A Virtual Laboratory for Cooperative Learning of Robotics and Mechatronics

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Abstract - **In this paper we describe the design and implementation of a remote virtual laboratory for cooperative learning of Robotics and Mechatronics over the Internet. The context of this work is a Doctoral Project which includes several efforts to provide remote access to laboratory facilities in other universities. We discuss some of the issues that were encountered in designing the software and hardware components of our outdoor laboratory and its associated web interface.**

Index Terms - Cooperative Learning, Mechatronics, Robotics, Virtual Laboratory.

INTRODUCTION

One of the fundamental characteristics of the educational chore in the engineering careers, mainly in the engineerings Mechanics, Electric and Electronic, it is the great number of hours of the laboratories that you/they are imparted in the same ones, as well as the cooperative work that you/they should carry out the students in this laboratories.

For the case of universities highly in demand and of scarce resources like they are it the university institutions of the Dominican Republic, the access to the laboratories is still more critical and more painful. With this result it's necessary to introduce the teaching of highly sophisticated technologies as the Robotics and the Mecatronics, faces to the university planners with these obstacles.

All the above mentioned us to propose the use of virtual environments and of remote access for the teaching/learning of Robotics and Mecatronics, in such way that leaves beyond the simple use of tools for the simulation and emulation of equipments, until the activation possibility and remote monitoring of physical structures and their use in a shared way and colaborative among the national universities that possess the infrastructure for it.

JUSTIFICATION

The study programs in Engineering in the area of Robotics and Mecatronics, like bases of the Industrial Automation, they should combine theorical and practical aspects so that the students acquire knowledge and abilities, which require the intensive use of laboratories endowed with such equipments as Robots, CNC, PLCs, sensors, integrated in nets and supported by appropriate communication protocols. In the particular case of the Dominican Republic, some facilities has begun to be available hardly for some years ago.

The need to experience and solve real problems bears to the execution of activities of laboratories that you/they should be carried out in a present way or through simulation software packages, letting students master procedures, skills and Technologies in offline settings, where current equipment does not exist or has limited availibility.

Therefore, the laboratory showed in this work seeks that the students could access systems far through Internet and carry out experiments at distance, in such a way that several universities of the country that possess some specific laboratory of Industrial Automation, can share the same one with other universities, forming this way a net of integrated laboratories and shared, minimizing costs of acquisition and operation, and maximizing its use.

VIRTUAL LABORATORY AND REMOTE LABORATORY

A stage that had to cover in this investigation was the elaboration of a taxonomy that allows to categorize the Virtual Laboratories of the Laboratories of Remote Access. We understand for Virtual Laboratories those ones where you can make simulations of physical devices using software [1]. In some cases, a well designed virtual laboratory can substitute a real laboratory, mainly when this incorporates elements of animation (graphics, sound, virtual reality).

The virtual laboratories that are accessible through Internet/Intranet are highly attractive to reduce the costs of acquisition of equipments; using a browser like interface for a virtual laboratory has the following advantages:

- It is independent of the platform.
- It has a great and easy way of use.
- The need of additional software is minimum in the client's side.

On the other hand, the Laboratories of Remote Access allow that real experiments of laboratory are controlled far through a connection Internet or via Web.

Associated to these types of laboratories they are the aspects of Virtual Factory and Remote Factory (or Telemanufacture). The Remote Factory uses services offered through Servers to execute production operations in real time; this way the telemanufacture activities are present from the

conception until the creation of the product. On the other hand, the Virtual Factory is a synthetic factory atmosphere where they are integrated objects, activities and real processes with objects, activities and feigned processes.

DESCRIPTION OF VIRLAB

Our group has been designing and constructing VIRLAB (**VIR**tual **LAB**oratory for cooperative learning of Robotics and Mechatronics) as to means to incorporates and to share several university's laboratories, as it shown in Figure 1. VIRLAB is a system that allows to university students of subjects of industrial automation (Robotics, Mechatronics, PLC´s, sensors) to practice commands of positioning of feigned devices learning basic and advanced aspects. Also, the commands can be sent to real devices, located in the laboratories of the net, to see theresults in an on-line way through Internet, once the system distributes the accesses among the available laboratories.

