia (Argentina) implemented VISIR Remote Lab in his subject Theory of Circuits. The subject Theory of Circuits is in the second year of Electronic Engineering at the Engineering College of UNPSJB. VISIR Remote Lab learning tool was introduced to the subject to give students more options on real circuit experiments. To the traditional lab activities, practice was added to allow students to analyze and interpret the forced temporal response to a resistive, inductive and capacitive circuit (RLC). In this type of practice students had to experiment on a real circuit, i.e. select components and instruments, make the connections, set the instruments and carry out the measurement. Before the practice, students made the modeling, calculus and simulation of the target phenomenon.

The modeling developed by students was based on the circuit theory from which set physic magnitudes had to be calculated, expressions of variables obtained and results interpreted. The behavior of the model was also simulated by means of appropriate software and the results were compared. In the next stage, students carried out the experiments using VISIR Lab and contrasted the results against calculus and simulation drawing conclusions from results. To organize the tasks, a lab guideline was designed where the objective of the practice, the activities preliminary to real circuit experiment and procedures were made explicit. Students had access to the remote lab and all necessary information about VISIR from the subject webpage (http://www.ing.unp.edu.ar/electronica/asignaturas/ee016/) and links to WebLab-Deusto from University of Deusto, Spain.

3.1 Students' use of VISIR during the experimental practice

The students carried out the activities individually in the computer room of the Electronic Department. At the beginning of the activities, a professor guided students in the use of VISIR Lab about how to access to the remote lab by means of assigned users' names and passwords. Then students carried out the selection of components, the wiring, the instrument configuration and the measurement following the procedure given and the objectives set for the practice. During this process, students shared with classmates the results of each individual experience, their learning and conclusions, this time being the role of professor that of a moderator.

To analyze and interpret the behavior of electric variables of RLC circuits, the guide suggested the model shown in the figure with R1= 100 ohm, C1=2.20nF, L1=10 mH.

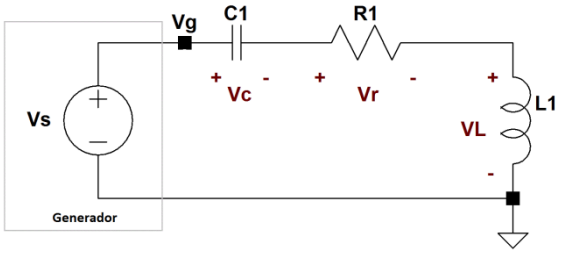

Fig. 2. Experimental practice exercise

The procedure established that the circuit should be wired on the "protoboard", generate a square signal, 500 Hz frequency and 1V PP amplitude, and obtain the signals Vg and VL from the oscilloscope from which attenuation and resonance frequencies should be measured (theoretical magnitudes are $\alpha=R1/2L1$ $\omega_0=1/(L1*C1)^{1/2}$ respectively). To obtain the attenuation frequency students observed from the oscilloscope the time $\tau=1/\alpha$ by which VL falls to a 37% of its minimum value. To determine the resonance frequency, they observed the period T of the sinusoid and calculated $\omega_0=2\pi/T$.

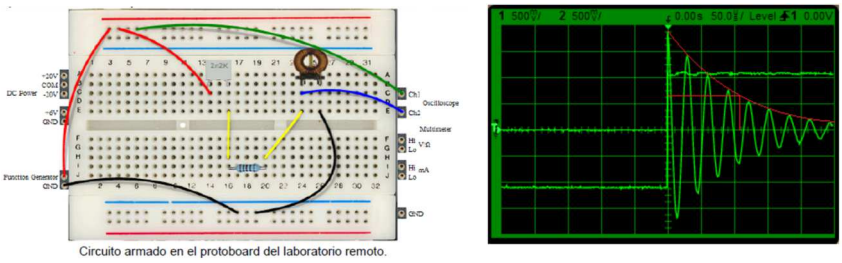

Fig. 3. Practical implementation and results at VISIR remote lab

The results obtained from the experience using the VISIR Remote Lab were then compared to the previous activities. Students submitted a report with the description of the practice carried out and the conclusions drawn to the professor.

