Exploring Bluetooth based Mobile Phone Interaction with the Hermes Photo Display

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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 its widespread adoption in today's mobile phones, little exploration seems to have taken place in this area - despite its apparent significant potential. This paper describe the findings of an exploratory study involving our Hermes Photo Display which has been extended to enable users with a suitable phone to both send and receive pictures over Bluetooth. We present both the technical challenges of working with Bluetooth and, through our user study, we present initial insights into general user acceptability issues and the potential for such a display to facilitate notions of community.

Categories and Subject Descriptors
H.4.3 [**Information Systems**]: Communications Applications – Information browsers.

General Terms
Design, Reliability, Human Factors.

Keywords
Situated displays, Bluetooth, Mobile Phones, Interaction.

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 utilizing Bluetooth (or its successor protocol. Zigbee (see: www.zigbee.org)) users should have the capability to interact without incurring personal financial connectivity costs. But 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.

Bluetooth has specific characteristics that enable different forms of interactions than those possible with SMS, email etc. that we have previously studied. One of these is the locality of Bluetooth. This locality means that it is possible to implicitly determine which display (or a small set of displays) the user is intending to interact with. Also the locality ensures that the user is near the display creating a certain level of social accountability. We have previously seen that this is an important issue for public displays [6] and comments obtained during this study reinforce this.

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).

When we refer to such situated displays we agree strongly with the definition provided by O'Hara [14]:

> *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.*

The main research objectives of the study described in this paper were two-fold:

i). to ascertain the technical feasibility of the idea, i.e. to identify the key technical challenges to working with Bluetooth technology, given the currently available software support, and,

ii). to carry out an initial user study in order to gain insights into general user acceptability issues and the potential for such a display to facilitate notions of community.

The remainder of this paper is structured as follows. In section 2 we will present an overview of the Hermes Photo Display. Next, section 3 presents implementation details (addressing research objective one). Section 4 presents the design and results of our initial user study (addressing research objective two). Section 5 describes areas for future work and this is followed (in section 6) by a discussion of related work. Finally, section 7 presents a summary and some concluding remarks.

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2. THE HERMES PHOTO DISPLAY

2.1 Initial Deployment (Version One)

We first deployed version one of the Hermes Photo Display in June 2003 and was in place and in use for a period of approximately one year (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 [5] 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.

The Hermes Photo Display is actually a Phillips 'smart' (i.e. wireless) display and this is housed in a wooden structure (see figure 1). This structure was built in order to obviate the need to drill into the university building! Such problems of physical installation, whilst seemingly trivial, are in fact a major and persistent issue for any form of public situated display. In our previous work, creating suitably secure mountings has been a real challenge and we have 'lost' displays despite our efforts. Displays deployed outside need to be weather proofed, and if physically accessible may need to be vandal as well as theft resistant. The problem of drilling holes is also non-trivial and as Rodden et al. [17] have noted in their use of Brandt's timescale for buildings, the structure of a building (walls, beams, roof) typically may last from fifty to many hundreds of years, whilst ubicomp technology is operating at the timescale of 'services' or even 'stuff' - relative ephemera with timescales from days to perhaps 10 years for more stable technology. The wooden frame epitomises this clash of timescales.

Figure 1. The Hermes Photo display

While the system was used as an extension to the Hermes system, the owners of door displays would regularly send pictures to the display from conference destinations etc.

Clearly with MMS we already support some level of interaction with the photo display – but we wanted to experiment with ways in which users can interact when co-located with the display via a Bluetooth connection to their mobile phone. We have developed and deployed version two of the Hermes Photo Display in order to explore these issues.

2.2 The Hermes Photo Display (Version Two)

Version two of the Hermes Photo Display enables the user to navigate through the complete set of pictures received by the system by manually cycling through a series of pages (each displaying 10 pictures) by pressing a 'next page' button (see center of figure 2). Alternatively, a user can wait for the system to automatically cycle from one screen to the next (a new page is displayed after 60 seconds).

