Embedded Information

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Abstract. Observing mobile phone information push services it appears that endless information is available. Users can subscribe to many different messaging services. However, much of the information is interesting only in a very specific context of use. We investigate how information can be provided to users – exactly when it is needed. Our approach is based on a variety of information displays unobtrusively embedded into the user's environment. We place the information displays in context. In contrast to the traditional approach on context-awareness where a context is recognized and then the appropriate information is delivered we look at providing information already in context.

1 Introduction

Potentially everyone has access to enormous amounts of information nowadays. Much of the information available is however meaningless to a specific user at most times. A person driving in Munich city centre has most probably very little interest in information about traffic jams on the motorway around London. Location and context aware presentation of information is regarded as a general way to tackle this problem [1]. In this area much research is aimed at mobile devices. Different products are available for mobile phones. Here the context is estimated based on sensed information (e.g. the cell-location). A basic problem remains – all these contextual information services share a single device on which they are delivered and they require potentially user interaction – even if the information is not of interest to the user. Recognizing the context and delivering the right information at the right time in the right place is still a difficult problem. And it seems that people are easily annoyed if they get the 'wrong' information pushed to there phone.

We suggest a different approach for contextual information delivery. Instead of detecting the context we place the information – by the choice of the information display - in context. The assumption is that in future we can afford environments where there is a massive over-provision of displays. Displays are regarded as very specific information appliances [2]. We want to investigate environments where a large number of displays are distributed and casually available to the user. Our first step is to provide additional information at decision points (e.g. what should I wear, do I go by bike or by car, should I take the umbrella or not) that help to make a more informed decision.

Using a scenario we first introduce the basic idea of embedding information. Using the specific example of weather information we outline potential devices and use

cases. We then discuss a set of basic design criteria for embedding information. In a further section we show our current developments and discuss our plans for a planned study.

2 Scenario

In the following scenario the envisioned concept of embedding information is outlined. This scenario is also the basis for our prototype. For the prototype we concentrate on a limited number of embedded displays.

> *Mary is working at an insurance company in Munich. She lives out of town and commutes by public transport. She often spends the evening after work in town and meets with friends. It is a day in August.*
>
> *When she gets up in the morning the display on the wardrobe shows that the temperatures today will be pretty high and that she has a formal meeting with a customer in the afternoon. Mary chooses appropriate clothes for the day and dresses. The shelf where she keeps here bathing costume is illuminated. She decides to take things for swimming with her – perhaps there is a chance to meet with her friend Anne and go for a swim after work. In the bathroom, the shelf where the sun cream is kept also is illuminated but she thinks she will not need it today. On her way out Mary sees that the umbrella stand is slowly flashing – indicating that there is a low probability of rain. She thinks to herself perhaps there is a thunderstorm in the afternoon and takes the umbrella with her.*

The scenario above illustrates several instances where information is embedded at places where decisions are made. It is not tried to detect the awareness of the user. There are no actions taken to draw the attention of the user to the information device. The displays are unobtrusively integrated in the environment.

3. Embedding Weather Information

There are various sources of real-time information on the internet providing information on many different topics. Similarly information push services are available for mobile phone. In our current research we concentrate on weather information and how to embed this information into the environment of a user.

The following examples outline how weather related information can be integrated into objects and places.

3.1 Temperature forecast for one day

The temperature forecast over a single day is currently very precise and can be obtained on a town by town level. People use the information about the expected outside

temperature when they chose clothing, for planning activities, or deciding on the means of transport they are using.

Typical objects and environments where this information can be embedded into are places where decisions are made that relate to dressing and leaving the home. The following examples illustrate this:

- **Wardrobe Display**
  Information about the weather helps to decide what to wear. If the users knows already what to wear he or she can easily ignore the information without effort.

