DEVELOPING INTERACTION STYLES TO SUPPORT INFORMAL COMMUNICATION AT HOME

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Abstract: In this paper we describe FRIDGE, an experimental prototype of an informal home messaging appliance, that combines the use of paper and electronic media. It allows two-handed input, combining a graspable user interface and pen input. The paper describes the design rationale for the application and the findings of an early user test. The less experienced participants were less forgiving about some of the limitations of the technology than the participants with more computer experience. Overall, the findings show that participants were quickly able to use the application and that they liked the idea of combining paper and electronic media.

Keywords: Interaction Mechanisms, Interdisciplinary Design, Interfaces, Input Equipment.

1. INTRODUCTION

In paving the way towards a future home, where a plethora of purpose-specific information appliances surround the residents, one of the challenges for interaction design is to make it possible that people can discover, and remember, how to use such appliances without any manual or explanation. This paper describes FRIDGE, an experimental prototype of a mixed-reality messaging appliance for the home, that supports message exchange and display for a household, whether that is paper-based or electronic.

The super-ordinate research goal, that this prototype serves, is to study interaction styles suitable for in-home information appliances. We call these residential interaction styles to underline the special requirements which are set upon interaction design for this context. More specifically, the usage of home information appliances must be assumed to be incidental, the target users are more diverse than for a work related context, users are unlikely to read a manual and are less inclined to spend much effort to use their appliances. Below we introduce the type of activities that FRIDGE is designed to support, the design approach, our first findings from its evaluation and the current evolution of our research.

In many households, people like to use surfaces such as fridge-doors, or pin-boards, or even doors, to post bills, leaflets, photographs, postcards, etc., to maintain shopping lists, to leave messages to each other, or reminders to themselves. The fridge-door in particular, is so popular that special products are marketed to support this paper-based activity. Fridgemag for example, see picture 1(a), is a plexiglass-cover of the fridge-door, behind which pictures are displayed, thereby replacing the common magnet holders.

On the other hand, the consumer electronics industry is marketing fridge-doors, e.g., Frigidair by ICL in figure 1(b), and microwave ovens that are internet terminals.

There are several advantages to providing internet connectivity via such household appliances. From a marketing perspective a different consumer population is addressed than with desktop computers. From the user perspective, it makes internet

Fig. 1. (a) Fridgemag from www.fridgemag.com and (b) and the ScreenFridge by Electrolux, see www.electrolux.co.uk/screenfridge/digital.htm

functionality available within a new context, and it can support every-day activities with computation and information access. Rather than replacing the paper based activities, the electronic medium can augment them at their preferred location.

2. RELATED WORK

Computer output in the FRIDGE system can be projected on any white surface, e.g., a cupboard, or a table-top, or a fridge door (hence the name of the demonstrator). The computer output is superimposed on any physical paper or other objects that are on the surface. This way of mixing paper and electronic media can be traced back to the DigitalDesk system (Welner, 1993). Compared to systems of that ilk, which have been concerned with supporting work, designing for the home context means that functionality and interaction should be considerably simpler.

FRIDGE supports free-hand pen-input, with no handwriting recognition involved and a graspable user interface (Fitzmaurice, *et al*., 1995). Pen-input is arguably a very natural form of interaction. Children learn to use pens even before they learn to speak. However, as we also discovered in our study, while the agility, speed and accuracy of physical pens are hard to match with current electronic equivalents, these qualities have come to be expected by most people. Excluding hand-writing recognition is essential to preserve the naturalness of pen-input: first, with physical pens there is no recognition going on, and secondly, monitoring and correcting the hand writing recognition complicates the task of handwriting.

