Touch Proxy Interaction

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Figure 1. InTouch allows rolling to be shared

Figure 2. LumiTouch converts touch to light

Figure 3. ComTouch converts pressure to vibration

CHI 2008, April 5 – 10, 2008, Florence, Italy
ACM 978-1-60558-012-8/08/04.

Abstract
The purpose of this research is to build and evaluate collaborative touch devices that influence behavior change over individuals in small group situations. This paper presents touch proxy objects for collocated collaboration and communication. Touch proxy objects afford and represent touch in order to allow the sense of touch to be shared between people. This paper presents preliminary observations from studies performed on existing touch communication objects.

Keywords
Tangible interfaces, haptics, interaction design, CSCW, face-to-face interaction, group decision-making.

ACM Classification Keywords
H.5 [Information Systems]: Information interfaces and presentation (H.5) (I.7)--User Interfaces (D.2.2, H.1.2. I. 3.6) Haptic I/O

Introduction
We live in a world where meetings are an essential part of organizations for sharing information and decision making. Often, people will fly around the world in order to exchange handshakes at the beginning and end of a collocated meeting. This brief exchange of touch is a significant cue to the engagement and commitment of both parties. During the meeting, people may engage their hands by writing or drawing in parallel to the conversation. Others may fidget or manipulate pens or cups to convey boredom or use the items for common

reference. We ask whether there are ways to co-opt the use of hands for active listening. In short, we present the notion of tangible proxy objects, objects that transmit representations of the touch for the purpose of group collaboration.

One issue in group interaction theory is improving the sense of engagement and creativity in problem solving and finding common ground[4]. My approach is to look at how people increase their active engagement through the use of shared tangible objects (either synchronized objects or one object that is shared) to provoke more creative discourse and allow background feedback of the state of the conversation[8]. This research examines how touch 1) provides a marker for distributed cognition, 2) serves as a means for obtaining common ground, and 3) allows nonverbal information to be transmitted during a meeting.

Unlike prior research in groupware, the work proposed here is distinct in its specific focus on devices that require the use of tactile senses in the act of problem solving. Specifically, the presence of a tactile mediation object aids participants in externalizing their ideas in order to jointly examine their logic more thoroughly. My hypothesis is that the tactile objects provide affordances that enhance the natural dynamics of a small group interaction through providing an explicit nonverbal expressive channel between people.

Research Goals

The goal of this research is to build and evaluate devices that persuade behavior change over a group of individuals. Towards this goal, this specific project has three research objectives: (1) to build a set of devices that allows the sense of touch to be shared (either via synchronized objects or one object that can be passed around) between participants of small group meetings (2) to evaluate the contribution of tactile interactions to group collaboration environments, and (3) to establish a set of design guidelines for building touch proxy devices and applications.

Research Results to Date

The design space of haptic remote interpersonal communication is populated with three main projects that contribute to the theme of tangible interfaces for collaboration and communication. Each project is described briefly below along with lessons learned.

InTouch, LumiTouch, and ComTouch

InTouch, designed by Brave[1] is a set of synchronized distributed rollers(figure 1). Two people can convey the sense of touch over a distance by rolling their hands over the device. The devices afford unbounded rotary motion between two people who can twist the rollers back and forth. There is a force feedback circuit that gives the illusion of real-time sharing of touch. Observational studies have shown that people often talk to each other while holding onto the devices. In these types of force feedback devices, "tug-of-war" interactions arose due to being unable to distinguish their input from that of the other user[5]. They tend to not focus on the device itself, but operate it as they continue talking.

LumiTouch is a set of picture frames that allow passive and active transition of low-bandwidth interaction [3](figure 2). The picture frames measure the distance of a person to the picture and transmits the distance as the brightness of an LED on the "remote" frame. People can passively observe that another person is in front of the picture and can transition to active communication

by squeezing the sides of the picture frame. The top three sides of the picture frame are mapped to different colored lights. The squeeze pressures are transmitted as brightness of a particular color. In our laboratory setup, people who were collocated were often observed to squeeze the colors to create their own sense of meaning. Informal studies performed for a class project showed that people were able to employ the colored light combinations to convey a sense of affect and intensity.

ComTouch is a set of vibrotactile hand-held pads that transform the pressure of touch into vibration (figure 3)[2]. Two users may talk and squeeze at the same time. When a person squeezes, the pressure is translated into vibration amplitude. In published studies, people were observed to utilize the vibrotactile in 3 types of *tactile gestures*: turn-taking, mimicry and emphasis during conversations. Also, people were capable of creating their own encodings for the tactile channel, such as employing Morse, binary (yes/no), or numerical codes. When people were collocated, they had a tendency to try to observe their partner's reaction to the stimuli and adapt their interaction based on their partner's reaction. There was more outspoken interest in conveying the right meaning rather than focus on the device capabilities.

These three devices depict a space for touch communication that also impact collocated meetings. Indeed, it was often observed that these remote haptic communication systems work in collocated small group situations (such as demonstrations to laboratory visitors, informal chatting situations).

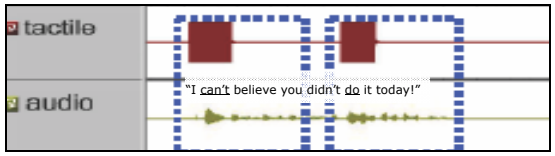

Figure 4. Tactile Emphasis in Conversation

The main contributions in tangible proxy interaction are: active listening (people appear more interested in what is being said due to the device providing a medium for nonverbal feedback), awareness of nonverbal information (figure 4) (emphasis, turn-taking, or emotional information), and reference cues (people use the tactile object and spatial position to refer to differing ideas). The prior work also suggests some key design criteria for shared tactile objects: causal mapping, ability to go hands-free, legibility of use.

Although 3 tactile gestures were reported in the ComTouch research, there may be more tactile gestures dependent on the affordances designed into the objects[7]. Separate from those already built (rolling, pushing and squeezing), there may be other affordances that can be capable of conveying different types of information over the background channel (such as pulling or stretching or sliding). My next direction will be to analyze how the shared tactile sensations enable new avenues of expression for improving common ground, nonverbal expression and emotional communication. The experimental protocol proposed is based on task-based conversational analysis. Synchronous occurrences of device usage with conversation are tagged and related to the context of the verbalized exchange. Other statistical methods may be employed for comparing and contrasting the perception of users for the different affordances.

Conclusion and Future Research

The outcome of this preliminary research is a demonstration that tactile interaction tools can positively impact group interaction. My planned future direction is to continue design of tactile proxy devices that identifies the relationships between haptic interaction and group behavior. I plan to build an integrated system that records the verbal and tactile communication of a group for data analysis. With an evolving understanding of the attitudes and intentions of the individuals in a group, the system will apply techniques for influencing the behavior of the group to encourage more productive communication. Specifically, the system will provide new alternatives to mediating group discussions, and thus affect the outcome of decision-making by engaging the sense of touch to actively increase participation and common ground.

This approach to thinking about the evolution of remote communication regards the sensory engagement of people during collocated interaction. We hope to observe that during face-to-face interaction, information gains from shared grounding can be attributed to synchronous stimulation of the sensory pathways. This particular research is concerned with stimulating the sense of touch and identifying the effects it will have on group communication, both perceived and otherwise.

Acknowledgements

I would like to thank my advisors, Hiroshi Ishii, Rob Jacobs, Cynthia Breazeal, and Chris Schmandt for their support of my work.

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