Exploring Mobile Phone Interaction with Situated Displays

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ABSTRACT
One of the most promising possibilities for supporting user interaction with public displays is the use of personal mobile phones. Furthermore, by utilising Bluetooth users should have the capability to interact with displays without incurring personal financial connectivity costs. However, despite the relative maturity of Bluetooth as a standard and the widespread adoption in today's mobile phones market little exploration seems to have taken place in this area despite its apparent significant potential.

Keywords
Situated displays, Bluetooth, Mobile Phones, Interaction, Prototyping.

1. INTRODUCTION
One exciting avenue for supporting user interaction with situated/public displays is the use of personal mobile phones. 'Historically', one obvious drawback of using mobile phones has been cost, however, by utilising Bluetooth (or its successor protocol) users should have the capability to interact without incurring personal financial connectivity costs. However, despite the relative maturity of Bluetooth as a standard (it was actually standardized in 1996) and its widespread adoption in today's mobile phones little exploration seems to have taken place in this area despite its apparent significant potential.

In this paper we introduce our current work on exploring this area. The work described is being carried out under the auspices of the EPSRC funded CASIDE project (Investigating Cooperative Applications in Situated Display Environments, see: www.caside.lancs.ac.uk/ for further details).

2. CURRENT EXPERIMENTS – SITUATED DISPLAY DEPLOYMENTS
In the last three years we have deployed a small but significant number of situated displays within the Computing Department of Lancaster University. When we refer to such situated displays we agree strongly with the definition provided by O'Hara [8]:

> *In recent years, more and more information is being presented on dedicated digital displays situated at particular locations within our environment. At their most basic, digital display technologies allow information to be more easily updated dynamically and remotely. However, these new kinds of interaction technologies also allow people to use these situated displays in novel ways both as for the individual's purposes and in the support of group work.* (O'Hara et al. 2002).

The following two subsections describe two of these existing deployments and our initial experiments to investigate how Bluetooth technology might provide new and useful ways for users to interact with the deployed displays using their own personal mobile phones.

2.1 Interaction with Office Door Displays
The first Hermes door display (see figure 1) was installed outside one of the offices in Lancaster's Computing department in March 2002 and by October 2003 the number of deployed units had increased to ten. Unfortunately a move of building meant that the Hermes system (see [4] and Chapter 6 of [9] for more details) had to be dismantled but during the 24 months of its use 775 notes were left by visitors and over 5278 messages were set by owners.

Figure 1: An early Hermes display.

The system is currently being redeployed in the new office building and we are currently experimenting with new design ideas. For example, in the initial Hermes system each office only had one display - we are trialling the use of two displays per office. This would allow one display specifically for supporting interaction with the visitor to an office, e.g. enabling the visitor to leave a note for the owner. The other display would be solely for the owner leaving messages to visitors.

One concern with the original system was security – we did have 2 units stolen outside of office hours. One potential benefit of Bluetooth is that users can interact with the system, e.g. to leave a note for the owner of the door display, while the display is more safely secured within the office.

Currently it is envisaged that visitors will be able to use the system in order to download, via Bluetooth, information from the office door display such as the owner's contact details. However, studies have shown that owners are prepared to share certain information when a student has made the journey to their office which they would not necessarily make available on, for example, their web home page. We plan to investigate this issue more fully and ascertain whether the owner of a door display is prepared to share and make available objects such as calendar details based

on the scoping effect resulting from the limited range of the Bluetooth signal – in effect restricting the availability of such information to persons that are within close proximity to her actual office (see figure 2a). Figure 2b shows the kind of message that could be 'scribbled' and then sent by an owner or visitor using a mobile phone equipped with a touch screen.


Figure 2a (left): Visitor using his mobile phone to interact with a Hermes display, and, figure 2b (right) the kind of display that could be composed using the jotter app found on touch-screen based phones such as the Sony-Ericsson p800.

