Towards Wearable Displays Aiming to Enhance Social Interaction

Thomas Olsson
Tampere University of Technology
Department of Pervasive Computing
Korkeakoulunkatu 1, P.O. Box 527, 33101 Tampere, Finland
Thomas.olsson@tut.fi

Kaisa Väänänen-Vainio-Mattila
Tampere University of Technology
Department of Pervasive Computing
Korkeakoulunkatu 1, P.O. Box 527, 33101 Tampere, Finland
kaisa.vaananen-vainio-mattila@tut.fi

Pradthana Jarusriboonchai
Tampere University of Technology
Department of Pervasive Computing
Korkeakoulunkatu 1, P.O. Box 527, 33101 Tampere, Finland
pradthana.jarusriboonchai@tut.fi

Submission to CHI'15 workshop Mobile Collocated Interactions: From Smartphones to Wearables.

Abstract
Compared to traditional mobile devices, wearable technology creates new opportunities for enhancing social interaction. For example, wearable displays could augment the wearer's appearance by showing relevant information about them. We have studied how to support co-located interactions with various mobile solutions. One of our current goals within this research is to understand how wearable and close-to-body displays could be used to trigger and motivate interaction between co-located people – both between familiar people and strangers. We briefly present two designs with which social opportunities in various social contexts have been explored, as well as highlight opportunities and challenges for future work.

Author Keywords
Wearable devices; co-located social interaction; ticket-to-talk; social cue; proximity-based interaction.

ACM Classification Keywords
H.5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces – Computer-supported cooperative work.

Introduction
Mobile device interfaces are inherently designed for personal use: they have limited display size, direct

touch input, and require conscious interaction from the user, etc. Mobiles are in many situations used for personal and private interaction with the device itself. This can distract the fluency of an ongoing social situation, as well as hinder engendering of new face-to-face interaction as people are cocooned in their private human-technology interaction bubbles. Despite the degree of attempts to turn the mobile devices more social, the stamp of 'personal' has stuck hard on mobile devices in users' minds. As the workshop description proposes, it is worthwhile to focus on alternative technologies that do not yet have such historical burden to overcome.

We believe that certain types of wearable technologies provide possibilities for enhancing social interaction. This is especially opportune with wearable and close-to-body displays which could augment one's appearance by displaying interesting information about oneself to the surrounding others. The ever-increasing sensing capabilities and connectivity of, e.g., recent smart watches and head-mounted displays enable context-aware applications that can also consider the social context and provide users with social notifications.

In our earlier research we have focused on Social Devices [5], that is, personal mobile devices with proactive features intending to facilitate social interaction between co-located people. This technology choice was made because of the omnipresence of mobile devices in people's everyday lives and their technical versatility. Recently, however, we started to explore the idea of utilizing wearable devices as Social Devices – particularly displays in different form factors.

We argue that wearable displays have the following strengths as tools for enhancing co-located social interaction (partly based on the characteristics described by Henriques [4]). First, they are as unobtrusive as clothing or accessories and can be seen as an augmentation of them. Just as clothing is often seen as an expression of one's persona, it is natural that the content output by the wearable displays represents the user wearing them. Second, in social interaction, they have the potential to be visible and audible to the co-located people. At the same time, they can provide their users with subtle and private cues about what social opportunities there are nearby. Inspired by that and the early visions of Wearable Communities [6], we have designed two concepts that aim at increasing others' awareness of a person by displaying relevant cues about her interests or current activities. The ultimate aim of this is to increase people's motivation to initiate social interaction.

Related Work and Our Concept Designs

Earlier designs of wearable devices with similar social purposes include, for example, the following. The BubbleBadge [3] is designed to look like a brooch that is capable of displaying information. It augments face-to-face interaction by providing information about the user or the environment. Social Fabric Fitness increases awareness and group performance with a shared display on the back of an athletic shirt [7]. The system was found to support collaboration among group members and make the running experience more fun and motivating. CommonTies is a smart wristband that alerts the wearer of another CommonTies user that shares certain interests or criteria with them [1].

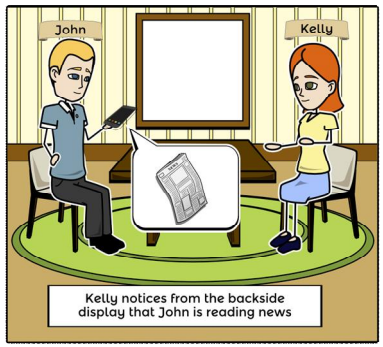

Figure 1. The "Family Breakfast" scenario about a display that reveals some information about what one is doing with their mobile device.

