Temperature Sharing to Support Remote Relationships

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Abstract

Among the data that can now be readily sensed and
shared, we believe temperature has potential to
support relationships, because people perceive warmth
as intimate and temperature as indicative of comfort
and wellness. We interviewed 20 participants who
interacted with prototypes of temperature sensing and
sharing systems. Participants believed that shared
temperature information could make their remote
relationships stronger by supporting coordination,
reassurance, and intimacy. They also perceived many
challenges common in UbiComp – such as difficulty
interpreting data and tradeoffs between intimacy and
privacy. We discuss nuances and guidelines for using
temperature information as "shared informatics" and
how these results can inform future research and
system designs.

Introduction

People long for continued, closed relationships.
However, in a long distance relationship, there are
fewer opportunities and channels for people to share
information that supports awareness and
connectedness. Designers and researchers have
created and studied artifacts to mediate the effects of
distance using various strategies [4].
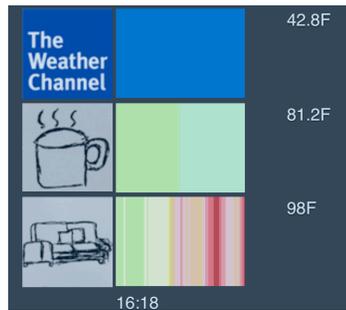
Figure 1 TempFeel system prototype

Home sensors are becoming cheaper and ubiquitous, and new products such as *Spotter* (which monitors motion, sound, light, temperature, and humidity) are reaching the market. Understanding the relationship needs that each type of data might support can guide the design of systems that use data from these sensors to support relationships. Temperature, for example, may be a natural channel for creating intimacy over distance, as people perceive physical warmth or cold as warm or cold emotions in interpersonal relationship [4].

To elicit views about how monitoring and persistently sharing temperature information could support awareness in remote relationships, we built a functional prototype for sharing temperature information, along with paper prototypes of four alternative systems. During semi-structured interviews, we presented these prototypes to 20 participants in remote relationships.

Participants hope to use persistent temperature sharing to promote connectedness, facilitate conversation, and provide assurance. They also worried about potential breaches of trust and privacy. In the remainder of this abstract, we discuss these results and implications for future design and research.

Prototype System Design

Messages that describe temperature or that produce changes in temperature can support subtle communication between couples to build intimacy [5]. Previous work on thermal communication has focused on sharing these discrete messages. However, as joint activities are important for maintaining relationships [2], we believe that persistent sharing of temperature information between remote couples and family members an underexplored opportunity in thermal communication research.

In particular, thermal sensors placed throughout the home or office might reveal traces about loved ones' activities. For example, a warm chair might indicate someone was just there or a steaming cup of tea might communicate where someone is in his or her morning routine. While previous research informs designers how people perceive shared ambient information from sensors, it also cautions that people have different perceptions, interpretations, and expectations for different technologies or types of data. Thus, we sought to investigate specifically how people might perceive and hope to use ambient, persistent temperature information, particularly to support remote relationships, as well as their concerns about this use

TempFeel System Prototype

We designed *TempFeel* as prototype to help us probe how people might react to persistent temperature recording and sharing and to compare it to other types of data. As previous research suggests, continuous sharing, asymmetric communication, and ambiguity are important design principles for using ambient information to support remote relationships [6], we designed TempFeel to support these criteria.

TempFeel consists of a mobile website and a Phidgets board connecting five different sensors: two thermal sensors, a pressure sensor, a light sensor, and a proximity sensor. The TempFeel interface displays real time and past temperature variations as a series of color bars (Figure 1). We also prepared four design sketches to elicit additional feedback and reactions (Figure 2) about what needs people thought
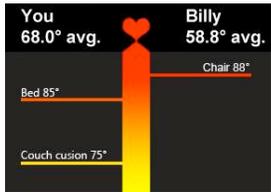
(a) Thermal Comparison

(b)Thermal Notification
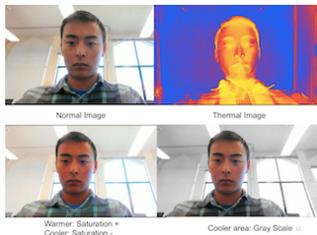
(c)Thermal Camera
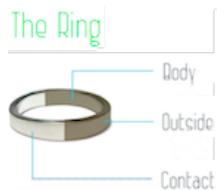
(d)Thermal Ring

Figure 2 TempFeel Paper Prototypes

temperature information might support. This use of low fidelity prototypes allowed us to explore a broader design space than we could implement in the functional prototype.

