Connexus: A Communal Interface

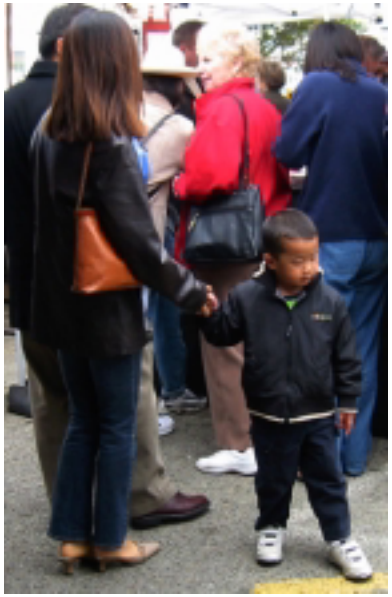

Figure 1: Nonverbal, ambient, co-located, awareness communication observed during initial user studies

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Abstract
Human communication and interaction comprise a wide range of verbal and nonverbal cues. Further adoption of novel telecommunication methods such as e-mail, chat, instant messaging (IM), mobile phone SMS text messaging, and videoconferencing; have augmented our mediated interaction abilities. However, a significant (and important) amount of human expression and interaction information is never captured, transmitted, or expressed with current computer mediated communication (CMC) tools. We also lack ambient methods of maintaining contact when not co-located with family and friends. Communal Interfaces is a new research effort aimed at the study of nonverbal human cues: their intent, motion, meaning, subtleties, and importance in communication. In this paper we address issues involved in the design, construction, and evaluation of Connexus, one such communal interface.

Keywords
Ambient Telepresence, Instant Messaging, SMS, Text Messaging, Awareness, Tangible Interfaces, Haptic Communication, Nonverbal Cues, Personal Communication, Wearable Computing, Co-Presence.

Industry/category
Mobile phones, pagers, text messaging, computer supported communication devices, multimedia messaging systems (MMS).

Figure 2: Sensing and actuation layout

Figure 3: Wireless Dot style Mote

Project statement

Humans communicate and interact among each other in rich and complex ways. When co-located we adeptly trade off between a wide range of cues, both verbal and nonverbal. However, when we examine the technologically mediated communication tools we use when *not* co-located, we quickly see our information channels restricted to primarily verbal channels such as text and speech. While there is emotional augmentation such as emoticons for text messaging and timbre, pitch, intensity, and inflection for voice calls, there is a need to explore nonverbal interfaces between non co-located people.

Our research in communal interfaces is focused on developing novel, mediated communication tools to explore methods of nondisruptive interaction when not co-located. People send such messages quickly, efficiently, and often without being distracted from their current task. These signals are also typically very personal in nature, involving touching and other forms of physical contact.

Communal interfaces should allow for easily establishing and maintaining emotional, ambient connections. Our studies of co-located human interactions led us to the following design criteria for communal interfaces: (1) non-disruptive I/O (i.e., ambient), (2) always on, (3) personal association to the communication artifact, (4) support for nonverbal communication, and (5) attempt to provide some level of exchange of human emotions (i.e., emotional interface).

Process

We initiated our exploration of this research area by watching nonverbal interactions of co-located people who had prior established relationships [1]. These observations primarily occurred at public markets, shopping districts, parks, sporting events, and on public transportation. The results point to a fundamental human urge to maintain some open communication channel at almost all times when co-located.

We speculate that these activities serve an important role in the development of human relationships.

Related Research

Strong and Gaver initiated exploration of devices that supporting implicit, personal communication as opposed to the explicit, goal-oriented style typically found in CSCW research [2]. Researchers have also addressed the “glancing” metaphor with the exploration of MediaSpaces, Portals, and awareness devices [3, 4]. Various physical interfaces have enabled remote individuals to arm wrestle [5], blow kisses [6], transmit hugs [7], exchange simple touching [8, 9], and send gestures [10]. Similarly, there has been a tremendous amount of sociological studies of mobile phone usage.

Research Details

An important part of our research was the construction and evaluation of at least one such communal interface called Connexus. A Connexus is a small, simple, wrist-worn personal object augmented with simple sensing, actuation, and *ad hoc* networking support. The focus was to design a system that would allow exploration of how humans would communicate when not co-located, without the use of text or speech. The basic idea was to create a small collection of sensors to capture

We repeatedly observed couples, friends, and families that maintained some form of physical touch with each other even when their attention was drawn to another task or they were directly involved in a conversation with another person. This contact did not always manifest itself as direct handholding but rather more subtle touching of fingers, hands, arms, legs, backs, and shoulders.