Graspable interfaces allow the manipulation of electronic objects through physical handles, as opposed to virtual handles (like a cursor) which is the traditional form of desktop interaction. These interfaces are arguably (see Abowd and Mynatt, 2000) more natural on the grounds that they offer

Fig. 2. Manipulating notes with the graspable interface.

richer affordances than the traditional selection input devices. Among several other benefits, they enable two handed input, truly parallel input by multiple users, and leverage off our well developed, everyday skills for physical object manipulations (Fitzmaurice, *et al.*, 1995)

3. THE FRIDGE PROTOTYPE

Input in FRIDGE is supported through a combination of a graspable user interface with Mimio, a commercial pen input device by Virtual Ink. Its canonical application is whiteboard applications for supporting meetings. The graspable user interface is implemented with VIP (Greef and IJsselsteijn, 2000; Aliakseyeu *et al*., 2001) a development of the BUILD-IT system (Rauterberg, *et al.*, 1998).

VIP supports interaction through computer vision techniques: it tracks inch-sized infrared-reflecting patches, turning them into physical handles for interactive virtual objects (a set-up similar to the meta-Desk (Ullmer and Ishii, 1997), which however used back-projection). Patches can be attached to small bricks as in the BUILD-IT system, or to magnets to put on a fridge, or to pins for a pin-board, etc. Currently, researchers at IPO are experimenting with VIP as an input device for picture and photo browsing applications (De Greef and IJsselsteijn, 2000) and for architectural design (Aliakseyeu and Martens, 2001). Compared to earlier graspable user interfaces, such as those of the Active Desk experimental system (Fitzmaurice, *et al*., 1995), the advantage of this input technique is that the graspable handles are untethered (no cables) so they can be more agile.

Figure 2 shows a snapshot of FRIDGE in action. Apart from the paper notes and actual picture-prints which are affixed on the display, the user sees a collection of projected portraits of family members and a note-book icon.

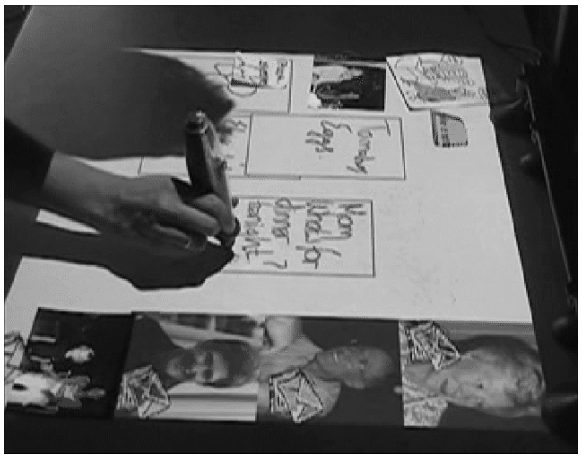

Fig 3. Writing on notes with the Mimio pen.

The user of FRIDGE can:

- Grab notes by putting a handle on them and release them by hiding the handle from VIP.
- Create, rearrange and delete notes.
- Write and draw on notes using the Mimio stylus (see figure 3).
- Mail a note to one of the family members whose portrait is decorated with an envelope icon. Received mail is simply posted on the display. (Receiving mail was simulated for the purposes of the evaluation).

Having two input techniques helps avoid overloading a single device, so it is easier to guess and to remember how to use the system: the pen is not seen as a general-purpose pointing device but is used only for writing or drawing. Notes behave similar to paper-slips in several ways. They are not resizable and scrollable, they cannot be 'minimised' but they can be moved, rotated and stacked. Unlike files on a desktop, notes are not grouped in folders, backed-up or recycled. It is hypothesized that this should result in a very simple conceptual model of the interactive system.

The mail facility is a very limited electronic mail application. The aim has been to make electronic mailing and message posting easily accessible in situations where, normally, it would not be: e.g., replying to a mail that arrives while cooking, or a enabling a child, too young to read and write, to send a drawing to its parents at work. The functionality is similar to SMS messages on mobile phones, but instead of typing through a numeric keyboard it supports free-hand input of the message (therefore supporting drawing or annotation of notes).

