Supporting Access to Museum Information for Mobile Visitors

Carmine Ciavarella, Fabio Paternò

ISTI-CNR
Via G.Moruzzi, 1 – 56100 Pisa - Italy
{c.ciavarella, f.paterno}@cnuce.cnr.it

Abstract
A number of applications can benefit from the use of mobile devices. An example is the museum application domain where a wide variety of users want to access information regarding the works of art while freely moving about. In this paper we discuss the possible design choices when developing interactive mobile applications supporting this type of user and show which have been adopted in a specific case study and why.

1 Introduction
Nowadays mobile devices have powerful computing capabilities. This opens up new scenarios in which users can interact with them in many environments. Intelligent devices can be located anywhere to support users in their daily activities and accompany them in their movements.
The new services enabled by this technological evolution should take into account user movements and, consequently, the change of the application context of use (see for example, (Butz, Baus, & Kruger, 2000), and (Cheverst, Davies, Mitchell, Friday & Efstratiou, 2000)). By context of use, we mean not only the surrounding environment, but also the available interaction devices and the tasks that the user intends to accomplish. Knowledge of the context of use is fundamental to designing usable services. In this paper we discuss the design of a location-aware, context dependent museum application. Most of the solutions adopted can be applied in other context-dependent in-door applications where the user position cannot be tracked through GPS or similar technologies.
Several researchers have considered the museum domain. It is characterised by mobile users without a precise goal and with the need of information dependent on the current context. In our case we have addressed this problem and then experimented the results in a real museum (the Marble Museum), which also provides us with the opportunity to receive feedback from real users. We have developed a new version of an interactive mobile application where in designing how to provide users with access to the museum information we have also considered the issues related to the user location. A number of projects have been carried out to address such issues. The aim of GUIDE (Cheverst, Davies, Mitchell, Friday & Efstratiou, 2000) is to investigate the provision of context-sensitive mobile multimedia support for city visitors. It is based on the wireless networks, located in Lancaster: information about positioning is transmitted from strategically positioned base stations. This system applies out-door technologies that cannot be proposed for in-door environments like museums.
Museums are an interesting application domain for interactive mobile devices. Museum visitors can be assisted in various manners. One possibility is the use of audio guides: visitors can use a vocal output device. They can select the work of interest by entering its code through a numeric keypad. Audio guides are precursors of electronic guides. They are useful but do not support the visual channel. Using devices, like PDAs, that support both audio description and images, can solve this problem. In addition, another issue can be addressed: user orientation. One approach is

suggested by the IrReal project (Butz, Baus, and Kruger, 2000): they have built a navigation system using infrared transmitters. These transmitters, placed at strategically important points throughout a building, are useful to provide directions or other localised dynamic information stored in computers linked to them. This approach is not wholly suitable for museums where visitors have specific requirements. Also, this solution is expensive and difficult to install because of the need for a computer for each beacon.

In location-aware systems the information regarding works or sections is selected depending on the user's position and length of stay in that position. This information is used to understand what the user's interests are. This approach has been used for the Hippie system (Oppermann & Specht, 2000) within the HIPS project. The authors have also considered how to effectively present information to the user while taking into account the user model (interests and preferences of users). This project also addresses the problem of how to adapt the user interface to the user model. The model can be modified either directly by the user at the beginning of the session or by the system's taking into account the history of user interactions and the choices performed by the user. The suggested information can be accessed through links to the descriptions of the works that best correspond to the current user model. When accepted the suggestions are used to update the user model. One potential limitation of this approach is that often the user's position alone is not enough to indicate interest in the closest work of art; external reasons, such as a crowd preventing movements, can be the reason for a user's stopping. Thus, the risk is that the system wrongly identifies the user interests and determines the corresponding user model.

One solution to such limitations of location-aware systems has been proposed for visiting "Filoli", a Georgian Revival house (Aoki & Woodruff, 2000). In this case the application provides the users with an image of the current room with the works of interest highlighted by red borders. Then, the user can select the object of interest with a pen, which activates an audio comment or a video. It is possible to change the viewpoint of the room's representation by selecting one of the device's buttons. In this case, one possible limitation is the use of pictures to represent the room content duplicating the information that the user is already seeing, with the risk of requiring multiple interactions to identify the selectable elements of interest. In addition, this solution is valid only for those museums where the elements of interest are arranged along each wall, while it becomes difficult to follow in cases where they are spread throughout the room.

