A MOBILE SOFTWARE DEVELOPED FOR ART MUSEUMS: CONCEPTUAL MODEL AND ARCHITECTURE

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Abstract: Mobile devices as smart phones or PDA are common devices in our daily life. Museums and art galleries are provided with some electronic guides in order to do more pleasant the visit to the exhibition. Our research group has been working in designing and developing mobile software for art museums based on PDA. The problem studied in this paper is to prove the suitableness of using PDA instead of the traditional electronic guides. It is interesting to know how to use these devices as a medium to guide and improve the visitors' experience. Before presenting the components of our solution we introduce the important items and concepts by means of our conceptual model.

1 INTRODUCTION

Museums used to offer visitors some mediums to guide and enjoy the visit. These electronic guides are an item with audio facilities in several languages. It permits users to be informed about pieces of the museum even in several languages.

In this paper we suggest a new way of interaction instead of using old communication systems, but new technology. Then, we thought about a system in which people could interact in many ways. The system we have developed is completely available to visitors, who can rent a pocket computer (PDA) in the museum (Gallud, 2005), the Museum of Cutlery of Albacete (Spain).

The system running in the museum can manage its visits, public news and events in its Web page, to provide restricted information for determined expert people, to sell items on-line. Pieces can be managed and catalogued with multimedia information (audio, video, image, text…) and displayed in portable devices such as PDA's or tablet PC's with portability warranty in the applications.

A first task before designing the system is the definition of the conceptual model of a museum. What are the items we should consider common to all museums? How do we can define a scalable and modular system?

The paper follows describing in section 2 some of the most relevant previous works in this field. Section 3 introduces our proposal about the conceptual model of a museum. Section 4 shows the definition of our first system and the evolution to the today's system is showed in section 5. Finally, the conclusions and future work is presented in section 6.

2 ART AND TECHNOLOGY

The application of new technologies in museums is not a new topic. There are several experiences that work in real cases with success. Technology is used to provide visitors with the ability of interacting with the museum. In a typical scenario, the visitor can use his or her sense of touch (hearing and sight) to learn about the subject of the exhibition. Multimedia devices, 3D sound, DVD and other systems are employed to do people enjoy in the museum.

In this project we focused on the use of pocket computers (PDA) as a powerful tool to help visitors in their visit to the museum. The challenge was to find out if our system be a new barrier or a helpful tool in the museum, if the PDA technology would be useful to artist and their work of arts, if there are reasons for museums to avoid adopting new advanced technology. They are not questions easy to

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answer reading former works, so we decided to define our conclusions building a complete system.

Before beginning our project we should take a look to previous works. There are several former projects that have tried to use wearable computers in museums. One of the most important references in this subject is the work developed by Ciavarella and Paternò (Ciavarella 2003 and 2004) in the Marble Museum of Carrara (Italy). This project is currently working and offers to users a PDA with all the information preloaded by means of memory cards. The PDA is able to detect when the user is entering in a new room thanks to infrared devices located at the beginning of each room.

Other Museums have already developed projects based on handled devices (Steele, 2002), as the Field Museum in Chicago, Herbert F. Johnson Museum of Art of New York or Kew Gardens outside London. Most of them use handled devices as a useful tool in the inventory process (see references). These projects are all prototypes and normal visitors do not use any PDA.

The exhibitions are ideal scenarios for applying augmented reality or mixed reality. There are many HCI groups working in this area, as the work of Ciolfi (Ciolfi et al, 2002) where an interactive museum exhibit is designed using or the work performed by Bernt Schiele (Schiele et al, 2001) where a wearable computer is developed as an alternative to the traditional guides.

3 CONCEPTUAL MODELING OF A MUSEUM

One of the first tasks relating the design of mobile software for museums is to define the conceptual model.

In this section we try to answer the question "what is a museum?" We would like to combine the most general and abstract view together with the particular case of the Cutlery Museum of Albacete.

We think a museum is conceptually composed by, at least, two types of information:

- Catalogue information
- Environmental information

Catalogue information is related to museum registry. Information is stored according to defined structures and procedures that museums should follow to accomplish international standards (Carretero, 1996) (ICOM-CIDOC, 1995). Usually, this information is described in technical language, and it should be adapted to visitors. It is also usually available in electronic format. So, and we are not going to board this type of information in this article, although we provide a mechanism to provide extra information adapted to pieces.

