Interacting with Tangible Displays

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Abstract. In this paper we present the concept, implementation and evaluation of distributed small display devices used for environment based messaging. These displays can visualize messages including possible answers defined by a remote person. The recipient can select one of these answers via gestures that are recognized by the tangible display. We kept these gestures as simple and intuitive as possible, implemented a corresponding prototype and evaluated the interaction concept with a first user study.

1 Introduction

Despite the fact that people draw information from all sorts of sources like posters, talks, radio or books; displays still constitute the most important devices to convey messages. Much research has been put into questions of how ambient displays should be, how to separate public and private information and where displays can or should be placed. Although we tried to tackle all of these issues, one of our main points of interest in the project we describe here was to find out more about the level and type of interaction users want to have with regard to displayed information.

We had two assumptions that we wanted to verify: First, the value of passive ambient displays can be increased by adding some way to react to the information they display. And second, although many people are used to interact with their mobile phone, people want to keep such interfaces as simple as possible, even if this reduces the amount of features provided.

To be able to get further insight into these problems and evaluate them in practice, we implemented a sample application and describe it and the results we were able to draw from it in the next sections.

2 Example Implementation: Location Based Communication

The central idea of the system is to design a messaging system that is less targeted to support communication between specific persons but more between a person and certain locations. To achieve that, we built small devices containing a microcontroller platform (Particle [4]), a display (Barton I²C LCD, 5 lines of text à 16 characters), and a radio transceiver powered with a AA battery. These units are self contained and can be put anywhere users think it is appropriate. This includes places where common

Post-Its are kept, next to other information devices like computer monitor or telephone, and locations where people often pass by like the house entrance or bath room. The compact and unobtrusive design of the displays lets them fade into the background. Instead of sending messages to someone, notes are sent to one or several specific displays. To be able to still communicate private messages meant for one person, we assume that persons have one or some displays associated with them that are not to be read by others. We also envision integrating a simple type of authentication between display and user to overcome this problem. Examples are simple messages like “Don’t drink the wine” posted to the display at the fridge or requests like “Can anyone please feed my fish?” with possible answers “done” or “already died”.

In contrast to most ambient displays that have emerged in the last years, our devices are not merely meant for output. We found that many types of information lead to immediate actions. Especially messages from other people often require or invite giving an answer. In order to provide an added value without at the same time increasing the complexity of the devices to that of modern PDAs or mobile phones, we added support for simple gestures as input method. Examples are turning the display by 90 degrees or shaking it. These actions can be recognized by interpreting the output of a 3D acceleration sensor (LIS3L02AS4).

To each message sent a set of predefined answers can be attached from which the recipient can later choose one to be sent back to the sender. In the current implementation, messages can only be created using a web based interface. However, it is optimized for browsers on PCs as well as for small devices which makes it easy to send a note using a mobile phone. A MySQL database ensures that messages are kept during times when displays are not available and is responsible for maintaining user data etc.

Other communication systems that use situated displays include the Hermes system [1] where a PDA is installed next to an office door. In contrast to our system, each device is owned by one person and only this owner can send messages without being close to the display. These restrictions have been lifted in the WebWall project [2]: large public displays are used to communicate various kinds of information and allow direct replies or changed. This, however, implies that information is always on display and there is no way to restrict the visibility of private messages to one or several specific persons. The IM Here project [3] implements such a system but it needs complete computers with accessible keyboard and display to read and answer messages.

3 User Study

Based on the prototype described in the previous section we conducted a small user study with 8 students aged between 21 and 25. The goal was to evaluate the overall idea of gesture based interaction with tangible displays. First the testers should handle the displays without any knowledge about the provided functionalities and supported gestures. Afterwards we explained how to use the small displays. Based on this the testers conducted the second phase. In every phase there was a predefined sequence of messages provided by the display and the students had to set predefined answers.

