Entangling Ambient Information with Peripheral Interaction

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Abstract
Ambient information systems have been an active research area since the 1990s. However, most of these ambient systems let the user only passively consume information, and do not provide a way to interact with it. In this paper, we offer a view beyond just representing information. We propose to engage the user in a peripheral interaction with the ambient device. By keeping it peripheral, all advantages of ambient information systems – e.g. keeping the users aware without burdening them – are preserved. We will demonstrate this concept with two prototypes: an ambient appointment projection and a presence-indicating tangible.

Keywords
Ambient information, peripheral interaction

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

General Terms
Design, Experimentation, Human Factors

Introduction
In the non-digital world, ambient information can be found everywhere. The light, which comes through the window, offers information about the time and weather. Body language gives us hints about the feelings of oth-

ers. People walking in the hallway provide us with auditory feedback about the activity in our surrounding environment. We consume and interpret all this information without focusing our attention on it.

Digital ambient information, which might be collected by sensors, can have a number of advantages: Concerning the capturing of information, hardware sensors can be more sensitive than the human perception. Furthermore, information can be collected in places, in which the user is not present and therefore would not be able to absorb it. Consequently, information of various sensors from various places can be combined and interpreted and therefore provide more elaborate information. Above all, this information can be stored and made available whenever needed. In general, digital ambient information consists of only few pieces of non-critical information and often is presented in an abstract way [4].

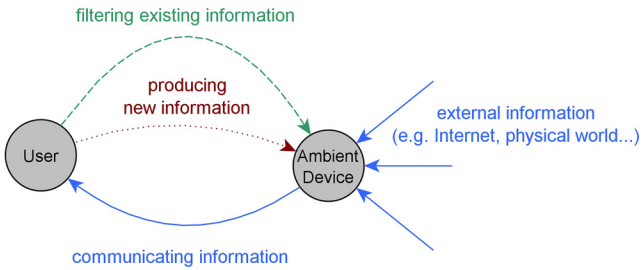

figure 1. The interplay of a user and a digital ambient device

The basic interplay between the user and the ambient device is depicted in figure 1 (solid blue lines). One or more external sources are communicated to the user through the ambient device. The user in this case is a passive consumer.

Going beyond this basic presentation of information, we need to take the users and their actions into account. This paper presents the first steps towards this goal by offering a classification and briefly introducing two prototypes which combine ambient information with peripheral interaction.

Related Work

A good overview of ambient information systems is offered by Pousman and Stasko [4] who also present a taxonomy. They depict four design dimensions: Information capacity (amount of information), notification level (degree of interruption), representation of fidelity (way of displaying the information ranging from direct to very abstract) and aesthetic emphasis (importance of aesthetics).

The interplay of interaction and ambient information has been taken into account by different research groups. Streitz et al. [7], Vogel et al. [8] and Ryu et al. [5] present ambient displays, which offer interaction prospects to the user. All three define different interaction zones in the vicinity of a display ranging from ambient and implicit interaction to explicit interaction. Depending on the zone the user is standing in, the displays offer more detailed information up to personal and private data. In all three cases the user is augmented with small gadgets, such as an air mouse or RFID tags.

Darren Edge proposed peripheral tangible interaction [1, 2], which he defined 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 infor-

mation which otherwise resides on the periphery of their attention" [2].

Beyond Basic Representation of Information

As shown in figure 1 (dotted red and dashed green), the users can interact in two different ways: On the one hand, they can produce new information (dotted red) – e.g. about their current situation – by their actions, which the ambient device then can communicate. It is possible to combine information of several users or external information. A typical example for this case is presence information. On the other hand, an ambient device can react to user input by filtering the already available content without changing the overall available information (dashed green). One example is recognizing a nearby user and offering personalized information for this particular user.

The interplay (figure 1) of the users, their actions and the ambient information can be further divided into more detailed categories.

Producing New Information

Figure 2 shows different possibilities for the user to produce more information, which can then be shown in an ambient way. Most importantly, the interaction of the user can be broken up into implicit and explicit interaction. 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" [6] and usually collected by sensors. Using explicit interaction, the user is actively putting information into the ambient system, e.g. by manipulation of the device itself or entering data via a PC or a website. Life logging can be placed in this space and can comprise elements of implicit and explicit interaction.

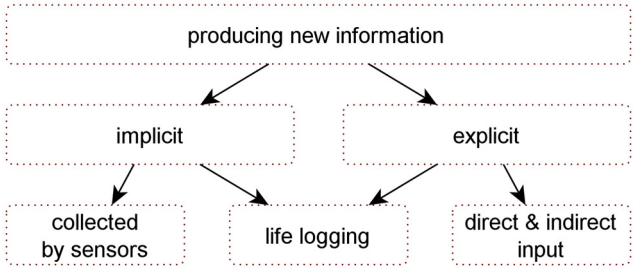

figure 2. Ways of information production by the user.

Filtering Existing Information

Another form of interplay between ambient information and the user is filtering existing and available information as depicted in figure 3. In this case, there is no new information generated by the user's actions, but only the view is adapted, e.g. further details or even private data is available on demand. Once again, the user can either be offered an adapted view by implicit interaction (e.g. coming closer) or by explicit interaction (e.g. executing a predefined gesture or turning the device).

Concerning both types of interaction, one very important fact always has to be kept in mind: The key feature of ambient information is to offer additional information to the users without further burdening them. The same requirement has to be imposed on the interaction with such a system. Consequently, interaction with an ambient information system needs to be casual and peripheral.

