EXPERIENCES OF SUPPORTING LOCAL AND REMOTE MOBILE PHONE INTERACTION WITH TOUCHSCREEN BASED SITUATED DISPLAYS

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ABSTRACT
The use of mobile phones appears to provide a range of opportunities for supporting interaction with public displays. Furthermore, such interaction can help overcome some of the problems associated with interactions with public displays, e.g. the potential inability of users interact with a touch screen display because of its physical placement (e.g. inappropriate height for a wheelchair user), supporting multi-user interaction and as a means for enabling user content to be transferred to a public display. In this paper we discuss our explorations of some of these issues and present design guidelines as a result.

Author Keywords
Mobile phone, user interaction, situated displays, user experience, user evaluation.

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces; H.5.1 [Information interfaces and presentation (e.g., HCI)]: Multimedia

INTRODUCTION
The use of mobile phones appears to provide a range of opportunities for supporting interaction with public displays. Furthermore, such interaction can help overcome some of the problems associated with interactions with public displays, e.g. the potential inability of users interact with a touch screen display because of its physical placement (e.g. inappropriate height for a wheelchair user), supporting multi-user interaction and as a means for enabling user content to be transferred to a public display. In this paper we discuss our explorations of some of these issues and present design guidelines as a result, based on our experiences with supporting both local and remote mobile phone interaction with a number of situated display deployments.

Our basic for the research involves a tight cycle where theoretical issues and understanding, developed through reflection on empirical observations, are used to design deployed systems that test and explore the theory. These deployed systems then create a new context for observation of user behaviour and thus lead to fresh insights, discoveries and refinement of theoretical understanding.

A central aspect of this methodology is the deployment of systems as technology probes [Hutchinson, 03]. In order to achieve real use, these systems must do more than just explore interesting issues; they must also meet real or emerging needs. We therefore adopt an iterative and participatory design approach to each deployment where the observation and involvement of users will serve the dual purpose of traditional user centred design and source for more theoretical analysis.

The remainder of this paper is structured as follows: In section 2, we discuss the how mobile phone interaction was supported with the Hermes 1 system, in section 3 we describe the way in which mobile phone interaction was

supported in our work on the Hermes Photo Displays, which followed on as a natural extension to our work on the door displays. In section 3 we discuss the current and planned role of mobile phone interaction with the latest version of Hermes. Section 4 presents a closing summary.

MOBILE PHONE INTERACTION IN THE ORIGINAL HERMES OFFICE DOOR DISPLAY SYSTEM

From an early design stage we realized the potential importance of providing the owners of Hermes displays with the ability to remotely send a message (via SMS) to the display situated outside their office using their mobile phone. Details of this aspect of the system can be found in [Cheverst, 2003], but in summary, early users of this feature encountered reliability problems (messages would appear to be sent but would not appear on their display) which severely damaged their trust and future use of this specific feature. However, some later users experienced high levels of reliability with the remote messaging feature – one lecturer in particular used the remote messaging feature fairly frequently for approximately six months without experiencing any reliability problems with the SMS feature. Examples of his messages include:

"am running 20 mins late", "On bus 2.15 - in soon", "On bus - in shortly", "Gone to the gym", and "In big q at post office.. Will be a bit late. C".

Comments received from users of the remote messaging feature centered on the need for the system to provide greater feedback regarding whether or not a remotely sent message has been successfully displayed on his/her door display.

THE HERMES PHOTO DISPLAYS

We deployed an early version one of the Hermes Photo Display in June 2003 in one of the corridors of our Computing Department building. It was in place and in use for a period of approximately one year, until it was taken down following our department's move to a new building. This first version of the system was effectively an extension to the Hermes office doorplate system and enabled Hermes users (and more specifically the owners of Hermes displays) to send pictures to the display in a similar manner to sending pictures to their office door display. In more detail, users could use MMS or e-mail in order to 'post' a picture and the subject header of the message was used to stipulate the location of the destination display, e.g. "PUBLIC LOCATION C FLOOR". It should be noted that the initial system did not allow users to cycle through all the pictures received but would instead automatically select a sub-set of pictures to display.

