Exploring the Potential of Peripheral Interaction through Smart Furniture

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Abstract
During everyday office work we are used to controlling our computers with keyboard and mouse, whereas the physical space around us remains largely unattended. Addressing this untapped potential, we follow an approach that is based on gestural interaction with smart furniture interfaces, subtly blended into the work environment. Adding to existing work on peripheral interaction, we provide a case study of a novel input technique that turns a flexible chair into a ubiquitous input device within an office environment. We propose using imprecise semaphoric chair gestures to support always-available, hands-free, and eyes-free interaction.

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Smart Furniture, Chair Interaction, Peripheral Interaction, Office Environments

ACM Classification Keywords
H.5.2. [Information Interfaces & Presentation]: User Interfaces - Ergonomics

Introduction
In the course of a working day we perform a variety of different activities, oftentimes in parallel, and keep shifting our attention back and forth between tasks of varying importance and urgency. These shifts might be deliberate actions such as briefly skipping a song when

Figure 1. Users controlling a desktop computer through the movements of their body, while sitting on a sensor-equipped flexible office chair.

listening to music while writing a report, or situational context changes such as reacting to an instant messenger notification during the creation of a project schedule. Regardless of the specific use context, such scenarios always involve a focused primary task and a peripheral secondary task requiring temporary attention, only to slide back into the periphery again. Still, such short interruptions can disrupt our concentration, make us lose focus and decrease our performance [1]. This is especially problematic in the office context, where we want our attention focused on the actual work. Thus, it is desirable for transitions between primary and secondary tasks to work rather effortlessly, with minimal physical and mental demand. We think that this type of interaction with secondary tasks should aim at keeping a task in the periphery of our attention, while still providing the opportunity to control it when needed.

In our work, we focus on improving users' interaction with peripheral tasks in the office context by providing the opportunity for gestural interaction with smart furniture (e.g., navigating to the next item in a list by briefly swinging the lower body to the right while sitting on an interactive chair). Thereby, in comparison to traditional input devices, our goal is to reduce physical constraints (i.e., supporting hands-free, eyes-free interaction) and mental effort (i.e., using simple gesture mappings) to support input that can take place nearly in parallel with a user's primary task. We believe that smart furniture is very well-suited for such peripheral interaction styles due to its ubiquity and currently untapped potential as input medium. As an example, we propose the concept of using a flexible, interactive office chair for imprecise gestural interaction within a desktop environment.

Related Work

With digital information and communication technologies finding their ways into the work environment, people spend increasing time in managing various activities simultaneously, which results in frequent context switches that may have negative effects on performance and emotional well-being [1]. Therefore, efforts have been made to design calm technologies that aim to reduce information overload by letting users select what information is at the center of their attention [11]. Moreover, special interest has been on the design of inattentive interaction techniques that can be easily performed in the periphery of attention. *Whack Gestures* is an example of an inattentive, inexact interaction technique, allowing users to interact without the use of fine motor skills or detailed visual attention [3]. It has been shown that such semaphoric gestures can provide substantial benefits for secondary task interactions [4], and allow users to vary their level of engagement with a task [7].

While early work in the field of smart office environments has demonstrated the ubiquitous integration of interactive technology into the work environment [10], the focus has more recently turned towards supporting users by extending interaction to the periphery. *The Unadorned Desk* is a recent example which exploits the physical space around a desktop computer as input canvas [2]. Similarly, our work adds to the research that has been done in the field by proposing a novel case study that extends the design space of such inattentive interfaces to gestural interaction with smart furniture that is subtly blended into the work environment. Thereby, we make use of novel input approaches, which go beyond touch or freehand gestures to provide key aspects of inattentive, imprecise, eyes-free, and hands-free interaction.

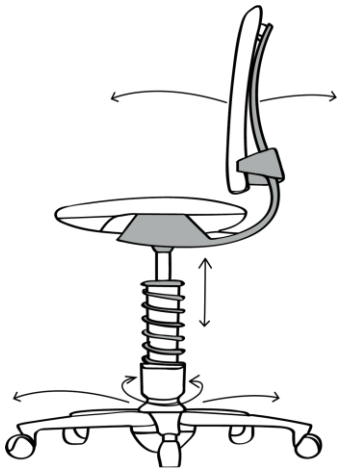

Figure 2. Horizontal and vertical degrees of freedom provided by the 3Dee™ flexible chair (www.swopper.de/en/3dee).