This version of the Hermes Photo Display also enables a user to i) use her mobile phone's built-in 'picture' application in order to send a picture to the photo display over Bluetooth, and, ii) use the interface on the Photo Display to select a picture and then receive this picture onto her phone via Bluetooth.

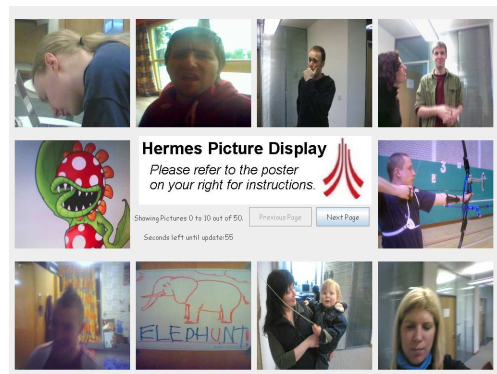

Figure 2. The Hermes Photo Display showing the picture presentation

2.2.1 Sending a Picture

In order for a user to send a picture to the Photo Display she needs to follow the same simple steps as she would to send a picture to a friend's Bluetooth phone. The basic steps are as follows:

i). user selects the required picture on her phone,

ii). user selects 'Bluetooth' under the 'send as' option,

iii). mobile phone searches for devices in range and then displays the list of devices (see figure 3),

iv). user selects the display (currently called PubDisplay(C) due to its location on the C floor of the university building),

v). if the user has not paired with the display previously then she will be prompted to enter her phone's pass key (see figure 3) – details of the pass-key appear highlighted in a poster to the right of the display).

The process of sending a picture takes approximately 1 minute. This time comprises approximately 25 seconds to discover the display as a Bluetooth device and another 20-30 seconds in order to send an image of approximately 250 Kbytes).

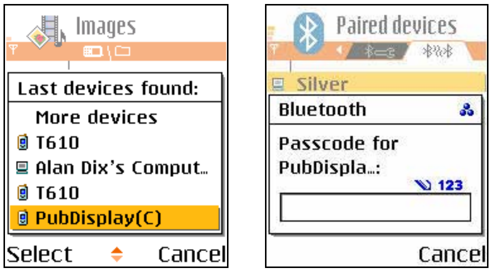

Figure 3. Selecting the display on the user's mobile phone (left) and entering the pass key (right)

2.2.2 Selecting and Receiving a Picture

The typical steps required for selecting and receiving a picture are as follows:

i). user selects the picture on display – this is achieved by touching the picture which is then highlighted with a yellow border (see figure 4),

ii). the display then highlights the fact that it is searching for devices in range (see figure 4) and provides a graphical indication of the time left to complete the search. In addition, the user is shown the size of the file selected (an earlier version of the system did not reveal the file size but several users requested that this information be made available),

iii). the user can select her phone from the list presented on the display (see figure 5),

iv). the user can then choose to accept the incoming file from her phone (see figure 6).

The process of receiving a picture takes approximately the same time as that of sending a picture.