4. EVALUATION OF FRIDGE

We have conducted two usability evaluation sessions with FRIDGE. The first, formative, evaluation was conducted with colleagues of the authors, who are also researchers in user system interaction. The second involved outside subjects, mostly elderly, who did not have computing, e-mail or SMS experience. These evaluations were a necessary step in refining our design, and were not intended to draw widely generalisable conclusions about interaction styles. Regarding our interest in residential interaction styles, there are several interesting points that came out, particularly pertinent to the contrast between researchers and non-computing experts.

4.1 Procedure and tasks

Subjects were required to fill-in a pre-session questionnaire with the purpose to identify their habits concerning posting pictures, drawings at various places at home, whether they use the fridge or some other place, whether they live alone or with other people etc. In general we tried to identify their habits and attitudes towards the activities supported by FRIDGE.

Users were asked to perform all the simple tasks that FRIDGE supports. They were given no directions for using the device, apart from the fact that notes were to be manipulated with the blocks and pen was for writing. We gave them enough time to complete the tasks. All users managed to achieve their tasks, although several errors were committed and there was a considerable variation in efficiency.

After the session users were asked for feedback about the interaction styles, about the functionality of the system, and concerning the concept of mixing paper and electronic activities in such an appliance.

4.2 Participants

User tests with the first prototype of FRIDGE were performed with eight volunteer participants with extensive computer and e-mail experience, and with six participants with no computer or e-mail experience at all.

The average age of the experienced participants was 27 years, and the average age of the inexperienced participants was 68 years. The participants represent a range of different households, such as people living alone, living with a partner, and living with either their children or their adult parents.

4.3 Context of use

The responses to the questionnaire show that participants engage in activities at home that might be supported by FRIDGE. At home participants write messages for others, shopping lists and reminders for themselves and leave them on the table, on a special board or other locations, such as on the stairs, near the phone or on the computer monitor (the latter

applies to the first group of test users). Most participants use any piece of paper that is available for writing notes, or sometimes write it in a diary or on the calendar. It is interesting that only one participant keeps notes on the fridge itself. Most participants (13 out of 14 subjects) decorate their houses in some way by putting postcards, pictures or drawings on a special board or a flat surface, such as a shelf, piano, mantelpiece or the window sill. The older and less experienced participants mentioned decorating their house with drawings more frequently than the participants with more computer experience. Hardly any participants post printed material such as newspaper clippings or advertisements. The specific location for keeping the information is important, e.g. close to the phone, or in a central location like your desk. The participants reported that they create special areas for keeping notes and for displaying information. In some cases there is overlap, but some location are also special purpose.

4.4 Observations and participants' opinions

These first tests confirmed some of the design hypotheses but, also, exposed some of the limitations of FRIDGE in its current state. All subjects were able to learn to how to use the prototype within a few minutes, without hardly any help at all. Overall, the participants found the prototype interesting and fun, but it should be kept in mind that this could be attributed to many factors external to the design (e.g., their willingness to be cooperative, the novelty of the situation, etc.).

However, the participants without computer experience were less enthusiastic about FRIDGE. About half of the non-experienced participants would prefer to use their present 'system' for exchanging and displaying information, and would not use something as FRIDGE in their home.

The participants were very happy with the VIP input device for non-dominant hand input, although given its experimental state we expected them to complain about it. An initial explanation was first that its novelty made it more fun to use, but also that the tasks for the non-dominant hand were not demanding in precision and dexterity. Not all users, however, found it easy to manipulate the brick to quickly grab and let go of the notes. Most users started by pulling the handle sharply off the note, and gradually (but quickly) developed a strategy of tilting it to the side, to hide the infrared reflecting surface from the camera. In contrast to the lenient view to the brick input device, participants were much more demanding for the pen input, although that device was quite robust. Being accustomed to physical pens, they expected resolution, speed and accuracy to match those of a standard pen.