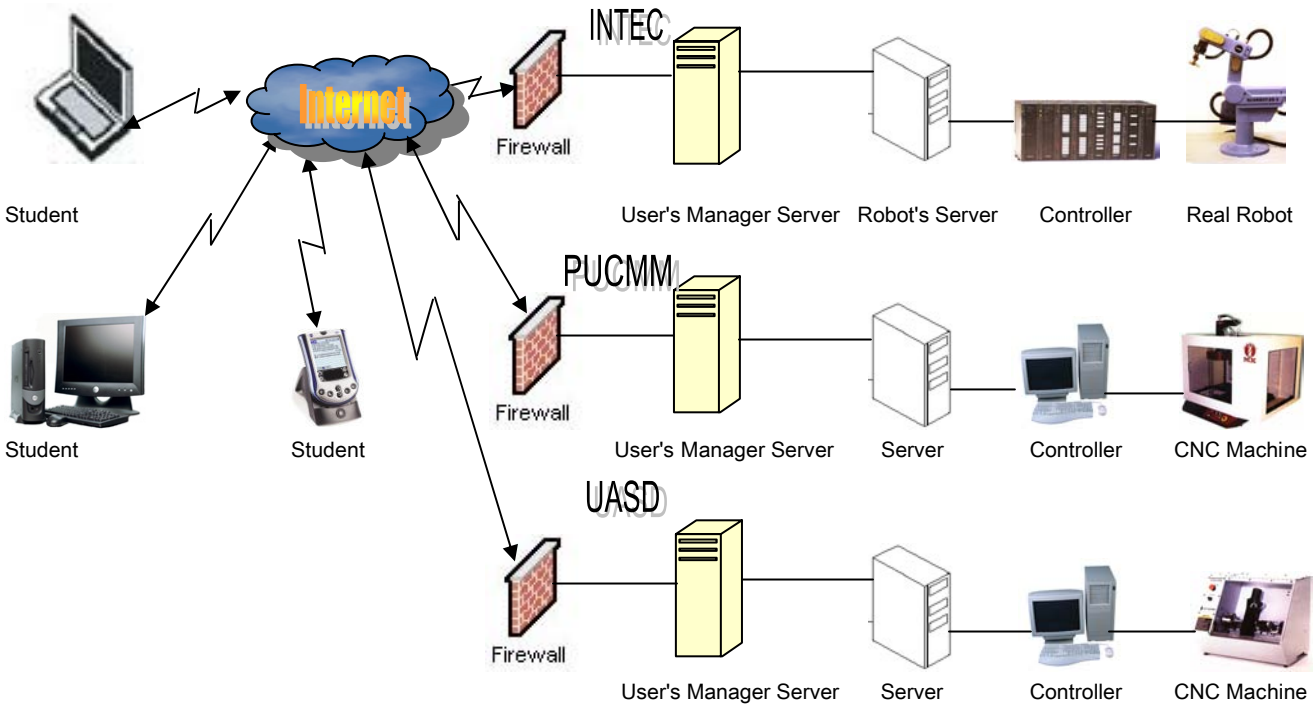

FIGURE 1
ARCHITECTURE OF VIRLAB

TECHNOLOGICAL ASPECTS

The first version that we have developed of VIRLAB offers an interface created with Java and VRML, a standard software of Internet to represent scenarios of virtual reality. At the present time, we are working in a version based on Java and Java-3D. The only means required by the student are a computer (of desk or portable) with connection to Internet, a navigator web and the components of software of the virtual machine of Java and of VRML in their case.

VIRLAB FEATURES AND BENEFITS

With VIRLAB, students participate from a classroom, the office or from home through their own PCs. This system provides students with a complete learning environment where they can view the instructor and course material, as well as interact with the instructor and the other students, feedback through the toolbar or HTML pages (see figure 2), collaborative whiteboard, application sharing, or by email, text messaging or in chat rooms.

Other characteristics of VIRLAB are:

- Synchronous learning: Enables instructor led lessons for large groups that engage the students as if they are in the same classroom.
- Asynchronous learning: On demand, self-paced interactive training.
- Collaboration tools: Student to teacher and student to student collaboration tools.
- Multiple concurrent lessons: Can be transmitted concurrently to different groups of trainees.
- Scalable: Enables delivery to training to any number of geographically dispersed students.