- **Shelf Display**
  Displays to highlight shelf space and objects in the shelf can suggest the user to take things for specific activities or in particular circumstance. E.g. if it is going to be hot, the shelf with the bathing costume is highlighted and if it is really cold the shelf with the gloves and scarf is highlighted.

- **Key Display**
  Integrated in a key or a key chain can be temperature information that indicates dangerous driving conditions, e.g. below 0°C.

3.2 Probability of rain

For many areas information about the probability of rain is available. This information is not as precise as the temperature forecast but gives a good indication whether or not one has to expect rain. Similarly, people use this information when they decide on dressing accessories as well as on the means of transport.

The following objects demonstrate potential objects in which this information can be embedded.

- **Umbrella Stand Display**
  A display on the umbrella stand that visualizes the probability of rain during the day can help the user decide whether or not to take an umbrella. We envision a visualization that gets more explicit the higher the probability of rain is.

- **Key Table Display**
  Providing the information of rain probability on the key table can help the user to make the decision what means of transport to take. E.g. when instantly recognizing that the rain probably is close to 0 the user may take the bike instead of the car.

3.3 Sun intensity

In many areas the information about sun intensity and expected sun intensity is available. Especially when preparing for outdoor activities this information is relevant to decide on sun protection. Here a mechanism similar to the shelf display can be used.

4. Design Criteria for Embedding Information

When embedding information, the possibilities and opportunities seem endless. In contrast to a single mobile device that delivers information always to the person we deliver information always into a context. The basic principle behind our approach is over-provision of information displays. The following design criteria are central when embedding information.

- Embedding information **where and when it is useful**
  It is central to provide the information so that the user can benefit from it. Usually information is embedded at points where decisions are made or where the user has choices. The information provided should increase the user's ability to make an informed choice.

- Embedding information **in a most unobtrusive way**
  The information provided should not be forced onto the user. If it is possible, it should be embedded in such a way giving the user the right clue but in a way not to become an annoyance. Concepts of ambient media [3] and calm technology [4] are seen as a basis.

- Providing information in a way that there **is no interaction required**
  It is essential that there is no action required from the user when information is provided. This requires dedicated information displays that are only used for providing a specific type of information.

5. Prototyping Embedded Information and Towards a Study

At the moment we are building different prototypes of embedded information displays. We are in particular interested to use technologies that would be extremely cheap, especially in larger quantities. Therefore we limit ourselves to wireless display modules with little processing power (PIC18F452 Microcontroller), small wireless network bandwidth (about 19200 kbit/s), and a variety of displays ranging from simple indicators (LEDs) to small graphical LCDs (96x48 pixel), see figure 1 for some examples. The prototypes of the wireless display units are built on top of the Smart-Its platform [5]. We deliberately chose not to use PDAs (or disguised PDAs) as we anticipate, in the long term, systems with hundreds of displays and we want to explore what minimal displays are useful for.

We are currently working on the following specific displays:

- Wardrobe Information Display
  The wardrobe information display is a wireless LCD display. It is a graphical I2C-display connected to a Smart-Its module. It can be used to display short texts and small graphics.

- Shelf illumination display
  This is a simple display that can draw the user's attention to a specific location in an unobtrusive way. It consists of a Smart-It with LEDs connected. It can be used as binary display or to display a level (percentage).

- Umbrella stand display
  The umbrella stand display is very specific for visualizing the rain probability in context. Here we experimenting with using different LED colors and patterns to be unobtrusive and still able to catch the user's attention.