2.2 Interaction with Public Photo Display

We first deployed the Hermes picture display in June 2003. The system is effectively an extension to the Hermes system and was first designed to enable users on a particular corridor to send pictures through MMS, e-mail etc.(see figure 3a) - in the subject header of the message the user would stipulate the location of the display, e.g. "PUB LOC C FLOOR". The display is actually a Phillips 'smart' display and in addition to displaying a picture presentation the system was recently extended to support a presentation to show the vCards of users that have 'registered' with the display (see figure 3b).

Figure 3a (left): the Hermes Picture Display showing the picture presentation, and 3b (right) showing the registered users' contact details presentation.

Clearly with MMS we already support some level of interaction with the photo display – but we are currently experimenting with ways in which users can interact when co-located with the display via a Bluetooth connection to their mobile phone. To this end we are investigating a range of interaction and user interface ideas.

2.2.1 Asynchronous Interaction

A user can use the built-in application on his or her mobile phone in order to send or receive a picture or contact details in vCard format (RFC 2425) from the photo display over Bluetooth.

Figure 4 below illustrates the photo display and a user sending a file (in this case it happens to be a picture) via their phone to the display. As a prerequistite to sending a file the user must firstly pair with the display - this involves searching for the display (see figure 5a) and then entering the appropriate pass key (note that details of this appear in the centre of the presentation).

Figure 4: Visitor using his mobile phone to interact with the Hermes Picture Display using Bluetooth.

In order to select a picture or vCard for download onto a mobile phone a variety of approached are possible. For example, a registered user may simply touch the display to select a picture or vCard and then select their (discoverable) Bluetooth phone from a list in order to initiate the transfer.

Figure 5a (left): Visitor waiting to pair with the public display, and, figure 5b (right) user accepting to receive selected vCard file.

However, requiring a user to touch the screen necessarily restricts the number of users that can select a picture concurrently (however, in practice this might provide an interesting opportunity for social engagement!). So with the aim to investigate how we might support a group of users interacting with the display (for example during a departmental research open-day) we are also considering more synchronous interaction approaches. Note that at this stage we are considering how to support simultaneous interaction with a small group (i.e. of no more than 8 people) – clearly other approaches would be required to support scalability up to an arbitrary number of users but it is certainly not clear that such scalability is required at this stage nor that such highly scalable solutions would be appropriate for the smaller sized group numbers envisaged for this particular deployment.

2.2.2 Synchronous Interaction

A number of approaches are possible, some more engaging and visible than others and it is our intention in the coming weeks to carry out (initially) simple user studies in order to find which methods users prefer. The remainder of this section considers the selection and download of vCards from the display.

One implication of supporting a more synchronous interaction style is that the user must first download and install a Java application (see figure 6 below) and one of our early studies will be to determine how users feel about this, e.g. in terms of issues such as trust etc.

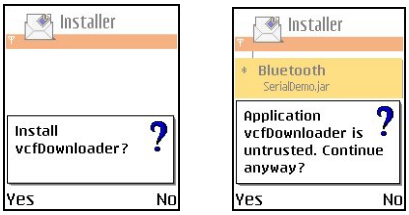

Figure 6: Downloading a Java application to support a more synchronous interaction style.

2.2.2.1 Method A – Use of colour on the display

On pairing with the display the user downloads a small Java application. This application assigns the user a colour and this colour is used to highlight the image currently selected by her. The user can use keys/joystick on her mobile phone to select the appropriate vCard and she can press the OK button in order to receive the picture. Sample screen shots showing how the display would appear with two different users is shown below in figure 7.

Figure 7: Two different approaches for annotating the presentation to show images selected by different users.

2.2.2.2 Method B – Simple use of Id's

This approach is simpler but may not necessarily be a more pleasing method for the user. Again the user would download a small application and would then press the appropriate button to select and retrieve the required vCard.

Figure 8: Annotating the presentation with digits to enable a user to select a vCard for transfer.

2.2.2.3 Method C – GUI on the mobile phone

This approach would take advantage of the mobile phone's colour graphical display. The user again downloads a java application which in this case displays a set of thumbnails on the phone – the user can then choose the image relating to the vCard that she wishes to have added to her contacts list.

