APPLYING HCI DESIGN PATTERNS TO PDA APPLICATIONS ON ART MUSEUMS

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Abstract: Mobile activities such as m-commerce, m-learning, etc, are being increasingly adopted by people. Actually, new mobile activities are being explored, and one of them is supporting Augmented and Immersive Reality (A&IR) features on physical spaces. An example of this vision is exposed in at The Cutlery Museum in Albacete, know as MCA in Spain. Based on users' suggestions and usability reports, we discovered a set problems and improvements that could leverage HCI in a future new version of the application. To design the new version we used HCI design patterns for Space Structured Applications (SSA). As MCA application is a SSA, this paper presents a proposal of a new version of UI for the MCA application applying these patterns.

1 INTRODUCTION

Nowadays, mobile activities such as m-commerce (Elliot and Phillips, 2004) (Gary and Simon, 2002), m-learning (Georgiev T. et al., 2004), etc, are being increasingly adopted by people. For example, (Upkar V. and Vetter R., 2002) estimate that 237 billion mobile terminal users have conducted m-commerce in 2002, generating revenues of more than u$s14 billions.

New mobile activities are being explored, and one of them is supporting Augmented and Immersive Reality (A&IR) features on physical spaces to improve information availability.

Main reasons to use A&IR are physical space constraints and information media restriction to text and image only. Audio and videos are difficult to play in public because people must be "synchronized" at the beginning of reproduction.

Improvement on information availability started on the Web. Examples of this view were: The Museum Educational Site Licensing Project, the Art Museum Image Consortium at http://www.amn.org/AMICO/ , the Virtual Museum of Canada at http://artsmia.org/directories/, Minneapolis Institute of Arts at http://artsmia.org/directories/ and the Online Archive of California at http://www.oac.cdlib.org/.

Some authors (Léger, 2004) (Georgiev T. et al., 2004) suggest that m-commerce and m-learning are the "next step" of Web applications.

An example of this vision applied to art museums is exposed in (Gallud J. et al., 2005) at The Cutlery Museum in Albacete, know as MCA in Spain. The MCA is an emblematic institution of the city that is currently using PDAs to guide visitor through the museum.

These devices have several limitations. An obvious one is PDA screen size. So, user interface should be simplified without sacrificing usability.

Based on users' suggestions and usability reports, that followed the CIF (Common Industry Format for Usability Reports) standard defined by the ISO/IEC DTR 9126-4 (Lozano M. et al., 2007) we discovered a set problems and improvements that could leverage HCI in a future new version of the application.

A catalogue of HCI design patterns for Space Structured Applications (SSA) (Tesoriero R. et al., 2007) presented a collection of design patterns was published at (Tesoriero R., Montero F., et al, 2007).

As MCA application meets SSA characteristics, this paper presents a proposal of a new version of the UI based on HCI design patters presented in (Tesoriero R. et al., 2007).To aboard these ideas, the article is structured as follows.

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First, basic functionality and interface interaction of old application interface will be exposed. A detailed description and analysis of main issues to aboard are also described. Once actual system interface problems and improvements are described, new user interface is explained pointing HCI design patterns application. Finally, conclusion and future work is established.

As we mentioned at Introduction, this application will be used as an electronic guide for MCA visitors.

It provides four ways of guiding visitors.

1. Recommended routes
2. Guided tour
3. Access to finder
4. Unguided tour

2 MCA USER INTERFACE

To analyze UI problems and improvements we will summarize how user interacts with the application actually.

Figure 1 show UI screen transitions. To depict interface behaviour a state diagram-like was used.

Each box represents a screen, arrows a transition from one screen to another. Actions that perform a screen transition are identified by a label above the arrow line. An arrow without label expresses an implicit transition (more than one, expresses selection).

2.1 Recommended Routes

Recommended Routes mode was designed to guide users interested in specific subjects. Samples of these roads may be knives of XVII century or French scissors. To provide this service, a list of recommended routes is displayed to the user. Once a route is selected, first piece location is shown at exhibition on screen. User can see selected piece information, by pressing *ver Pieza* (see Figure 8); or can select to select next piece in order, by clicking on *siguiente*; or can go to previous piece clicking on *anterior* (see Figure 2).

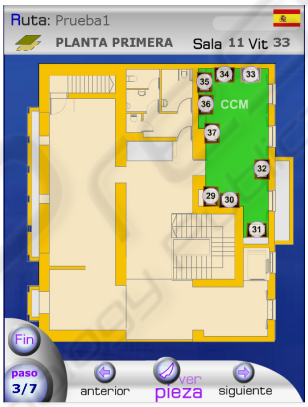

Figure 2: Recommended Routes.