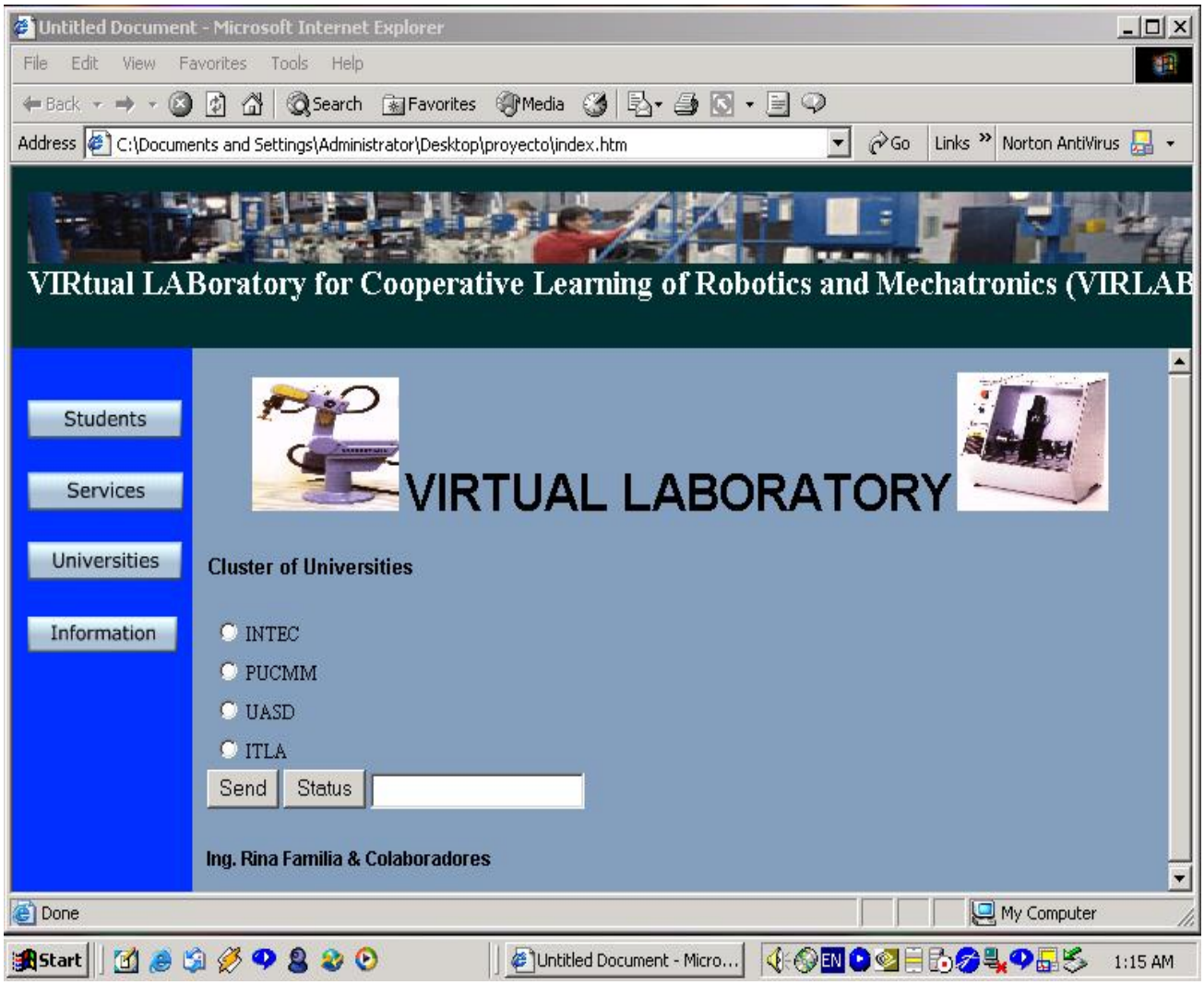

FIGURE 2
VIRLAB'S INTERFACE

CONCLUSIONS

- The virtual laboratories for the learning of Robotics and Mechatronics contribute to develop abilities and search habits and analysis of knowledge upgraded to apply then in the solution of problems.
- The main impact of these laboratories resides in the capacity that is believed to achieve a significant improvement in the way of making things that could be made by other means, and to train activities that cannot be made otherwise.
- These laboratories are guided to work with maximum independence and autonomy, but at the same time in collaboration with other students and supervision.
- To achieve this impact is to integrate the technological and didactic aspects from the beginning of the design of the learning and not in sequential neither independent form.

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