Using Robotic Tele-embodiment to Distance Learning

Ronei M. de Moraes, Liliane S. Machado and Rodrigo K. Rangel

Abstract ? **Distance Learning brings a new concept of classroom: the virtual classroom, where students and teachers physically distant are gathered on the WEB. One of the possible tools for communication among people in a virtual classroom is the teleconference, where students are passive and cannot interact directly to the teacher. In this paper, we propose the use of telerobotics to immerse students in a virtual classroom making them active participants in the teleconference.**

Index Terms ? **Distance Learning, Tele-embodiment, Telerobotics, Interactive Teleconference.**

I. INTRODUCTION

Advances in Distance Learning bring new classroom concepts. The most simple classroom idea is the instruction with blackboard transmitted on WEB [8, 16]. Nowadays, the distant student can interact with virtual environments where teleconference or videoconference, slides projection and chat rooms are presented to give him the idea of a real classroom [11]. However, these methodologies do not allow a bi-directional interaction between the student and the teacher as occurs in real classroom. Several students report dissatisfaction about the limitations of these virtual study environments when compared with real study environments [5].

The use of tele-operated robotics systems by WEB can be found in several projects [4,10,15,18]. Some of these projects have the learning as purpose [1, 12] and have robot tele-operation as a way to provide better comprehension of scientific phenomena in different fields of knowledge.

In this work we propose the utilization of tele-operated robots as an embodiment tool of distant students in a real classroom. Each robot can interact directly with the teacher, what removes the student passivity in classes by teleconference. The robots are low-cost sub-systems composed by a video camera (webcam), microphone, stereo audio output, two degrees-of-freedom movements mechanism, a LCD display and a light system to alert the teacher in case of a student question. This set is controlled by a PC/Linux running Java and is manipulated at distance by a student on WEB. So, he can have his own perspective of the class and can record it in his personal computer.

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II. TELEPRESENCE AND TELE- EMBODIMENT

Immerse someone in a distant reality is not a new idea. In 1954, Goertz and Thompson developed a mechanic device controlled electronically for tele-operation [6]. Nowadays, there are several systems like this and the most knew is the one used in the Mars Pathfinder Mission [2] where an intelligent robot was tele-operated by radio signals from Earth. Changes in this conception are producing new ways of immersion by the use the WEB and robots controlled at distance [14]. It generated the idea of personal telepresence or tele-embodiment where a person controls a robot by WEB to interact in another reality [15]. A first advantage of this is the individual mobility in a real reality, allowing interactivity with people and objects of the real world physically distant.

However, due the Internet architecture is important to observe the possibility of a delay between the tele-command and the effective action performed by the robot. In case of mobiles robots is necessary some additional architecture to control them during the delay [3, 7].

III. DISTANCE LEARNING AND TELE-EMBODIMENT

Several projects in Education use remote controlled robots to improve the comprehension of scientific phenomena. Nakano et al. [12] constructed a laboratory where students can conduct experiments controlling a robot by WEB and measure temperatures and voltage remotely. All and Nourbakhsh [1] used a micro robotic video camera to allow children the study of insects with large view proximity. Nourbakhsh [13] emphasizes the importance about the use of robots in the education of some sciences and even the learning of robots functioning and programming.

In Distance Learning [9], students are present in classes by WEB. The virtual classroom is normally based on teleconference systems to transmit instructions with a blackboard or whiteboard [8]. Sometimes, slide projection systems and chat support this tele-conference where the goal is provide some kind of interaction among students and the class presented. The concept proposed by Moraes and Machado [11] looked at the integration of a tele-conference system and two kinds of chat, one for student-teacher communication and another one for student-student communication in a triple environment.

However, in tele-conference systems students just observe a display and do not have any interaction with the class. It can

produce some discomfort and dissatisfaction [5]. So, the idea of immersion and interaction is only superficial. The telepresence is a good solution for this problem because will make students active participants in the class, like in a real classroom.

IV. PROPOSE OF CLASSROOM WITH TELE-EMBODIMENT SYSTEMS

We propose the use of a telepresence system into the Distance Learning classroom. This way, each student will tele-operate a robot by WEB and control it. For each robot is necessary the use of a PC compatible microcomputer running Linux and Java software to interface and serve the control methods to the distant student.

In this work, we propose a robot equipped with the following sub-systems:

a) video camera (webcam),
b) microphone,
c) stereo audio output,
d) two degrees of freedom movements mechanism,
e) small LCD display and
f) light system.

The video camera (webcam) and the microphone capture image and voice and send them from the classroom directly to the remote student, by Internet. This student is connected to one of the computers in the classroom and could move the video camera, microphone and liquid crystal display set with two degrees of freedom. Depends on the devices the student has in his personal computer, he will be able to use or not some features of the system. It includes talk and to be visible to the teacher (in case of existence of a microphone and a webcam). The light system will allow call teacher attention in case of doubts and the stereo output system will be used for communications among the teacher and all the students in the classroom.