3.2 Impact

Adopting the new tool VISIR Remote Lab to carry out the experiments turned out to be an appealing option for both students and professors. The tool is accessible and has an outstanding graphic interface. During the experience, there was an immediate adoption to the remote lab and the tool resulted intuitive, especially to students who

most of the time anticipated teachers' explanations about use. Probably, being familiar with similar real instruments at the UNPSJB lab, students did not need to read manuals or additional online information about VISIR.

Many aspects from the subject Circuit Theory syllabus were strengthened using a remote lab, namely the teaching objectives, the management, the task organization, the accessibility and the relation and integration with other pedagogical means and resources.

3.3 Analysis of the experience

The VISIR instance of the University of Deusto is deployed on the WebLab-Deusto RLMS (Remote Laboratory Management System) [3], which offers a set of administration tools in order to analyse the performance of the users during their remote experimentation sessions.

If this analysis is focused only on the UNPSJB target group, the following conclusions can be obtained:

- The number of students involved in experience were 11.
- The total number of uses of the lab has been 46. On average, a student has accessed to the lab 4 times.
- The total time of all the sessions has been 79215.06 seconds, that is 7201.37 seconds per user.
- The maximum number of access per day was 23, being 3561 seconds the maximum period per day (Figure 4)

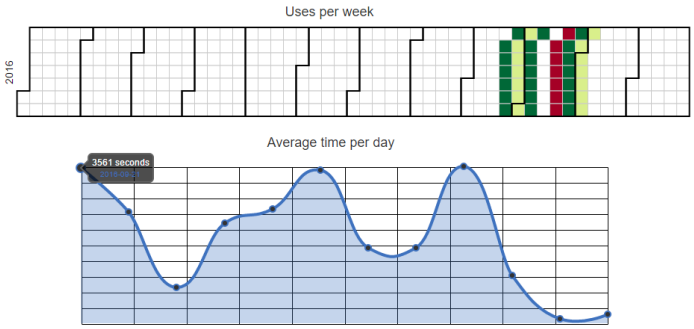

Fig. 4. Analysis of uses of VISIR by students from UNPSJB

If the experience of most active user (unpsjb_1) is studied, we can obtain the following information:

- The user with the account unpsjb_1 has accessed to the lab 11 times. The total time spent by the user on the lab has been 11780.19 seconds.
- The day that the user spent more time on the lab was on October, 18, being 60 1hour performing experiments on the lab. From this session, the following information can be obtained:

- The user performed 31 experiments on the lab. This does not mean that the user built 31 experiments, but he/she executed 31 times one or different experiment on the lab.
- This session was before the last one, and he/she did not perform any work circuit. This means that he/she did not try to build any not allowed circuit or measurement.
- During the whole session, the circuit under test was the same and it was built by the user in the same way. He/she only changed the configuration of the instruments to obtain a better resolution of the measurement and then a better understanding of the circuit behaviour.

4 Conclusion

The outcomes defined for VISIR+ project are the natural evolution of the use of the VISIR remote lab during the last 10 years. This remote lab has been tested and used by all the European partners involved in the project, so now it is high time it was deployed in other regions as Latin American. Then, all the experiences and experiments developed for ten years are going to be shared between all the institutions of the project. The Project implemented Training Actions to bridge these experiences between European and Latin American institutions. This paper shows how the VISIR instance deployed at University of Deusto is being used by Universidad Nacional de la Patagonia San Juan Bosco (UNPSJB) in Comodoro Rivadavia. However, this is only the first step of the VISIR spreading in Latin American countries. According to the working plan of the project, two VISIR platforms will be deployed on Argentina, making easier and faster its use by other Argentinean institutions.

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