Since this early deployment a number of iterations of the system have taken place and different deployment domains have also been explored.

A user study involving the display was carried out in 2005 (see [Cheverst, 2005] for more details) and one of the findings of this study was that users became frustrated if the picture which they send to the display did not appear immediately after the transfer had completed – the system had been designed to schedule received pictures for display in a round robin fashion and therefore a received picture might not be displayed for several minutes depending on its place in the schedule.

The user study also highlighted the potential for supporting synchronous interaction with the display and the problems associated with enabling more than one user to interact with the touch screen display at one time. Requiring a user to touch the screen as part of the receiving picture process restricts the number of users that can select a picture concurrently, although in practice this might provide an interesting opportunity for social engagement.

We developed a version of this system which supported synchronous interaction – this version required users to download an J2ME application onto their mobile phone, which allowed them to use their cursor keys in order to select a picture to download to their phone via a matrix displayed on the phone which reflected the matrix of pictures shown on the photo display.

A brief user trial was carried out in March 2006 (see Figure 1 below) in which the system was used in an unprescribed fashion by a small number of visitors to the Computing Department. As you might expect, users spent some time matching up the grid pattern shown on their mobile phone with the grid pattern shown on the display, but users were able to complete selection and downloading tasks.

Figure 1. InfoLab visitor interacting with the Hermes Photo Display (March 2006).

More importantly for this kind of system, users appeared to enjoy the process and commented that they found the interaction to be an engaging, fun and playful activity.

We have also briefly experimented with representing the users' selections on the display itself rather than their mobile device, allowing them to concentrate on just one

screen. This was achieved by displaying coloured borders around the images on the display, with a different colour representing each current user. However, there is a clearly a limit on the number of users which can be concurrently supported in this way.

In parallel with our explorations into synchronous interaction methods, we have also explored alternative domains. One of these is a photo display for a rural village nearby to Lancaster called Wray [Taylor, 2007]. In our early deign sessions with our user group from the Wray (members of the village 'Computer Club' with varying levels of computing skills) we discussed idea of a photo display for the village based on something similar to the Hermes Photo Display. We also discussed the idea of supporting the uploading and downloading of pictures to the photo display via mobile phones and the idea was greeted with some enthusiasm. Consequently, we developed the Wray Photo Display to support this feature. Figure 2 shows the leader of the Computer Club 'playing' with this feature when the first version of the display was ready for an initial deployment in the Wray village Hall in August 2006. The interface displayed on the Wray Photo Display screen is shown below in Figure 3.

Figure 2. Bluetooth Interaction with the Wray Photo Display (March 2006).

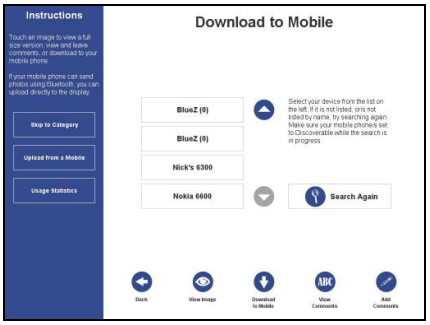

Figure 3. Bluetooth Interaction with the Wray Photo Display (March 2006).

However, since its deployment very few occurrences of this type of interaction with the system have taken place. One possible reason for this is that the system is not advertised adequately and certainly the display does not 'afford' the property of supporting the transmitting/receiving of images via Bluetooth.

THE HERMES II SYSTEM

The Hermes system was dismantled in July 2004 and working prototypes of a new version of Hermes (Hermes 2) were deployed in the new department building in May 2006. A full deployment across two corridors and 40 offices is currently being completed. From the user's perspective, one significant change from the original Hermes system is the use of a larger 7 inch widescreen display. This larger screen was chosen by the majority of door display owners from the original Hermes system during a 'show case' study in which a variety of display options (based on high fidelity prototypes) were presented to previous owners.