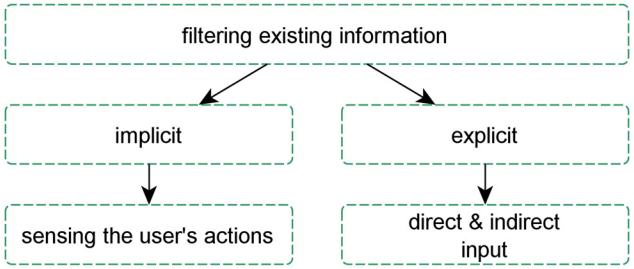

figure 3. Ways in which the user can filter information and adapt the view of the ambient device.

Often, information which is not relevant to the main task is presented next or even above the currently important data and interrupts the current workflow, but in return offers interaction possibilities. By moving this kind of information to the periphery and offering ways to interact with it in a non-focused way (e.g. by performing a simple gesture) will help the user not to move the focal attention away from the main task, but still react to other information. We expect that this will lead to fewer interruptions and less attention shifts.

Granularity of Interaction
Different input mechanisms – especially for explicit peripheral interaction – can be imagined. A glance at an object or display or a region somewhere in the users' vicinity can be understood as input to the system. On the other hand, a casual gesture, such as wiping can be interpreted. Even more detailed hand gestures can still be peripheral. Speech input as well as direct manipulation of a digital or tangible object can also be imagined.

These input mechanisms differ in granularity and therefore they are able to encode a diverse number of commands. Very casual input, such as the wiping gesture mentioned above, will only offer few options, e.g. wiping towards the user and wiping away from the user, while a precise hand gesture, possibly tracked by a touch sensitive surface, could offer a much wider variety of options.

Nonetheless, for peripheral interaction, it can be expected that in most cases there is no need for many commands.

Additional Characteristics
Another characteristic of ambient information systems and peripheral interaction is the distinction between public and private information (and therefore interaction). Speech input, for example, can easily be overheard by others while small and therefore rather precise gestures are harder to be recognized by others. Interaction can be close by or rather far away, e.g. input on a touch sensitive surface at ones desk or input via a glance at an object a few meters away.

First Two Prototypes

To verify these ideas, we are planning to build a series of experimental prototypes. This, of course, also means to deal with the aesthetic and comprehensive design of ambient user interfaces. Anyhow the main focus will be on the interaction, which should be as self-explanatory as possible and be executed in a peripheral way.

Ambient Appointment Projection
With this first prototype, we propose an ambient visualization projected next to the user's keyboard (see figure 4) as a basic overview of all upcoming events and a reminder of close events. Users can acquire more details about an appointment whenever they want to.

Consequently, this prototype incorporates interaction by explicitly filtering information. Acquiring additional information is realized by a camera tracked casual hand gesture. Wiping towards the user will offer more details about an event as a balloon tip on the user's screen, while wiping away will snooze a reminder animation (e.g. a pulsating sphere of the spiral) of an upcoming appointment.

figure 4. A projector and a web cam are mounted over a desk for ambient projection and peripheral interaction.

We verified the balance between notification and distraction in a user study. Twelve participants were asked to type a given text as fast and correct as possible while not missing any appointments. We found that our ambient interface, compared to state of the art reminders, e.g. the one provided by Outlook, offers sufficient awareness, while handling appointments smoother by less disruptive reminders, which require a wiping gesture for details about the appointment in question.

Tangible Presence Indication

The second prototype communicates presence information of the user and colleagues or friends.

An Arduino[1] controlled tube consisting of several separate levels is placed on the user's desk. The upmost and biggest level (see figure 5) represents the availability of the tube's owner. By turning this level by hand (see figure 5 on the right) different status can be set (similar to instant messaging status like "available", "away", "do not disturb", but also more detailed options like "in a meeting" are supported and represented in a color coded way), by pushing down the upmost level, which integrates a button, the users can set the approximate time they will be in this status (indicated by the luminance of the level). Consequently, this prototype offers the user the possibility to explicitly produce new information.

All lower levels represent selected colleagues. The whole system is connected to Skype, so that it can be used with others who might not have such a tangible.

figure 5. A tangible representing presence information of the users and their colleagues. It also offers manipulation of one's status by turning and pushing down the top.

Before building the object, a survey with 46 participants was carried out to meet the requirements of the users. In general, this system is intended to be used in

[1] http://www.arduino.cc

an office and improve communication and lessen unwanted interruptions by offering an easy peripheral input method and therefore encourage more accurate presence information.

A long-term evaluation is currently being planned. For this purpose, two equal prototypes have been built.

Conclusion and Future Steps

The prototypes above denote a first step into the research of adding peripheral interaction to ambient information systems. They both act as one example for the two basic categories "producing new information" and "filtering existing information". The appointment projection was already tested in a lab study and proved to be equally effective in keeping the user aware of appointments. At the same time, it reduces displeasing interruptions and therefore is more convenient for the user. The tangible presence indication tube was built according to survey results. A long-term evaluation is currently being prepared.

To cover the whole spectrum of the classification depicted in figure 2 and 3, we will build more prototypes. They will also vary in granularity of interaction. When evaluating them, one has to keep in mind that the benefit of those systems often cannot be highlighted in a short, lab-based user study. This is due to the fact that they usually do not act as primary task, and therefore a long-term study is more suited. Another possibility, which is applied to ambient information systems, is a heuristic evaluation based on the findings of Mankoff et al. [3], who adapted Nielsen's heuristics to the special needs of ambient displays. Nonetheless, these heuristics do not include peripheral interaction. Consequently new evaluation methods need to be discussed.

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