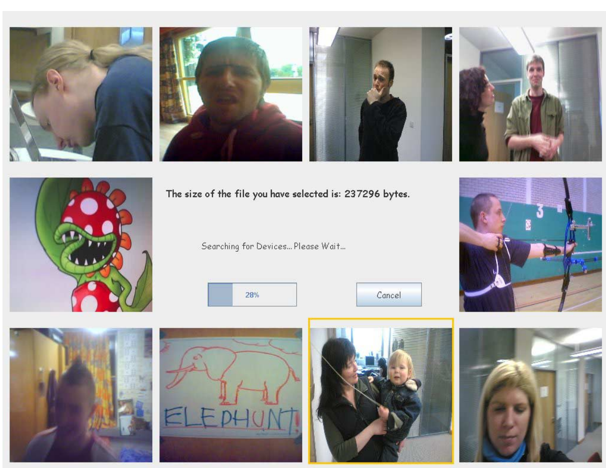

Figure 4. Searching for Bluetooth devices in range

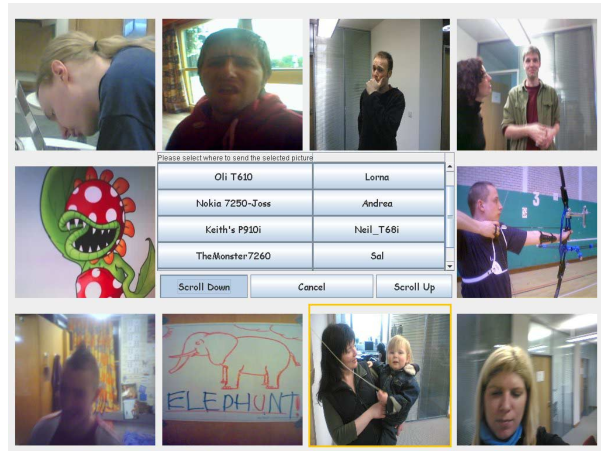

Figure 5. Requesting user to select device to receive image

Figure 6. Typical mobile phone display prompting the user to receive her selected image

3. IMPLEMENTATION ISSUES

This section provides a summary of the problems that we encountered when developing a system that supports Bluetooth interaction using Java. Following this we present an overview of our current implementation approach and the architecture of the Hermes Photo Display system.

3.1 Supporting Bluetooth Interaction

Despite the maturity of Bluetooth as a standard, the support provided development tools, especially in Java, is still relatively immature and integration with today's Bluetooth phones poses many challenges for the developer.

3.1.1 Interaction with a Mobile Phone

Sun's Bluetooth API specification (JSR 82) [13] for mobile devices was finalized on 22nd March 2002. However out of the many hundreds of different types of Bluetooth mobile phones in use today, as of March 2005, only thirty-four relatively new models support this standard [12]. For the other phones supporting Java and Bluetooth there is no practical way for a third party developer to utilize Bluetooth from a Java application. For Bluetooth enabled non-JSR 82 phones, the only feasible way to enable interaction with the Hermes Photo Display is via the 'built-in' applications enabling files to be sent and received via OBEX push. It should be noted that the Object Exchange protocol was developed by the Infrared Data Association (IrDA).

3.1.2 *Interaction with the Server*

Unlike Java Bluetooth support on a mobile phone, on a server machine the developer has choice over both the stack and API to use. Support on desktop machines can be split into two categories:

i). Bluetooth APIs which run on top of operating system stacks (e.g. BlueZ on Linux, see www.bluez.org/), and,

ii). Bluetooth APIs with built in stacks (e.g. Harald, see: www.control.lth.se/~johane/harald/).

There are several alternatives in each of these two categories, but few with a complete JSR 82 implementation (e.g. some do not support OBEX). Of these alternatives the only viable solutions are commercial products. One alternative approach is to use utilities provided as part of Bluetooth stacks (e.g. for sending and retrieving files) but unfortunately under Windows these are likely to be GUI based and exceedingly difficult to automate.

3.1.3 *Our Current Approach*

Our current solution, enabling asynchronous interaction via Bluetooth, is to utilize existing applications for OBEX push on mobile devices and on the server. The advantage of this approach is that it requires no additional applications to be installed on the mobile device. On the server we use the Open Source *BlueZ* Bluetooth stack running under Linux, together with freely available command line tools, which utilize the OBEX libraries to perform sending and receiving. The first of these utilities provides a daemon which continually receives and saves any files 'pushed' to the server using OBEX, the second 'pushes' files to a device using OBEX once an RFCOMM binding has been created to that device. These command line utilities are controlled by Java applications.

3.2 Current Implementation

A simplified overall architecture for the current implementation is shown in figure 7, it has been simplified in order to reduce complexity (for example the device discovery mechanism is not depicted). Four main entities are shown:

1. Linux Server – this provides basic Bluetooth functionality (as described in the previous section). Any files received via OBEX are stored in a shared file space and OBEX functionality is available remotely using Java RMI.
2. Shared File Space – this provides central storage of pictures which are used when generating the presentation.
3. Presentation Server – this is a PC running Windows XP (necessary for the Smart Display 'Presentation Client') on which the presentation is generated and user interface actions are handled.
4. Presentation Client – a 'Smart Display' (effectively a remote desktop thin client) providing output for the Presentation Server and input via its touch sensitive screen. This device can only connect to the Presentation Server using 802.11b wireless LAN.