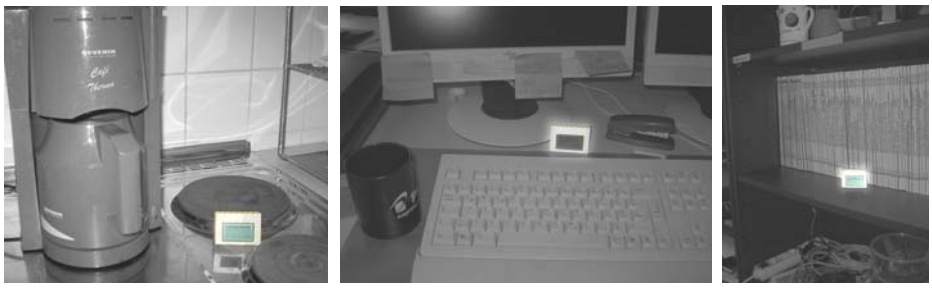

Fig. 2. This figure illustrates typical settings and locations for the small displays: In the kitchen, next to the computer monitor or in a shelf.

The goal of the first phase was to figure out if users expect and want to be able to give answers to messages and how intuitive the gestures and the provided functionalities are. At the beginning, most testers tried to interact with the device but had big problems to figure out the included functionality without any prior explanation. In particular the foreseen gestures for interaction with the display were hard to find out.: Some testers moved the display on the table because they thought that the arrows (see the picture in the center of figure 2) indicate a direction and not a rotation which was our intention. Furthermore their gestures were often too fast for our implementation and they were not able to set answers. Figure 3 shows other experiences from the first phase.

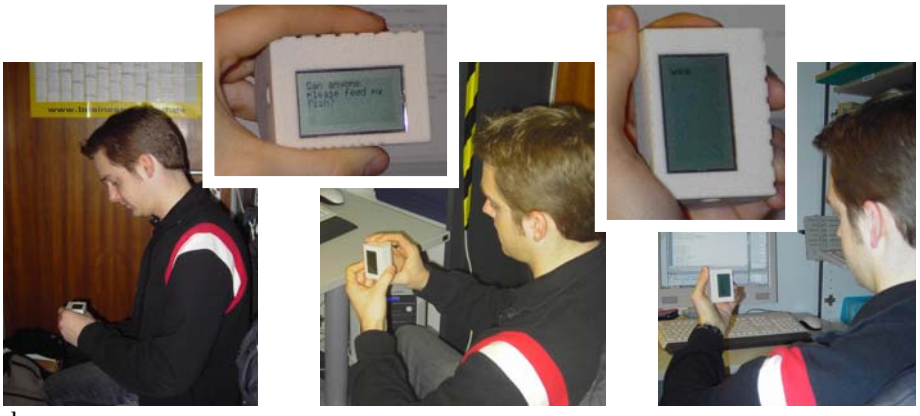

Fig. 3. A typical scenario in the user study: First the tester sees that there is a new message, picks the display up and reads the message. To answer the questions he tilts it correctly to the left, but in a way that he can no longer see the contents of the display. However, he soon recognizes that he can hold it comfortably in a way that he can read his answer.

Before the second phase we explained all possible gestures and functionalities to figure out how fast one can learn to use our implementation of gestures. The result was that everybody was able to give correct answers to the provided questions. This leads to the general conclusion that the provided gestures were not intuitive enough to use them without explanations but it is easily possible to learn them in a short time.

The evidence suggests that it is easy to learn a tangible interface, even with minimal explanation, but it is hard to make tangible UIs that are obvious to use.

4 Conclusion

We presented a project with which we tried to evaluate the idea of environment based messaging, affirm assumptions on user requirements going further than ambient displays, and see how intuitive and easy-to-learn a set of simple gestures is. We found that users are interested in the system and do request the possibility of interacting with the displays. We learnt that the affordance of the interaction is too low to make it intuitive. Even though, after a quick explanation, all testers could use the system easily, we saw that providing different or several ways of input are necessary to enable the use of such a system without additional guidance.

5 Future Work

As we have seen positive feedback to our assumptions and idea, we will integrate some of the suggestions we got from out testers. It especially seems to be important to enable access to the system with as many means as possible. Thus, we will look into creating messages using SMS, email, maybe direct input with a touch screen, keyboard or even speech. We will, however, drop the idea to include more complex gestures since that would increase the initial slope of the learning curve even more.

An interesting part to research will be how to homogeneously and intuitively implement interaction methods when adding completely different devices to the system like fixed picture frames, TV sets, computers, electronic paper, and so on.

After we have reworked the implementation and gathered more knowledge on the issues described above, we plan to make a larger user study where we deploy the system in people's homes for a longer period of time.

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