Mobile Interfaces in Tangible Mnemonics Interaction

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Abstract. The Tangible Reminder Mobile brings together tangible mnemonics with ambient displays and mobile interaction. Based on the Tangible Reminder Project we present a new interface for mobile devices that is capable of viewing and editing data linked to real world objects. An intelligent piece of furniture equipped with RFID-sensors and digitally controlled lighting keeps track of appointments linked to real world objects that are placed in its trays. The mobile interface now allows the complete waiving of classic computer interaction for this ambient shelf. Instead, by implementing the toolglas metaphor, the mobile interface can be used to edit and view linked data to objects.

1 Introduction

Mark Weiser [1] formulated in 1991 his vision of ubiquitous computing stating the goal of bringing together the virtual world and the real world in a constant intertwining.

The direct result for human computer interaction is that the interaction with real life artefacts can affect the virtual representations, thus making virtual objects easily graspable. According to Holmquist et al. [2] a lot of research is done in this domain focussing on different aspects depending on the primary goal they pursue: graspable interface, tangible interface, physical interface, embodied interface, to name just a few. Whatever the name, they are all unified by their common goal, to enrich the interaction with virtual objects by physicality.

One of the first projects to describe this linkage between physical objects and virtual representations is Ishii's and Ullmer's paper "Tangible Bits" [3]. Based on their observation with coupling everyday objects and virtual information, "Bits and Atoms", they tackle an interesting question: how can physical artefacts become interfaces for virtual objects and, from our point of view even more important, how can these interfaces be recognized? Their solution for this problem is the introduction of virtual light or virtual shadow. Both concepts show the information in a glow or shadow around the physical object in question. For example the software on the new Microsoft surface [4] table makes use of this concept. However, the visualization of information into the very vicinity of real objects requires a technically very well equipped environment. The Project Urp

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[5] uses a large display underneath the objects in order to view the virtual shadows. The SenseBoard uses a projector to display detailed information on a "View Details" command puck when it is placed over an item on the SenseBoard [6]. The AuraOrb provides newsticker information when a eyecontact sensor detects the focus of a user on it [7]. But if neither the environment nor the object itself is equipped with displaying technology, the augmentation of the objects remain invisible.

The solution for this problem is the use of other metaphors, for example the see-through metaphor or the magic lens [8] [9]. The information linked to a real object is not projected into the real world. Rather a mobile device shows the information linked directly on its screen. A mobile device also compensates the non-ubiquity of intelligent environments through mobility [10]. In the Tangible Reminder Project we now make use of this technique. The next section gives an overview of the first prototype of the Tangible Reminder. After that we will focus on the concept of the mobile interface and finally present the whole system with this new interface.

2 The Tangible Reminder

The Tangible Reminder is a device combining the benefits of ambient displays and tangible interaction with personal objects. It is designed as a tool to keep track of appointments and deadlines and particularly to remind the user on upcoming events. As shown in Fig. 1. the ambient display subsystem in our prototype consist of three trays in which freely chosen RFID-tagged objects can be placed. According to the urgency of the appointment linked to every object the trays are colored green, yellow or red. Showing the appropriate color, the display remains calm, avoiding distraction from other tasks until the deadline is due. After that it begins flashing, grasping the user's attention. [11]

A main idea was to let the user choose personal objects with specific associations in the topic of the appointments. We use RFID technology to identify the objects in the trays. As RFID-Tags have gotten cheaper and smaller, a user can tag any object he wants to. Choosing a personal object makes it easier to mentally link it with appointments. A study of van den Hoven et al. showed that nearly all personal souvenirs bear a mass of information for the owner [12]. The memories associated with the object can give a clue when spotting it in the tray, a mnemonic to remind the topic of the appointment. If more information is needed, the user has to interact with the system.

