

Using VISIR Experiments, Subjects and Students

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Abstract—The paper presents the results of applying the VISIR (Virtual Instrument Systems in Reality) system at the course of analog electronics for various degrees of the Faculty of Engineering of the University of Deusto (Spain). The efficiency of the VISIR had been monitored during past three years. Students' feedback was collected and analyzed. The research shows: 1) VISIR system is functional and useful learning instrument; 2) teacher experience at VISIR plays crucial role in its integration into student experimentation activities; 3) students get best knowledge and skills in the analog electronics from combination of experiments at traditional laboratory and remote lab/ VISIR.

Index Terms—Remote labs, VISIR consortium, analog electronics.

I. INTRODUCTION

VISIR (Virtual Instrument Systems in Reality) is an open laboratory dedicated to remote experimentations at analog electronics. The VISIR is equipped and allows carrying out tasks with real instrumentation. With VISIR the students in front of the computer execute the same job that they would perform at the traditional laboratory: select devices (resistors, capacitors, diodes, etc.), connect them in a breadboard, select and control the instrumentation, and finally, analyze the obtained results. The architecture and characteristics of the VISIR are well described in several papers [1,2,3].

The VISIR system has been implemented by Blekinge Institute of Technology in Sweden and it has been deployed in different Universities worldwide: University of Deusto (Spain), FH Campus Vienna and Carinthia University of Applied Sciences (Austria), Polytechnic Institute of Porto – School of Engineering (Portugal), and India; all of them are members of the VISIR consortium. The main objective of the consortium is to disseminate the benefits of the system, to promote the deployment of more copies of VISIR, and to share experiments and experiences among the members.

II. SCENARIO

VISIR is being used in curriculum of the Faculty of Engineering of the University of Deusto since 2007 for different degrees and fields of concentration: Telecommunication, Informatics, Industrial Technologies and Electronics. Presently the subjects related with VISIR are: Digital Electronics, Computer Technology, Analog Electronics, Circuits and Physics.

The scenario of the VISIR system application can be different: (1) at the classroom for illustration of the theory, (2) practice before regular lab sessions, (3) off campus usage, and (4) as a substitute of the traditional laboratory if the educational institution can't provide appropriate equipment.

As an example we will discuss the course Physics for Computer Engineering curriculum. The general objective of this course is to design a logic gate starting with the knowledge of the atomic electron behavior. The syllabus includes: the electron definition, understanding of current, Ohm's law, Direct Current (DC) circuits - resistors, Alternate Current (AC) circuits - capacitors, semiconductors, diode, the AC-DC converter, the MOS (Metal-Oxide-Semiconductor) transistor, the logic gate, and its characteristics. The students use only VISIR system for experimenting in laboratory.

The applications, assignments, and circuits are:

1. Function generator and oscilloscope. Various input signals are analyzed using an oscilloscope and reading values (see Fig. 1).
2. DC circuits. Basic circuits combining resistors in serial and parallel. Measure of voltage, current and resistor using a tester and a DC power based on Ohm's law (see Fig. 2).
3. AC circuits. Analysis and design of RC circuits, measurement of different values (see Fig. 3).
4. Diode characterization. Modeling of a diode using the DC power and the tester (see Fig. 4).
5. AC circuits. Analysis and design of a basic AC-DC converter: rectifier + filter. Measurement of different values (see Fig. 5).
6. MOS transistor characterization. Modeling of the MOS transistor.

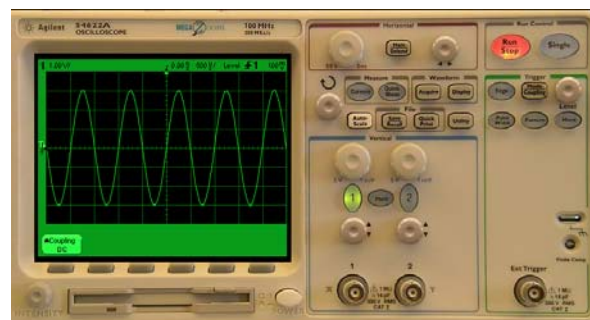


Figure 1. Oscilloscope of the VISIR system

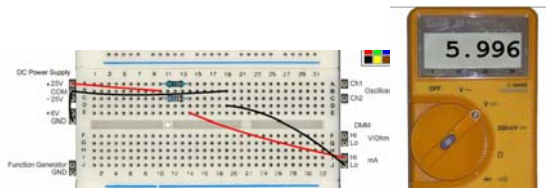


Figure 2. Basic DC circuit and voltage measurement with tester

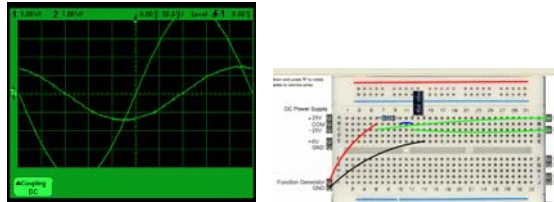


Figure 3.

