19th IEEE International Symposium on Robot and
Human Interactive Communication
Principe di Piemonte - Viareggio, Italy, Sept. 12-15, 2010

Telerobotics Connecting Classrooms between Japan and US: a Project Overview

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Abstract— **The goal of this short manuscript is to provide a research instance for the special session of HAI (Human-Agent Interaction) at the RO-MAN 2010 conference. One discussion issue being addressed in this community is the debate of virtual agents versus real robots. Here, we will bring our new research project on linking children across the world through telerobotics as a case which includes both virtual agents and real robots in a system to be developed.**

I. INTRODUCTION

We have been exploring the use of robotics technology for supporting the early childhood education. One approach is to develop robots which help and assist the educational/nurturing activity of adult care-givers at classrooms. With the background of conducting long-term field studies at the early childhood education center in UC San Diego, we investigate the characteristics of the robot during the social interaction and its practical use cases [1], [2], [3].

Another approach, which is the target of the paper, is to expand and enrich the educational environment itself by using the robotics technology. Particularly, we are aiming the use of telerobotics to connect remote classrooms across the world on the internet based on the robotic interface operated directly by children. In October 2009, we started the first research project funded by JST PRESTO whose final goal is to develop a sustainable infrastructure connecting classrooms between Japan and US, and evaluate the potential through field trials. The first target of this project is to offer a Japanese child in each trial an opportunity to join the US classroom activity by remote-controlling a robot placed in the US side.

The teleoperated system described above includes two opposing discussion topics at HAI (Human-Agent Interaction) community: virtual agents and real robots. The operator child in Japan will see a big monitor-screen showing a real-time video picture taken from a camera placed in the US side. Thus, for the operator child, the robot in the screen will take a role of an agent, and it can be virtualized if the video picture is rendered with AR (Augmented Reality) technologies. On the other side, the US children will be interacting with the Japanese operator child through a real robot, and therefore the system is considered to take on both the properties of virtual agents and real robots. In the following sections, we will explain the details of the project together with the research questions to be addressed.

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II. PROJECT DESCRIPTION

As part of the JST PRESTO program (Information Environment and Humans [4]), we started a research project trying to connect classrooms between Japan and US through the teleoperation of a robot. There are two centers each at Japan and US (Fig.1). The US center is in the Machine Perception Laboratory (Head: Dr. Javier R. Movellan) and the Early Childhood Education Center (Director: Ms. Kathryn Owen) in UC San Diego. The Japan center is in the University of Tsukuba and iias-Tsukuba, a large-scale shopping center in the city of Tsukuba where the first author of the paper (PI of the project) is currently constructing a classroom environment where long-term field trials can be taken place.

By using a motion-capture system, the bodily movement of an operator child in Japan is tracked in real-time and transmitted to the US side. The robot placed at the US classroom is remote-controlled based on the information sent from Japan (master-slave control). The basic design of the robot follows the specifications similar to (but much simpler than) the robots in tele-existence literatures [5], [6], [7] although in our case the degree of freedom and the servo-torque will be limited so that the system can assure enough safety for the users children under the supervision of adult experimenters. The robot will only be endowed basic mobility function and simple arms which can do a "*give and take*" task with the remote children. The face of the operator is projected on a screen attached on the robot so that the children in the US classroom can see and talk to it.

At Japan side, the operator child can see a big monitor-screen where a real-time video picture taken from a camera placed in the US side is projected. The video data stream is

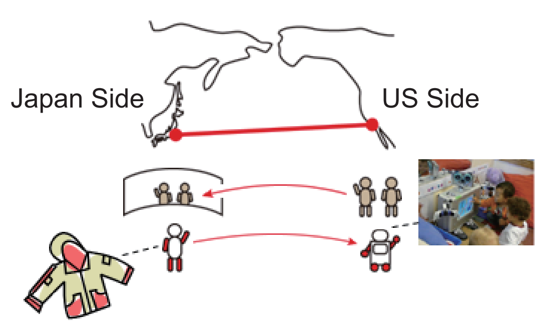

Fig. 1. Telerobotics between Japan and US classrooms

coded/decoded and transmitted over the internet through the LifeSize Room 200 system.

III. Research Problems

Along with the general goal of the project described in the previous section, there are several research issues which will be investigated through the project. Here we will overview three research topics:

A. Language learning

Recent studies revealed that robots could be an effective tool to promote the foreign language acquisition of children. Movellan, et al. reported that an autonomous robot speaking Finnish words accelerated children's spontaneous word acquisition in the classroom [8]. The robot we will use is not fully-autonomous. Instead, it will be remote-controlled and thus will be more like a physical avatar of an operator child, presenting an embodied interface which enables direct and intuitive communication with people who speak different languages. We have strong interests in the effect of the operator child's exposure to the US classroom environment together with the effect on the children in the US side. Cooperative tasks will be good learning instances to be tested. We will also need to explain the difference between conventional TV-based remote learning tools.

B. Social contingency

In developmental psychology, the social contingency detection of infants has been extensively studied [9]. It is also related to our study because the operator of the robotic interface is required to be able to perceive the remote body of the robot as contingent with his/her bodily movement so that he/she can interact and communicate with people in remote intuitively. A communication delay in the order of 0.3 - 0.5 sec is inevitable over the system. Furthermore, the visual sensory information the operator can get from a monitor screen is dimensionality-reduced (from 3D to 2D), therefore it is required for the system to present the information in such a way that the operator can easily detect contingency and control the remote body.

C. Survey research

It is expected for our study to investigate not only the technical issues but also the social response against the robotics application for supporting the early childhood education. This is also related to the recent discussions around roboethics [10], [11], [12] where the potential side-effect of introducing robotics into the educational environment is discussed. The debate covers not just the physical risk or the safety concern surrounding robots but also unknown psychological effect caused by them. We consider it crucial to elaborate the best balance between the merits and demerits of introducing robotics with local people in the society. Therefore, we will be in a position where we should gather public opinions by continuously immersing ourselves at the daily classroom environment. This is the reason why we put emphasis on conducting field studies at this project.

IV. Virtual Agents versus Real Robots

At the HAI (Human-Agent Interaction) community, there has been the debate of virtual agents versus physical agents where researchers are trying to address the role of the agent for interacting with humans through the comparative speculation between them (ex. computer agents and real robots). Up to now, both authors of the paper take a human-centered stance on which the adaptive capability of humans is considered to be so strong that it would absorb the difference between the two. But, it would also be an interesting study to compare the behavioral patterns of the Japanese and US children since they will attend a common task through both virtual and real interfaces.

Another perspective we have interests on is the superimposition of virtual agents on real robots [13]. This technique is useful to overcome the communication delay between remote locations. As described in the previous section, it is important for our system to keep an operator child perceive contingency between his/her action and sensation. For this purpose, we may use superimposing a virtual agent on a robot in a screen to compensate the communication delay.

V. Acknowledgments

This work was supported by JST PRESTO program. It was also supported in part by the Grant-in-Aid for the Global COE Program on "Cybernics: fusion of human, machine, and information systems" at the University of Tsukuba.

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