In the next section we discuss about the solutions adopted in our case to better support the user during the museum visit.

2 The Design of the Context-dependent Support

In this section we focus our discussion on how we have chosen to determine the user location, and how we take into account the context in which the interaction takes place and the techniques used to support user orientation.

2.1 Location-awareness

The identification of the user position in an in-door environment can be performed at two different levels of granularity: one is the possibility of identifying the exact position, thus, in the case of a museum, the system can identify the closest work of art; in the other case the system is able to identify in which room of the building the user is located. The first case can be useful to try to identify what works of art are more interesting for the user based on the assumption that the duration of the time when the user is close to a work of art is proportional to the interest for it. However, this can be a wrong hypothesis because there may be many reasons why a user stops somewhere (it could be because of other visitors or some obstacles). Thus, wrong deductions may negatively influence the application in determining the user interests. This is one of the reasons for our choice of the second criterion.

In order to determine the user position we have installed infrareds emitters at each ingress to a new room (see an example in Figure 1). Such emitters have been made ad hoc for our application. They transmit a unique identifier through IrDA protocol. When the user gets in a new room the emitters sends the identifier to the PDA, then the application detects it and changes presentation accordingly.

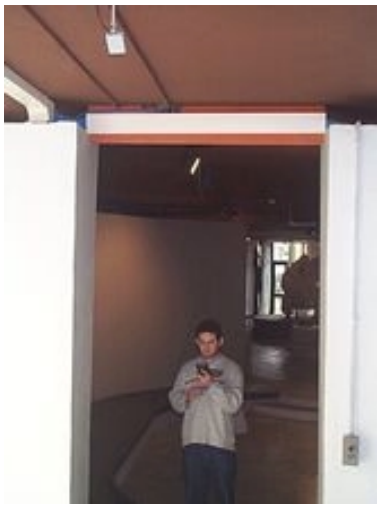

Figure 1: The Context of Use in the Application**.**

The angle covered by the infrared emitter is 90°. The signal transmitted by the emitter is composed of eight characters. Initially we used only three characters, thus the string sent by the emitters had the following type '001@@@@@'. However, after first experiments we realised that this solution needed to be improved because the infrareds can bounce over surfaces: if the signal that reaches the infrared port of the PDA do not respect the spectrum of the IrDA protocol then they can be interpreted wrongly: we can obtain three character strings with wrong content because the identifier provided is different from that associated to the room where the user is entering. Thus, we have extended the string transmitted by the emitters by adding three characters that are used as they were "parity bits". The algorithm is simple: each number is associated with an alphabetical character: "0" is associated with "A", "1" is associated with "B", etc. Each time a new string is detected, the application checks that the part of the string composed of numerical characters corresponds to that composed of alphabetical characters. For example a legal string is "001AAB@@". Thus, the application can correctly determine the room where the user is entered. The emitters are realised by stand-alone technology: they are made in such a way to transmit a signal (composed of eight characters) per second. They only need the power to work. Thus, our system is quite easy to install.

2.2 Context-dependency

The application provides information regarding the works of art in the museum taking into account the user position for this purpose. In the user interface we have introduced elements that support the access to the information and elements that support the user orientation. When the user accesses a new section, then the surrounding environment changes. This event is explicitly highlighted by the application to the user.