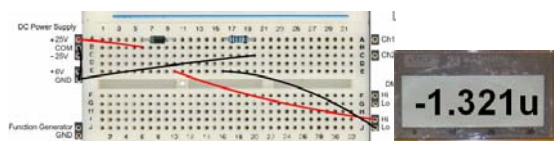


Figure 4. Diode circuit

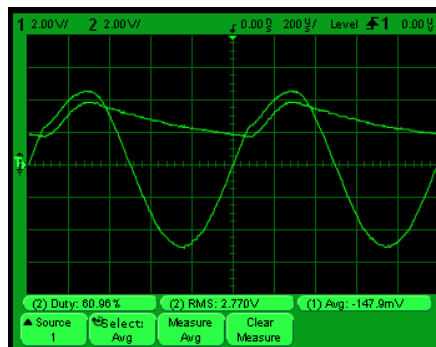


Figure 5. AC-DC converter: oscilloscope and values

III. STUDENT'S OPINION

In this section we demonstrate the survey filled by the students (see Table I) and the results obtained. The survey is divided in four blocks: Usefulness, Usability, Sense of Reality/Immersion, and Problems. Problems part is not included in the paper. The methodology of the survey has been designed based on results acquired four years ago at University of Deusto [4] and the surveys presented in [5,6].

The students provide answers to the survey questions in the number format where "5" points to the complete agreement of the responder with the sentence, and "1" points to the complete disagreement. Each colour-line describes the different experience of the teacher/educator with VISIR, see Table II.

The University of Deusto has two campuses: Bilbao and San Sebastian, which is located in about 100 kilometers from Bilbao. On the San Sebastian campus the traditional/real laboratory is unavailable (see Table II, column RealLab). On the Bilbao campus students can use both types of laboratories: traditional and remote/VISIR. The column "Exp." describes the experience of the teachers (see Table II, column Teacher) with remote experiments, and especially with VISIR.

TABLE I.
SURVEY FOR VISIR

USEFULNESS

Q1. WebLab helps me in the subject: concepts, practical exercises, projects, etc.
Q3. It is a good idea to extend this WebLab to all the students
Q11. I would like to use the WebLab in others subjects
Q12. I am satisfied with the WebLab
Q17. I have been motivated by the WebLab to learn more about the subject

SENSE OF REALITY/IMMERSION

Q2. Using the WebLab, I feel that it is real and not a simulation
Q6. I would like to have a WebCam to see something at the WebLab: a clock, a device, a screen, etc.
Q10. Being far from the VISIR, I have felt myself to be in control of it

USABILITY

Q4. I have enjoyed using the WebLab
Q5. WebLab is easy to use
Q7. The different devices (power supply, multimeter, oscilloscope, etc) are easy to use
Q8. I don't have problems with the assigned time
Q9. The devices implemented in VISIR are well selected

The subjects involved are:

- Computers Technology at Informatics Degree in Bilbao and San Sebastian campuses.
- Digital Electronics at Engineering and Informatics Degrees in Bilbao and San Sebastian campuses.
- Circuits at Engineering Degree in Bilbao campus.

At the first two above subjects the students from Bilbao campus used the traditional and remote laboratories equipment while the students from San Sebastian campus used only the remote laboratory equipment. At the third subject the students used the remote experiments only.

The averages of the surveys are shown in the Table III. The maximum value is 5, and the minimum value is 1.

Analyzing the Fig. 6-8 and Table III we obtained the following results:

- The students described the VISIR as a useful tool for the learning. For 1 - 9 scenarios (legend on the Figures 6-8) the student evaluation lays in the range from 3 to 4.
- The students described VISIR as a tool easy to use (good usability). The values lay in the range from 3 to 4 as well.
- The students showed concern about the sense of immersion of this learning tool. They evaluated this characteristic between 3 and 3,5.

The sense of immersion is related to the usefulness of the VISIR. Therefore, in order to improve the VISIR system the immersion of the user must be augmented. The same results for remote experiments were achieved by Corter, E. *et al.* [5].

