Extending Interaction to the Periphery

Doris Hausen
University of Munich
Amalienstraße 17
80333 Munich, Germany
doris.hausen@ifi.lmu.de

Andreas Butz
University of Munich
Amalienstraße 17
80333 Munich, Germany
andreas.butz@ifi.lmu.de

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Abstract
Communicating information in the periphery of human perception is common practice in the design of ambient systems. However this normally leads to passive, non-interactive displays. We propose the concept of peripheral embodied interaction, which is carried out in the physical world on the periphery of the users' attention. We offer a classification of peripheral embodied interaction consisting of five design dimensions and show two initial prototypes, which incorporate peripheral interaction capabilities.

Keywords
Embodied interaction, peripheral interaction

ACM Classification Keywords
H5.m. [Information interfaces and presentation]: Miscellaneous

General Terms
Design, Human Factors

Introduction
The concept of ambient information – information, which resides on the periphery of the users' attention but can move to the focus [4] – is widely accepted in HCI research. Many systems have been proposed but only very few of these systems are interactive. We believe that the notion of ambient information can be ex-

tended to include interaction, leading to an interaction style that is carried out alongside the users' current primary task without asking for their full attention.

A related concept was introduced by Darren Edge: peripheral tangible interaction [2, 3]. He defines it as "episodic engagement with tangibles, in which users perform fast, frequent interactions with physical objects on the periphery of their workspace, to create, inspect and update digital information which otherwise resides on the periphery of their attention" [3]. By considering further physical capabilities, this idea can be expanded from tangibles to embodied peripheral interaction. This paper proposes a classification of peripheral embodied interaction and shows two experimental prototypes.

Peripheral Embodied Interaction

Our understanding of embodied interaction is in line with Dourish, who describes it as the attempt "to move computation and interaction out of the world of abstract cognitive processes and into the same phenomenal worlds as our other sorts of interactions" [1]. Users do not have the feeling of interacting with a computer, but rather act in the non-digital, physical world.

In our everyday life excluding the personal computer, we carry out small activities with a flick of the wrist in parallel to our current primary activity without really focusing on them. We can, for example, easily move a cup out of the way while talking to somebody. This is very natural to us and does usually not require a very precise execution. On the PC in contrast, even very simple tasks often require a context switch, precise pointing or exact knowledge about certain key presses.

We argue that especially simple things, which do not belong to the current primary task (e.g., typing a text), but still matter and require interaction (e.g., setting the status in an instant messenger) will benefit from new forms of embodied interaction. Our goal is to improve multiple task situations by moving secondary tasks away from the classical computer interface into the physical world around us. Ideally we keep the interaction belonging to the secondary task simple and casual, not requiring precise actions, and thereby reduce the mental load caused by it to a minimum. This form of interaction we call peripheral embodied interaction.

Design Dimensions

Peripheral embodied interaction can be carried out in many different ways, e.g., speech, gestures or eye tracking. More formally, one can categorize each interaction in five design dimensions: explicitness, input mode, granularity, privacy and proximity.

Explicitness

Explicit interaction is the common way to interact with a computer. Commands are purposefully given by mouse or keyboard to execute an intended step. In contrast, implicit interaction is defined as "an action performed by the user that is not primarily aimed to interact with a computerized system but which such a system understands as input" [5]. Explicitness hence is a dimension ranging from explicit to implicit interaction.

Input Mode

For peripheral embodied interaction, many input modes can be imagined. Gaze can be tracked and serve as input, as well as speech. Hands can be used to perform gestures or manipulate tangible objects. Other body parts can also be used depending on the situation.

Granularity
Based on the form of interaction, a different number of commands can be encoded. For example, glancing at an object encodes two levels – looking or not looking at it. In contrast, speech input enables an infinite number of commands. Casual hand gestures, such as wiping to and away from oneself, leave fewer options, while more precise gestures, e.g., a single or multi stroke gesture, can encode much more commands. Granularity for manipulation of a tangible depends on the tangible and its characteristics.