Figure 4. The Hermes II Office Door Display (taken March 2007).

One of the problems with Hermes II which was shared with the original Hermes system is that the display is placed at a height which would make it difficult for wheelchair visitors to the display to leave a message on the display itself, while placing the display at an accessible height would make it difficult for many non-wheelchair bound visitors to interact with the display and read owner messages. Unfortunately, current cost issues have prevented us from installing two displays per office door at different heights, although it is interesting to note that in the film *Minority Report*, two eye scanners are placed at different heights in an entrance in order to support both wheelchair and non-wheelchair users.

We are currently working on this problem by adding a feature that enables a visitor to leave a message on a door display using his/her mobile phone. Out initial hopes were that visitors would be able to compose a text message and then simply transmit this message to the relevant door display as a simple OBEX Bluetooth transfer, without requiring the visitor to download any new software to his/her phone (just as they might transfer a picture to the Hermes Photo Display). However, while some of the earlier Bluetooth equipped phones did support the facility to send SMS messages via Bluetooth (e.g. the Sony Ericsson p800), this facility is strangely lacking in the majority of more recent phones. In order to keep the service free for the

visitor wishing to leave a message it may be that we have to return to idea of requiring software to be downloaded on the phone.

An interesting implication of Bluetooth based interaction with the new Hermes deployment is the large number of Hermes devices that will be detected by a phone when 'Finding Bluetooth Devices' in one of the Hermes corridors.

Another mobile phone feature that we are supporting with the Hermes II system is the facility for owners to receive visitor messages via their mobile phones. Scribbled messages may be received via the MMS service while textual messages (e.g. those entered via the door display's on-screen keyboard) may simply be received as a text message. We are currently investigating the best means of enabling video messages to be transferred to an owner's mobile phone.

RELATED WORK

There is surprisingly little published work relating to the combination of mobile phones, situated/public displays and Bluetooth. One exception is the work on ContentCascade [Himanshu, 2004] which enables a user to download content from a public display onto her mobile phone using Bluetooth. The system was tested in a small and informal user study using movie clips. The ContentCascade framework enables users to download either summary information or the movie clips themselves.

More recent work by Marsden *et al.* [Maunder, 2007] has investigated the potential for supporting mobile phone interaction with public displays in order to enable users to select and download content without requiring the user to keep their phone in the Bluetooth discoverable state. Their approach required the user to take a picture of the content screen that he/she wishes to download and then send this picture back to the public display server as a Bluetooth transfer, thus providing the server with the user's phone's Bluetooth MAC address. The server then performs image recognition in order to determine the content required by the user, which is then transferred via Bluetooth to the user's phone.

SUMMARY

In our experiences with the deployment of touch screen situated display based systems we have found that supporting mobile phone based interactions can provide a number of advantages.

1. It can usefully support interaction to a display by multiple users and can support synchronous interaction (although this may required software to be installed on the user's phone).
2. It can support interaction by users who, given the positioning of the display, are physically unable to interact directly.
3. It can serve as a useful tool for transferring content, e.g. pictures, to a display and as a receiving tool.

Interestingly, our studies (to date) with the Photo Display have not revealed much of the 'social embarrassment' issue uncovered by Brignull *et al.* [Brignull, 2003] (that users could feel self conscious about being seen to be interacting with a public display) but this is likely to be a result of the affordances and nature of the places where our photo displays have been deployed.

As might be expected (given discussions by Dix on pace and interaction [Dix, 1992]) we have found that for both remote and local interaction the need for the system to provide the user with appropriate feedback is important. In the case of the Hermes remote messaging users wanted feedback that their texted message had been displayed on their door display in a timely manner and with the local interaction with Photo Displays users wanted the pictures that they sent via Bluetooth to appear on the display instantaneously.

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