Linking Children by Telerobotics: Experimental Field and the First Target

Fumihide Tanaka
Graduate School of Systems and Information Engineering, University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki, Japan
fumihide@iit.tsukuba.ac.jp

Toshimitsu Takahashi
Graduate School of Systems and Information Engineering, University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki, Japan
taka@bcl.esys.tsukuba.ac.jp

ABSTRACT

The paper describes our project whose final goal is to link remote classrooms by telerobotics. The first target is to offer children in Japan an opportunity to remote-control a robot placed in an US classroom, and participate in the classroom activities. By conducting field trials at nursery schools and language schools for children, we aim to identify and solve critical problems which might prevent this potentially popular technology from becoming a reality. Here, we will report the development of a remote-hand device which seems to be the most required element for the proposed system.

Categories and Subject Descriptors

I.2.9 [**Artificial Intelligence**]: Robotics; H.4.3 [**Information Systems Applications**]: Communications Applications; K.3.1 [**Computers and Education**]: Computer Uses in Education

General Terms

Design

Keywords

Telerobotics, telepresence robot, distant communication, distant education, robotics for children, early childhood education, social contingency, delayed feedback

1. INTRODUCTION

Telerobotics is expected to provide a wide range of applications in society. Starting from industrial robots, medical use, and space teleoperation, recently we see its applications also for social interaction purposes. A series of telexistence or telepresence robots [4, 2, 1] are aimed at offering distance communication between humans. Particularly, we have strong interests in its application in early childhood education. Since 2004, we have been conducting research in the area of robotics that supports early childhood education by immersing ourselves into the daily classroom environment [5, 6]. We had noticed that remote communication applications such as Skype had already been used in this domain, and thus it seems quite likely that people would expect the next step of development. Nevertheless, we still think that there are a lot of practical issues that are unsolved. We may even be unaware of some issues which might prevent this potentially popular technology from becoming a reality. To investigate, identify and solve these issues, we feel that conducting field trials would be the best approach.

In 2009, as part of the Japan Science and Technology Agency (JST) PRESTO program, we started a research project whose final goal is to develop and operate a telerobotics infrastructure linking classrooms between Japan and US in real-time. We will involve all the people working at and around the classroom in the project: nursery and elementary schools both in Japan and the US, companies that are in the education business, and, of course, children and parents. This is important since we'd not only like to show the results of our research but also develop a feasible model of the proposed system. The philosophy of designing robots by immersion (immersing ourselves into the target environment) is inspired by the RUBI project [3].

This paper reports our trials conducted during the first year of the project. Particularly, we are developing a remote-hand device which we had identified would be the most crucial requirement for the telerobotics system linking remote classrooms for children. We will also explain the experimental field for this research project.

2. TELEROBOTICS SYSTEM LINKING CLASSROOMS BETWEEN JAPAN & US

Our first target is to offer children in Japan an opportunity to join the remote classroom activity in the US in real-time through the teleoperation of a robot. Figure 1 depicts the proposed system. The physical movement of an operator child in Japan is captured and transmitted to the US side. The robot placed in an US classroom is remote-controlled based on the information sent from Japan. The operator child can see monitor screen(s) where real-time video pic-

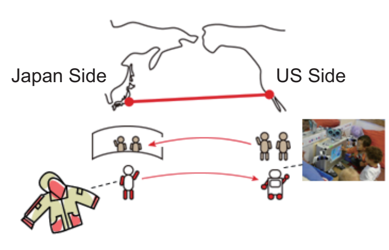

Figure 1: System overview: a child in Japan wearing a capture-device remote-controls a robot placed in the US, and joins the remote classroom activity.

tures taken by cameras installed in the US classroom are projected. The video data stream is coded/decoded by LifeSize HD video conference system. Most importantly, it is necessary that the system can be used by children in the daily classroom environment. Therefore, the system must be designed to be simple and easy to use while being robust and safe. For this reason, the first thing we needed to do was to identify the most crucial element to be provided by the system, which will be explained in the next section.

Regarding the experimental field, we are fortunate to have the cooperation of Minerva Language Institute Co., Ltd. which manages 600 English learning schools for children in Japan. Among them, we started the project at a classroom in iias-Tsukuba, a big shopping mall (estimated 12 million visitors per year) located in Tsukuba. Our first target age group is 3 to 5 years. In Japan, currently there is a huge demand for foreign language education, particularly for children. Since not many children even in the classroom have had an opportunity to communicate with other children/teachers outside Japan, people will surely welcome it with enthusiasm if they or their children have the opportunity to join a classroom outside Japan in real-time. In the US side, we are collaborating with the Machine Perception Laboratory and the Early Childhood Education Center in the University of California, San Diego. These are the places where the first author of the paper has been staying at between 2004 and 2007 to conduct a long-term field study of interaction between toddlers and robots [5, 6, 3].