In our first prototype we established a non-ubiquitous way of allowing this "easy transition to more in-depth information", one of the heuristics both for graphical user interfaces [13] and ambient displays [14]. If additional information was desired, the object had to be removed from the tray and put on an interaction platform connected with an ordinary computer or laptop. The information was then displayed on the monitor. Also, before usage an object had to be technically linked to an appointment and additional information like addresses, images etc. The inspection system and the input system were the same in the first prototype,

Fig. 1. The ambient display subsystem of the Tangible Reminder, with an object in each tray, showing the different colors for different states

so the user was able to change linked information when an object was placed on the platform. This form of inspection and input on traditional computers is not very ubiquitous, so we will present an alternative to that approach here.

3 A Concept for Mobile Interfaces for Tangible Mnemonics

One goal of tangible interaction is the masking of computer interaction by implicit actions with real objects. But this masking is also the problem for tangible interaction systems application in real life. This masking hinders the use of ready-mades, objects present in everyday life as it clouds the linkage between the real object and the virtual data. Neither the linkage itself, i.e. which data an object represents can be seen nor it is clear how this data can be edited.

Both issues are solved in the original Tangible Reminder system by braking with the paradigm of implicit interaction by simply using a laptop as editing and viewing station. While this is true for objects linked to absolute appointments, the first steps to further pushing the computer in the background is taken. The introduction of relative appointments supersede the explicit computer interaction. Instead, the simple act of putting an object in the tray already triggers the

appointment. For instance, the simple act of putting a special tea cup into the Tangible Reminder shelf results in an alert 3 minutes in the future. Clearly, this way of editing linked data is an improvement. Nevertheless, the visualization of the linkage and thus the display of the data still involves the computer.

To overcome this drawback, Ishii and Ullmer [3] have proposed to use digital shadows or digital light. Whilst this metaphor is clearly interesting and integrates nicely into the real world, it is also very demanding as it needs a lot of special hardware and sensor integration which is only present in special rooms today. Instead we decided to tackle the challenges of displaying linkage and editing linked data via the use of mobile devices. Not only can they be easily carried to the real object in question, but they also perfectly support the see-through metaphor of Bier et al. [8]

A portable device in this case acts as a magical toolglas, showing the link to a real object when placed over it. In the display the user can see the linked data and manipulate it if desired. This metaphor is easy to understand and to use. Nevertheless, the decision in favor of small and portable devices does not completely hide the computer. It rather shifts the interaction part to a small device. This device, though a complete computer as well, is perceived as being much simpler and easier to use. It does not cloud the computer as such but it clouds its complexity [15]. With the adoption of small computing devices, especially cell-phones, in time even smart-phones this approach is getting even more appealing.

4 The Tangible Reminder Mobile

The ambient display subsystem (see Fig. 1) of the original Tangible Reminder follows Weiser's vision of implicit computer interaction and fits nicely into the surrounding. It brings together small personal objects acting as mnemonics, with a calm but also demanding interface if needed. Therefore, we decided to keep this part of the Tangible Reminder unchanged but to completely replace the input and inspection subsystem.

4.1 Interaction with the Tangible Reminder Mobile

To interact with an object in the Tangible Reminder Mobile system it is sufficient to simply put the PDA, containing the new mobile input and inspection subsystem, near an object enhanced with an RFID. Via the integrated RFID-Reader the Tangible Reminder Mobile recognizes that the object nearby can be associated with virtual data. It queries the database and retrieves the stored data. This data is shown on the display pane. Fig. 2 depicts the scanning of a globe, which is in this case associated with a journey to San Diego. Besides the time additionally the reminder period is shown. The simple act of moving the Tangible Reminder Mobile near an object shows its linkage and capacities. The act of posing the Tangible Reminder Mobile over an object results in showing the virtual content of a real object as if watched through a magic lens for digital data.

