Integration of WebLab Systems in Engineering Studies

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Abstract — *In this paper, the results of a new experience based on the integration of WebLab systems in Engineering Studies at the University of Deusto are presented. The content of this paper describes the use of a Laboratory supported by Web Technologies and its application to practical teaching of Industrial Automation processes. The teaching practices based on these systems require a new methodology that influences the design and use of these systems on the part of both teachers and students. At the present time, most of the WebLab systems incorporate their own methodology and the specifications for these systems. However, a methodology of appropriate teaching applied to these systems does not guarantee the wanted results. The success of quality teaching is only guaranteed if these systems are correctly integrated into the practical teaching of Engineering Studies. The paper is composed of the following sections: the first, motivation and strategic plan; second, current problems of Engineering Laboratories; third, description of the proposed WebLab system; fourth, integration of the WebLab system into current methodologies Finally, results, conclusions and the viewpoint of the authors concerning the future and possible incidences of the WebLab systems in the Engineering Studies.*

Index Terms — *E-Learning, Engineering Laboratories, WebLab systems.*

MOTIVATION. STRATEGIC PLAN

At present, the University of Deusto is developing its 2000-2003 Strategic Plan, whose motto is" The Value is the Person" [1]. One of the factors that is considered essential to achieve the proposed Vision is related to pedagogic innovation. This innovation intends to impel the student's protagonism through an autonomous and significant learning.

The pedagogic proposal contains two fundamental strategic options which we should develop and which affect the student's formation as well as the teacher [2]. To carry out the proposals of this key factor, three performance projects are proposed:

- Methodology Design. The composition of a catalogue of didactic methodologies favouring the autonomous significant learning of UD students. Boosting didactic strategic resources which lead to lectures/classes being more active and dynamic.

- IT Training: Development of a platform providing educational software in line with the UD learning model. Training to aid the incorporation of computer technology into university education.

- Instrumental Student Preparation. Creation of familiar basic work tools which favour academic work and behavioural habits of high quality. Development of these tools in order to make them easily available.

In this context of pedagogic innovation, we present the use of a laboratory supported by Web technology and its application to the practical teaching of processes of Industrial Automation. The teaching practices based on these systems demand a new methodology that influences the design and use of these systems on the part of professors and students.

This new methodology provides the student with a laboratory through the Web from which a student can carry out the same assemblies or experimental measurements as those that he/she normally makes in situ in a conventional laboratory. This system adds the advantage that the practices can be carried out at any hour and from any point of the net.

CURRENT PROBLEMS OF CONVENTIONAL LABORATORIES

The subject of Industrial Automation is given in the second year of Industrial Engineering at the University of Deusto. The number of students enrolled in this subject is 310. Students receive a weekly practical class lasting an hour which is worth 1,5 credits. Each practical class is divided into groups of 40 students. The students also have a schedule-free laboratory session with the support teacher and monitors to carry out their practicals in an autonomous way. However, the problem with the current system is the following [3]:

- Size of the laboratory: The laboratories require extensive facilities to adapt the practicals to students' groups besides the safety reasons.
- Large investment in equipment. The cost of a laboratory with practical industrial equipment is very high. The upgrading and the maintanance of the equipments is expensive for an educational center.
- Specialized personnel: The laboratories require dedicated personnel specializing in the teams. A plan of periodical recycling of their laboratory personnel is required to adapt to progressive advances.
- Security: Students need to know the safety norms and prevention of risks related to the laboratory teams.
- Pratical groups. In conformity with the orientations of the general services of education, the practicals should be carried out in reduced groups for greater assimilation and comprehension of the contents.

In consequence, the laboratories are busy for subject's practicals. Therefore, the schedule-free use of the laboratories is considerably reduced. The laboratory timetable is from Monday to Friday from 2 pm to 9 pm. This time is insufficient to attend the demand of all students.

DESCRIPTION OF THE PROPOSED WEBLAB SYSTEM

The proposed WebLab system brings the students a new teaching methodology that provides them with a laboratory through the Web technologies, from which they can carry out the same work and experimental measurements as those usually carried out in situ in a conventional laboratory.