Privacy
When we are typing or using the mouse, bystanders can really only tell what we are doing if they see the display. Peripheral embodied interaction can be observed much more easily, depending on the input mode. For sensitive data, this should be taken into account when designing such a system. In addition to public and private data there is personal data belonging to the user but not secret to others (e.g. presence in the office).

Proximity
Interaction can happen over a variety of distances. While manipulating a tangible usually requires the tangible to be reachable by hand, glance and speech recognition can be carried out over a larger distance.

Prototypes

We have built two prototypes using the notion of peripheral embodied interaction:

Ambient Appointment Projection
The ambient appointment projection (figure 1 left) offers a spiral visualization of the overall time flow of upcoming appointments, which is projected on the users' desk. Once an event is coming close, the spiral starts pulsating to remind the user about the appointment.

figure 1. Two prototypes: the ambient appointment projection (left) and the tangible presence indication (right)

Peripheral interaction happens by a wiping gesture of the hand, which is tracked by a camera. Wiping towards the user will offer details about the next appointment as a balloon tooltip. Wiping away from the user stops the pulsating of a reminder. Using this embodied approach, the users do not get disrupted as forcefully as by state-of-the-art reminder pop-ups. The gestures have been selected to meet the metaphor of fetching wanted or pushing away unwanted things. The casual nature of the gestures ensures that the users do not need to focus their attention on this interaction.

The appointment projection was tested in a lab study with twelve participants and smooth handling of appointments was attested to it.

Tangible Presence Indication
A cylindrical object consisting of several levels (figure 1 right) shows presence information about the user (biggest and topmost level) and selected contacts (other levels). The object is connected to Skype and encodes

customized statuses (communicated in Skype as mood messages) besides the standards “available”, “away” and “do not disturb” in a color-coded way. We hope to support more accurate and detailed statuses with this prototype and thereby reduce unwanted interruption but also encourage communication.

By turning the topmost level, users can set their status, by pushing down this level, which integrates a button, they set the time they expect to be in this state. Again, this can be carried out without switching the context on the screen. Adjusting information by turning or pushing a button is very natural in the physical world (e.g., for controlling a stove or audio equipment). The object was built based on the results of a survey with 46 participants. A long-term user study is being planned.

Classifying the Prototypes

Figure 2 shows the two prototypes classified along the five design dimensions. Both systems use explicit interaction, operate on personal data (calendar data and presence information) and need to be nearby for interaction. The appointment projection interprets gestural input with a low granularity (wiping towards and away from the user) while the tangible presence indication supports interaction trough object manipulation with a medium granularity (nine statuses).

Conclusion and Future Steps

In this paper we proposed the concept of peripheral embodied interaction and a classification for it along five design dimensions. We built two initial prototypes for peripheral interaction – the ambient appointment projection and the tangible presence indication. First user study results support the concept and the expectations we have for its usefulness.

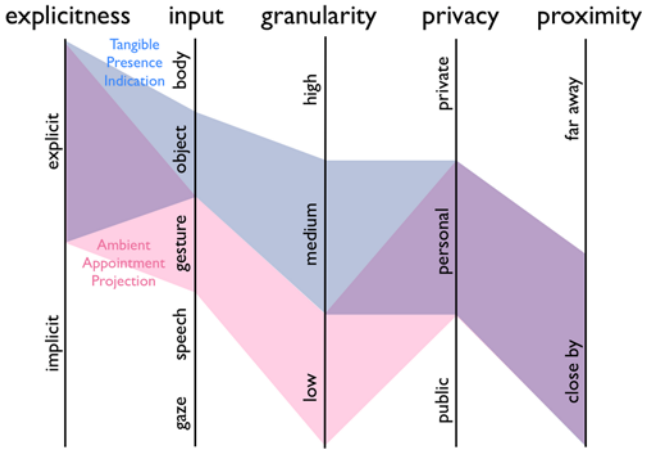

figure 2. Classification of both prototypes along the five design dimensions

In the future more prototypes need to be built to test the whole spectrum of the classification and to depict best practices for peripheral embodied interaction.

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