Utilizing Mobile Phones as Ambient Information Displays

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Abstract

Mobile phones have become a ubiquitous technology and for many people a daily companion, primarily used for communication and information access. The fact that the phone is accompanying the user makes it an interesting platform for building applications that utilize the phone as an ambient display. We explore the domain of ambient displays and persuasive technology with regard to communication. In this paper we first analyse the technical capabilities of mobile phones that can support the collection of information. Then we present designs of how the screen saver on a phone can raise users' awareness of their personal communication behaviour.

Keywords

Mobile phones, ambient displays, information art.

ACM Classification Keywords

H5.2. User Interfaces, D2.2 Design Tools and Techniques, H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

In many parts of Asia, Europe, and America mobile phones are used commonly in daily life to communicate, coordinate and to access information.

The majority of people in these areas are having a phone with them at most of the times. If they do not carry the device on the body then it is in close reach. Due to the usage in various different kinds of situations, mobile phones function as probes of the users' everyday life environments. Mobile phones contain communication logs of messages and calls, as well as user created content, such as calendar notes and photographs. These features make a mobile phone a versatile storage of user's personal data.

Mobile phone usage has created cultural trends of its own, especially among teenagers [6]. Numerous ways for personalizing the phone relates this phenomenon. Choice of the model, changeable covers, ringing tones and wallpaper selections are commonly regarded to show personal preferences or as part of the image the user wants to reflect.

Interaction with the phone and through the phone reveals and reflects on the user's behaviour. Although mobile phones are commonly used in public, they are perceived as very personal items [3]. The users do not tend to reveal the personal information the phone contains to others, and privacy related to this data is highly valued. With regard to younger users (teenagers) initial interviews reveal that communication meta-information is regarded as very private information. And sharing of this information requires trust. Typical examples of such information are:

- Number of SMS receive from a certain person?
- Who did call you recently?
- Whom did you call recently?

Such information is of interest to the user and showing it on the screen saver is an option. However, as the information is very personal, it is not appropriate to visualize it in a way that is obvious to everybody. This was the initial rational to investigate the concept of ambient information visualization [4,9] further.

Visualization of information related to communication can help to increase the user's awareness and hence make it a persuasive technology to push for a certain behaviour [2]. If a user decides that communication with her parents is important, ambient visualization can become a central means providing this awareness.

Even so smart phones offer a variety of additional applications reaching from address books to video play-back, their potential as platform as ambient information display and as persuasive technology has not yet been utilized. Nonetheless, they offer a potential platform for such applications by offering various kinds information for input data, sufficient computing power and display technologies, and existing personalization culture.

Previous research has introduced information art concentrating on public spaces and large physical elements [7]. An example of personal information art is an ambient display, which shows status of user-defined information, e.g. traffic or temperature measures, as arbitrary elements on a wall display [9]. Information visualization for large audiences has been demonstrated e.g. in IN-Visible system, where ambient presentation of subway information is displayed in public urban spaces [1]. Utilizing personal mobile devices has so far not been considered as platform for information art.

In this paper we introduce how mobile phones can be used for presenting personal information in ambient manner by creating information art. We present design cases, which utilize communication patterns as input.

Using the Mobile Phone as Sensor for Persuasive Technologies

Current mobile phones contain a lot of information that can be used as input data for persuasive technologies. Considering the use of mobile devices and research that assessed the inclusion of sensors into the phone [8] there are the following parameter that can be become a source of information for persuasive applications: activity with the device (e.g. calling, messages), user location (e.g. based on cellular-id or GPS information) and co-location (e.g. proximity to other devices) and physical activity (e.g. sitting, running).

In this paper we concentrate of information that is available in existing phones in the mass market. The focus of the design cases is on the communication meta-information (e.g. number of calls send and received, number of messages sent and received, communication with a certain person).

Communication Behavior

Meta-data on communication is typically available on the phone in a list showing recent calls, missed calls and calls received. Similarly can the information about sending and receiving messages be extracted from the sent folder and in inbox of SMS and MMS. Additionally, many service providers make the information about calls made and received available in the form of itemized bills which can be downloaded from the users account with the provider. Such itemized bills usually include further information, such as duration of the call

and cost of the call. For the designs presented in the later section we assume access to this information. For prototyping meta-data on communication can be traced either from the phone of by accessing the online itemized bill. For a deployment of such a concept in the large we would expect that one model is that the service provider offers such a screen saver as additional service (and basically selling the itemized bill in a different visual appearance).

It can be assumed, that the communication patterns represent information which the user him/herself is interested in for both for affective and practical reasons, but which is also considered to be private as outlined before. Communication logs reveal information not only about who are the people regularly contacted, but also how communication patterns (frequency, duration, content length) to a certain person change over time. Thus, communication logs offer a potential information source for information art presented in ambient manner. To explore the possibilities we constructed a design exercise with about 50 students in an HCI class which is reported in the later section.

User Location and Activity

The phone can provide information about the user's location in the physical world. Depending on the technology used the location information is available with a different level of detail. All mobile phones, when operational for communication, have the information which base station they are connected to. This can provide a location cue. Not all systems do reveal this information to the programmer. Phyton for Nokia Series 60 provides the cell-ID and JAVA J2ME specifies an API (still not supported on many phones). The cell-id information, even so it is coarse, can in most cases

Figure 1: Solar System.