The 2nd year subject of Industrial Automation is framed within the first two levels of the Pyramid of Automation (acquisition and control level). The Industrial Automation laboratory of the Engineering Faculty at the University of Deusto is organized into three integrated categories: personal computers, wired logic and programmed logic.

The first category is composed of 35 PC Pentium II connected through the network to a server in which Microsoft 2000 Server is installed. The second category, components which permit carry out the programming in wired logic are: 8 pneumatic panels and 6 electric automatism panels. The last category, programmed logic, is composed of 35 PLCs: one of then is of high range, 20 are half range, 14 are low range, 10 EasyPort interface with 8 analogic & digital input/output and, finally, there are also 4 integrable scale models (System Production to Modulate) which include Distribution Station, Testing Station, Processing Station and Hydraulic Punching Station [Figure 1].

The proposed WebLab system enables one to control the scale models of the automation laboratory through the internet. The control is carried out in a simple, flexible and robust way. The system takes advantage of the power of Microsoft 2000 Server and its application Terminal Server installed in the client. The terminal server placed in the student's computer can operate in any operative system: Windows98, Windows NT, Windows 2000, etc. This software is free and any student can have it. This application allows a client to control the application of the server. It also allows several users to display the application at the same time with different desks. The pneumatic panels are connected to the server by means of an EasyPort interface via serial port or PLC.

The structure of the proposed WebLab system is made up of the following processes:

First, a simple laboratory located in the university campus. The scheduled practicals are mounted in the laboratory panels. The scheduled practicals are developed in a sequential and progressive order of knowledge. This implies that a student will be able to continue with the following practicals when he has carried out the previous ones satisfactorily. The access control is managed by means of a list of authorizations with corresponding identification and student keys.

Second, a WebCam carries out the process of visualization of the didactic panel. The camera is located in the panel and squarely captures the images of the elements that integrate the equipment [Figure 3].

Third, once the communication between the university server and the student's computer is established, the student's computer screen will have two windows [Figure 4]. The first window visualizes in real time the images given by the camera and refreshed each second. This window only has a visualization property. The second window shows the control diagram and circuit of the laboratory panel. This window has the property of interacting on the control diagram. The student, by means of mouse or data entry via keyboard, can select the on/off state of the automation. The system provides a graphic tool that provides the user with a sequential vision of the control diagram, also highlighting with color and brightness the process that is being carried out at that moment. This tool is the key to the learning system and interpretation of normalized electric planes.

INTEGRATION OF WEBLAB SYSTEMS

Most conventional WebLab systems conventional are composed on a single unit of independent teaching [4]-[5]. The complete system of learning is based on the use of this tool. Therefore, the success and the importance of these learning systems resides in the design and programming of the WebLab system. Besides teachers, specialists in programming of Web technologies (e.g. Java, Flash etc.) are necessary to create and support it. These systems constitute a closed structure which is not flexible. A practical is always executed in the same sequential order as it has been programmed. The execution of the automation process has been programmed previously and the student always observes the same execution. Therefore, the behaviour of the automation process depends on a previous programming. Student carries out the start/stop of the system and he observes his execution. Student does not participe in the control because the electro-pneumatic circuit has been programmed previously. Actuators always belong together in a single diagram of movements. Therefore, these systems are not flexible for the student or for the teacher and their structure is closed. Student loses motivation with time because he does not experiment with his/her own ideas and interests.

Alternatively, we present a new focus based on the integration of a WebLab system into the teaching of Engineering Studies . This system does not constitute an independent unit of E-learning teaching. The system is integrated and synchronized in the laboratory practicals. Student uses this technology to reinforce his/her knowledge and to experiment with her own practicals.

The structure of the proposed system is an open and flexible one. The success of this system does not depend on the designer. The teacher modifies the practices without modifying the design. Student carries out a practical in the following order. First, student introduces in their computer a electro-pneumatic circuit for the control of the automation system. Second, student checks the correct operation of the system, and finally, once observed its correct operation, executes a real control observing in its monitor the real behavior of the system and in another window a realistic simulation of physical behavior [Figure 3]. This window have a help page with the description and operation mode of each component.