Fig. 2. Scanning the globe for the associated appointment

4.2 The Mobile Input and Inspection Subsystem

The subsystem on the PDA serves for two purposes: It shows the data linked to a certain object plus it is capable of editing this data or adding data if not yet stored with an object. Suitable objects contain a RFID-Chip simply sending an ID whenever a reader comes into close vicinity. With the readers we are using this reading distance is limited to about 5 cm which is very small. The reader therefor has to be posed directly over the object and its RFID to automatically raise the inspection screen. As we are dealing with appointments and reminders, the inspection screen shows the name of the appointment together with the exact date and the period after which a reminder should occur. Additionally a photograph of the associated real object can be shown. Fig. 3 shows this dialog in detail. In order to add or edit data stored with an object, the edit screen has to be opened. There all relevant data can be entered. To keep the interface usable we decided for special input fields like date-pickers to keep the pen interaction simple. The only text-field capable of free text is the appointment name. All other data can only be modified via controls. This better meets the accuracy of

Fig. 3. The mobile device running the Tangible Reminder Mobile program, displaying the appointment view

Fig. 4. The appointment form allows for changing the associated appointment and the way of reminding

pen interaction on mobile devices as well as it reduces input errors. Fig. 4 shows an example for the input screen. Here the appointment linked with the globe is changed from an appointment on the 24th of December to a journey in June.

4.3 System Design and Changes Compared to the Original Tangible Reminder

To allow for the nice and simple magic-lens approach we decided to port only the input and inspection subsystem to the PDA while leaving the underlying concept unchanged to further support the display subsystem. The original Tangible Reminder makes use of RFID-Chips to recognize objects and to link them to appointments. There are different ways of making a small device capable of reading RFIDs. Instead of using an extra device, we equipped our PDA with a SD-Card-RFID-Reader. This solution integrated the Reader into the PDA and keeps the system small instead of using separated devices.

The laptop in the original Tangible Reminder did not only work as an input device, it also kept the data stored for the linked objects. This data was retrieved by the display system to control the reminder functions of the shelf. The new Tangible Reminder system separates this earlier intertwining and divides the system according to their functions. The virtual data is now stored on a server

that provides all domain related functions via a web-service. This service can be contacted and controlled by the display subsystem of the shelf as well as the mobile magic-lens subsystem. Thus, either subsystem has to deal only with the exact functions it has to fulfill.

We rather make the virtual space underlying the real world accessible independent of environmental hardware by lending real objects a mobile interface, in our case rendering the Tangible Reminder system completely independent of traditional computer interaction.

5 Conclusion

With the Tangible Reminder Mobile system we presented a mobile interface for an ambient mnemonic system, the Tangible Reminder. This system brings together ambient displays with tangible interaction by reminding a user on appointments previously linked to everyday objects, functioning as mnemonics. To establish the linkage between real life objects and virtual data we needed a classic graphical computer interface in the original system.

The Tangible Reminder Mobile System now provides an interface on a PDA making the Laptop as input device unnecessary. It thereby renders the Tangible Reminder system to an intelligent piece of furniture not recognized as computer interface. The mobile interface itself makes the usage of the Tangible Reminder more natural by implementing the magic lens metaphor. The smaller device not only makes the classic interface disappear, it also keeps the interface seemingly simpler. It combines the tools for information display and data manipulation and makes the interface mobile like the user chosen real life mnemonic objects.

The interface therefor bridges the gap between the real and the virtual world and solves the problems of data manipulation and display in an elegant way. No classic computer interface is needed, just a PDA is used, a device that gets more and more common. The switch to this mobile interface is another step towards real implicit interaction with everyday objects with no computers visible, towards the vision of natural interaction with virtual data and ubiquitous computing alike.

6 Future Work

The Tangible Reminder Mobile system is just a step on the way to implicit and computer-less machine interaction. Further development is needed and planned in mobile interface improvement and in the field of implicit interaction. The integration of camera images to literally implement a see-through tool could make the interface more intuitive. However, from our point of view the benefit is marginal unless the system recognizes and marks the detected object which is a hard problem without marker usage. The next step therefor would be to recognize objects visually and superimpose digital data directly in the video image, implementing the digital shadow metaphor of Ishii and Ullmer [3].

Another direction the Tangible Reminder can evolve is the use of real life artefacts that allow for programming by combination and handling of tool and mnemonic. This way, the computer could be made completely invisible and virtually superfluous. Yet, the problem of information display has to be solved. This could be done by switching to another media, sound and voice feedback for instance or attaching a display or projector to give visual feedback.

Both extensions will make the Tangible Reminder an even more integrated intelligent piece of furniture not recognized as a common computer interface, lowering the inhibitions for computer usage.

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