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TABLE II.
LEGEND'S DESCRIPTION

Legend	Teacher	Campus	Subject	Year	Real Lab	Exp
1	Javier	Bilbao	Comp. Tech.	08-09	Yes	High
2	Javier	Bilbao	Digital Elect.	08-09	Yes	High
3	Inaki	Bilbao	Comp. Tech.	08-09	Yes	Low
4	Inaki	San Seb.	Comp. Tech.	08-09	No	Low
5	Inaki	San Seb.	Comp. Tech.	09-10	No	Med
6	Inaki	San Seb.	Digital Elect.	10-11	No	High
7	Javier	Bilbao	Digital Elect.	10-11	Yes	High
8	Ignacio	Bilbao	Digital Elect.	10-11	Yes	Med
9	Imanol	Bilbao	Circuits	10-11	No	Low

TABLE III.
SURVEYS' RESULTS

USEFULNESS

	1	2	3	4	5	6	7	8	9
Q1.	4,1	3,9	3,5	3,4	3,6	4,3	3,7	3,3	3,0
Q3.	4,5	4,4	3,4	3	3,4	4,2	4,0	3,7	3,3
Q11.	4,1	3,9	2,7	2,7	3,1	3,9	3,6	3,2	3,8
Q12.	4,2	4,1	3,3	2,7	3,3	4,0	3,7	3,3	3,7
Q17.	3,9	3,8	3,2	3	3,4	4,0	3,3	3,1	2,6

SENSE OF REALITY/IMMERSION

	1	2	3	4	5	6	7	8	9
Q2.	4	3,4	2,8	2,1	2,9	3,8	3,3	3,1	3,2
Q6.	3,4	3,1	2,9	2,8	3,4	3,7	3,7	3,7	3,4
Q10	3,9	3,3	2,7	2,1	3,0	3,3	3,4	3,1	3,2

USABILITY

	1	2	3	4	5	6	7	8	9
Q4.	3,7	3,8	3	2,9	3,3	3,9	3,6	3,3	3,6
Q5.	4	3,8	3,2	3,6	3,4	3,7	3,3	3,4	3,6
Q7.	4,2	3,8	3,4	3,3	3,5	4,1	3,8	3,5	3,1
Q8.	4,2	3,8	2,8	3,1	3	2,9	3,3	3,3	2,9
Q9.	4,4	4,0	3,3	3	3,5	4	3,9	3,5	3,8

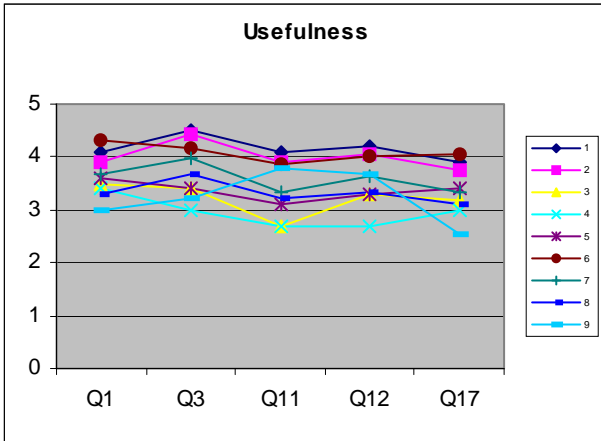


Figure 6. Usefulness (see Table II)

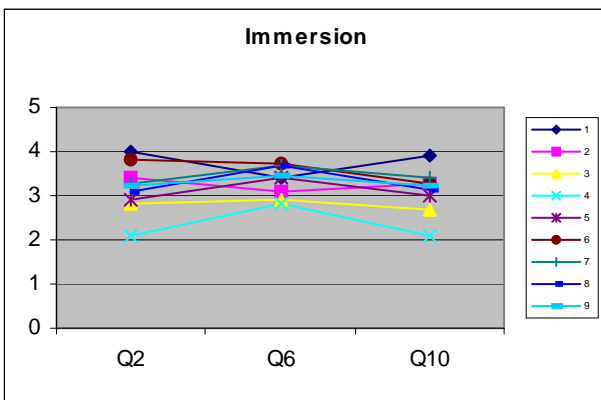


Figure 7. Sense of Reality/Immersion (see Table II)