3. THE DEVELOPMENT OF A REMOTE-HAND DEVICE FOR CHILDREN

From the observation of classroom activities, we have found that most educational activities in children's classrooms somehow include grasping behaviors of children. For example, flashcards are the most frequently-used educational material in the classroom. Teachers use them in many ways at vocabulary learning lessons, but they always contain a situation where children grasp these flashcards (and read them, or hand them to others, etc.) so that children do not get bored with the lessons. In case of lessons for children, it is very important to give them the materials in a way so that children can keep concentrating and they don't get bored too soon. Grasping is an important behavioral element for this purpose, which is commonly seen in classroom activities.

Therefore, we developed a simple remote-hand controlling device with haptic feedback (Figure 2). It is basically same as data-gloves available on the market, but we developed the device by ourselves since every child has his/her own hand size and thus it had turned out to be difficult to make use of the ones available in the market. Our device is equipped with bend-sensors (over fingers) and vibration motors (on fingertips) which can communicate with a PC through Bluetooth, and a thin rechargeable Li-Polymer battery that lasts for more than 3 hours.

The design of haptic feedback is particularly important for the system. From our communication trials between San Diego (USA) and Tsukuba (Japan), we observed that there is a communication delay of at least 300 - 500 msec, which could be a hurdle in establishing social interaction. Especially, in our case, the users of the system are children, and therefore we cannot give difficult instructions in advance. To overcome the issue, we are currently investigating the

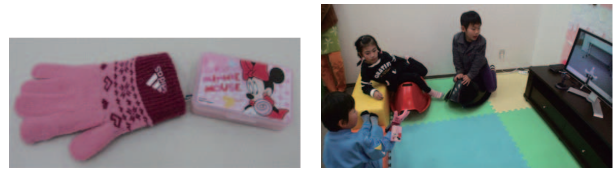

Figure 2: (Left) A glove interface with haptic feedback which controls a remote-hand device. (Right) Field trials at an English learning school for children in Tsukuba.

design of a system for giving feedback based on the theory of social contingency [7] in developmental psychology literatures. The basic idea is to give local feedback (produced at the operator side) during the delay period. Even infants are known to be able to detect social contingency between his/her actions and outside events within a certain amount of delay time [7]. Here, we are investigating if it is possible to extend the time by introducing multiple feedback responses composed of haptic vibration and sound.

4. CONCLUSIONS

Towards the final goal of linking remote classrooms for children by offering a telerobotics system, we reported our first target of developing a remote-hand device incorporating local feedback which allows an operator child to detect social contingency easily. We also described the target experimental field of classrooms in Japan and the US.

5. ACKNOWLEDGMENTS

This work was supported by JST PRESTO program.

6. REFERENCES

[1] S. O. Adalgeirsson and C. Breazeal. Mebot: A robotic platform for socially embodied telepresence. In *Proc. of the 5th ACM/IEEE International Conference on Human-Robot Interaction*, pages 15–22, 2010.

[2] H. Ishiguro. Android science: Conscious and subconscious recognition. *Connection Science*, 18(4):319–332, 2006.

[3] J. R. Movellan, F. Tanaka, B. Fortenberry, and K. Aisaka. The RUBI/QRIO project: origins, principles, and first steps. In *Proc. of 4th Int. Conf. on Development and Learning*, pages 80–86, 2005.

[4] S. Tachi. *Telecommunication, Teleimmersion and Telexistence.* IOS Press, 2003.

[5] F. Tanaka, A. Cicourel, and J. R. Movellan. Socialization between toddlers and robots at an early childhood education center. *Proceedings of the National Academy of Sciences of the U.S.A. (PNAS)*, 104(46):17954–17958, 2007.

[6] F. Tanaka, J. R. Movellan, B. Fortenberry, and K. Aisaka. Daily HRI evaluation at a classroom environment: reports from dance interaction experiments. In *Proc. of the 1st Annual Conference on Human-Robot Interaction (HRI-2006)*, pages 3–9, 2006.

[7] J. S. Watson. The perception of contingency as a determinant of social responsiveness. *Origins of the Infant's Social Responsiveness*, pages 33–64, 1979.