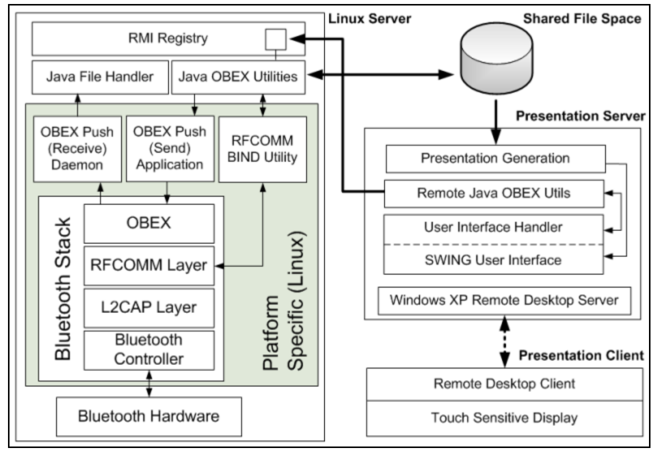

Figure 7. Simplified overall architecture for photo display

3.3 Specific Challenges Encountered

This section describes some of the problems we encountered during implementation and our solutions to these problems.

One of the first challenges we came across during our preliminary testing was an issue concerning the DIAC (Device Specific Inquiry Access Code) of the Hermes Photo Display. The DIAC specifies the type of Bluetooth device, with a major and minor device class (e.g. 'Computer' and 'Laptop' respectively) and optional service classes. We found that certain older Bluetooth phones have a difficulty discovering the display when attempting to send a file. In particular, the only devices discovered were those including a DIAC advertising an 'Object Transfer' (OBEX) service. To solve this problem we calculated a more appropriate DIAC including the Object Transfer service definition.

Another interesting finding that arose during testing of the file exchange procedure was that different types of mobile phones run their Object Transfer service on different channels. For example the Nokia 7610 uses channel 9, while the SonyEricsson Z600 uses channel 10. This introduced an extra step in the file sending process, i.e. to determine which channel the service is running on prior to the actual OBEX push of the file.

We also found that the successful discovery of a device did not always provide the device's 'friendly' Bluetooth name (needed to allow a user to identify her device). Occasionally this was returned as 'n/a', which necessitated an additional request to the Bluetooth stack in order to retrieve the appropriate name.

3.4 Ongoing Problems

Unfortunately we have encountered several problems with our approach which we have been unable to solve. One of the most obdurate problems encountered during testing has been the reliability of the Bluetooth discovery process. In particular, the discovery of a device, even when in range, may require multiple attempts for successful discovery, each attempt taking ten seconds or longer. This problem is aggravated when a large number of Bluetooth enabled devices are concentrated in a relatively small area (something that is likely to occur in many of our envisaged scenarios). For example, at one point during the user study there was approximately ten devices all in range, and the server had trouble discovering more than five or six at once, unpredictably failing to find different devices on each discovery attempt.

It would be nice to think that some of the 'teething' problems we have had with Java access to the Bluetooth stack will fade with time as new phones are produced. While this is undoubtedly happening to some extent it is likely to be slow and patchy progress due to the economic drivers of the industry. The features included in phones are to a large extent driven by the needs of telco operators. Bluetooth as a means of access to headsets or sync-ing with a PC are fine, but if it becomes a method of free communication (for example, using it for local messaging as we intend) then it challenges their core business model. If we wish Telcos to promote more effective local wireless connectivity, then we may need to think about how this interacts with business models, for example, if locally-sourced Bluetooth applications use the Telco for micro-payments then this may create income streams that are not reliant on GSM/GPRS charging.

4. EVALUATION

Having ascertained the technical feasibility of the approach (by building the system) we planned an initial user study.

