Web based Design of Virtual Teaching in the Laboratory of Automatic Control

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Abstract

This work describes one of the main Web based Control learning projects known as: The Design of Virtual Teaching in the Laboratory of Automatic Control, that is presently being developed by the Department of Processes and Systems of the Simón Bolívar University in Caracas-Venezuela. This project is mainly focused in developing more effective teaching methods by using interactive Web based experiences to complement the traditional day to day laboratory practices performed alive at the University. Such project uses the newest technology of information methods based in the usage of a Web teaching server, and the development of self learning multimedia material.

1 Introduction

The Engineering Courses Systems of Automatic Control are based on two mu tually complemented components: theory and practice. The laboratory experiences become a powerful learning tool because they enable the student to deepen and to put in practice all the knowledge he already acquired in the theory. As a result, this experiences require its physical presence since it will be the best way that will enable him to manipulate the control systems.

The experimental part of the laboratory practices uses specialized equipment like process training plants that represent the physical problems usually found in the industry. The research previously done on the subjects to be studied in the practical experiences, generates a faster and deeply learning environment since it allows the student to use the laboratory resources and the time more efficiently and effectively.

Web based teaching system has satisfactorily resolved the implementation of the beginning stages of the learning process. First, by transmitting basic concepts, and second, by providing ways of acquiring deeply knowledge through the understanding of several examples, the making of different exercises, etc.

The Web is becoming the most important and attractive tool for education, see for instance: Dormido (2002), Poindexter (1999), Owston (1997) and references there in. Due to its conception and great availability, we consider that it will be the future virtual educational tool. Since the Web allows the combination of a series of elements such as: text, images, audio, video and animations, it guarantees an elevated level of interactivity, and avoids the distraction and lost of interest from the students. It also has an advantage over the books because it integrates both video and audio, it displays the interactivity that a VHS doesn't have, and unlike a CD-ROM, it eliminates geographical boundaries by facilitating the communication with other people around the world at all times.

The Web is considered the greater and the most diverse source of information in the world today because anyone can easily incorporate any type of information according to his/her needs, and publish new educational material keeping it up to

date with the latest scientific discoveries. It also facilitates the distribution of information between Universities and research centers.

The lab of Automatic Control of the University Simón Bolívar has decided to choose the Web like its platform for its new technological teaching. The following part of this work describes the fundamental aspects on which the new virtual laboratory project will be based.

2 Developing the teaching method

To run this project the laboratory must have a Web server with a data base for each student attending the course. Besides the necessary application tools needed to perform all the courses. It is important to announce that this project will follow the standard procedures required for this type of work detailed in en Llamas et al. (1997).

According the expertise acquired in the past years by other Investigation Centers in the Distance Teaching and Learning projects (Sánchez et al. (2000), Anido et al. (1999), Schmid (1998), Aktan et al. (1996)), we will mention the main aspects to be taken into account to be included in the present project of virtual teaching.

3 Learning step by step

From the pedagogical point of view, it would be convenient that the access to each lesson could be conditioned according to actions previously developed by the student. A good example of it, will be the need of the student to do some research on a specific lesson before undertaking the study of another one, since a series of concepts needed for the understanding of the second lesson are present only in the first one.

It must offer the student the option to:

- Retake the selected course exactly on the part where he stopped on the past session.
- Start over the selected course.

The learning procedures must guarantee that the student had passed some tests that will measure its knowledge in a specific lesson before approaching another one. The system will show all the actions that the student have been performing throughout the course, and at the end, the teacher will evaluate the knowledge of the individual by a virtual examination page that automatically will notify the final results to the instructor.

The adoption of the students of this new way of learning will enable them to develop personalized study habits since they will be able to do their homework at their own time and place, and avoiding the need to adjust to a specific time schedule.

4 Cooperative learning

The collaborative learning must provide a series synchronic and asynchrony tools that will enable the teacher and the student to get in touch at all times. This provides a cooperative learning environment that actually stimulates the learning process on the student since he starts to feel that he belongs to a group and is not left aside. Among the communication tools that must integrate the system we find:

(i) E-mail: is the most used communication tool, and the easiest way for the users to get in touch because it allows the sending and receiving of messages to other users of the lab. Its usage doesn't need the simultaneous coincidence of the communication agents. To make it a user friendly tool the address book of both the teachers and students must be actualized.

(ii) Discussion forum: its mission consists in becoming the way to share information. In this section the student will be able to visualize and share experiences with the other members of the group. And by this way, it won't be necessary for the teacher to repeat a lesson already given in class.

(iii) Video Conference: consists of a tool where the students can share a visual context and real time working sessions with specialized instructors through the distance. The use of video conference breaks all the geographical boundaries, and by doing so it enables the reinforcement of the learning process. It can be used to complement , support, or as a source of an educational multimedia system that brings together two or more distant groups of people in a cheap way.

5 Tracking and monitoring

The system must have the capacity to tracking and monitories the student. Due to the fact that each one has a data base which is automatically actualized any time he performs an assignment, all the activities that the user have done will be displayed along the course.

This module must provide an application able to confirm in the student that the correct learning process has been performed, and that all the objectives have been achieved. Besides all the above mentioned, the teacher will also be able to know the degree of advance reached by the student. This new learning method will provide the user with some type of retro alimentation that will enable him to slowly become self guided in his learning process and work harder on his weak points.