Most participants (11 out of 14 subjects) would prefer combining the functionality of selecting and manipulating the notes with the functionality of writing and drawing in the pen over having two different input media. This seems to be in contrast with the initial design decision of providing two different input devices to increase the naturalness of the interaction. It is noted though that participants could be actually reporting their assessment of the two interaction techniques, and secondly, that the simplicity of the interaction was largely a result of the combination of the two input techniques.

The functionality that is provided in FRIDGE was easily understood and used by the participants. Participants had most trouble to get used to the way in which notes had to be deleted: by moving them outside of the interaction space. In some cases notes were lost, when the intention was just to reposition them. Most subjects quickly understood how new notes could be created.

An interesting contrast emerged between the two groups of subjects. Those with computer and human computer interaction expertise missed extra mailing functionality, such as editing and managing of an address book, they expressed the wish to send and post spoken messages and missed the speed of a keyboard. Note, that on their computers they do not use speech messaging, but they thought it was a desirable feature to have at a home messaging application. The second group (of non-computer experienced people) were very pleased with the limited functionality provided. Although they were more apprehensive about participating in a user trial, they quickly figured out how to use the system.

Overall, the impression is that participants enjoyed interacting with the mixed reality aspects of the system. Four people stated that they did not enjoy using a mix of electronic and paper notes and pictures. Again the participants without computer experience where less enthusiastic about this feature of the application. Most participants enjoyed combining the advantages of real paper, such as easy to take somewhere else, with the advantages of electronic media, such as easy to save and change.

It is hard to draw more final conclusions from a laboratory evaluation. A similar study placed within a more realistic context, e.g., the participants' homes, can potentially reveal more about the advantages of mixing electronic and paper media and the suitability of the interaction styles studied hereby.

5. CONCLUSION

With FRIDGE we explored two issues. **First** was the concept of a **mixed reality messaging board** application for the home. We tried to gauge the reactions of people for such an information appliance, and the design issues involved. The success of such an application is likely to depend on the location in which it is installed, and it even seems

important to support at least two locations for such an application, as most participants used various places in their home for keeping notes and displaying information.

Some positive indications have been obtained. To get more valid results the prototype needs to be made sufficiently robust for field-testing inside people's homes. For example, VIP is very sensitive to variations in lighting, some interaction elements need to be polished, e.g., animations are required for feedback, and a some more features need to be supported by the mail facility. Currently, work is under way to replace the VIP platform, with an ultrasound-based motion tracking system that should overcome many of the robustness limitations.

Where possible such appliances should be tested inside people's homes, and to assess their fit in 'every day life'. Another path towards a more ecologically valid assessment is inside a Living Lab'; a residence where participants will be staying for periods of 1-2 weeks, with the purpose of assessing their usage of a range of new technologies. This Living Lab, is a research facility that is currently being set-up at the Eindhoven University of Technology (Markopoulos and Rauterberg, 2000, Markopoulos 2001), that is similar in aims to the Aware Home project at Georgia Tech (Abowd, *et al.*, 2000).

The **second issue**, and perhaps more interesting, in the larger context of residential interaction styles, is **the naturalness of the interaction**. Subjects learned easily and quickly how to use the bricks and the pen. In part this was enabled by the simplicity of the application which is the essence of the information appliances concept. The mix of two novel and natural interaction styles proved successful, although to truly satisfy the needs of users both supporting technologies call for significant performance improvements. Note however that many participants preferred using only the pen input device. Further research is needed to determine whether providing the combination of these two input devices would be perceived to be as more natural than interacting using only one input device.

The test subjects included elderly, although we did not try to address them as a separate and distinct group of users. Current work concerns the design of such devices for children, and investigating which interaction styles are more appropriate for different age groups. In this context, FRIDGE is one departure point and it will be modified slightly to enable tasks that are more meaningful for children; subsequently it may be adapted to explore other concepts for games, painting and learning applications.

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