# Realtime remote laboratory for instrumentation control

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## ABSTRACT

*The WebLab-GPIB, developed at University of Deusto, provides students with an Internet based application. With this application they can work on GPIB lab exercises without the necessity of physically sharing real equipment. The experience brings out a real solution for the practical problems of scheduling when the same devices are shared among quite a big group of students in the laboratory. The paper shows the architecture, the educational value and the results of the WebLab-GPIB.*

## 1. INTRODUCTION

In the following sections is described the experience with the WebLab-GPIB since the last two years. First is presented the experiments that students have to do in a subject and how the WebLab-GPIB helps them to solve some management problems. Later, the architecture that has been used to develop the WebLab-GPIB is analysed and the way to use this WebLab. Finally, the educational value of the WebLab is studied and the conclusions and future work are presented.

## 2. SCENARIO OF WEBLAB-GPIB

In the fifth year of Telecommunication Engineering the students must fulfill some practical exercises which are related to the theoretical curriculum of the subject "Electronic Instrumentation". The description and objectives of each exercise are shown in Table I. One of the topics of this subject is about Global Purpose Interface Bus (GPIB IEEE-488). The students learn the concepts of the interface, its characteristics and its application field with the objective of being able to interact with the electronic instrumentation located in the laboratory, using this GPIB. So, as in others subjects of engineering education, is needed to add practical sessions to theoretical sessions [1].

**TABLE I.**

**PRACTICAL EXERCISES OF THE SUBJECT "ELECTRONIC INSTRUMENTATION"**

| Practice | Description | Objectives |
|---|---|---|
| 1. Spectrum Analyzer and RF signal generator | Frequency domain response of a filter, the losses of wires and AM-modulated signal analysis. | • Control of devices by hand.<br>• Data collection.<br>• Analysis of frequency domain response. |
| 2. GPIB protocol | AM-modulated signal analysis in a remote way using a C program which contains GPIB commands. | • Control of devices by GPIB commands.<br>• Data collection.<br>• Analysis of frequency domain response |
| 3. Network analyzer | To measure the S-parameters of a filter and a coupler in a different frequency range | • Analysis of S-parameters.<br>• Data collection.<br>• Importance of the calibration |

The telecommunication laboratory oriented to RF experiments only has two spectrum analyzers, two RF signal generators and two network analyzers. Practices are made in pairs and each exercise is planned for a two-hour work. So the scheduling lasts for about two weeks. The reduced number of devices generates complicated schedules to allow all of the students to fulfill the proposed questions if they have not finished them during the sessions.

To complete the first and the third practical exercises the students need to be physically in front of the devices and to avoid waiting lists and difficult schedules the solution is to buy more equipment (the cost may be over 30.000€). But in the second practice, the students don't need to be physically in front the devices. While they are coding they can be working in any computer with a C compiler. When the program has not compilation errors, it must be run over the computer connected physically with the devices under control through GPIB wires.

Therefore, as the students don't need to be in the laboratory, the professor can explain the practice to all the students in a session and then through a WebLab, the students can test their programs over the real devices located in the laboratory. In this way, the students don't waste their time waiting to use the devices and the professor doesn't spend a lot of hours in the laboratory.

In the WebLab-GPIB developed at University of Deusto, the PC computer connected to the devices is a server in with the WebLab application runs. The students can connect to this server through a web site, download the generated code by them and then it is executed in the server over the devices under control, and finally they can observe the experiment using a webcam and receiving a file with the results.

## 3. WEBLAB-GPIB SOFTWARE ARCHITECTURE

The current version of WebLab-Deusto has been designed using web 2.0 technologies [2] (see Figure 1). A single client application shown in the user's browser communicates with the server through HTTP. The architecture has a web-based firewall-safe system programmed with AJAX. The main benefit of AJAX is that it works on any web browser, without any plug-in installation required.

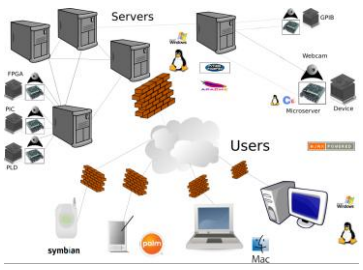


**Figure 1. WebLab-Deusto v3.0**

One of the advantages of the architecture and the technologies that have been used to develop WebLab-

Deusto is its scalability. Using this schema, the development of WebLab-GPIB didn't take the developers of the WebLab-Deusto much time. Even being the WebLab-GPIB a different kind of WebLab from WebLab-PLD and WebLab-FPGA [3], the incorporation of WebLab-GPIB into WebLab-Deusto was very simple and fast. It could be said that Weblab-GPIB is a portable a reusable application. Any device connected to the server in which the WebLab application runs could be controlled if it supports the GPIB standard.

### *3.1 Requirements on the Client Side*

As it happens with the clients of WebLab-PLD and WebLab-FPGA [4], the user of the WebLab-GPIB doesn't need to install any special software to interact with the remote experiment. It is not necessary any plug in and the user only need a web browser to connect to the WebLab. He can use a PC, a PDA or a mobile.