Figure 2: Aquarium.

provide meaningful information, e.g. the cell-id for the user's home differs most often from the cell-id of the workplace. Moving between places can be detected by monitoring changes in the cell-id and signal strength. Storing the history of visited cell-id and the frequency and duration of visits provides a basis for reasoning about the user's behaviour. Using more advanced reasoning on a set of more cell-ids in the vicinity can provide a more precise location, as demonstrated in [5]. Different phone models also include GPS which can give higher resolution location in outdoor setting.

Co-location offer information about encounters with mobile units (other users) and stationery objects (equipment in the office). This can be detected by using short range communication technologies, such as Bluetooth or WiFI. Encounters offer information of fine grain location and persons met. Co-location information can be used e.g. for tracking social patterns and places where people meet.

Physical activity can be detected with device integrated accelerometers. Several phone models also have ability to measure environment temperature and noise level.

Design Exploration of Ambient Displays using Mobile Phones

Using communication logs as the basic data we started to explore potential designs for ambient information displays. We assumed in this design phase that the information that is typically present in a itemized bill (all calls made with time and cost associated, all messaged sent and cost related) as well as information about incoming calls (as in the call lists of the phone) is available.

After a number of initial informal interviews with potential users and developers of mobile phone applications we decided to prototype the concept. To investigate the potential design space we gave 13 teams of 3 to 5 people each the task of designing a screen saver and a setup screen for the given task. The participants were mainly students of computer science and media informatics at the University of Munich in Germany. In a time frame of about 3 weeks they were expected to create sketches and a functional prototype (on a PC) of their concept. Requirements were that the visualization can be customized and has the properties of an ambient display.

Personal feelings, emotional situations (such as happiness or problems) and ongoing activities reflect on our communication behaviour. The task was that the application enhances the users ability to follow the overall communication activities, keep track of the frequency and intensity of the communications with different people. Again, the changes over periods of time and other ideas can be included into the designs.

The teams were free to include additional elements as parts of the visual design. The temporal resolution, e.g. communication happening daily or weekly, may be incorporated in visualization colours, shapes, or other details. The deviations in the visualization show the changes over time, e.g. when current visualization is compared to the one in last week or last month.

Design Cases on Ambient Visualization of Communication Behaviour

To document the intermediate results we selected four example designs that provide peripheral awareness for the personal communication pattern. Those examples

Figure 3: Circles.

Figure 4: Flowers.

are suited to show the potential design space and the options available for the ambient visualization of personal communications behaviour on a mobile phone. Screenshots of the introduced designs are presented in Figure 1-4. The animated designs of the prototypes are available on our website, see http://www.hcilab.org/ambientphone/.

Case A: Solar system

This prototype uses the solar system to visualize the information, see Figure 1. The planets are all constantly moving around the sun (the center). In the initial prototype each planet represents one communication partner. The size and velocity of the planet reflect the communication events. The bigger the planets the more messages exchanged, and the faster the planet moves, the more call conversations have taken place with the person. In the set-up screen of this prototype contacts can be assigned to planets. E.g. one can assign her best friend Max to the Earth and her grandma to Mars. The communication behavior with these people is then reflected by these components in the visualization.

This visualization offers further parameters that could be used to map information, e.g. activity of background stars, rotation of planets, or appearance of comets. During the discussion of the result one idea was to add a comet automatically to the visualization if there is a lot of communication a new person. The user would then be able to look up in the set-up screen who this is, and potentially map this new contact to a planet.

Case B: Aquarium

The aquarium prototype reuses a common screen saver scheme. In this case each chosen communication partner is represented by a fish, see

Figure 2. The fish are animated. In this prototype the size of the fish reflects the money the user spend on communication with this person; the bigger the fish the more money was spend in communication with this person. The speed of the fish is related to the time since the last call. If the fish is very slow there was no communication for a long time. The direction on the fish visualizes the direction of the initiation of calls. If the fish swims from left to right you call more often that you are called by this person.

Options available to convey further parameters are bubbles from the mouth of a fish, the animation of the mouth of the fish, and plants in the water.

More design examples

In Figure 3 an abstract representation is used. Each circle (distinguished by color) is a person and the size and speed of the circle represents communication meta-information with this person. Likewise each circle can be used to represent one call. The color links it to a person and the size shows to the duration of the call.

The flowers in Figure 4 are similar to the fish in the aquarium. In the basic version only the size of the flower is used and it represents the communication activity over the last weeks with the associate person. In the setup a contact can be assigned to a flower.

Next Steps

Creating a large number of prototypes by a diverse group of people proofed a very effective way for generating ideas and to assess the design space for this type of application. The designs shown are prototypes implemented in Macromedia Flash MX and Java running on a PC. The implementation of prototypes for use on

the phones is currently under development. Additional studies on the topic have been designed and will be carried out in near future. Our interest is in particular on how users want to customize their personal system (e.g. what options for association between contacts and visualization are preferred). The other area under investigation is the privacy requirements for the visualization. In particular, we will look at what level of abstraction in the ambient visualization is appropriate to allow the users of the phone to be aware of the parameters without making it too easy to guess for others.

Conclusions

Mobile phones are a widely deployed platform and for many people a central instrument for communication. We have experience that using the phone's screen for conveying information of interest to the user in an ambient way is feasible and interesting. Our initial designs show that especially the phone as a mobile companion can become a meaningful ambient display and potentially a platform for further persuasive technologies.

The usage model of mobile phones makes them suitable to be used as ambient display. The personalisation culture (currently mainly background images and ring tones) invites further investigation of means for personalisation. The design example shown in this paper maps a design space for novel services where information of interest to the users is visualized.

Acknowledgements

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