4.1 Aims of user study

The main aims of the user study were:

i). to explore whether the interfaces on today's Bluetooth phones and the delays associated with Bluetooth would affect the suitability of the phones as devices for sending/receiving files to/from a display and what kind of simple user interfaces would need to be developed on the display for supporting the send and receive functions,

ii). to gain insights into the extent to which a sample of university graduate students would feel generally positive towards the notion of engaging with the situated display,

iii). to gain initial insights into whether the use of such a display could help foster a sense of community when placed in specific locations around campus, perhaps associated with university societies. Also, to learn from students the kinds of places that such displays could be deployed on campus and whether support for additional types of content is desirable.

4.2 Study Procedure

In order to meet the aforementioned aims we designed the initial user study around two simple tasks:

task 1 – involved asking the user to send a picture from her mobile phone to the display,

task 2 – involved asking the user to select and receive a picture from the display to her mobile phone.

It was anticipated that completing both these tasks would take users between 1 and 5 minutes to complete depending on difficulties encountered, e.g. with the Bluetooth pairing process.

For this initial study we sought volunteer participants from undergraduate computing students and graduate students comprising PhD students and masters students with backgrounds in computing and/or psychology. It is important to stress that the participants were, therefore, self-selective and reasonably computer literate. Perhaps more importantly, all participants were comfortable using their mobile phone, and the majority of them (above 70%) had previously used Bluetooth and/or MMS on their mobile phones for sending or receiving files.

4.3 Design of the Questionnaire

The Questionnaire consisted of 4 basic sections (see: www.caside.lancs.ac.uk/HermesPhotoDisplay/Questionnaire.pdf). The first section comprised the identification data related to the participant, such as name, age, and previous experience with Bluetooth. The second section consisted of seven questions related to interface issues and general acceptability. The third section contained 14 questions related to social and community issues. Finally the fourth section contained two questions relating to possible future features.

Questions were answered on a 5-point Likert scale and each question had a space for optional comments from the participant.

4.4 Results

The non-random sample consisted of 17 students in Computing Department, 12 males and 5 females, with an age range of 18-32 and the majority responded to an e-mail based invitation to participate in the study.

The majority of the subjects (above 75%) were satisfied with the simplicity of the phone interface for sending or receiving a picture over Bluetooth and almost all of them found the system engaging. Most of the study participants (above 75%) appeared to like the idea of exchanging pictures between their mobile phone and a situated display on campus.

Almost half of participants are members of one or more university societies or clubs and more than 55% of subjects considered the were positive about the idea of having a display associated with their society. Having such society-displays for sending or receiving pictures was considered as potentially increasing the sense of community on campus.

Study participants welcomed additional features to complement the picture exchange, such as the ability to associate text with the pictures (75%) or to send/receive other types of media (70%).

Privacy issues and control over the displayed pictures was an important issue highlighted by the participants' answers. All of them considered it important to be able to request that certain pictures of personal relevance be removed from the displays (either previously posted by themselves or by other users).

In terms of interacting with the display, most of the study participants (above 80%) considered it important to be able to interact from some distance, e.g. several meters. Another relevant issue with any interactive public display is related to scheduling interaction, e.g. changing or switching the content presented on the display while other users are watching it. Most of the users (almost 60%) would feel uncomfortable doing this through their phones, and over 70% by touching the screen. In turn, almost all participants would feel frustrated if somebody else started to switch the displayed presentation while they were watching it.

In an attempt to explore the future potential of such displays, we investigated users' willingness to wirelessly download applications from the display in order to increase the quality of further interactions. More than 75% of study participants have a favorable attitude in this respect.

The following subsections focus in greater details on the most interesting findings of the study as related to the aims described in section 4.1. Samples of subjects' answers are also provided.

4.4.1 Interface Issues and General Acceptability

Question 2.2 was "**Overall I like the idea of being able to send pictures to a situated display on campus from my phone**" – 13/17 were positive, remaining 4/17 unsure, no negative. Comments were not forthcoming on this however and sometimes did not seem to match the participant's rating. For example, one partipant's Likert rating was positive but the comment was: "Don't know why I would need to!".

