Reducing Cognitive Load by Using the Periphery of our Attention

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Abstract
Going to the cinema, watching a movie and thereby eating popcorn is an enjoyable event. Nobody would consider watching the movie and eating popcorn as cumbersome or exhausting multitasking. This is due to our capabilities of carrying out small, well trained tasks (like eating) in parallel. However, when interacting with digital devices, we hardly use this skill and have to switch our focus and attention even for marginal tasks. As solution we propose peripheral interaction, which aims at moving small tasks to the periphery and thereby reducing the cognitive load caused by them.

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General Terms
Design, Experimentation, Human Factors

Introduction
Working on a standard desktop computer can be overwhelming at times. Besides the current primary tasks, users have to pay attention to several other

tasks, either because they are obligated to take care of it (e.g. keeping an eye on your upcoming appointments) or because notifications distract them and ask for their attention and interaction (e.g. a new mail has arrived). Additionally the number of those secondary tasks is constantly rising (e.g. social media, multiple devices).

Common user interface design usually asks for switching windows, pointing at small icons and generally for focus and context switches. We claim that this is too cumbersome for rather marginal tasks and therefore propose *peripheral interaction*, which targets at offering easier access to small tasks and thereby reduces cognitive load when interacting with those tasks.

Definition of Peripheral Interaction

Peripheral Interaction is an interaction style widely used in our physical life. For example, while listening to a colleague we can easily drink a cup of tea. In contrast, when interacting with digital devices, we are usually forced to interact with our full attention even if our task is only a small secondary task (e.g. keeping our instant messaging status up to date). Peripheral interaction is meant to be a subform of multitasking. It always contains at least one marginal task (we call it the peripheral task). The peripheral task is carried out in the periphery of our attention, a concept well known from ambient information systems [8]. The big difference is that ambient information systems usually only support monitoring information in contrast to peripheral interaction, which offers an active interaction possibility to manipulate the content of the system.

Figure 1. The prototype “StaTube” shows the user's and the contacts' IM states. By turning the upmost level the own state can be changed.

Related Work

Peripheral interaction is a rather new research area first examined by Edge et al., who coined the term peripheral tangible interaction as a *selective and fluid engagement in loosely related disperse episodes* [3]. While Edge et al. expect the user to selectively – but only shortly – change the focus from the primary to the peripheral task, Olivera et al. explore “a parallel non-engaging interaction channel” [9]. Bakker et al. have a similar understanding of peripheral interaction but also consider peripheral awareness (c.f. ambient information) and not only active interventions as peripheral interaction [2]. Consequently our definition is most in line with Olivera et al. [9] but we acknowledge that complete parallel interaction is hard to achieve and consider interaction causing micro-interruptions still as peripheral interaction.

The psychological foundation of peripheral interaction is described in divided attention theory, which states that we can divide our attentional resources between several tasks [1]. Consequently peripheral tasks are tasks, which can be carried out with only a minimum of attentional resources.

Experiments

Research on peripheral interaction up to now mainly focuses on tangible interaction [2,3,8]. To investigate peripheral interaction in a broader scope we expanded the design space [4] and defined (in a refined version) six design dimensions: explicitness, input, granularity, privacy, proximity and feedback [5].
In the following projects we focus on manual input and therefore built several prototypes.

Figure 2. The Appointment Projection projects calendar data onto the table. By a wiping gesture the user can acquire more details.

Figure 3. The Peripheral Audio Player supports alternatively free hand gestures (white box hides the tracking), tangible interaction (3D mouse) and touch gestures (through a mobile phone).

StaTube

StaTube [6] is a tangible, located on the user's desk and connected to Skype (see figure 1). To change the Skype state the user can turn the upmost level and additionally push it down to set a timer for specific states. Additionally, ambient information is included. The own state, as well as the states of selected contacts are displayed in a color coded way.

Appointment Projection

The Appointment Projection [7] (see figure 2) also brings together ambient information and peripheral interaction. The user's upcoming appointments are projected onto the user's desk as spiral. Different colors depict different calendars and different sizes different time spans. Peripheral interaction is incorporated by using freehand gestures. By wiping towards oneself, additional information about the next appointment is acquired and shown as balloon tooltip on the screen. Wiping away from oneself silences the pulsating spiral, which is intended to remind the user of a close by appointment.

Peripheral Audio Player

The Peripheral Audio Player (see figure 3) offers control over iTunes through peripheral interaction. Three modalities – tangible, touch gestures and freehand gestures – are incorporated, but we intend to only use one modality at a time. The supported commands are pause/play, next/previous song and volume.

Lessons Learned

StaTube as well as the Appointment Projection have been evaluated in long-term in-situ deployments.

Usage: Both evaluations showed that participants liked the interaction with the system and used the peripheral interaction possibilities quite regularly and consider it useful in their daily routine. During our studies, most participants started to ignore the standard GUI for functions that were provided by the peripheral interface (e.g. nearly all state changes were carried out using StaTube instead of the Skype interface).

Learnability: Peripheral interaction is an interaction style with a rather long learning curve. Most – but not all – of our participants were able to carry out the peripheral interaction without focusing on it at the end of our two week evaluations. Bakker et al. reported similar findings [2]. In general a learning phase is expected to adopt a new interaction style, especially if it requires not paying attention to it. This is also true for peripheral interaction in the physical world (consider walking, which allows performing all kinds of other tasks in parallel; but in the beginning we needed quite some time to learn it).

Modalities: StaTube evaluated tangible interaction, similar to other previous mentioned research projects. In contrast the Appointment Projection uses free hand gestures and proves that the concept of peripheral interaction is not limited to tangibles. With the Peripheral Audio Player we hope to get more insights on the effects of different modalities.

Benefits of Peripheral Interaction

The overall goal of peripheral interaction is to reduce interruption and focus switches for small task by moving them to the periphery of the user's attention. This is achieved by offering a *shortcut* to a task.

In general there are two types of tasks that can be improved. (1) Tasks which would be beneficial to do, but are neglected because they are considered too cumbersome (e.g. setting the correct state in an instant messaging client) and (2) mandatory tasks, which need to be carried out, but need focus and window switches and thereby are often circumstantial (e.g. getting calendar details). By offering a shortcut, which additionally can be carried out without focusing on it, neglected tasks are performed more frequently (see findings from the StaTube study) and mandatory tasks are considered to be carried out easier (findings from the Appointment Projection study).

Conclusion

Peripheral interaction, while common in physical daily life, is not yet transferred to digital devices. In this paper we offer first insights on peripheral interaction beyond peripheral tangible interaction. During in-situ deployments we were able to show that our prototypes indeed were operable in the periphery of the users' attention and thereby reduced the cognitive load imposed on them while carrying out small tasks. With the help of further comparative studies we hope to gain more insights about the different modalities and their implications.

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Biography

Doris Hausen is a third year PhD student at the Human-Computer-Interaction Group at the University of Munich, Germany. Her main research topic focuses on multitasking, especially on multitasking with small tasks, which she calls peripheral interaction. Before pursuing a PhD, she studied media informatics at the University of Munich, which is computer science with a focus on multimedia and HCI.
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