Results and Discussion

Participants (Table 1) wanted to use persistent temperature information to promote awareness, help them coordinate and facilitate conversation, and reassure them the other is okay (or alert them when not), They also described concerns that might limit their adoption of systems that support this sharing.

Relationship Goals
Promoting Awareness and Intimacy. Study participants perceived persistent temperature sharing as potentially satisfying their needs for feeling closer with their remote partner, family, or friends. One participant imagined installing the thermal sensor under her remote partner's pillow: "*if you wake up alone in the midnight, it would be nice to know the pillow is warm, to know the other is there, sleeping*" (P10).

Combined with knowledge of their partner's routines and context, this could help them vividly imagine what their loved ones were doing and create a sense of closeness, despite distance: "*If we could know where she is at and what she is doing while we are talking to her, I can imagine she is at some place I've been. It helps build my mental image*" (P20).

Coordinating and Facilitating Conversation.
Participants believed that inferring routines and activities from temperature information could help them identify opportunities to initiate direct conversations, especially when they were separated by several time

zones: "*Maybe I can share whether I'm awake or not to her. Because she always wakes me up so early.*" (P14).

Many participants wanted to use temperature information alongside synchronous communication channels such as phone or video chats: "*Sometimes I want to talk to my girlfriend but what should we talk about? ... 'Hey, let's look at our data from the day.' 'What was this spike then?' 'Oh I got a coffee'*" (P17).

Reassuring loved ones are okay. Several participants described wanting to use the system for eldercare, childcare, or pet care. Is their body and environment at a healthy temperature? Are they in a comfortable environment? Such use would require knowledge about healthy temperatures or knowledge of what temperatures their remote partner finds comfortable.

Concerns, Tensions, and Design Implication
Satisfying emotional needs while maintaining trust. Despite the perceived benefits, participants also concerned that sharing temperature could make them feel monitored in ways that made them feel untrusted. Systems supporting persistent temperature sharing might balance this tension by operating only in certain locations (e.g. a favorite chair), at certain time windows (e.g. from the time one's partner goes to bed until she wakes), or around a prearranged event (near the time for a weekly call between a parent and child).

Providing clear information while preserving privacy. Creating intimacy inevitably requires sharing private information. Ambiguity of ambient information is important in preserving privacy and inspiring conversations [1][6], but our participants felt that

	Gender	Remote relationship type
P1	F	Romantic, Family
P2	M	Romantic, family
P3	F	Romantic, family
P4	F	Romantic, family
P5	M	Romantic, family
P6	F	Romantic, family
P7	F	Romantic, family
P8	F	Family
P9	F	Romantic, family
P10	F	Romantic, family
P11	F	Family, friends
P12	F	Family, friends
P13	M	Family, friends
P!4	M	Romantic, family
P15	M	Romantic, family
P16	M	Romantic, family, friends
P17	M	Romantic, family
P18	M	Romantic, family
P19	F	Romantic, family
P20	M	Romantic, family

Table 1 TempFeel Participants

ambiguous temperature information could lead to confusion and anxiety.

Augmenting temperature information with additional, but limited, contextual information may address this tension. Integrating this contextual information could also help people perceive how a particular temperature *feels*. One downside is that providing more contextual information may reveal more private information and increase feelings of surveillance. However, it might also prevent speculation, misunderstandings, or confusion.

Maintaining contextual integrity while sharing across contexts. Nissenbaum [7] argues that privacy should be considered as contextual integrity, where each context comes with norms about what information will be shared within it and how that information should (or should not) be distributed. Remote relationships and technologies to support them can, however, create conflicts between a couple's virtual context and each person's physical context, which may be a personal space or space shared with others.

To address this, study participants suggested selecting sensor locations that would avoid sharing information about housemates' status and routines, such as by placing sensors only in their bedroom. This placement may work for romantic relationships, where participants saw the bedroom as a shared, intimate space, but was less appropriate for sharing with remote family members or friends.

Wearable sensors, such as the *Thermal Ring design* (Figure 2.d), could mitigate these contextual conflicts, especially if limited to sharing information about the wearer and the ambient temperature. Another possibility is to integrate sensors into personal products that are not shared, such as someone's favorite mug.

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