We also asked the question (question 2.4) "**Overall I like the idea of being able to select and receive pictures to my phone from a situated display on campus**" - 12/17 were positive, 4/17 unsure, 1/17 negative. Comments included: "Yes it would give the opportunity to have unusual screensavers and not just the latest Nokia download" while a typical negative comment was "I don't see the point".

We also asked the question (question 2.5) "**Overall I enjoyed engaging with the system**"? - 16/17 were positive, 1/17 negative. Comments included: "New and Interesting" while the one negative comment was "Slow, the discovery time is long and I hate waiting".

We also asked the question: "**I would be more favorable of the idea if the total time to send/receive a picture was significantly reduced**"? – to this statement 12/17 users agreed, 2/17 were not sure and 1/17 disagreed. Comments associated with participants that agreed with the statement included: "It was already very quick but yes more speed is always better" and "Slow to receive". One comment made by a participant whom disagreed with the statement was: "It didn't take long at all. Don't see a problem."

We asked the question, "**I feel that being able to interact with the display from a distance, e.g. several meters, is important**" – to this statement 14/17 users had a positive response, 2/17 were not sure and 1/17 gave a negative response. Comments associated with a positive response included: "no crowding", "I wouldn't want to have to stand right next to the screen", "Sure. No point otherwise. It should be casual" and "yes, would be better or fun if just wanted to quickly send or receive something". In order to support remote receiving of files users would need to download and run a java application. In order to ascertain whether users would be prepared to do this we asked the question (question 4.1), "**I would be happy to download a java application onto my phone using Bluetooth and running this program from my phone in order to interact with the display, e.g. to select a picture, without touching the screen**" - to this statement 13/17 users had a positive response, 3/17 were not sure and 1/17 gave a negative response. However, the issue of trust was clearly on the mind of some participants with comments including: "If the code was from a source I trusted" and "Seeing risks - what if the program maliciously reads my contacts/diary/personal info?"

4.4.2 Fostering a Sense of Community

Question 3.2 was "**A display associated with my university society would be a good idea and something I would consider using to send pictures, receive pictures or simply to view pictures associated with my society**"? - – to this statement 14/17 users had a positive response, 3/17 were not sure and no negative responses. Comments associated with a positive response included: "I'm a member of the climbing club. Would definitely put pics of me climbing stuff on it".

Question 3.3 was ""**If displays such as this were placed in certain places on campus then being able to send/receive pictures could increase my sense of community on campus**"? - to this statement 10/17 users had a positive response, 6/17 were not sure and 1/17 negative response. Comments associated with a positive response included: "Keep in touch with friends for free". Interestingly the participant that made the comment regarding her climbing pictures gave an 'unsure' response to question 3.2 and her comment was: "I don't have a sense of much community on campus. Usually I am just traveling through. As a graduate I tend to pursue my own social life with friends outside the university or just on my course. Don't know if a display would change that."

Question 3.4 was "**Please list below places on campus where you would like to see/use a display such as this**". In general participants were quite forthcoming and there was considerable overlap in suggestions, e.g. corridors in the sports center, undergraduate bars, Junior Common Rooms, bus stops, the main public square on campus, coffee shops and the underpass.

4.4.3 Content Issues

Question 3.5 was "**I would also like to be able to associate text with the pictures that I send to the display**"? - to this statement 13/17 users had a positive response, 4/17 were not sure and no negative responses. Comments associated with a positive response included: "Yes would add to the experience most definitely" and "A caption".

Question 3.6 was ""**I would also like to be able to send/receive other types of media such as video**" - to this statement 12/17 users had a positive response, 3/17 responded with unsure while 2/17 users had a negative response. Comments associated with positive responses included: "Football highlights" and "Sound clips would also be good!" while less positive comments included: "Doesn't concern me as my phone can not support video".

Question 3.7 was: "**I want to be able to request that certain pictures can be removed, e.g. if someone sends a picture of me to a display that I am not happy with**"? - to this statement all users had a positive response (with 12/17 responding with a 'strongly agree'). Comments included: "Yeah you might have problems with that... but I don't think you should immediately jump into censorship without trying it out. Think of WiKIs. Their self-governing seems to work." and "This is a necessity as otherwise there could be many complaints and the whole system would have to be scrapped".

