A Tricycle-style Teleoperational Interface that Remotely Controls a Robot for Classroom Children

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ABSTRACT

We consider the application of telepresence robots for supporting childhood education. One challenge here is to develop a teleoperational robot system that can be manipulated by children themselves. There are two requirements for realizing such a system. First, the system has to be sufficiently intuitive so that child users can control it without the need for detailed instructions. Second, the control of the system should have some amount of enjoyment so that child users do not get bored. To satisfy these requirements, we introduce a tricycle-style teleoperational interface that remotely controls a robot. We also report field tests that are currently being conducted at English learning schools for children in Japan.

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

Keywords

Telerobotics, telepresence robot, distant communication, distant education, robotics for children, early childhood education, tricycle, teleoperational interface

1. INTRODUCTION

Most telepresence robots designed so far target adult operators [2, 1]. In contrast, we are currently developing a teleoperational robot system for children [3]. The goal is to remotely connect classrooms using the system, making it possible for children in one classroom to join activities in other classrooms in real-time.

There are two crucial requirements for the teleoperational robot system. First, since our target is younger children (3–6 years old), we cannot presuppose giving detailed instructions about how to use the system to them. Therefore, the system (especially its user interface) has to be sufficiently intuitive so that children can control it without the need for detailed instructions in advance. Second, since younger children have a short attention span, it is necessary to control of the system to have some degree of fun, so that they do not get bored using it.

To satisfy the two requirements, we are currently developing a tricycle-style teleoperational interface that remotely controls a robot. This paper reports the latest development of our research as well as field tests that are currently being conducted at English learning schools for Japanese children.

Figure 1: Tricycle-style teleoperational interface by which a child operator directly controls a remote slave robot (Figure 2). The operator can see a Skype monitor on a tablet PC and can also control the gripper hand of the robot.

2. TELEOPERATIONAL ROBOT SYSTEM

The teleoperational robot system that we are currently developing is composed of three components: a tricycle-style teleoperational interface, a server PC, and a slave robot. The operational signals sent from the tricycle-style teleoperational interface are transmitted over the internet to the server PC. Then, the signals are sent to the slave robot over the internet. All the signals are encrypted when they are transmitted over the internet (using SSH tunneling).

The tricycle-style teleoperational interface is equipped with encoders on its rear wheels (Figure 1) by which it can send the information pertaining to forward/backward/left/right movement to the slave robot through the server PC. The child operator rides the interface while wearing a data glove on his/her dominant hand. By clenching the hand, the child operator can remotely grasp an object through the slave robot. These operational signals are first sent via Bluetooth to the tablet PC installed on the handgrip, before being sent to the internet. The tablet PC is also connected via Skype to another tablet PC fixed on the slave robot by which the child operator can see a screen image and can communicate with people in the remote location.

The slave robot is built on a mobile robot platform, Pioneer P3-DX (Figure 2). Its movement is controlled so that it is synchronized with the movement of the tricycle-style

HRI'12, March 5–8, 2012, Boston, Massachusetts, USA.
ACM 978-1-4503-1063-5/12/03.

Figure 2: The slave robot that is remotely controlled by the operator child. It has one DOF gripper hand and a Skype monitor PC. The mobile base is built on Pioneer P3-DX whose movement is controlled by the encoder signals sent from the tricycle-style teleoperational interface.

teleoperational interface. The slave robot is also equipped with a gripper hand. At this moment, the child operator is able to control only its opening/closing hand (one DOF). A Dynamixel servomotor is used and the hand can grasp small objects in the classroom. The slave robot is about 80 cm tall, which is shorter than the average height of children 3–6 years old.

3. FIELD TESTS IN CLASSROOMS

To identify the current problem being faced by our system and to find ideal use cases for the system, we have been conducting field tests in real classroom environments. We are fortunate to have had the cooperation of the Minerva Language Institute Co., Ltd., which manages 600 English learning schools for children in Japan. With their help, we started field tests at a classroom in iias-Tsukuba, which is a big shopping mall located in Tsukuba city. In Japan, there is currently a huge demand for foreign language education, particularly for children. However, in reality, not many children there have had the opportunity to communicate with people outside Japan. It is therefore expected that our system will be welcomed if their children have the opportunity to join a classroom outside Japan in real-time.

By way of pilot trials that connected the classroom at Tsukuba with an international school in Yokohama, which is attended by children whose native language is English, we found that although still there existed some technical issues, children in both the classrooms welcomed the robot system with great enthusiasm. In particular, it was encouraging to see that Japanese children who were usually shy could communicate with the native English-speaking children through the system. Another interesting observation was that the children on the robot side were very motivated to help the slave robot. As a task, we asked the child operator to grasp alphabet sponges and build English words by putting them on a whiteboard. Owing to the limited performance of both its hardware and software, it was sometimes difficult for the operator to grasp the sponges with as much control as he/she desired. Nevertheless, the children surrounding the robot frequently helped it to grasp the sponges and build English words, which resulted in increased opportunities for the child operator in the remote location to communicate through the system.

Regarding the evaluation of the system, we are currently

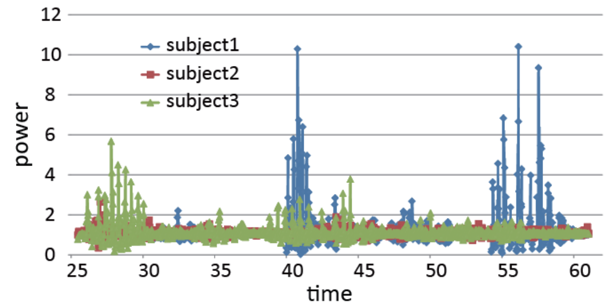

Figure 3: Sample data taken from the acceleration sensors used by children in classrooms.

investigating the use of acceleration sensors for the purpose of recognizing the movements of children. Children on both sides are asked to wear a small pouch in which is embedded a small acceleration sensor with a battery and a Bluetooth communication circuit. Figure 3 plots a test sample data obtained from one trial. We are currently trying to measure the level of engagement of children on both sides with the system on the basis of the analysis of their characteristic movements. By using videos taken during the trials, we first conduct the behavioral coding of the children. Then, by pairing the data obtained from the behavioral coding with the data from the acceleration sensors, we are trying to quantify the level of engagement.

4. CONCLUSIONS

The paper reported the development of a teleoperational robot system for children in a classroom. The key issue faced was in offering a controlling interface that satisfies the requirements of intuitive operability as well as in ensuring that it is fun for young users. We also described the introduction of acceleration sensors for the purpose of measuring the level of engagement of users with the system.

5. ACKNOWLEDGMENTS

We acknowledge the support from the Minerva Language Institute Co., Ltd., the JST PRESTO program, and the parents and children of the classroom.

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