We are focused on defining a model to represent information that surrounds piece instead of the piece itself. We called this information *environmental information*. A piece being exposed is wrapped by extra information that depends on exposition environment; for example piece physical place. So, a central item of our model is the Space. An art object must be exposed into a Space and the object has a Space associate to itself.. Pieces are usually exposed into a container, for instance a show. A show may represent a showcase, a frame in case of a painting, or anything that is able to contain a piece. A Space has a graphical representation, an associated resource and an identifier.

The interesting point here is that the Identifier entity allows the system to be isolated from the specific technology used to locate the object in the real space (RFID, WIFI, etc).

Besides, an object may be identified by one or more Identifiers. So it is possible to use different position and location technologies at the same time to improve system precision. For instance, you can use RFID to identify a showcase and a code bar to identify a piece into identified showcase.

Although a museum may have a media repository associated to its catalogue, extra information about pieces should be provided in order to present / adapt information to visitors.

Media and content exposed to visitors may differ from museum technical information. So this information should be related to museum pieces. Pieces are not the only spaces that may have information related. Often, spaces provide contextual information about pieces contained in them.

Information described on previous paragraph is represented by resources. So art objects may be associated to different resource media, for instance; images, audios, videos or text. Media should also be customized in different languages.

A museum is a cultural environment which may be physically organized in one or more buildings. A building is divided into floors and a floor is divided into rooms. In a room we can find terminals. A terminal represents a device that can be place into a room. It can be a show or panel.

Museums usually have information about pieces catalogued. Pieces are exhibited in shows. However, there is some information that is not catalogued; this information is provided to visitors through panels. Sometimes large shows are divided

into regions to organize pieces in groups to improve information understanding. So, each region is represented by a section that groups pieces that are related in some way. As consequence, pieces can be contextualized according to defined criteria, providing a context for each group of pieces.

Pieces are physically represented by a physical representation (*PieceRepresentation*) that relates the physical place of the piece to piece information.

The only linking point between *catalogue information* and *environmental information* is PieceRepresentation and Piece.

So, we decouple piece physical representation (*PieceRepresentation*) from piece technical information (*Piece*). *PieceRepresentation* acts as a Adapter to a concrete piece, providing additional information related to environment. This characteristic provides us the ability to adapt the model to any kind of pieces.

The *GraphicRepresentation* is the graphical representation of a space. Each space is represented in two ways:

1. Internally
2. Externally

Internal representation is used show the space itself.

On the other hand, *external representation* is a representation of the space from container space point of view.

GraphicRepresentation is a medium to decuple space graphical representation.

An overview of conceptual model is depicted on Figure 1.

4 MOBILE SOFTWARE: FIRST APPROACH

Two years ago, the first design of the system was deployed in the Cutlery Museum. By that time there were some critical aspects that had to be solved to adopt a solution that affected the whole project (software and hardware architecture and so on). In our case, these critical aspects were: (some of them would change in the following stages):

Timing: the most critical was the deadline for realising a functional version of the system. We only had six months. Positioning system: the first definition of the system was simple.

The system could take advantage of user position to retrieve information and minimize user interaction. However, we decided not to use any automatic positioning system because of the strict deadline. Instead of using an automatic system, we decided to employ a set of Museum maps. All objects in the Museum have a reference to localize the object in the system.

