Facilitating Opportunistic Interaction with Ambient Displays

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Abstract
Some public display systems provide information that is vital for people in their vicinity (such as departure times at airports and train stations) whereas other screens are more ambient (such as displays providing background information on exhibits in a museum). The question we are discussing in this paper is how to design interaction mechanisms for the latter, in particular how mobile phones can be used to enable opportunistic and leisurely interaction. We present results from an investigation into the use and perception of a public display in a café, and we derive some requirements for phone-based interaction with (ambient) public displays. Based on these requirements, we briefly evaluate three different interaction techniques.

Keywords
Public displays, mobile phones, ambient display, opportunistic interaction

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces – input devices and strategies, interaction styles

Introduction

In recent years, the number of dynamic displays that are installed in publicly accessible places has increased rapidly. Public displays nowadays routinely can be found in airports, transport hubs, shopping malls, museums and many large-scale public buildings such as universities. The vast majority of these systems are mainly broadcasting information of some relevance for the people moving in the environment in which these displays are installed, e.g. timetable information, advertisement or news headlines. We can roughly classify public displays in two categories according to their function in the context of the location where they are installed. Some displays fulfill a key function in the context of the tasks people perform while in a location. For example, a timetable display at a train station or a queue managing system in a large hospital provide vital information to visitors of either place, enabling them to decide where to go next and when. A different set of displays does also show relevant information but visitors to the locations of these displays do not *need* to know this information. For example, dynamic advertisement boards in a shopping mall or public screens displaying context information about exhibits in a museum can show relevant information (such as product offers or background information) but people can use the corresponding places without it. This type of public display is often referred to as an *ambient display*.

The topic of this paper is how to enable interaction with ambient displays using a mobile phone. We first briefly present related work before discussing a case study and interaction requirements for this class of systems. We then evaluate three different means of interaction against this initial set of requirements.

Related work

Interaction with public displays can be realized in different ways [11]. Widely used means include keyboards and pointing devices (mice, trackpads, trackballs) as well as touch-sensitive overlays [6]. Voice and gesture recognition [13] are further alternatives but rarely used for systems deployed in public places so far. Various kinds of sensors used in ubiquitous computing (e.g. passive infrared sensors, motion detectors or weight-sensitive floors) can enable interaction as well [12].

Another viable option to interact with public displays is the use of mobile phones. This kind of interaction can be realized in several different ways. A common approach is to establish a network connection between the screen and the phone (using, e.g., GSM, IR, Bluetooth or wireless LAN) to control the public display using some custom software on the phone [2]. The networking features of a mobile phone can also be 'misappropriated' to detect the presence of devices (e.g. by scanning for nearby devices with a network ID). Furthermore, it is possible to send text messages or images to the display via SMS/MMS [3][4][5]. Other approaches make use of the built-in camera that many mobile phones are equipped with. The camera can also be used to measure the optical flow resulting from moving the phone around in space, to present an augmented view of the public display or to track visual markers [1]. Finally, an external camera can enable interaction by tracking the mobile phone [8][10].

These approaches all have different properties in terms of what type of interaction they support (e.g. remote vs. co-present, asynchronous vs. synchronous), which we will explore in the context of a case study.

A case study

We have deployed an ambient display system in a café at the edge of Newcastle University and the Cultural Quarter of Newcastle upon Tyne, UK for about a year now. The system displays information relating to cultural events (such as plays, exhibitions or public lectures) and currently provides no means to interact with the content being shown (see Figure 1). During this time we have conducted a number of ethnographic user studies involving in-situ questionnaires, observational studies and two focus group sessions [6].

There are a number of key conclusions we can draw from these studies. In line with other studies [8], we found that people spend very little time looking at the actual display (in the order of a few seconds). Due to the setup of the display and the tables, some people will be unable to see the screen at all without turning their head. In terms of the content, most participants were in favor of the current design (a slow-paced slideshow of announcements about cultural events), which arguably blends in with the 'feel' of the place. Several subjects specifically rejected the idea of advertisements or sound output.

In the context of the study we also wanted to find out whether visitors of the café would want to interact with the content, and if so, how. In order to explore this, we generated several designs based around the idea of enabling visitors to the café to send text messages to the display. We varied both the layout integrating cultural content and viewer comments as well as the underlying theme (cultural events, art objects, 'question of the week').

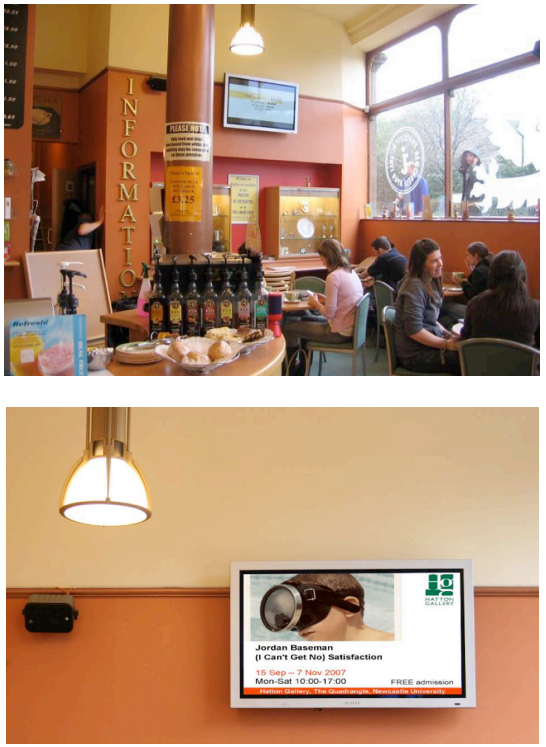

Figure 1. The ambient display in the café (top) and a close-up view of the information being displayed on it (bottom).

