

# Distance Learning through a Robotic Virtual Lab

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**Abstract:** *The World Wide Web allows students from remote areas to interact with teachers, other students and experimental instrumentation anywhere in the world, enlarging educational frontiers.*

*The main goal of this project is to allow students to work with a robotic manipulator from a remote site, enabling members of distant communities to access remote equipment to perform real experiments. To achieve this target, a communication and control system that uses the World Wide Web as an interface was developed as a final term project by a group of electrical engineering students at FEI – Faculdade de Engenharia Industrial.*

*The system is based on a PC computer, acting as a web server (receiving the requests from the student, translating the messages to commands that can be executed by the robot and controlling the robot execution) and is equipped with a video conference system, enabling the student to see what is being executed by the robot, in real time, and exchanging information with an instructor at school. This way, the student can receive the whole course through the WWW, without losing interaction capability, such as asking questions and getting an expert assistance to solve problems.*

*The project was developed under a partnership with Microsoft, which allows free access to the software tools needed, such as Microsoft Internet Information Server, Visual J++ and Visual C++, used to build CGI Scripts and servers that receive students data and control the robot. The video feedback system was also developed in Java, to allow students, with common Internet access but without videoconference equipment, to access the site.*

*After the final tests are concluded, the project will be used at FEI not only in distance learning activities, but also in videoconference and remote control applications.*

**Keywords:** *distance-learning, robotic learning, practice-based engineering education, final-term projects.*

## 1 Introduction

The World Wide Web [1, 2] allows students from remote areas to interact with teachers, other students and experimental instrumentation anywhere in the world, enlarging educational frontiers.

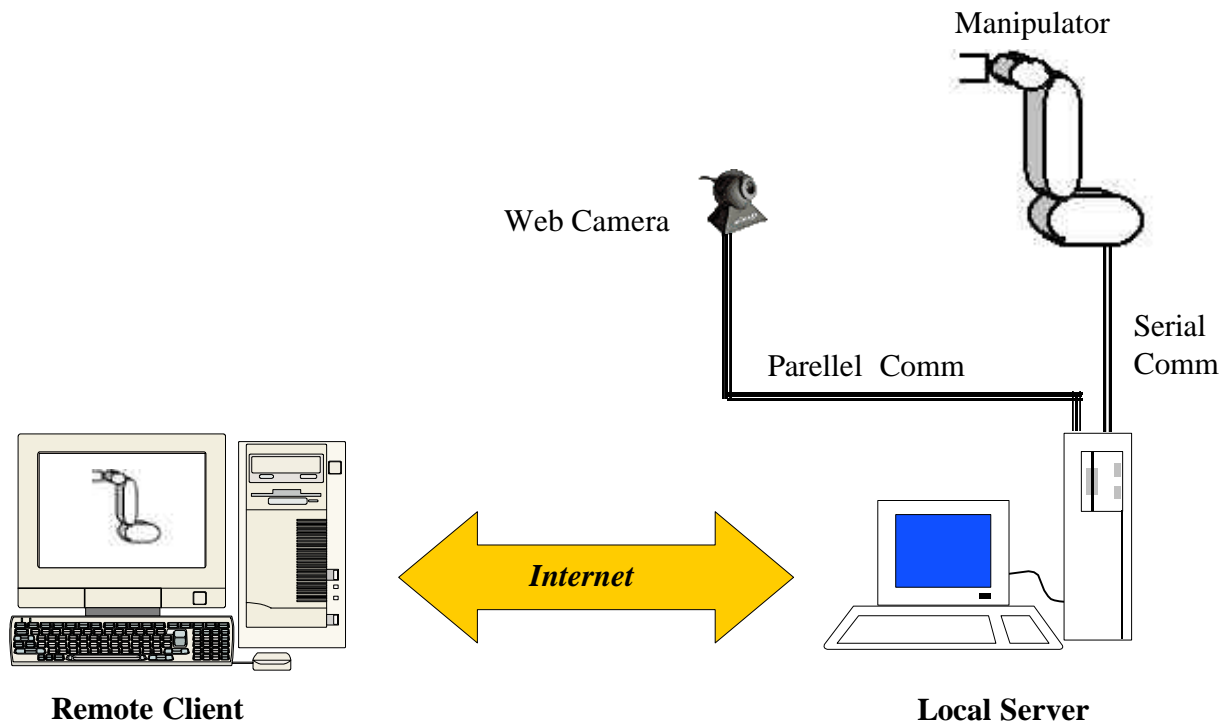
The main goal of this project is to allow students to work with a robotic manipulator from a remote site, enabling members of distant communities to access remote equipment to perform real experiments. To achieve this target, a communication and control system that use the World Wide Web as an interface is being developed as a final term project by a group of electrical engineering students, at FEI – Faculdade de Engenharia Industrial. [3]

## 2. The System Description

The system is composed of a robotic manipulator, a digital camera and a PC compatible computer, acting as a web server, videoconference server and manipulator controller. Figure 1 presents a sketch of the system. The client computer is the remote student computer.