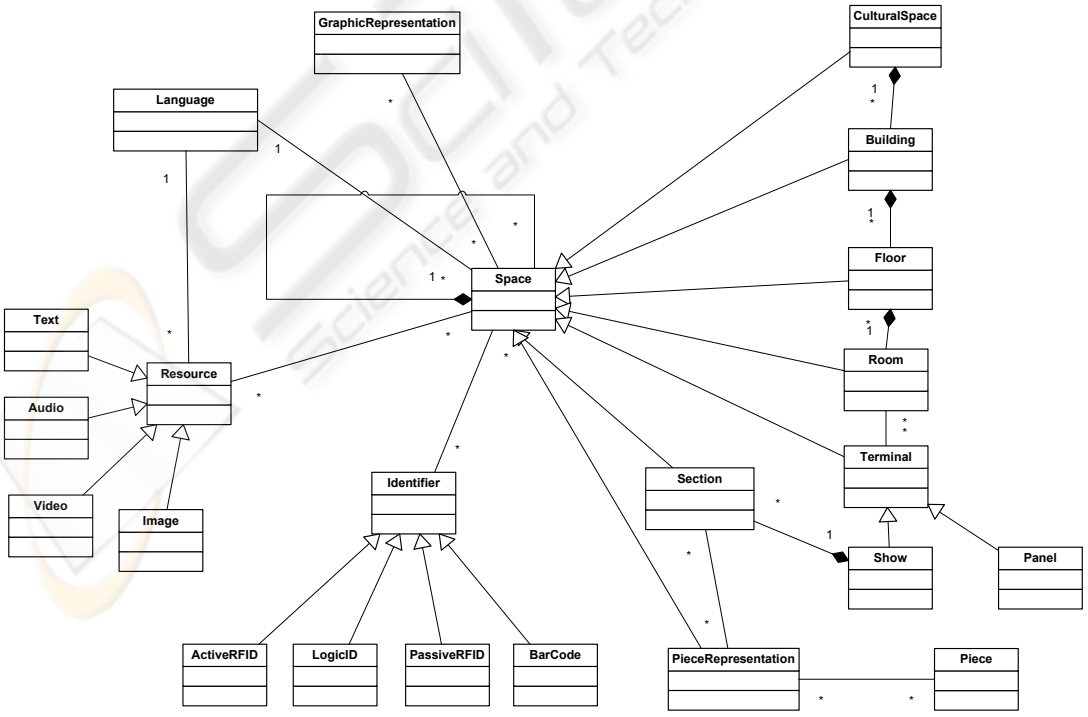

Figure 1: Conceptual model of a museum.

Location of the information: we decided to store all the information in servers. All client computers (desktop, laptop and PDA) request information from the server through a wireless network. This decision simplifies the maintenance tasks.

Technology to be used: This is another critical aspect of the development process. We decided to use a multi-technological approach, as it is described below.

We divided the whole system in three subsystems: the Web Subsystem, the Internal Subsystem and the Mobile Subsystem.

The Museum Web Subsystem (MWS) consists of a Web portal. This subsystem is described in (Gallud, 2005).

The Museum Internal Subsystem (MIS) is used to manage general information about pieces. Pieces can be inserted, modified and removed from the database with this subsystem.

One of the most interesting applications is the Plan Manager. An administrator can load a map of a floor of the building. Then he can place the following items:

- Walls cannot contain anything and limit spaces.
- Sections, rooms and zones allow to classified pieces in the museum be accommodated in one collection or in another…
- Panels are used to represent windows and pieces and can be placed in the same position like reality.

Pieces were added to database and then an administrator can take the pieces from the same database and put them into the correct show window or panel with the Plan Manager.

Every visitor can use a portable device, like a PDA, and if he has installed the mobile subsystem, he can interact with the system.

Another important subsystem is the Museum Mobile Subsystem (MMS). Thanks to the MMS, a visitor can view in a PDA, or in another portable device provided with wireless connections, additional details about the physical pieces that he is watching in a show window, just by clicking in the PDA.

All multimedia information (video, audio, text, etc. in several languages) is taken from the database server through the wireless network.

Besides, users can be warned if there is some interesting thing in the room where they are placed, or if there is an audiovisual exhibition or something like that. Events and exhibitions are introduced from the MIS described former.

5 ADDING NEW COMPONENTS TO THE SYSTEM

When new functionality is going to be incorporated in the system, problems like components reuse or system scalability arise. If there are no components reused or if the system can not be easily scaled, one can conclude the initial system has not been well designed. This is the situation we faced when we decided to incorporate new functionality. And this situation is easy to understand taking into account the rigorous deadlines.

On the other hand, as the time the system was released and deployed in the Cutlery Museum, we began to receive users' satisfaction evaluation and a number of improvement suggestions.

The desired functionality for the system was almost the same with the addition of the automatic positioning of PDAs and the redefinition of the user interface in order to provide a richer experience. Additionally we had to integrate our solution with the previous software running in a museum (catalogue application).

Only our experience in mobile software for museums was useful in the new system design but we could not reuse any software component. Anyway, experience is a degree.

In summary, we decided to redesign the system in order to support PDA automatic positioning, automatic database synchronization (from any catalogue database to ours) and, the most important issue is the user interface definition.

In this paper we are not going to describe the research aspects devoted to improve the user interface and the experience of visitors (with PDA) in the Museum. We focus on functional requirements affecting the architecture.

Two main requirements have been incorporated in the definition of the system: the positioning subsystem and the automatic database synchronization subsystem. Other important requirements were also taken into account in a lower degree: modularity, technology independence and so on.

The new components of the system are showed in Figure 2.

The positioning subsystem is responsible for giving the PDA a specific location according to a reference system.

