VIRTUAL AND REMOTE CONTROL LAB EXPERIMENT USING MATLAB

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Abstract: The work presented in this paper pretends to provide a general architecture for a virtual and remote control laboratory experiment for a tele-robot system using the Matlab platform.

1. INTRODUCTION

The accessibility of Information and Communication Technology (ICT) allowed the enhancement of the traditional learning methods. Nowadays, several universities have material and software facilities allowing students to perform laboratory experiments by simulation or with real equipment without any geographical or temporal limitations (Amadou, 2006).

The relationship between ICT and process control has reached a new stage, encouraging the creation of applications such as monitoring and control through the Internet, as well as teleworking, telemedicine, and telerobotics.

At this time, several e-learning laboratories have been developed. Two categories can be distinguished:

- remote distance-learning laboratories, which offer remote access to real laboratory equipment and instruments – figure 1;
- virtual learning laboratories, which offer access to an virtual environment using for this simulation software;

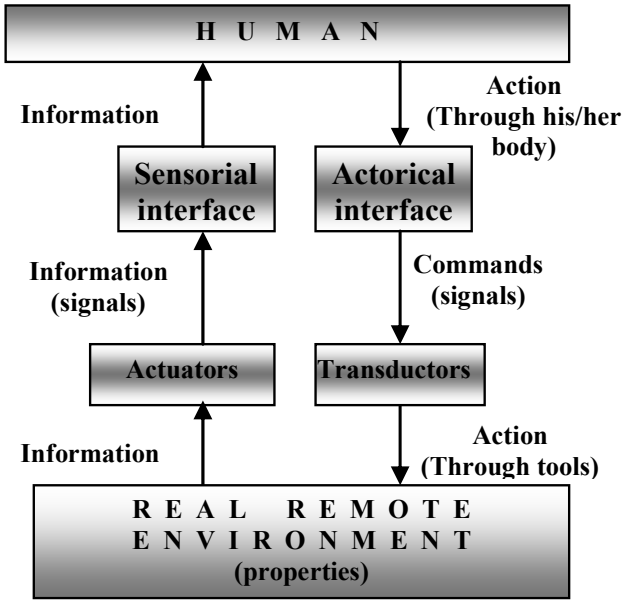

Fig.1. Remote distance-learning laboratory scheme

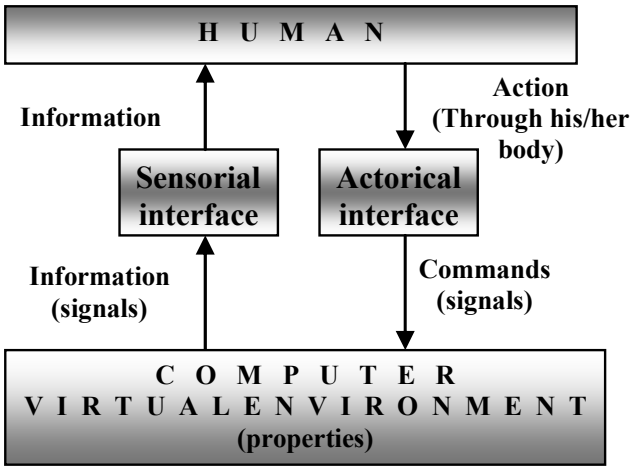

Fig.2. Remote distance-learning laboratory scheme

Based on the Internet, either a virtual learning laboratory or a remote distance-learning laboratory is available for setting up a laboratory in a learning environment. A virtual

laboratory allows continuous access to a simulated process on a computer. Remote distance-learning laboratories are an option halfway between traditional and virtual laboratories, allowing remote users to perform real experiments (Valera, 2005).
To implement virtual and remote laboratories, we have used one MATLAB-based software package, namely, MATLAB Web Server (by Mathworks).

2. THE VIRTUAL AND REMOTE CONTROL LABORATORY ARCHITECTURES

The scheme of the virtual and remote control architecture is shown in figure 3. In the picture two main areas can be seen: local area in which the user works, and remote area where the whole physical system and control elements are located.