The system starts when the web server receives the request from a student. At this moment, the server sends an HTML document [4] containing a Java Applet [5], from where the student can control the manipulator. The web server receives messages from this applet, it translates them into commands that can be executed by the robot and then executes these instructions.

As the system is equipped with a video conference system, the student is able to see what is being executed by the robot, in real time, and to exchange information with an instructor at school. This way, the student can receive the whole course through the WWW, without losing interaction capability, such as asking questions and getting an expert assistance to solve problems.



**Figure 1: a sketch of the system.**

The system development was divided in three separate parts:

- The local control of the robotic manipulator;
- The teleoperation of the manipulator and;
- The videoconference and visual feedback system.

These modules are described in the following sections.

### 3. The local control of the robotic manipulator

The robotic manipulator used for the development of this system is a Smart Man ED-7220B, which is shown in figure 2. It is an educational robotic manipulator with 5 degrees of freedom that can be controlled through a serial port.

This control system is responsible for sending the instructions to the robot. It consists of a program, developed in C Language, that is called by the web server when it needs to send a command to the robot.



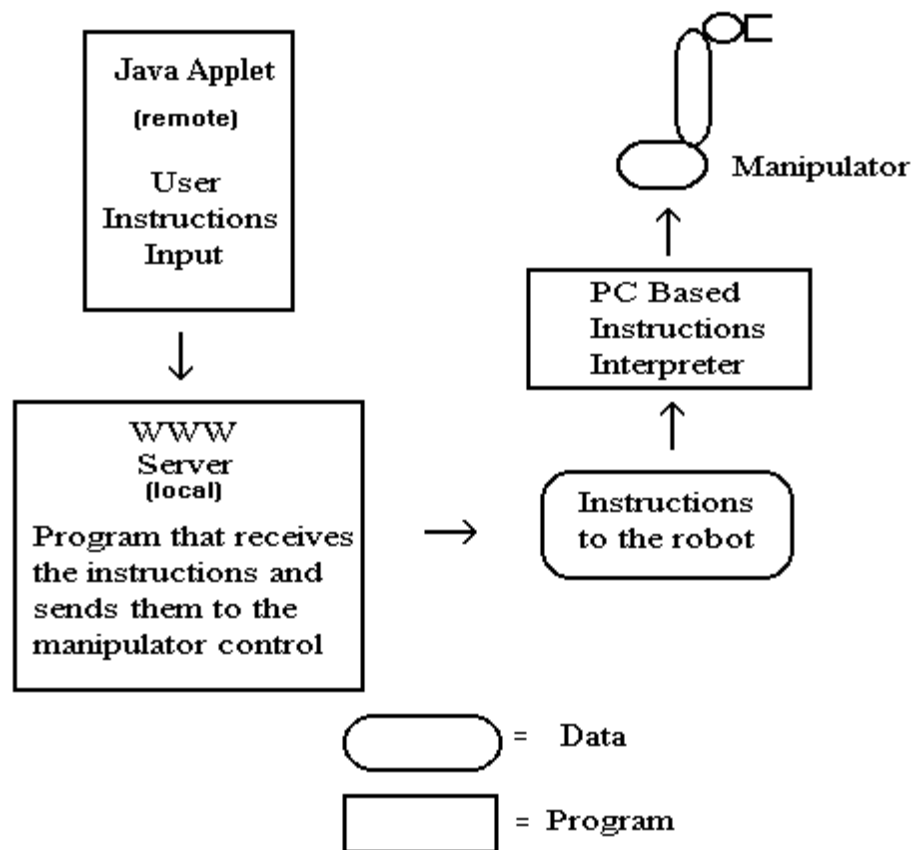
**Figure 2: the robotic manipulator.**

### 4. The teleoperation system

The interface that handles the communication between the remote user and the server is the most important part of this work. The diagram in figure 3 shows the interface mechanism.