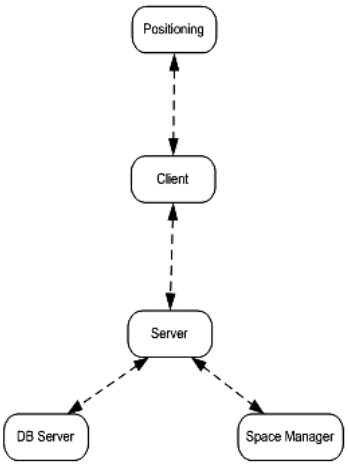

Figure 2: Subsystem view.

The automatic database synchronization subsystem is responsible for maintaining the coherence between both the internal and external databases.

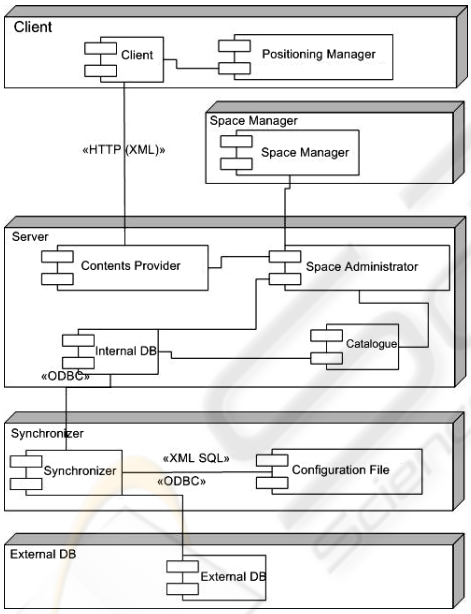

Figure 3: Detailed components view.

As *internal* database we mean the database eventually installed in the museum (usually the catalogue and an eventual media repository).The *external* database refers to our specific database for supporting the positioning subsystem and the other requirements.

Figure 3 shows a more detailed view of the new system's components. In the detailed view showed in Figure 3 we can see the main components of the system and the specific nodes hosting each component.

Both systems share a common functionality described as follows. A user with a PDA wants to visit the museum and runs the specific software for museums, in the entrance. In the first approach the user had to locate his or her position in the virtual map showed in the PDA. The new version of the system introduces an improvement by which the PDA is able to detect automatically the position of the user in the museum.

The positioning system allows the system to provide users with an unknown experience when they are visiting an art museum.

From a technological point of view, we considered the most relevant techniques to solve the automatic positioning system, and up to date, we have not closed the topic with a definitive conclusion. We have considered using infrared, RFID, WIFI and mixed approaches.

The variety of positioning systems forced us to define the system separately from the hardware employed. Figures 1 and 2 show how the client is able to interact with the environment in order to know its position in the real building. The client program running on the PDA can receive information from the environment in different ways: infrared sensors, RFID tags, Bluetooth or WIFI devices or whatever system available now or to appear in the future.

Figure 2 shows other components running on different nodes.

The person responsible to manage the art exhibition uses the Space Manager program to define spaces which will host art objects. The concrete art object is managed by means a software legacy. This software is supposed to reuse the information the museum had before the introduction of the mobile solution based on PDA.

To cope with information reuse the system assumes the existence of software legacy that introduces the need of a Synchronizer. The Synchronizer maintains the coherence between External database and Internal.

The Catalogue component is responsible for accessing information belonging to internal database. Relationship among art object information that is not related to environment is solved by this component.

Space administrator relates museum catalogue information to environment information. This information is usually structured and organized by SpaceManager.

The Contents Provider provides to the client with the information to be showed. This information is client independent because it is represented in XML format and it can be easily read by most of devices. So, information adaptation and communication is managed by this component too.

6 CONCLUSIONS AND FUTURE WORK

In this paper we describe the components structure of mobile software based on PDA applied to art museums.

This research is based on the idea that a PDA or pocket computer can be used in art museums to improve the users' experience.

The paper shows the conceptual model of a museum that allows us to design generic software for all kinds of museums. We have applied the concepts to a particular museum, the Cutlery Museum of Albacete (Spain).

The evolution of a real system has been described from the initial requirements to the actual ones. The most important requirement introduced in this new version of the system is the introduction of automatic positioning of PDA in the real building by means of using the available technology (infrared, RFID, etc).

The first version of the system was deployed in the Cutlery Museum of Albacete two years ago and has been visited by over 15.000 people.

The new system is being developed in the LoUISE research group and will be deployed in spring 2007.

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