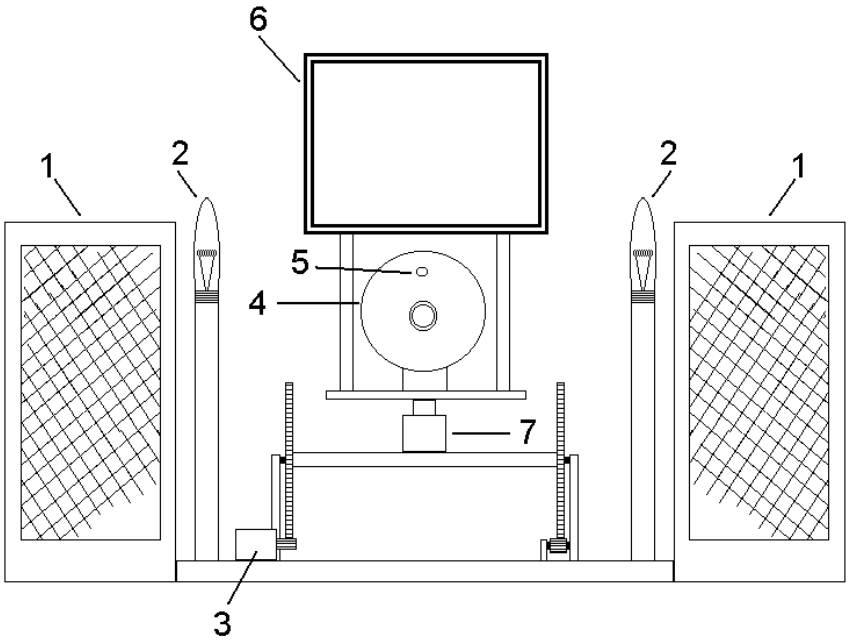

Figure 1 Scheme of a robot tele-operated by WEB.

Figure 1 shows a scheme of the robot where there is a stereo acoustic system (1), an alert light system to call teacher (2), a video camera (webcam) (4), a microphone (5), a small LCD display (6) and a servo motor for y (3) and x (7) axis rotation.

A peer-to-peer local network supports the classroom composed by this set of telepresence systems. Each student should access one, and only one, computer of this network to attend a class. The network server is invisible for the user and should direct him to one of the available computers after check that he is a regular student in the subject presented. A central router will be responsible for the execution of these tasks. Beside that, once a user is logged on a computer, he will be able to receive video and audio signals and will be capable of move the camera and turn on/off the alert lights. The system will make available the voice communication with the teacher and other students.

The scheme in Figure 2 shows a classroom equipped with tele-operated robots. Each virtual student has his own position in the room, according the computer he is connected (1). All the computers in the room are equipped with a telepresence system operated by robots. Each computer is connected by a high-speed network (2) to a switch (3) and the classroom access permission is given by a server (4). The server is responsible to control the access of registered students in the subject and is responsible to designate a free computer to a virtual student. The student can choose the location he wants among the available computers. The

number of available Internet access (5) in the classroom should be the same of students registered in the subject. In the classroom each computer/student can see the teacher next the blackboard/whiteboard (6) and can interact with this teacher or with the colleagues around by the use of the robot. Through the simplicity and modularity of the presented technology, the implementation of this kind of classroom is easy and not expensive. The expansion of users number in this classroom depends only of server capacity and Internet connection speed.

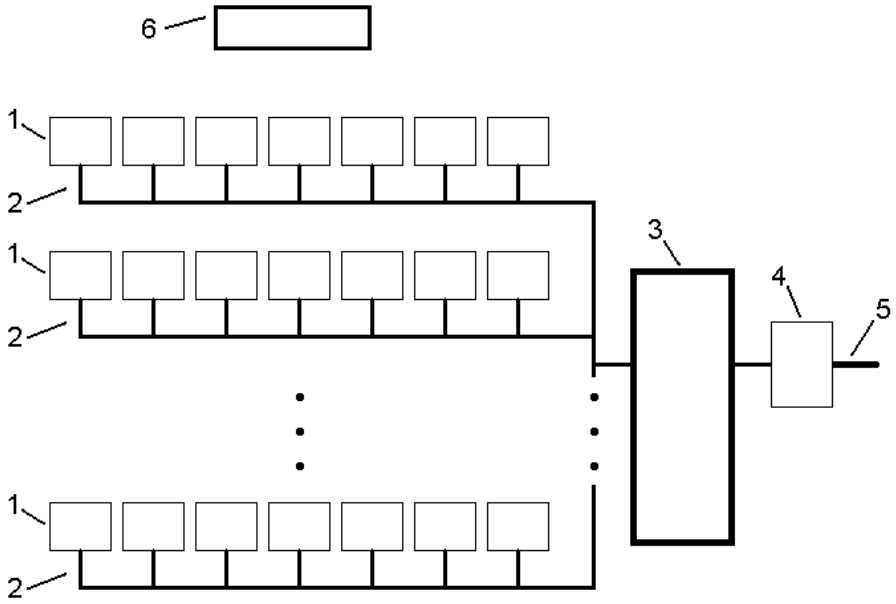

Fig. 2 Schematic diagram of a possible classroom equipped with a tele-embodiment system.

The classroom presented is part of the LabTEVE of the Statistics Department at Federal University of Paraíba – Brazil [11]. LabTEVE is a laboratory of assimilation and development of technologies for distance learning in Statistics.

V. FINAL CONCLUSIONS AND FUTURE WORKS

In this work we propose the use of tele-operated robots to tele-embodiment of distant students in a real classroom.

The utilization of robots in distance learning gives to users the possibility of a personal perspective and allows the manipulation of a camera, lights and sounds to give teachers and students interaction possibilities. This ways of interaction and immersion remove the passivity of a student in a class by tele-conference, as mentioned in [5].

The robot proposed in this work is a set of low-cost subsystems composed by video cameras, microphone, stereo audio output, two degrees-of-freedom movements mechanism, LCD display and a light system to alert teacher in case of a student doubt. This classroom has simplified and modular implementation, as showed in Figure 2.

The distant student can visualize the classroom as it really is and can observe around all robots and computers that represent his colleagues and interact with them too.

A future work is the use of augmented reality in the telepresence system, this way the computers in the room would be seen as avatars by each individual computer [17].

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