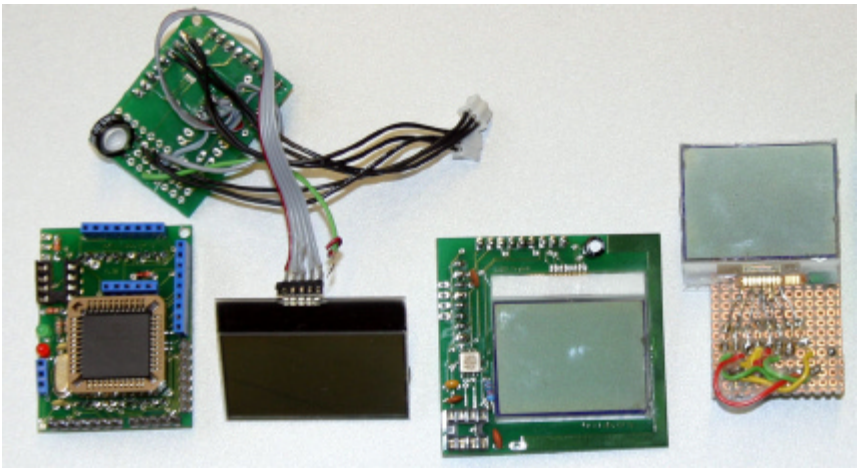

Figure 1: Low cost graphical LCD-displays connected to Smart-Its hardware as basis for experimental cheap wireless displays environments.

A further concern with a large number of distributed displays is that they have to be maintained or at least supplied with energy. Our designs here – even at prototype stage - take this into account and we look how to create information displays with minimal power consumption. A first and important step to achieve this is to recognize activity in the physical vicinity of the display. For this we include cheap sensors that detect the presence of people (e.g. Passive IR, Light, distance).

The general architecture we assume is that the displays are receivers and that there are one or more senders that provide information. The displays select from the provided information that is broadcasted the information they are designed to displays.

The system setup we will use in the first prototypical implementation and for deployment to the users in our study is depicted in figure 2. A notebook-computer will

be connected via a DSL-modem to the internet and retrieve information from web pages and from our database. Connected to the notebook-computer is a Smart-It that broadcasts the information wirelessly. Each display consists of a Smart-It that has a display unit attached. The displays receive the messages broadcasted and select the information that is of interest to this particular display.

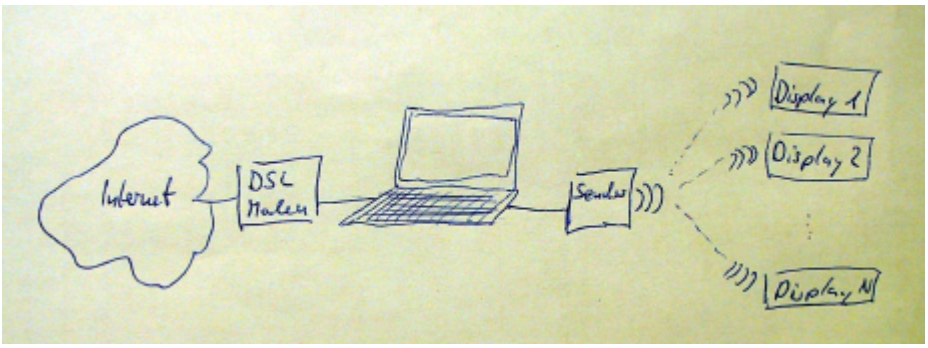

Figure 2: The general system setup for our prototypical test installation. Information is retrieved by notebook computer and broadcasted to the local set of displays wirelessly.

After completing the system and extensive tests we plan a 2 to 4 week study in people's homes investigating the potential of embedded information. We want to compare embedded information to information that is pushed to a mobile device using SMS/MMS. In particular we are interest in:

- Where and how do people want information to be embedded?
- How well informed are people when using embedded information?
  How do people rate the added value of such a system?
  How annoying do they find embedded information compared to pushed information?

6. Conclusions

We suggest the idea of embedding information as a form of achieving contextual information delivery. In this paper we have presented our initial idea of putting information in context and we outlined the basic principles of embedded information displays – embedding information where and when it is useful, in an unobtrusive way, and in a form that no user interaction is required.

Currently we are developing hardware and software that will be used in a user study in people's homes. We hope to get new insights on how to make useful embedded information displays from this study.

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