Another important aspect that will allow the performance of to this module, is the detailed study made after the sequences o working stages of each student to discover the study style that will eventually generate the best results in the learning process.

The system will detect incorrect navigation actions, for example: non authorized navigation sequences, student attempts in trying to open several sessions simultaneously, or the completion of anomalous sessions.

6 Principal tendencies in the teaching laboratories field about Internet

Although it is relative to publish educational material in the Web that can be used as a complement or as an alternative to the conventional theory teaching, the how to? implementation of the paradigm of practical learning to the modality of distance learning is not really evident. Our main concern relays on the following question: what must be done to transform a traditional laboratory to a Web environment where a virtual lab will be reachable through the internet; therefore, providing the student with virtual practices and given him the opportunity to experience with simulations and real plant. To solve this paradigm two principal tendencies exist in the teaching lab field and internet.

(i) The use of dynamic and interactive simulation. This solution involves a mathematical calculated environment in which plant simulations of didactic interest are being performed. This environment allows the complete configuration of mathematical models (disturbances, physical parameters, etc.); establishing therefore, the pedagogical objectives that the students must finally reach. In this solution the information is shown through graphical user interfaces (GUI). Example of this solution can be found in Cooper, Fina (1999) and Dormido et al. (2000).

The Automatic Laboratory Control of the USB has recently developed diverse laboratory practices using Simulink and Matlab® for the development of several systems like: the level of interconnected thanks, Ph control, etc., and as we already mentioned, the student interacts with the system through the GUI. In figure 1 a GUI window used in the lab practices is shown.

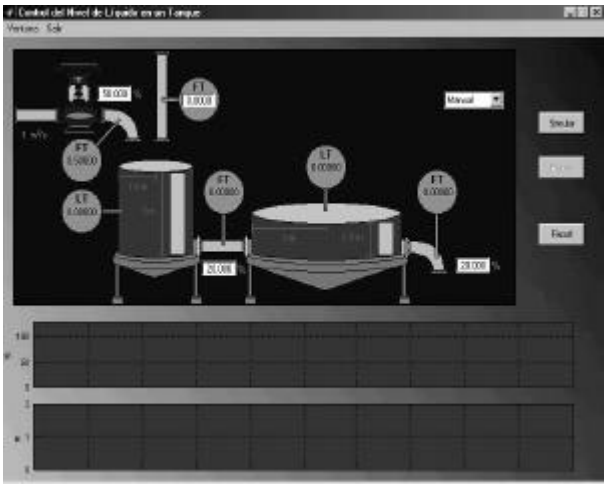

Figure 1. GUI window of lab practices.

(ii) The use of the Web is anther solution that will enable the remote access to any real laboratory through the usage of GUI interfaces. By using a Web navigator, the students will be able to access the instruments or existing experiments in the real laboratory located at the University.

With this solution, a visual and auditive communication with the plant on which the experiences are being performed is required. By doing so, the students will be able to visualize and discover on a real time basis how the control actions executed influence on a real plant. Through the direct visualization of the process via GUI, the student acquires a real feedback of the entire experimental process. Since the student and the system will record the experience, he will be able o do some research on a specific stage of the experiment upon its conclusion. Example of this solution can be found in Bhandari y Shor (1998) y Röhrig y Jochheim (2000).

At the moment, our laboratory has four Quanser® training plants: the inverted pendulum, the ball and beam, the rotoflex and flexgage. All of them are remotely controlled via Intranet. To control the training plants in real time we use the WinCom® (client – server) applications that come together with the equipment. The configuration used for the connection of the equipment is shown in the figure 2.

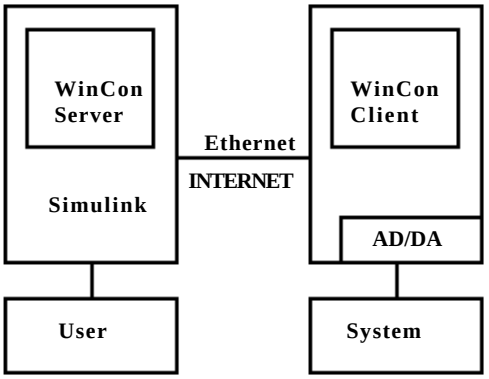

Figure 2. Control configuration via Intranet.

The control diagram its performed by a remote computer (server) using Simulink®. Upon its execution, it is complied with the toolbox RTW of Matlab® using WinCon® libraries, and the generated code is send to the client compute via intranet. The connection is successfully done because this computer contains the acquisition cards (AD/DA) which facilitate the connection among the equipments. This way, the control loop remains closed in the client machine, and since it is not distributed between the client and the

server, there will never be delayed in the control tasks transmission across the net.

7 Conclusions

This work has presented the Web Based Project Design of a Laboratory of Automated Control oriented to enhance the effectiveness of the teaching profession. To achieve this goal, we seriously recommend the development of complementary interactive activities to the physical attended laboratory practices. We can differentiate this project from the traditional teaching methods because it uses the most important technological tools developed in the past decade.

To reach the main goal in teaching, which mainly involves the better understanding of the students of the theory and practice on the control systems subject, different studies were made. Among this studies, we considered that the main characteristics that must be included in the teaching Web based method are:

Step by step learning, that stimulate the student control learning process.

Cooperative learning, that stimulate the laboratory group members.

Continuously students monitor and evaluations.

Module of distance teaching practical experiences via Internet and Virtual Lab that of remotely controls the plants.

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