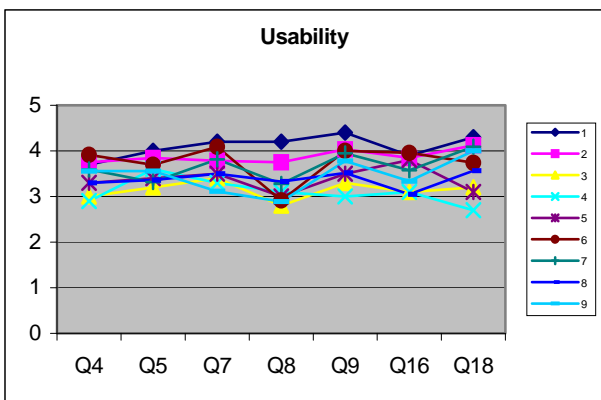


Figure 8. Usability (see Table II)

The Table IV shows selection of the two most representative questions at the blocks Usefulness, Usability, Sense of Reality/Immersion. The evaluation is organized from the highest to the lowest values. The main results are:

- The students are satisfied with the remote experimentation if the teacher has a broad experience with VISIR system.
- The students' satisfaction grows with the improvement of the teacher knowledge and skills in the remote/VISIR experiments.
- There is a high probability that the next semester students' evaluation and satisfaction of the remote laboratories for the teachers of scenarios 8 and 9 will be higher since their experience will be improved.
- Usually, the students are more positive in using remote laboratory if they have experimented at a traditional lab environment. This conclusion is not true for the case-scenario 6.

Attending [5] it is interesting to evaluate the correlations among the different questions of the survey. Figure 9 shows the main correlations among Usefulness (Q1 and Q11), Sense of Reality/Immersion (Q2 and Q10) and Usability (Q4 and Q5).

The highest correlations are found between Q1-Q2 and Q1-Q4:

- Q1. WebLab helps me in the subject: concepts, practical exercises, projects, etc. USEFULNESS.
- Q4. I have enjoyed using the WebLab. USABILITY.
- Q2. Using the WebLab, I feel that it is real and not a simulation. SENSE of IMMERSION.

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TABLE IV.
ORDERED SURVEY

USEFULNESS

	1	6	2	7	5	9	8	3	4
Q1.	4,1	4,3	3,9	3,7	3,6	3,0	3,3	3,5	3,4
Q11.	4,1	3,9	3,9	3,6	3,1	3,8	3,2	2,7	2,7

SENSE OF REALITY/IMMERSION

	1	6	2	7	5	9	8	3	4
Q2.	4	3,8	3,4	3,3	3,2	3,1	2,9	2,8	2,1
Q10.	3,9	3,3	3,3	3,4	3,2	3,1	3,0	2,7	2,1

USABILITY

	1	6	2	7	5	9	8	3	4
Q4.	3,7	3,9	3,8	3,6	3,6	3,3	3,3	3	2,9
Q5.	4	3,7	3,8	3,6	3,3	3,4	3,4	3,2	3,6

	2	4	5	10	11
1	0,67	0,74	0,49	0,03	0,53
2		0,36	0,19	0,12	0,26
4			0,25	0,13	0,47
5				-0,36	0,23
10					0,01
11					

Figure 8. Correlations among Q1, Q2, Q4, Q5, Q10 and Q11

It can be said that for improving the Usefulness of VISIR it is important to augment in the user the sense of reality when he is using the VISIR interface. This conclusion is totally in line with the prediction of [5]. A deeper statistical analysis must be done.

IV. CONCLUSIONS AND FUTURE WORK

In this paper we present the results of survey held during last three years. The research shows: 1) VISIR system is a functional and useful learning instrument; 2) teacher experience at VISIR plays the crucial role in its integration into student experimentation activities; 3) attending the correlations of Figure 9, the sense of immersion of the remote experiments should be improved; 4) best knowledge and skills at analog electronics students get from combination of experiments at traditional laboratory and remote lab/ VISIR.

The future research and development with VISIR at the University of Deusto will be focused on:

- Integrating VISIR for more courses, disciplines and degrees.
- Engaging the teachers, professional trainers, and educators for using remote experiments in their curriculum.

- Providing comprehensive training and support for teachers, educators, and trainers to build their competences in the remote experimentation.
- Improving the sense of immersion of the students when they are using the VISIR.
- Designing and implementing an automatic assessment system using VISIR for evaluation with remote experimentation.
- Implementing VISIR in a cloud computer network in order to share experiments with other universities and education institutions in efficient way.
- Collaborating with VISIR consortium for dissemination and deployment of the tool worldwide

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