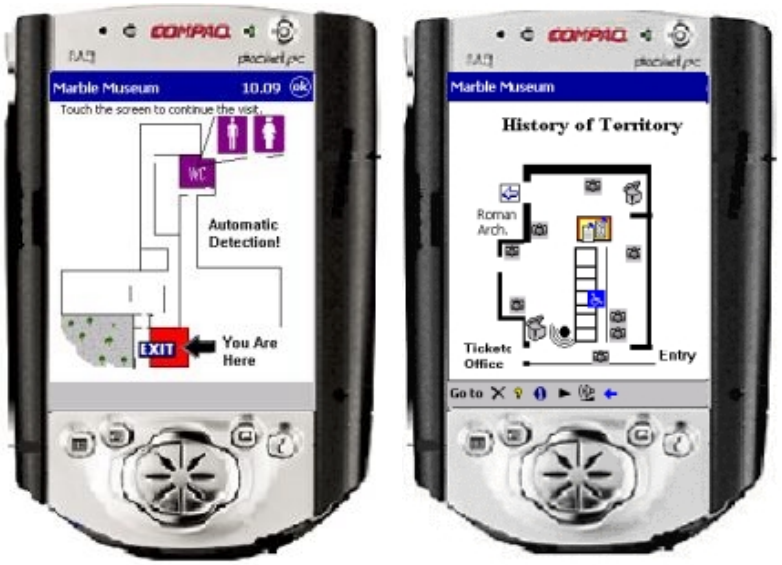

Figure 2: Automatic detection of the user position**.**

When entering in a new section is detected, the application shows where it is located in the museum map (see for example, Figure 2, left part) and generates a specific sound highlighting the event in order to attract the user attention. Then, as soon as the screen is touched the section map is shown (see for example, Figure 2, right part). It indicates the position of the works of art in the map. Different types of icons are used in order to indicate the types of works located in the room, in addition to their position. Indeed in the museum several types of works are contained, thus different icons have been used to represent each of them. An alternative solution would have been to include the pictures of the works itself. However, the limited resolution of the PDA (240x320) makes this solution impossible.

To ease user orientation in the museum some specific design choices have been made. The first one is to orient the section maps on the PDA screen in such a way to reflect the same view as when the visitor enters physically in them. In addition, some reference points are highlighted in the map: way in, way out and location of the infrared emitters. In addition to such reference points, we have introduced some techniques that allow users to navigate in the application and access information of interest. In particular, the user can access general information regarding the museum and the thematic sections through specific commands. We have also introduced the possibility of going back to the last previous presentation accessed through a back button similar to that provided by Web browsers.

The actual design of our system is the result of the evaluation test that took place in Marble Museum of Carrara last year. It involved 95 users: they filled a questionnaire, answering questions about various aspects of the application (Ciavarella & Paternò, 2002).

2.3 Information presentation

We have identified three information levels to support. For each of them the information is provided in a specific manner:

- *Museum level*, this is the most general level, overall information is provided, including its history.

- *Section/subsection level*, information specific to the current section is provided. Such information can be useful to prepare the user regarding what can be found in the current section/subsection in order to better decide whether or not to visit it and how long. The biggest sections have been divided into subsections in order to provide a more refined description of their content.
- *Work level*, at this level the specific information regarding a work of art is provided, including those regarding the author, when available, the production year and the material. The next figure is an example of an artwork presentation.

In presenting the information the multimedia features of the PDA have been exploited: colour screen, audio file, videos allows the application to provide multimedia information implemented in standard formats without loosing resolution and saving memory space. The audio presentations (in Italian and English) are pre-recorded MP3 audio files. Each work is presented through a 140x140 Jpeg picture and a number of MPEG videos provide information related to the content of the museum but not visible in the museum (for example, historical videos or videos showing how marble quarrying is currently performed).

3 Conclusions

The increasing availability of mobile devices with powerful capabilities enables new use scenarios characterised by moving users needing access to information relevant to what he can currently observe. The museum field is characterised by visitors who freely move needing context-dependent information without a precisely defined goal. Thus, there is a need for context-dependent information, which should be provided without disorienting the user.

We have presented a work where an interactive system has been designed in order to support mobile visitors while accessing museum information. It exploits the multimedia capabilities of the PDA platform available (Ipaq Compaq with 1 Gigabyte flash memory) and uses specific infrared emitters to identify the room where the user is located. Thus, we have obtained a low-cost and easy to install solution that can be adopted in other similar applications. It has recently been made available for all the Marble Museum visitors. We plan to gather user feedback through a new round of questionnaires and interviews.

4 References

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