Unobtrusive Interaction for Wearable Computing

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Abstract
Interaction with wearable devices such as smartglasses is yet a problem. While the input space is limited, the interaction itself can have strong social implications in public spaces. Missing social conventions and technology apprehension can affect the users willingness to perform interaction in public. One possible way to address this, is to reach for preferably unobtrusive interactions that do not cast a lot of attention upon the user. Social acceptance may then rise due to continued exposure with the technology.

Author Keywords
Wearable input; Unobtrusive; Social acceptance

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces

Research Situation
I am in my second year as a PhD student in computer science at the Institute of Media Informatics at Ulm University. The PhD program has no prescribed duration, but I am planning to graduate within 4 years, leaving enough time to make changes to the direction of my research based on the insights of the consortium. Before starting the PhD program I was employed at the institute as a research associate during my master's degreee and interned at Nokia Re-
search in Sunnyvale (US) where the focus was on interaction with novel handheld near-eye displays [9]. This influenced my research agenda towards unobtrusive interaction and especially input techniques to allow for subtle and seamless interaction. My experience has primarily been in building novel devices and researching new ways of interaction.

Background and Motivation
Head-worn displays (such as Google Glass) allow for quick access to information that is always available when the device is worn. User interaction with virtual content, however, is yet a problem. Visual output and physical input are decoupled, due to near-eye optics altering the visual perception to a virtual plane floating in mid-air. This plane is neither graspable nor touchable and granting no physical resistance or haptic feedback so that direct touch interaction is difficult to achieve. Also, while the virtual content is invisible to bystanders, the interaction is not. Pointing gestures in mid-air can have strong social implications, when the intent is unclear to the observer. Spacious gestures are therefore prone to draw attention.

Voice input allows for handsfree interaction, but is obtrusive in shared public environments such as lectures where it can disturb other people. Another means for input is touch interaction situated at the eye-wear (e.g. Google Glass has a touchpad near the user’s temple). This however, is directly at eye-level to bystanders and thus likely to draw visual attention. In addition, tapping gestures on one’s forehead can evoke negative social connotations, depending on the cultural context.

By now, no interaction or user interface paradigm has established itself as state of the art. Often with consumer devices (such as the Epson Moverio, Ora or Vuzix), the device just serves as an external display and in lack of established interaction, a tethered handheld touchpad is provided.

Related Work
Wearable input has gained a lot of attention within the literature. Handheld devices, such as the Twiddler [10] can be used as an accessory input device for rich interaction, such as text input. However, this means another device has to be carried along by the user. To avoid this, interaction interfaces can be worn on the body such as Nenya [1], a magnetically tracked finger ring that can be turned for subtle input. In NailO [7], the nail of a finger is extended with a nail sized touch surface to allow for simple touch gestures. Another possibility is to utilize devices that are already worn or carried by the user. In Multi-Fi [4] multiple devices, such as head-worn display, smartwatch, and smartphone complement each other for input and output, while in PocketTouch [12], capacitive touch sensing of a phone is used for touch input through the fabric of the users pockets.

Interfaces can also be interwoven into the fabric of clothing. In FabriTouch[5], a textile touchpad is integrated into a pair of trousers, while in Pinstripe [8], folds of various worn garments can be pinched and rolled between fingers for continuous input.

A lot of wearable interaction techniques have been researched, yet the focus has barely been on unobtrusiveness. Profita et al. [11] conducted a user study to evaluate the social perception of textile interface on various locations on the body and gained cultural insights.

Even though subtle interaction techniques have been proposed, subtlety often comes at the cost of input fidelity. Ashbrook defined microinteractions as interactions that last up to 4 seconds [2]. This aims for short and simple gestures that do not distract the users attention. We believe it is
also important to consider seamless transitions into longer and more complex interactions that yet remain subtle and unobtrusive.

**Research Goals and Method**

We envision that in the future ongoing miniaturization will allow for wearable devices whose form factor and appearance is unobtrusive to bystanders, e.g. smart eye-wear that is embedded into a regular pair of glasses or even into contact lenses. Our aim is to (1) develop input techniques for such devices that are unobtrusive and yet allow for rich interaction, (2) derive UI design guidelines based on the affordances (3) and to investigate and evaluate the internal perception of the user as well as the external perception of bystanders.

**Novel Input Devices**

The spatial area at the upper thighs is often mentioned in user studies where participants would potentially accept wearable touch input [6]. Our current work in progress on input devices is focussing on this area, because it allows for a quick access time from the resting position of a users hand with little movement involved and by this keeping the obtrusiveness low. Existing e-textile interfaces are mainly utilizing very simple directional touch gestures [5] or small touch areas for distinct functions [6]. Our goal is to design for short and subtle interaction at this location that yet allows to seamlessly transition into longer and complex interactions.

**UI Design Guidelines**

In regard to the distinct properties and affordances of the input device, we develop and evaluate UI design guidelines that take into account different interaction techniques. The interface should allow the user to perform their task as quickly as possible without disrupting their attention [13] and allow the user to interrupt the interaction immediately to be able to shift their full attention to a more important real world task when required. Complex tasks often require longer interactions and more attention while being potentially less subtle and unobtrusive. We believe that the tradeoff between subtlety and complex interaction should be choosable ad hoc by the user during interaction.

**Evaluation**

So far, we evaluated the internal perception of users during interaction in public. As a next step, we want to establish methodologies for the external perception of bystanders.

**Dissertation Status**

The University of Ulm supports cumulative dissertations, therefore the focus is on publishing papers around the theme of unobtrusive interaction and to later combine these into a coherent PhD thesis.

In a first work we built *Belt* [3], a novel touch input device that incorporates a touch surface encircling the user’s hip into a common belt worn by the user (see Fig. 1). We leverage the wide input space for a horizontal spatial mapping of information and support for subtle and unobtrusive interaction. Users can rest their hand in the front trouser pockets where they can still reach for the belt with their thumb. We conducted a qualitative user study and found out that users preferred the area above the front pockets as appropriate input space (see Fig. 2). For very short interaction (2-4 seconds) they found most of the input space to be socially acceptable.

In recent work, we extend the interaction to not only allow for quick information retrieval, but also a more profound interaction model that enables more complex tasks.
So far, our study design was focussing on the interaction of the user in lab studies and in the public. In the future we want to include the external perception of bystanders to learn more about obtrusiveness, as well as social signaling of intent and action of interaction gestures. We seek to establish a methodology for interaction design that can help the HCI community to create more unobtrusive interaction techniques.

Expected Contribution
My overreaching goal is to design interaction techniques that users would be willing to perform in public. By reaching out for unobtrusiveness, we bring together the design of HCI-techniques and the internal and external social perception of those who are willingly or unwillingly confronted by these in public.

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References