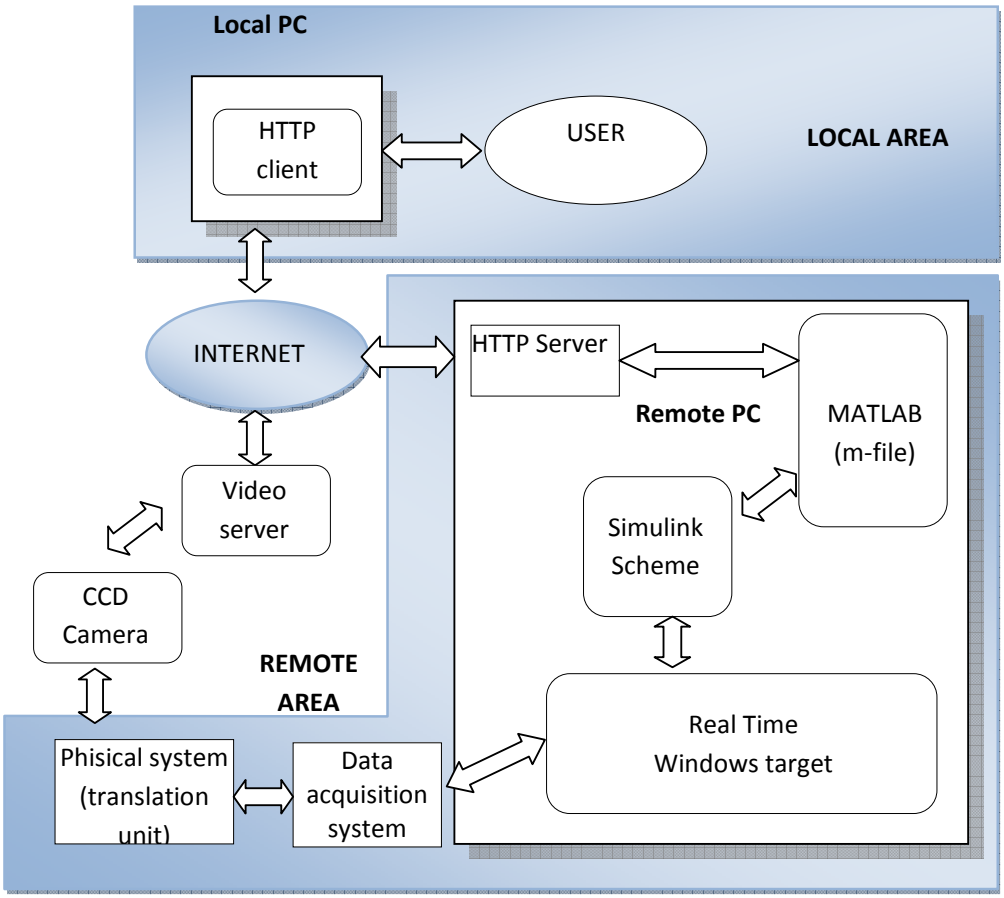

Fig.3 General architecture of the system

The elements of local and remote area are the following:
For the local area:

- Computer with Internet connection and an HTTP 4.0 client application. The application is optimized for Internet Explorer.

For the remote area:

- High speed Internet Connection.
- Computer Server.
- Data acquisition system – the control unit of the translation unit.
- Physical system to control the translation unit.

- Images capture device and a web video server: a CCD camera connected through a Matrox acquisition device to the video server.
- Http Server. This server allows the communication of the computers using the http protocol.
- MATLAB R2007 with SIMULINK.
- Real - Time Windows Target Toolbox V.2.1: this toolbox allows Simulink schemes to be executed in real time. For this purpose, it provides the necessary blocks for the interaction with the data acquisition system.

The Software part of the system consists of two modules:

1. Web application: this includes client-server communication using HTTP/HTML protocol, the user interface, user's access control, and the main CGI application. The Common Gateway Interface (CGI) is a standard for interfacing external applications with information servers, such as HTTP or Web servers.
2. Real-time application: this is a set of predefined Simulink control schemes and Matlab code, based on Real time Windows Target toolbox, which implements the real time execution of Simulink schemes over a specific physical system.

PHP is a popular script language that has been chosen as far as it is an open language widely supported by most web servers and O.S. platforms, and with an extensive library that supports every network protocol. PHP code runs on the web server so it shows a controlled environment for the programmer and can communicate with any other process running in the server (Matlab application in our case).

3. EXPERIMENTAL SYSTEMS

The experimental system is presented in figure 4.

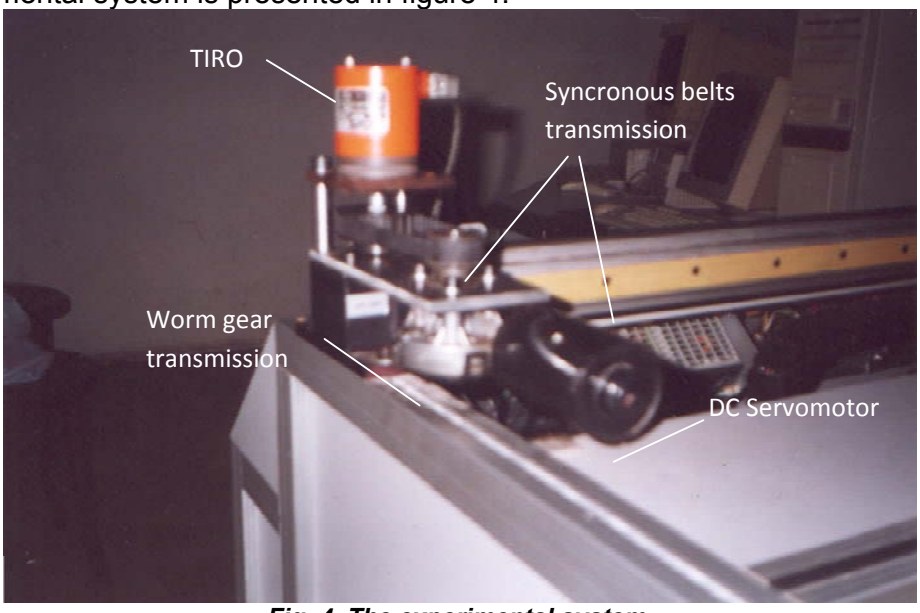

Fig. 4. The experimental system

The system consists in one DC servomotor, a worm-gear transmission, two synchronous belt transmissions and an incremental rotation transducer.

Once the user has accessed the system, a page appears in which all needed data to perform the real-time execution is requested. User can choose the physical system (DC motor, worm gear transmission), the control model (speed or position feedback), the type of execution (Simulation or Real-time execution) and regulator type (P, PI, PID, etc).

After introducing all data, the experiment can be performed; when is finished, the output signal is shown on the screen. After the execution, a web page with the graph of the output signal is presented to the student (in this case the engine velocity). This page shows that the system allows the download of all the signals involved in the execution in order to be analyzed by the students.
During real-time execution the user has access to a compressed video stream showing the experiment. For this, a high bandwidth internet access is required.

4. CONCLUSION.

This paper presents an experiment realised by our research team in the field of virtual and remote control laboratories. The advantage of the proposed system is that it helps the student to perform practice experiments remotely without a strict timetable. The tool developed, presented in this paper can also be used to test new control schemes over different physical equipments.

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