To develop the proposed exercise, the student only needs a C compiler and the VISA libraries that are necessary to communicate the PC with the GPIB board. This board is installed in the server and it is the interface between the computer and the GPIB. The libraries and other files (as headers files) are supplied by the professor during the theoretical lessons.

## 4. HARDWARE ARCHITECTURE

The following figure, Fig. 2, shows the hardware architecture that has been used to develop the WebLab-GPIB. The dotted line represents the division between the traditional laboratory and the WebLab. The only one difference between the hardware architecture of a hands-on laboratory and of a WebLab based on GPIB is that in the last one Internet is the join between the end user and the devices. The rest of the architecture is the same.

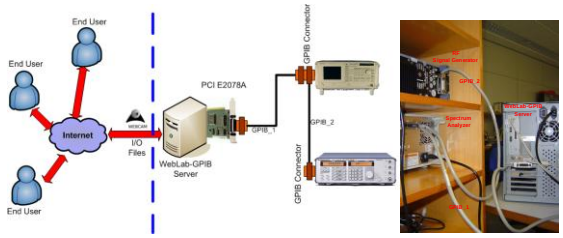


**Figure 2. WebLab-Deusto 2.0**

The GPIB PCI board is plugged in the server, which is connected through the GPIB wires to the devices under control, the spectrum analyzer and the RF signal generator. Two wires are needed: one from PCI board to the spectrum analyzer and other one from the spectrum analyzer to the RF signal generator: a bus network topology is created.

## 5. RESULTS OF WEBLAB-GPIB

Since 2007 WebLab-GPIB was in use by the students registered in the subject "Electronic Instrumentation", in the fifth year of Telecommunication Engineering. This course has 45 students registered, out of those 30 have done the GPIB exercise using the regular laboratory and 15 have done the practice using WebLab.

Table 2 summarizes the results of a survey proposed to the students. This table gives to the professor an idea about the students' satisfaction about the utility and quality of the WebLab. Grading system goes from 1 to 5.

**TABLE II.**

**RESULTS OF A SURVEY PROPOSED TO THE STUDENTS ABOUT WEBLAB-GPIB**

| Question | 2007 | 2008 |
|---|---|---|
| Number of accesses to the WebLab | 75 | 50 |
| 1. Has WebLab helped you with the subject? | 2.7 | 2.9 |
| 2. Did you feel that you were in a better position by having been in the WebLab group? | 3 | 3.1 |
| 3. Do you think it is a good idea if this WebLab experiment is extended to all the students? | 4.2 | 4.3 |
| 4. Is it easy to use? | 4.2 | 4.0 |
| 5. How is the quality of the Webcam? | 1.9 | 2.1 |
| 6. Do you think it is a good idea? | 4.6 | 4.5 |
| 7. What do you think about the time assigned to each connection? | 3.4 | 3.2 |
| 8. Do you think it is a useful tool? | 3.9 | 4.1 |
| 9. Being far from the prototype, Have you felt yourself to be in control? | 3.5 | 3.2 |
| 10. Would you like to use WebLab in other subjects? | 4 | 4.1 |
| 11. What is your global satisfaction with WebLab? | 2.8 | 3.1 |

If it is taken a look to the table, is very interesting to observe that most of the students think that the use of WebLab-GPIB is a good idea and there agree to use it in other subjects. WebLab-GPIB must improve the quality of the Webcam and perhaps time connection should be greater than it is now. It is very curious that in the general questions about the WebLab (3, 4, 6, 8, 10) the mark is over 4 and in the questions about personal experience with the WebLab, the marks are bellow 3.

## 6. CONCLUSIONS AND FUTURE WORK

The WebLab-GPIB has demonstrated the reusability of the developed architecture for other WebLabs in WebLab-Deusto. Furthermore, this architecture can be used anywhere for any devices which support GPIB interface standard. In this way the deployment and set up of the WebLab will be very simple and reusable.

In future versions, the program downloaded by the students must be tested to avoid malicious code and forbidden sentences. The current version of WebLab-GPIB only allows fixed experiment. For this reason, currently it is working in adding a system that allows the students to select different devices to test them in real time using this remote lab.

## REFERENCES


[1] Samoila, C. Ursutiu, D. Cotfas,P. "Enhancing engineering education through remote experiment". III Simposium Internacional REV 2006, Brasov (Rumanía), July 2006

[2] J.García-Zubia, D. Lopez-de-Ipiña, P. Orduña, U. Hernández, and I. Trueba, "Questions and answers for designing useful WebLabs", Vol.2, No.3 (2006) of International Journal of Online Engineering (iJOE) http://www.ijoe.org/ojs/viewissue.php?id=2

[3] J.García-Zubia, D. Lopez-de-Ipiña, P. Orduña, U. Hernández, and I. Trueba, "And approach for WebLabs analysis*" Vol. 3, No. 2 (2007) of International Journal of Online Engineering (iJOE)* http://www.i-joe.org/ojs/viewarticle.php?id=119

[4] J.García-Zubia, D. Lopez-de-Ipiña, P. Orduña, U. Hernández, and I. Trueba, "Evolution of the WebLab at the University of Deusto" *EWME 2006*, Stockholm (Sweden), June 2006