Figure 9: Exploratory UI design using J2ME wireless toolkit (note that the positions of icons correspond to those that appear on the presentation appearing in figure 3b).

3. Current State of Development

Having completed development of the asynchronous approach, we are currently developing the java applications to enable the trial of the synchronous approaches. This is being achieved using Linux servers running an Open Source Bluetooth stack These applications will utilize the RFCOMM transport - one of the higher levels of the Bluetooth stack - which emulates asynchronous serial port connections over a Bluetooth link. RFCOMM sits on top of the L2CAP (Logical Link Control and Adaptation) layer (providing connection and multiplexing of higher level protocols) which in turn sits on top of the lower hardware oriented layers.

4. Supporting Community - On and Off Campus

The overriding aim of the CASIDE project is to investigate how the deployment of situated displays can support the notion of community, in both campus and other settings. However, situated displays do not typically fit the traditional single user mouse/keyboard interaction style. We will seek to explore the interactions that manifest themselves (over time) in a range of settings both on and off campus.

Much of this exploration will be guided based on our understanding of the settings and will utilise techniques found in context-aware computing (location-aware behaviour, automatic personalisation/content creation based on sensed context, etc.) and tangible interfaces as well as more familiar modalities such as e-mail, instant messaging and mobile phones.

Our approach will be based on a combination of theoretical research, collection of empirical data sets (e.g. arising from use of cultural probes [6]) and prototyped application development.

This methodology 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.

As is evident, and has been noted previously, a central aspect of this methodology is the deployment of systems as technology probes. 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 will therefore adopt an iterative and participatory design approach to each of our deployments where the observation and involvement of users will serve the dual purpose of traditional user-centered design and source for more theoretical analysis.

4.1 Deployments within Campus

On campus we plan to explore how the styles described above can support interaction, e.g. the football or climbing society could have displays situated alongside their existing more traditional notice boards (see figure 10 below). Walking past a display could serve to prompt the player of a football team to send pictures or video footage from their mobile phone of a game they watched over the weekend. He or she may then use their phone to download a match report that had been posted previously.

Figure 10: Notice board outside the University Climbing Wall.

4.2 Deployments Off Campus – Domestic and Residential Care Settings

Outside of the campus setting we intend to investigate how public displays can be used in care settings. This follows on from previous work (see [3]) but here we hope to explore how these technologies can support a sense of community. For example, a recent design workshop revealed the potential for using a display situated in the common room of a residential care facility in order to support a sense of community between both residents and staff. When deploying technologies in such settings it is crucial that the deployed systems are reliable – effectively the early studies/deployments described above can serve as an excellent means for 'burn-in' testing of the technology solutions.

5. 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 [7] 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.

However, there is now a reasonable body of research on situated display technologies – and a good survey of this can be found in [9]. The WebWall is a system which enables multi-user communication and interaction via shared public displays, e.g. airports, [5]. WebWall allows pervasive and seamless access to the web-based application such as simple sticky notes, and image galleries via devices such as mobile phones or PDAs. WebWall's architecture enables a strict separation of I/O technologies (like HTTP, email, SMS, WAP, MMS etc.) from components managing storage, presentation logic and physical display technologies. While WebWall would clearly be able to incorporate Bluetooth, it is less clear how the special features of Bluetooth could be used in the current architecture.

Other examplesof work describing deployed systems that utilize the combination of mobile phone and situated displays with SMS include the txtBoard system [1] developed by the Appliance Studio, for example, have developed an Information Appliance - this supports 'texting to place' and has the family home as its primary deployment domain. In [11] the authors describe the short term trial of a system supporting the sharing of pictures which utilises a laptop-sized display situated in the family's living room. In terms of work describing phone/display interaction based on visual codes, one interesting approach is described in [2]. An interesting potential approach for the pairing of devices, e.g. mobile phone and situated display, could be 'SyncTap' [10].

6. SUMMARY

In this paper we have introduced our current work on exploring the use of Bluetooth equipped mobile phones to support interaction with situated displays. Our approach is to produce prototype deployments and involve potential users at an early stage. In the near future we hope to take our designs beyond the university domain and into a residential care facility.

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