The comments we received were mixed. While some people completely rejected the idea of interacting with the system (e.g. as being inappropriate for the place), others welcomed it. A common concern was how content would be moderated (e.g. how to avoid that inappropriate or offensive messages would be displayed publicly).

Implications on interaction

One conclusion we can draw from the comments is that the means of interaction with an ambient display has to be *in line with the nature and use of the place*, where it is mounted. In the case of the café, audio-based interaction was clearly undesirable, as it would interfere with the regular use of the place. Similarly, interaction using gestures would be 'out of place' in a café.

A second concern relates to the briefness of use; people usually just glance at an ambient display for a few seconds. If something on the screen catches the eye of a viewer, that person is not likely to spend a lot of time interacting with the system as ambient displays usually only show information that is potentially relevant but not required. Hence, interaction should be possible *without delay* and *without configuration.* While this is desirable in the case of focal displays as well, it is more likely that users will put up with potential hurdles (such as having to download and install some software to enable their phone to interact with the display) if they have to use the display in order to fully make use of a place.

A third observation relates to moderation of user-contributed content. Since potentially inappropriate or offensive content was a key concern shared by most of the participants, a further desirable property for an interaction mechanism would be that it *promotes self-moderation.* For example, if users have to walk up to a display in order to interact with it (instead of controlling it from afar), it is immediately obvious who is responsible for a particular contribution, and thus subject to social protocols or peer pressure.

While further research into requirements for interaction with ambient displays is certainly necessary, our study provides some initial hints towards what properties might be desirable for an interaction mechanism.

Initial comparison of interaction techniques

In order to explore how well different interaction techniques meet the criteria for enabling interaction with an ambient display that we discussed in the previous section, we want to compare three example techniques that do not require any custom hardware/software in the context of a café scenario: SMS/texting, image-based communication via Bluetooth and an approach based on visual markers.

The idea of sending a text message (SMS) to a public display has been applied in a number of systems (e.g. [3]). The messages sent are either shown directly on the screen or parsed for commands/keywords that trigger certain functions (e.g. voting by texting the number of the preferred option to the screen).

The Bluetooth-based mechanism realized in the BlueVote system [2] relies on images, which are sent over a network connection[1]. The system pushes images (containing descriptions of choices, e.g. different options to vote on) to all mobile phones in range that have a Bluetooth receiver. Users can either reject or accept these images, and cast a vote by sending back one of the images they received from the system.

[1] Although there is no technical reason preventing the sending of text over a Bluetooth connection, mobile phone carrier are not exactly keen to provide this service (as it might cut into their SMS business).

In [9] we presented an approach based on the idea of purely visual communication. Users can take photographs of visual markers shown on or near a public screen that correspond to the functions available for this display (e.g. a spray can to paint on the screen). The public screen is in the field of view of a camera that tracks these visual markers, so when a user displays one of them on the screen of their phone the system can track the location and orientation of the phone.

Looking at the first criterion of *being in line with the nature and use of a place*, both the texting approach and the Bluetooth based interaction would be appropriate. The latter is virtually undistinguishable from the former when observed by a third party, and attending to one's phone is common activity in a café such as the one we explored. Using visual markers in the way described above however requires people to stand (and gesture) in front of the display. Even if the screen was not mounted high on the wall, interacting in such a way would likely disturb/distract others and thus potentially interfere with the use of the place.

The second desirable property we identified relates to an interaction technique requiring *no start-up time or configuration*. Interaction through text messages scores high on both parts (provided the user is in range of the GSM network): as a core function of a mobile phone is readily accessible and does not require any configuration. The BlueVote interaction mechanism is slightly more problematic in this respect: while receiving files from a system is usually very easy (provided Bluetooth is turned on), sending files back can be tricky and may require configuration (security setting, locating, identifying and selecting receiver). The marker-based system scores well in this category: taking a photograph and showing it on the display of the phone is usually straightforward on a camera-equipped mobile phone.

The third criterion we identified was the promotion of self-moderation. One way to achieve this is by exposing to the co-present people who is actually interacting with a system (e.g. who is contributing a particular piece of content). Both texting and Bluetooth based interaction do not inherently support this (as it is not clear to an observer whether a person is actually interacting with the public display or just sending a text message to a friend). While the public screen could display the phone number (or phone name/network address of the phone) of whoever sent in a message, this also raises privacy concerns. The marker-based interaction technique, by requiring people to interact while standing in front of the screen, ensures that it is obvious to other co-present people who is responsible for a particular piece of content.

Conclusion

In this paper we discussed interaction with ambient displays, in particular what properties are desirable for interaction techniques to be used in such a context. While our results are preliminary and further in-depth studies are certainly needed, some of them may provide some initial guidelines for the design of mobile phone-public display interaction. We will continue to investigate these issues by deploying an interactive system in the café that will use SMS as the means of interaction.

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