inTouch: A Medium for Haptic Interpersonal Communication

Scott Brave and Andrew Dahley
MIT Media Laboratory
20 Ames St., Room E15-468
Cambridge, MA 02139 USA
{brave, andyd}@media.mit.edu

ABSTRACT
In this paper, we introduce a new approach for applying haptic feedback technology to interpersonal communication. We present the design of our prototype inTouch system which provides a physical link between users separated by distance.

Keywords
Haptics, interpersonal communication, force feedback, telepresence

INTRODUCTION

Touch is a fundamental aspect of interpersonal communication. Whether a greeting handshake, an encouraging pat on the back, or a comforting hug, physical contact is a basic means through which people achieve a sense of connection, indicate intention, and express emotion. In close personal relationships, such as family and friends, touch is particularly important as a communicator of affection.

Current interpersonal communication technology, such as telephones, video conferencing systems, and email, provides mechanisms for audio-visual and text-based interaction. Communication through touch, however, has been left largely unexplored [4]. In this paper, we describe an approach for applying haptic feedback technology to create a physical link between people separated by distance. The aim is to enrich current real-time communication by opening a channel for expression through touch.

INTOUCH

The idea behind inTouch is to create the illusion that two people, separated by distance, are interacting with a shared physical object. In reality, each user is interacting with his/her own object; however, when one of the objects is manipulated, both users' objects are affected. In our current design, the two connected objects each consist of three cylindrical rollers mounted on a base (Figure 1). When one of the rollers is rotated, the corresponding roller on the remote object rotates in the same way. This behavior can be achieved using haptic (force-feedback) technology with sensors to monitor the physical states of the rollers and internal motors to synchronize these states.

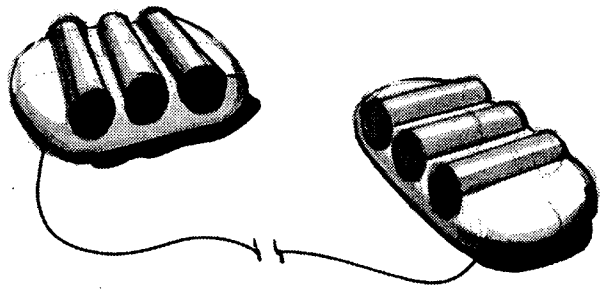

Figure 1. inTouch conceptual sketch

Two geographically distant people can then cooperatively move the rollers, fight over the state of the rollers, or more passively feel the other person's manipulation of the device. The presence of the other person is thus made tangible [2] through physical interaction with the seemingly shared object. Since the two objects are not mechanically linked in reality, inconsistencies in their states must be resolved by the system agreeing on a single consistent state and then employing the motors to guide the objects into that state.

Objective

Unlike the majority of applications of haptic technology, inTouch is not focused on the simulation of physical forms. Much of haptics research is aimed at the creation of virtual objects with form, mass, and texture that can be felt through feedback from a haptically augmented device. With inTouch, the idea is not to create a device to represent the physical form of the user at the other end, but rather to create a physical link for expressing the movements or gestures of that person. The physical form with which the user perceives to be interacting is thus not a simulation of the other user, but the device itself. The richness of the interaction then comes not from the representation of form, but from the representation of movement as mediated by the coupled objects. This is interesting in that it places great importance on the physical design of the device.

The application of haptics to teleoperated systems is similar to the mechanism of the inTouch system. In teleoperated systems, a user controls the actions of a robot (slave) with a distant mechanical device (master). The movements of the user are read by sensors within the device and then translated to the actuators of the robot. Haptics is often applied in these systems to improve the performance of the operator by translating

forces, imparted on the robot by the environment, back to the control device [1]. Such systems can be used in a way similar to that suggested by inTouch if a second user physically interacts with the robot directly. These systems, however, are not intended for such use and thus lack the elegance desired in a device for interpersonal communication. inTouch is designed primarily with the purposes of physical interpersonal communication in mind.

The Design

The choice of rollers as the manipulable part of the object was made for two related reasons. First, rollers can be rotated in either a clockwise or counterclockwise direction indefinitely. Unlike a joystick or throttle, for example, where the motion of the device is bounded, the roller affords [3] more fluid and continuos strokes. Although the roller has the potential to be manipulated aggressively, thrashing between bounds is not possible. For this reason, we felt that the motion of the roller was more appropriate for the expression of subtle emotional states than a bounded motion.

Second, rollers were chosen because they allow both passive and active interaction between users. A user can actively "grab" and manipulate the rollers by applying enough contact force to minimize slippage under the hand. In this way, the motion of the hand is directly translated to the rollers and the interaction is a kinesthetic one. If both users manipulate the rollers in this way, the interaction is fairly equal and mutual, like a handshake or a hug. Alternatively, one user could allow the rollers to slide comfortably beneath the hand, interacting in a more tactile and passive way, feeling but not affecting the motion of the rollers—like getting a pat on the back. Interactions falling between these two extremes, reflecting various levels of engagement with the rollers, are clearly also possible.

We decided to use *three* rollers for a combination of functional and aesthetic reasons. Because we wanted the user to be able to feel and activate all of the rollers simultaneously with one hand, additional rollers would require a reduction in roller diameter. Three was chosen as a compromise between the higher spatial resolution provided by more rollers and a greater surface area (on each roller) to "grab" and interact with possible with fewer larger diameter rollers. The three rollers also gave a visual balance to the design, suggesting its rotational movement and drawing people into interaction.

The Prototype

The first prototype of inTouch (Figure 2) was implemented through direct mechanical connection of the corresponding rollers with flexible drive shafts. This is clearly not the preferred method of connection over any reasonable distance; however, the mechanical prototype was sufficient to begin user testing. Furthermore, the prototype was intended to provide a physical benchmark for later implementations with electronic connection and hardware controlled motors.

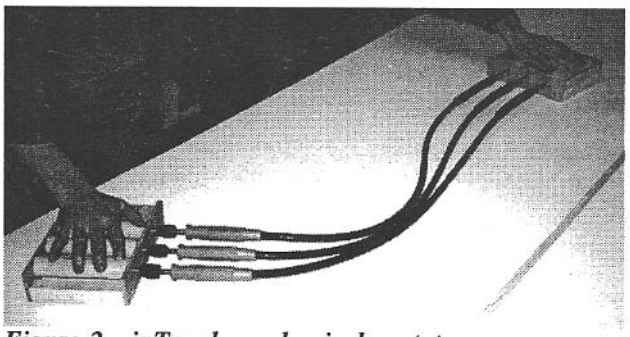

Figure 2. inTouch mechanical prototype

We have yet to conduct formal user testing with the prototype, but initial observations of people interacting with the system were encouraging. Users indicated interest in the shared manipulation of the device and often described the interaction as "playful". Some people who used inTouch commented that the friction on the rollers was too high, hindering fluid rotational motion. Some also remarked that the lack of ability to pass concrete information made the semantics of interaction ambiguous. Others, however, applauded the subtle and abstract nature of the interaction, while agreeing that it was most applicable to intimate relationships.

FUTURE WORK

Future work will concentrate on user testing and further refinement of the design. The electronic version of inTouch is also currently under development and will require investigation into control algorithms to achieve the desired feel.

CONCLUSION

This paper has presented the philosophy and design of inTouch. The inTouch system provides a physical link between people separated by distance, unattainable with current interpersonal communication technology. We believe that inTouch suggests a new pathway for the application of haptic technology which has the potential to enrich intimate interpersonal communication across distance.

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