Peripheral Microinteraction For Wearable Computing

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Abstract
Computers are ubiquitous and the trend of wearable devices is continuously increasing. Nowadays these small devices are permanently supplying the user with many pieces of information. Accessing and responding to this information without involving the user's full attention is the goal of peripheral interaction, hence allowing the user to execute her main task with minimum interruption. In this paper, we introduce the concept of peripheral microinteraction, and highlight and illustrate properties allowing users to seamlessly interact with their devices with a minimal visual, cognitive, and physical cost in mobility context. We also present interaction concepts showing the feasibility of peripheral microinteraction.

Author Keywords
Peripheral interaction; microinteraction; eyes-free interaction; wearable computing; input interfaces.

ACM Classification Keywords
H5.2 [Information interfaces and presentation]: User Interfaces – Interaction Styles.

Figure 1. InEar BioFeedController illustration.

Figure 2. ShoeSoleSense prototype.

Introduction

Designing mobile interactions with computing devices is facing a new opportunity with the recent development of wearable computers that can be directly worn on the user's body. As such, computing devices can be always accessible [2] and visible [5] for their users. This enables new interaction scenarios that were less explored in the past. However, it remains unclear on how to best design interactions with such devices.

As users often need to pay attention to mobility tasks, suitable interactions in mobile scenarios should be performed quickly and easily without requiring the user to concentrate on the interaction itself, as pointed out by Ashbrook through the concept of microinteraction [1]. Such interactions include responding to an incoming phone call, switching music, taking a picture, responding to a notification, making a short note, etc. While microinteractions have been explored for mobile devices, they have been less explored for peripheral wearable devices, which motivates our work.

Peripheral Microinteraction in Mobility

We aim to combine the properties of both peripheral interaction and microinteraction as "peripheral microinteraction". In this study, we define peripheral microinteraction as a kind of interaction that takes place whenever a user wants to change the state of a computational system while being focused on a primary task. Changing the song on a music player while crossing the street is an example of such an interaction. To qualify it as a peripheral interaction, the user must not have to switch his attention from his primary task to the interaction with the device itself. Efficient multi-tasking is an obvious expected advantage. A distraction of a primary task may possibly cause danger – as in the given scenario, crossing the street without paying enough attention to the road could lead to an accidental event. Peripheral interaction is thus desirable in mobile situations. We aim to propose how to design simple and suitable interaction technique for peripheral interaction to accomplish safe interactions in such scenarios.

Properties of Peripheral Microinteraction

The most common alternative input modalities in research seem to be audio and gestural input. Voice-based input, while becoming more available with systems such as Siri, seems to be often rapidly neglected by users (85% of people haven't used Siri since iOS 7 was released[1]). This might be due to the fact that voice based input techniques are still not as reliable as expected by the users - especially in noisy environments. Also, social awkwardness of such techniques can still be a problem. This leads us to extract the two most important properties, **reliability** and **social acceptance,** which may even prevent users from interacting with wearable devices at all. Factors that influence the frequency of use are the **availability** of a device (e.g. a smartphone buried deep inside a bag or clothes) and the **joy of use**. Moreover, interactions tend to fail or to be disliked when inputs are too complex. Because the complexity of the output of a microinteraction is generally small (e.g. vibrating a phone), its corresponding input should be accordingly simple. Thus the **simplicity** of input (e.g. simple and memorable gestures) also has a positive impact. In the context of mobility, when being on the go or driving a

[1] http://www.ibtimes.com/apple-ios-7-85-percent-people-havent-used-siri-46-percent-think-apple-oversold-its-release-1437900 [Last retrieved 2nd January 2014]

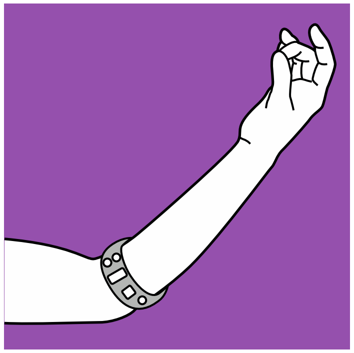

Figure 3. Augmented armband example.

Figure 4. The Ring Ring concept.

car, it is desirable to enable the user to have a free field-of-view. This kind of interaction is called **eyes-free**. However, in mobile contexts, when driving a car, carrying groceries or wearing gloves, using hands to interact with the system is not always possible. Hence, **hands-free** interaction is also an desirable aspect for microinteraction in mobility.