We also noted a high degree of reaching out with simple hand and body gestures to connect to the other individual. Often we observed directed glancing. Rather than to establish direct eye contact, this occurred more often for simply checking on the other individual's location, activities, and attention. What's important to note is that this ambient awareness technique was rarely used as a method to initiate further direct communication. There was sufficient satisfaction in simply gaining some knowledge of the other person's state of being.

information from one end and transmit them to the other end for expression using various actuators. Rather than creating a fixed mapping of sensor to actuator, we were motivated to explore the interaction "language" that would evolve through individual user-driven personalized mappings. This customization is performed through a simple Web interface to a message mapping server. Since all Connexus messages are handled by this server, we also have a convenient tool to perform evaluations of the system usage outside our laboratory. The overall design is based on research into small, wireless Smart Dust using the Mote [11] hardware platform for the prototype.

Sensing

Rather than overwhelming the user with sensing we chose a few reasonable sensing modes that were readily available. These design decisions were driven by the initial user studies performed. While we admit that we may not have chosen optimal sensing modes, we were more interested in moving towards a prototype that we could begin evaluation on rather than exhaustively iterating through sensing technologies. **Force sensing resistors** provide pressure detection over a low resolution surface array on the top of the Connexus. This allows for simple touching to be sensed. By time stamping the sensed data, rich signals such as a user swirling their finger along the surface of the Connexus can be detected. Ambient **light** is easily sensed with a photocell. As a user moves inside, outside, or places their hand over the Connexus, a signal is generated. A small **heartbeat** sensor allows detection of an individual's pulse. This provides access to a personal "life signal" of another person.

Actuation

Similar to the sensing, we simply chose a few reasonable actuators to provide a sufficiently interesting set of output modes. When electrical current is applied to a **Peltier Junction**, a temperature difference is created with one side of the thermocouple being hotter than room temperature, and the other being cooler. This allows the Connexus to heat and cool the skin it is contacting. Using an array of **superbright LEDs**, we are able to output a range of subtle glowing colors, not unlike a typical mood ring. Intentionally avoiding literal text, we were able to explore innate human responses to illumination and color. Simple vibrations are easily and privately felt through skin contact. Various vibration patterns and duty cycles provide a number of output possibilities for the Connexus. We used simple, flat, pancake **vibration motors** to induce vibration.

Privacy

The communal interfaces described in this paper touch heavily on issues of privacy. While initial prototypes and usage studies are designed to be conducted between individuals with strongly established relationships where privacy is less of a concern, we are not insensitive to the importance of privacy when designing such communication systems. Initial studies have exposed a stronger emotional connection to individual messages if the Connexus pair is first exchanged between users face to face. The communication model is then restricted to send and receive messages only between that pair of users (rather than between others in a group). This "friendship bracelet" model seems to strengthen the bond and impact of the messages.

Figure 4: Connexus Scenario: Tapping to send message, received as ambient glowing, and sliding finger to acknowledge message.

Everywhere Evaluation

The physical Mote hardware in each Connexus allows wireless communication on the 915MHz band within tens of meters. However, the intended usage is over much wider areas, similar to mobile phone network coverage. Therefore, we have architected a system that allows the Mote to communicate with a mobile phone and hence utilize General Packet Radio Service (GPRS) to send and receive messages. This allows Connexus users to maintain connections at almost any location, such as in buildings, at baseball games, in a mall, on a bus, or at the park.

Results

Our research into the design of communal interfaces has reinforced our appreciation for the intrinsic value of ambient nonverbal awareness cues used effortlessly by co-located humans. Fundamentally, we believe that such ambient communication is essential in building and maintaining human relationships, establishing trust, and enabling persuasion. We are currently performing a new set of user studies with the Connexus prototype to learn more about its acceptance and usage models. Humans are physical beings where touch, warmth, and holding evoke vital emotions. Finally, it's clear that our current computer mediated communication tools fail to support the rich gamut of such communication styles when not co-located. The hope is that our studies and those of others will lead to a better understanding of this significant genre of ambient human communication and interaction.

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