Figure 2. CueSense prototype worn on the chest area.

Back-of-Device Displays to Increase Activity Awareness
Our first concept takes the first step towards close-to-body displays by utilizing a secondary screen to display cues of one's current activity with a mobile device to nearby people. The concept is meant particularly for situations where familiar people feel reduced connectedness because of a member is interacting with a mobile device and the other(s) do not know what they are doing (for example the family situation in Figure 1). The activities happening in the digital world remains unknown to co-located others – even trusted people to whom the activity would be relevant. This opens up a design space to increase awareness of digital activities and create shared experiences around them. Overall, we believe that revealing bits of the content of the activities to nearby people can foster face-to-face interaction and reduce social isolation.

Cowan et al. [2] suggested several use cases where projectors attached to mobile devices could support face-to-face interaction: e.g. facilitating spontaneous sharing, conversation triggers and playful interaction, collaborative coordination, and personal expression. For simplicity, the form factor of the display chosen for a user study was the backside of smart phones but in practice the display could be worn in any part of the body and placed in various positions. In fact, our preliminary user study suggests that alternative positions for the display, such as on the chest or upper back would be preferred.

CueSense: a Wearable Display with Proximity Sensing
Building on several of the ideas in related work, CueSense is a small display that users can place on any part of their bodies to present textual social content about themselves to others. Unlike in the earlier work, we provide tickets-to-talk for face-to-face interaction based on existing content from social media (Facebook and Twitter). The concept is meant to help triggering interaction between unfamiliar people or familiar strangers that notice to have something in common (e.g. in an event, school, or other social gatherings). CueSense performs match making of the content of two users, presenting only information that they have in common. Another novelty builds on Hall's proxemics theory [8]: CueSense presents different content on two different levels of proximity. At public distance, approximately 10 meters, CueSense displays public information about the person – something that one is free to share in any situation. At social distance (approx. 2 meters) it shows content from Twitter (e.g. tweets of common followers) and Facebook profile information, such as likes or favorites.

Because of technical challenges with our first Arduino-based implementation, the prototype for a user study was a simulated wearable: an Android application on a 5.5-inch mobile device (i.e. a close-to-body display). Proximity sensing is performed by initiating Bluetooth discovery every few seconds, which returns the received signal strength indicator (RSSI) of the other device.

All in all, the commonalities between the two concepts are: (1) broadcasting one's profile and allowing new form of self-presentation through displays (2) with a purpose to enhance or trigger face-to-face interaction (3) by utilizing wearable or close-to-body technology as a form factor. By further exploring the wearability of the displays, we believe we can provide nearby people with digital information about a person in a way that is both acceptable and truly enhances social interaction.

Discussion and Future Research

We believe that our two designs and the related user studies will provide interesting additions to the discussion of the social acceptance and first user experiences of such systems, as well as how to evaluate them in real-life settings.

From the social interaction point of view, we think wearable technology offers interesting opportunities: (1) current *social norms* with mobile devices (e.g. not looking at others' devices or spying on others' displays) might be easier to overcome because of the new form factor and the built-in social purpose (cf. the intended personal characteristic of smart phones). (2) Wearables can be perceived more as an *extension* of oneself, which might allow people to assign them a more active social role. (3) Wearables can be more readily accepted to utilize interaction techniques that also benefit group situations, such as speech input/output, gestural interfaces and proxemic interaction.

On the other hand, the following issues remain as research challenges, which we intend to focus on in the future:

(1) How can we let people feel that they are in control of what is shared about them but, at the same time, provide them with proactive social features and thus feelings of surprise and social pleasure? The devices should react to the current social context so that the displayed information is not too privacy sensitive but still serves as a ticket-to-talk.

(2) How to select or define the target person(s) to whom the displayed information is targeted (with regard to how detailed, personal and mutually relevant it is)? Our designs are challenging to scale up from one-to-one situations to those with multiple people.

(3) How to measure the social impact and user experiences of such systems in authentic social settings? We intend to develop a conceptual framework of the social UX in this field. This would allow setting desirable design targets for future concepts as well as operationalizing appropriate metrics for evaluation.

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