Question 3.9 was ""**I would like to have the ability to remove a picture that I had previously sent to the display**"? - to this statement 15/17 users had a positive response, 1/17 responded with unsure while one had a negative response. Comments associated with positive responses included: "yes, very important" and "Choices to the user are always welcomed!".

5. FUTURE WORK

Our future work will involve both exploring additional interaction approaches, such as synchronous interaction, and actual deployment.

5.1 Exploring Synchronous Interaction

Requiring a user to touch the screen as part of the receiving picture process (see section 2.1.1) necessarily restricts the number of users that can select a picture concurrently (however, in practice this might provide an interesting opportunity for social engagement). In order 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 ways in which the user can have more synchronous (while still remote) interaction.with the photo display using her mobile phone, e.g. by using the phone's jog dial to select a picture for download [3].

5.2 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 utilize techniques found in context-aware computing (location-aware behavior, automatic personalization/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 [8]) and prototyped application development.

This methodology involves a tight cycle where theoretical issues and understandin, developed through reflection on empirical observations, are used to design systems that through deployment test and explore the theory. These deployed systems then create a new context for observation of user behavior 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 [11]. 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.

5.3 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. Walking past a display could serve to prompt the player of a football team to send pictures or video footage from her mobile phone of a game that she watched over the weekend. She may then use their phone to download a match report that had been posted previously.

5.4 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 some of our previous work (see [4]) 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 [9] 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 invaluable 'burn-in' testing of the technology solutions.

6. 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 [10] 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. While the Bluetooth based Personal Server [19] provides a much more general approach designed to support the mobile user by exploiting the growing infrastructure of public displays.

There is now a reasonable body of research on situated display technologies – and a good survey of this can be found in [15]. The WebWall is a system which enables multi-user communication and interaction via shared public displays, e.g. airports, [7]. 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. .

The txtBoard system [1] developed by the Appliance Studio, is a situated display appliance that supports 'texting to place' and has the family home as its primary deployment domain.

In [18] 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]. A potential approach for the pairing of devices, e.g. mobile phone and situated display, is 'SyncTap' [16].

7. CONCLUDING REMARKS

In this paper we have introduced our current work on exploring the use of Bluetooth equipped mobile phones to support interaction with situated displays. In particular, the ability for users to both send pictures from their phone to the situated display and, more novel, to enable users to receive pictures from the display onto their phone. This initial study has been carried out as part of our work on the CASIDE project, which is exploring, as one of its key research questions, how networked displays in semi-wild settings influences and facilitates coordination and community? Our general approach is to produce prototype deployments and involve potential users at an early stage..

The primary aims and results of this initial study are as follows:

- An initial aim of the work was to ascertain the technical feasibility of the idea. Although, we experienced numerous challenges when implementing the system the technical feasibility of asynchronous send/receive of picture files between phones and 'standard' PCs has certainly been proven. Furthermore, we have made details descriptions of our technical solutions available on the web to encourage other groups to work in this, perhaps, under-explored area.

- In addition to technical feasibility, we also wanted to explore whether the interfaces on today's Bluetooth phones are appropriate for sending/receiving files to/from a situated display and what kind of simple user interfaces need to be developed on the display for supporting the send and receive functions. Our preliminary prototype and study certainly indicate that it is 'possible' to implement acceptable forms of interaction on current technology, but has also highlighted shortcomings.

- To gain an insight into the extent to which a sample of university graduate students would feel generally positive towards the notion of sending pictures to and receiving pictures from a situated display via their mobile phones. From the initial study we found that participants were positive about the approach and that the delays due to Bluetooth pairing and file transfer did not overly detract from the overall experience.

- To gain initial insights into the potential of this approach for supporting and fostering a sense of community. From the initial study we found that participants were generally positive about this notion and were forthcoming with locations were such displays could be situated around campus. Although, only providing an initial insight, the finding is certainly sufficient to encourage our group to continue development in this area.

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