EXPERIENCES OF SUPPORTING LOCAL AND REMOTE MOBILE PHONE INTERACTION IN SITUATED PUBLIC DISPLAY DEPLOYMENTS

Keith Cheverst, Dan Fitton, Nick Taylor
Computing Department,
Lancaster University,
Infolab21, South Drive,
Lancaster LA1 4WA
United Kingdom
{k.cheverst,d.fitton,n.taylor3}@lancaster.ac.uk

Chris Kray
School of Computing Science,
Newcastle University,
Newcastle upon Tyne, NE1 7RU
United Kingdom
c.kray@ncl.ac.uk

Jörg Müller
Institute for Geoinformatics,
University of Münster,
Germany
joerg.mueller@uni-muenster.de

Submitted to the CHI Workshop on: Designing and Evaluating Mobile Phone-based Interaction with Public Displays

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 or content from the public display to be transferred to the users device. In this paper we discuss our explorations of some of these interaction related issues based on a small number of deployed systems.

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 or display content to be transferred to the users device. 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 research approach 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 meet real or emerging needs, and they have to integrate with the situative context without interfering with the activities usually carried out at the location of their deployment. 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 the next two sections, we discuss how mobile phone interaction was supported with the Hermes 1 system and the Hermes Photo Displays, which followed on as a natural extension to our work on the door displays. In the following section, we review the current and planned role of mobile phone interaction with the latest version of Hermes. Leading on from that discuss, we present mobile phone interaction with iDisplays, a university information system, and MobiDiC, a public display advertising system. The final section summarizes our main contributions.

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 centred 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 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 one 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) and Hermes II Office Door Display (March 2007).

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).

However, since its first deployment in the village hall and subsequent deployment in the village Post Office (where it occupies quite a prominent position) 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.

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.

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 a simple facility to send SMS messages via Bluetooth (e.g. the Sony Ericsson p800), this facility is strangely lacking (with revenue issues being a likely factor) in the majority of more recent phones (or the facility requires a significantly more complicated set of actions to be performed). 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, or rely on audio/video recordings (as the new hardware is sufficiently powerful to support this kind of interaction).

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.

MOBILE PHONE INTERACTION IN THE IDISPLAYS SYSTEM

The iDisplay system [Müller, 2007] is a university information service consisting of 10 public displays installed at the University of Münster, Germany. Faculty can submit information via a web application, which is shown on the displays alongside information gathered from local sensors and from the web. In order to enable users to take information with them and communicate it to friends, we developed a Java application that users can install on their mobile phones, and that enables them to connect to the displays via Bluetooth using JSR82. The application provides several services to users: they can request an email with extended information, they can send an SMS containing a selected item to a friend, or they can store the information on the mobile phone.

During the deployment we observed several issues relating to the application. Even when disregarding the fact that the application only runs on a limited number of mobile phones (i.e. those supporting JSR82), it was very difficult to convince users that the application would provide enough value such that they would install it on their phone. In addition, those users who did install it only used it for a few times. Furthermore, we found that people would usually just walk past the displays without stopping. If they were installed in a waiting area where people had nothing else to do, they might be more enticed to give it a try.

Figure 3: User Navigating using the Shopfinder application on the iDisplay System.

MOBILE PHONE INTERACTION IN THE MOBIDIC SYSTEM

MobiDiC is a public display advertising system consisting of 20 public displays installed at the city center of Münster. The displays show coupons (see Figure 4) that can be photographed by passer-bys using their mobile phone. To claim a discount at a shop, people can then present the photographs at a participating shop. Shopfinder is a small companion application supporting the coupon/advertising system. People can download it after having taken a photograph of a coupon in order to get guidance to the shop, which offers the coupon. They initiate the download by sending the coupon to the display via Bluetooth Object Push. The display system then generates a customized Java application and sends it back to the mobile phone. When users launch the Shopfinder application, it shows a series of landmark pictures that help users finding their way to the shop. In one version of the system, overview maps are shown on the public displays when users pass them. In interviews, most users were pretty enthusiastic about the couponing system, because it is absolutely anonymous and no private data is revealed. They also liked the Shopfinder, although most users considered the process pretty complicated. The System was first deployed in September 2007, and since then a few dozen coupons have been converted; the Shopfinder application has been downloaded a similar number of times. .

With the indoor version of the shopfinder system running on the iDisplays we found that users interacting with the iDisplays when other people were present and performing some task (e.g. playing table football) were concerned that there interaction would not prove a disturbance. Similarly for the outdoor version of shopfinder system running on the MobiDiC displays we observed users interacting with the displays describing their concern for ‘getting in the way’ by standing in a public thoroughfare (in this case between a bus stop and the entrance to the train station)

An interesting observation concerning privacy issues arose during a study in which we tested the Shopfinder application both indoors and outdoors. In more detail, users appeared unconcerned that public displays were showing information about their personal navigation task (e.g. a navigation route to the toilet) on a display clearly visible to other members of the public.Although all three systems (the iDisplays interaction, the MobiDiC Coupons and the Shopfinder application) have been deployed in highly frequented locations for several months, very few people actually chose to interact with the systems. At this stage it is not clear why this is the case. There are several possible explanations, though. It might be that the perceived value of the applications is too low for people to make the effort of interacting with the system. It is also possible that the non-interactive version is providing enough information, and users do not see the need to interact. Furthermore, it is possible that the systems are being overlooked either entirely [Huang 2007] or in parts (i.e. people might not realize that they can interact with it). Finally, the download procedure may be too complicated, and it may be necessary to resort to a different means of interaction.

Figure 4: Taking a Photo of the MobiDiC Coupon display.

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 to determine the content required by the user, which is then transferred via Bluetooth to the user's phone.

Some systems use Bluetooth as a means to detect the presence of people rather than as a means to enable explicit interaction. Two examples of these systems are the BluScreen system by Rogers et al. [Rogers, 2007], which links advertisement displays, agents bidding for advertisement space and the detection of presence via Bluetooth, and Bluefish [Kindberg, 2007], which displays avatars in response to detected Bluetooth devices.

SUMMARY

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

1. It enables simultaneous and synchronous interaction for one or more users (although this may require 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 user content, e.g. pictures, to a display and to transfer display content, e.g. text items, coupons, or guide programs, to the users' mobile phone.

As might be expected (given discussions by Dix on pace and interaction [Dix, 1992]) we have found that for both remote and local interaction a system needs to provide the user with appropriate feedback. 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. Similarly, when a user of the iDisplay system posted new content (e.g. a talk announcement) to all iDisplays using a web form, he or she would tend to immediately walk to the closest display in order to manually check that the posted content was being displayed in an appropriate manner (despite receiving a preview of how their content would appear on the iDisplays via the web page).

Interestingly, our studies (to date) with the Photo Display, iDisplays and MobiDiC have not revealed much of the 'social embarrassment' issue uncovered by Brignull et al. (that users could feel self conscious about being seen to be interacting with a public display). Apparently, as a result of the affordances and nature of the places where the display systems have been deployed, 'social embarrassment' seems to play a lesser role for these systems. At least for the iDisplays and MobiDiC systems, users seem to be more concerned about not standing in the way of others or interruptting them. Furthermore, this resonates with comments we received during focus group sessions about the cafe display [Kray, 2007]: participants were concerned that screen content (added by others) might interfere with their enjoyment of the place. Identifying the relationship and relative importance of social embarrassment and interference with co-present people is an interesting direction for future research.

ACKNOWLEDGMENTS

This work is partially funded by the EPSRC CASIDE project (grant ref: EP/C005589).

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