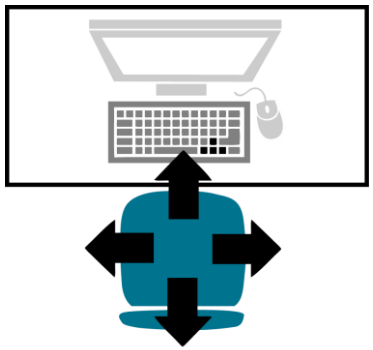

Figure 3. Frequently used music player commands are mapped to the four canonical directions.

Smart Furniture for Peripheral Interaction

Furniture elements can be found everywhere, pervasively embedded into our daily life, barely noticed as functional tools or design elements. Currently, we see more and more devices with embedded sensing and communication capabilities [11]. We believe that furniture provides a particularly interesting design space for fitting interactive technologies in our everyday life, as it is an integral part of our physical environment that can be ubiquitously accessed, and provides familiar simple operations and appealing tangible material properties. If we are thinking of a traditional desk workplace for example: the chair, the table, or the floor itself could serve as alternative input/output channels that broaden the design space for peripheral interaction, making room for other use cases where traditional interaction techniques might not be suitable.

Chair-Based Peripheral Music Control

Normally, a chair is just a well-designed and robust device that supports sitting. In the recent years, the design has advanced to increasingly *flexible chairs* that support dynamic sitting. To explore whether this feature could be used to control a computer, we developed an interactive chair interface based on a commercially available office chair (see Figure 2) that we equipped with motion-sensing capabilities [8]. Taking advantage of human capabilities to perform simple motor activities while sitting (e.g., tilting, rotating, bouncing), it supports interaction through a set of semaphoric chair gestures. We implemented two application scenarios that utilize these gestures in the context of focused (i.e., web browsing) and peripheral (i.e., music control) interaction with a desktop computer [9].

In a user study with 15 participants (6 female; 20-51 years), we compared the chair-based input to keyboard and touch interaction in a peripheral music control scenario [9]. Therefore, frequently used music player commands were assigned to the four canonical directions left/right to play the *previous/next track*, and up/down to *increase/decrease volume* (see Figure 3). Corresponding chair gestures were performed through simple tilt movements (i.e., briefly swinging the hips to a specific direction) along the left-right or front-back axis of the chair. Results of the comparison between chair, keyboard, and touch interaction indicate that the novel chair input technique is particularly supportive for peripheral interaction due to the benefits of always-available, eyes-free, hands-free operation. Furthermore, participants enjoyed the possible diversification of interactions, and introduction of light physical activity into the work routine. The embodied aspects of chair-based input seemed to facilitate interaction, and support reduction of resumption lags. Based on these unique features, chair gestures seem highly promising for opportunistic interaction with non-critical peripheral tasks, as they enables users to effortlessly interact with an application and rapidly re-focus on other ongoing activities. Similarly, this approach could be extended to other application scenarios (e.g., e-mail) and gestures (e.g., vertical bounce movement).

Discussion

We believe that letting users control secondary tasks through their physical work environment has great potential to simplify their interaction with computers. By combining smart furniture interfaces with imprecise gestures (which need to be easy to learn, memorize, and perform), we believe that we can provide interactions that support seamless transitions between tasks.

A Case Study of Peripheral Interaction through Smart Furniture: Key Benefits of an Interactive Office Chair Interface

Always-Available: while sitting in front of a computer, motion gestures on an interactive chair can potentially be detected anytime to provide always-available access to application functions [4].

Eyes-Free: the resulting interactive chair interface can be operated eyes-free, as input is based on body movements that require no attention to a visual interface [6].

Hands-Free: with a chair as hands-free input device, users are provided with a true additional input dimension, as their hands can remain on keyboard and mouse, or perform other activities (e.g., writing, handling a phone).

Engaging: the introduction of technologies that integrate motor body movements into our interactions with digital systems provides great potential to avoid monotony and physical inactivity [5].

Still, there are open questions and challenges to be addressed. In particular, when augmenting everyday objects with sensing capabilities, gestural interaction can be hard to distinguish from natural movement (e.g., fidgeting, posture changes). Therefore, providing either explicit or implicit mode-switching mechanisms will be essential to avoid false activations. Furthermore, the regular usage of specific furniture items should not be influenced negatively. Especially when designing for gestural interaction within office environments, social acceptability is a further important factor to be taken into account. To resolve possible issues in this context, gestures for interaction with smart furniture items will need to be designed carefully and tested in respect to social, performance-related, and functional factors.

Outlook

We plan to extend our research by investigating the application of gestural chair input for other usage scenarios beyond the proposed music player control (e.g., notification handling), and exploring new possibilities for smart furniture interaction within a desktop environment (e.g., foot gestures on the floor). Further, we plan to conduct a field study that allows us to generalize our approach and create guidelines on the usage of imprecise gestures with smart furniture, especially for peripheral interaction in the office context.

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