When the server URL address is requested by a browser, a program written in C in the local server checks if the manipulator is available. If it is not available the server returns a document explaining why it is not available. If it is available, the server returns an HTML document with a Java applet, where the user can input the instructions to the manipulator.

The Java applet works as a one way communication line, from the remote user to the server. Every time the student changes a parameter at the applet client, it submits the data to the local WWW server. When the server receives the data, it is converted into instructions for the manipulator and then the server calls the local control program, passing the instructions as parameters.



**Figure 3: the modules of the teleoperation system.**

The main problem for a remote operation of any system is the feedback of its states to the remote user. The next section presents a partial solution to that problem.

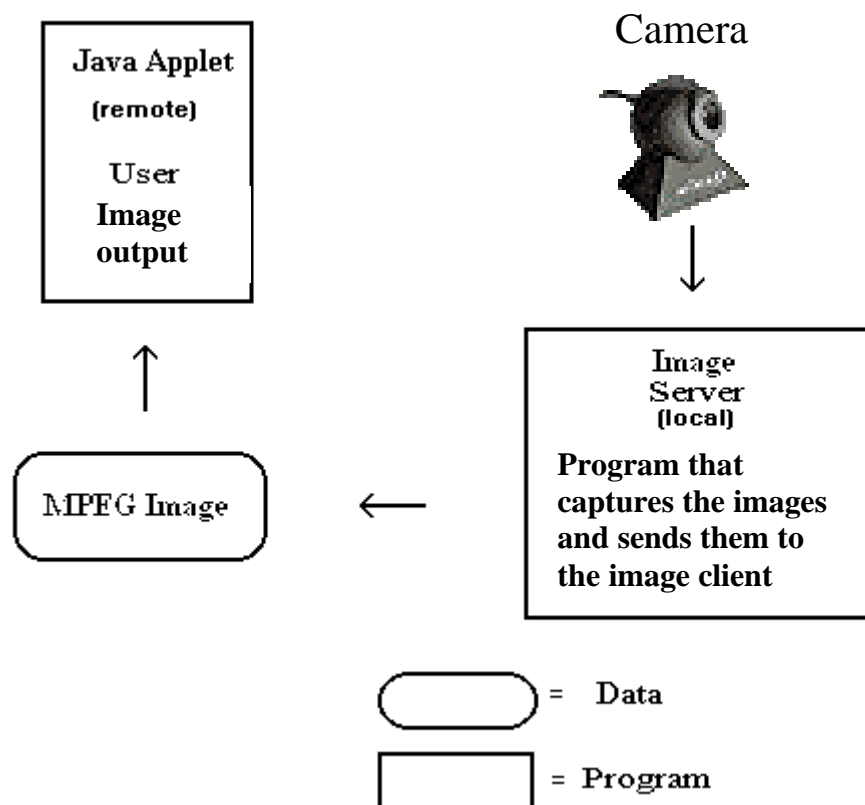
## 5. The visual feedback and videoconference system

This module consists of two separate Client-Server programs and a Connectix WebCam digital camera (figure 4).

The image server program is able to grab images from the camera connected to the server computer, where it is executed. After the image is captured, it is compressed using the MPEG image compression format [6, 7, 8] and then sends the image to the student's client. The program then waits for a request for a new image from the client.

The second program, the image client, receives the image and displays it. After receiving the image, this program sends a request to the server for another image. With this request-based communication, the overload of the network is avoided.

One problem is that only these programs do not constitute a videoconference system: they present to the student the current state of the robot but do not allow the student to communicate with an instructor. To solve this problem we adopted CUSeeMe [9], a well-known Internet based videoconference system, to enable the communication between students and instructors.



**Figure 4: the modules of the visual feedback system.**

## 7. Conclusion

The main achievement of this work was not only the operational version of the system, but also its development which was done by a group of students, working on their final term project. This allowed FEI students to deal with several technologies such as robotic systems control, web servers and clients, Java development and videoconference systems. The final-term project system is described in full details in NALLI et al. [10].

The project was developed under a partnership with Microsoft, which allows free access to the software tools needed, such as Microsoft Internet Information Server, Visual J|++ and Visual C++, used to build CGI Scripts and servers that receives students data and controls the robot.

The video feedback system was developed in Java, to allow students, with common Internet access but without videoconference equipment, to access the site. The site pages were developed with FrontPage 98 HTML editor.

After the final tests are concluded, the project will be used at FEI not only in distance learning activities, but also in videoconference and remote control applications.

## 8. References

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