Student has possibility of control of the system with different circuits. Student generates his own circuit and relates it to the automation panel by means of input/outputs logical block [Figure 3]. The pins of this logical block receive and transmit a sign to the interface which communicates with the industrial automation panel. Student can modify the circuit changing the connection of the pins and then each circuit corresponds to a different diagram of movements or execution. This way, an autonomous teaching is potentialized which supplements its formation.

Finally, the system controls the access and time of execution. By means of a key and identify of the student have access to the practice practical which corresponds him. The results of the practical are saved into the system computer, and after these results are supervised by teacher.

RESULTS

In this section are shown and analyzed the results obtained from the influence of the practical classes in the theoretical practice comprehension of the subject Industrial Automation. These results reflect the point view of both teachers and students [7]. From the teacher's view point, it is verified that the incidence of the use of the proposed system allows students to secure the theoretical-practical comprehension of programming automation sequential processes and improves the schedule-free laboratory sessions.

To achieve the student's view point, a survey was carried out once the academic year had ended. Students expressed their degree of agreement on a valuation scale from 1 to 5 for each proposed statement. The statements are focused to evaluate aspects related to methodology used, the student's autonomy to carry out the practicals, integration of the WebLab system in the subject and the difficulties arising in the use of a new technology. The most important results in this evaluation confirm the following aspects:

- It facilitates the theoretical-practical comprehension of the sequential automation processes.
- It allows the student to select when to carry out the practicals and their duration.
- Integration of the practicals in a synchronized way.
- Students are familiarized with the technology used.
- Students value the integration of these technologies positively in other industrial processes.
- High use incidence in the closed schedule of the laboratory (Monday to Friday from 10 pm. to 11 pm. and greatly used on saturdays and holidays).

The results shows the main advantages of using these Web Technologies. However, it is important to mention some inconveniences which arose on the WebLab systems being put into operation. The majority of these problems were subsequently dealt with. Furthermore, the student's tendency to carry out more of the proposed practicals as a result of the system's novelty factor should also be pointed out. This inconvenience was overcome by arranging the practicals and their timetables in sequence with theoretical classes. Finally, problems not pertaining to the WebLab systems should also be mentioned, i.e. those which arose due to external factors, such as reliability of the Web, the on-campus electrical system and so on.

CONCLUSIONS

In this paper, we have presented a new WebLab system for the control of industrial sequential processes. On the other hand, these new learning techniques are already present and at the student's disposal. The most outstanding conclusions obtained from the results previously mentioned are the following:

- This emergent technology, put an array of new teaching possibilities at the disposal of the university, schools and teaching institutions.
- Students feel more motivated if they themselves can handle their experiments and therefore explore the possibilities of the experiments following their own interest, curiosity and ideas.
- The industrial process can be controlled from any computer located anywhere, via the internet.

Finally, WebLab laboratories add a new dimension to the methodology of traditional teaching, their universality [6]; they are open or exportable to any experimental laboratory.

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FIGURES AND TABLES

FIGURE. 1
ELECTRO-PNEUMATIC PANEL, PROCESSING STATION, ELECTRIC PANEL, DIDACTIC ELECTRIC PANEL.

FIGURE. 2
CAMERA.

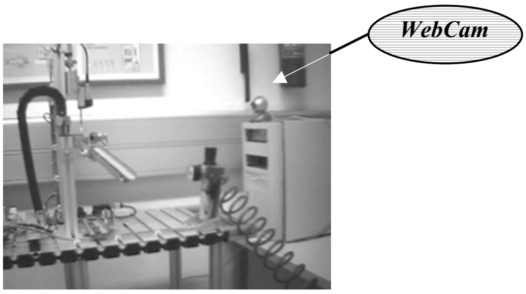

FIGURE. 3
STUDENT´S COMPUTER SCREEN .