Advantageous Concepts for Peripheral Microinteractions in Mobility

We now describe concepts that introduce different approaches regarding input and output which rely on different hand, foot or head gestures.

InEar BioFeedController

"InEar BioFeedController" [7] (**Figure 1**) is a headset that enables fully hands-free and eyes-free interaction with mobile devices. Simple head gestures (exaggerated head shaking & nodding) and facial expressions (eye winking or ear wiggling) enable a response on incoming phone calls or a control of a music player without distracting the user from his primary task (e.g. having a walk). The prototype is safe for use in traffic, because no tactile or visual contact is required, thus visual attention can remain on the road.

ShoeSoleSense

"ShoeSoleSense" [8] (**Figure 2**) is an insole that enables location independent hands-free and eyes-free interactions through the feet. The prototype measures pressure under the feet and enables a device such as a smartphone to exploit an additional input modality through foot gestures (e.g. through different ways of tapping on the ground). Also it is possible to use peripheral information, taking into account whether the user is walking, standing or lying/sitting to adjust the output. For example, while walking, phone calls might be ringing louder. Also, the prototype provides additional feedback by heating up the feet and vibrating in dedicated areas on the surface of the insole. So events such as incoming phone calls can also be felt through vibrations under the feet and the level of priority can be transmitted by the temperature..

Arm/Wrist-band

Utilizing an armband (**Figure 3**) as an input device is an interesting approach which has been considered by several researchers. (e.g. using EMG: Saponas et al.[10], using an accelerometer: Feldman [4]). Combining both sensor types enables precise arm and hand gestures. For instance finger snapping can serve to trigger an action such as starting an audio recording, shaking arm to decline an incoming phone call, etc.

Ring Ring

The "Ring Ring" [6] (**Figure 4**) takes advantage of the light emitted by LEDs to provide non intrusive information. By varying the light intensity and color, it is possible to easily transmit useful information. We evaluated the prototype in a context where users were focused on a primary task. One result is that participants could not distinguish different light intensities emitted by the ring efficiently when focusing on a primary task, showing that visual perception in peripheral interaction is significantly reduced.

WatchIt

"WatchIt" [9] (**Figure 5**) is a wristband augmented with position sensors that allows users to interact eyes-free. Through simple pointing or sliding gestures with the finger along one dimension, "WatchIt" provides an efficient mean to perform reliable peripheral

Figure 5. WatchIt enables eyes-free interaction on wristband.

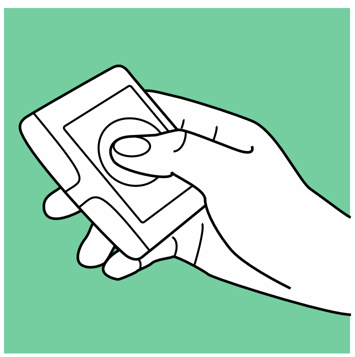

Figure 6. earPod prototype.

interactions that require no visual attention and only need reduced cognitive attention as shown by a user study. Performing gestures on the wristband while being in a conversation is nearly imperceptible and does not lead to interruptions or awkward situations.

earPod

"earPod" [11] (**Figure 6**) is an eyes-free menu technique using touch input and reactive auditory feedback. earPod allows simple tapping and sliding gestures to select a variety of commands. Study results indicate that earPod is potentially a reasonable eyes-free menu technique for general use, and is a particularly well suited for mobile device interfaces.

Conclusion

In this paper, we highlighted properties that should enable beneficial peripheral microinteraction in mobile contexts: reliability, social acceptance, simplicity, eyes-free and hands-free interaction. In order to be performed eyes-free and with a minimal cognitive attention, interaction techniques can rely on proprioception as users know the exact location and orientation of their body parts. Gestural interaction with wrist, arm, feet, head movements often already enable hands-free and peripheral interaction, so that the user can pursue his primary task, which is generally executed using the hands and the fingers. Additionally, the output channel can be enriched by leveraging on the various human senses for instance by feeling temperature or pressure, by distinguishing between melodies or tone frequencies or by perceiving color changes in the peripheral field of view. We hope these properties and concepts will help in designing new techniques for peripheral microinteraction in mobility context.

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