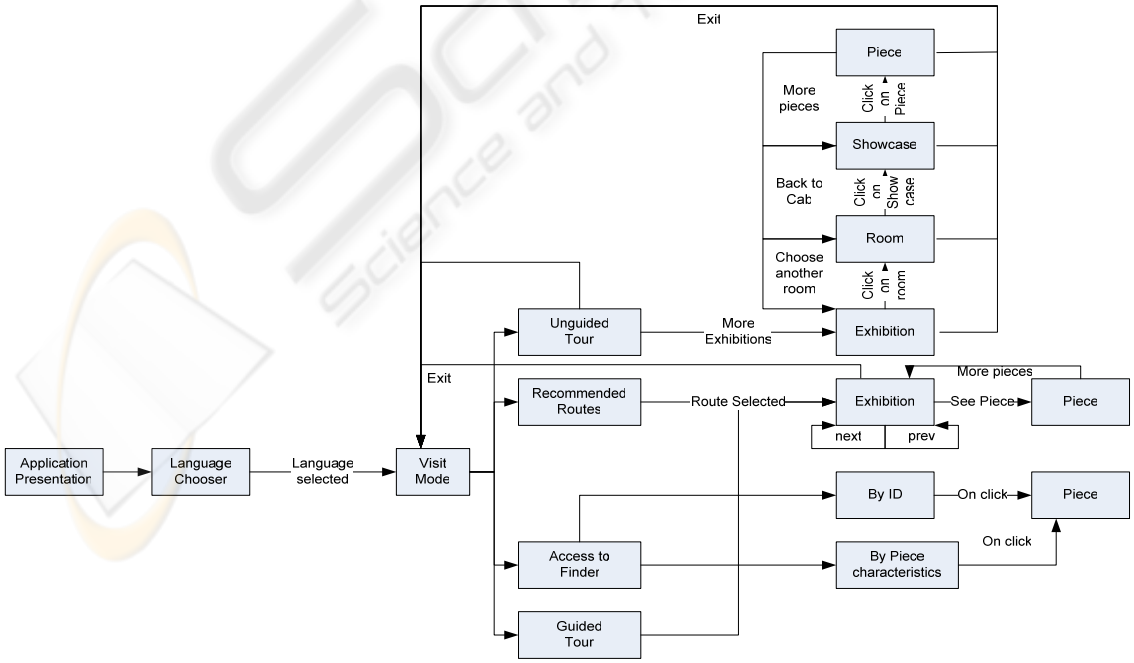

Figure 1: UI screen transitions.

2.2 Guided Tour

This mode was designed as a general purpose route to guide inexperienced visitors or users through the whole building.

Functionality and behaviour is identical to a selected route on "Recommended Routes".

2.3 Access to Finder

This screen is used to look for pieces or showcases on museum. This search can be performed on two ways. The first one is using piece characteristics (Figure 3). The second one is by entering the code of piece or showcase (Figure 4).

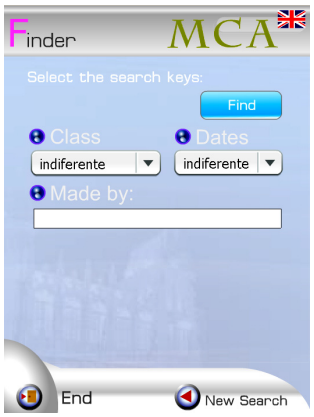

Figure 3: Search by piece characteristics.

Figure 4: Search by code of piece.

Once search process is concluded, pieces or a list of pieces are shown to the user. User may select pieces and the application displays a screen as shown in Figure 8.

2.4 Unguided Tour

This mode of guiding allows a user to navigate across application to get information about pieces and showcases.

Information is displayed on levels. Three levels were defined: exhibitions, rooms, showcases and pieces. User interfaces for each level are defined in Figure 5, Figure 6, Figure 7 and Figure 8 respectively.

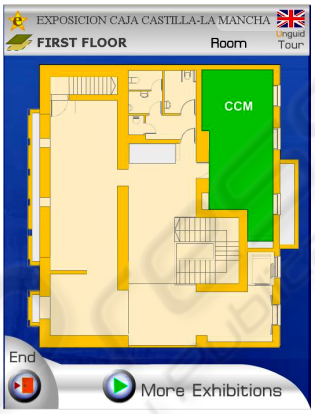

Figure 5: Floor screen.

Figure 6: Room screen.

Figure 7: Showcase screen.

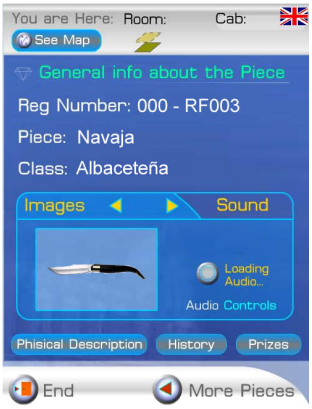

Figure 8: Piece screen.

3 ANALYSIS OF MCA USER INTERFACE

The system has been working for 18 months approximately.

People were queried about the system and were asked to express their feelings about MCA application.To get general impression about user satisfaction of MCA application a questionnaire was prepared according to the CIF (Common Industry Format for Usability Reports) standard defined by the ISO/IEC DTR 9126-4. Details and results o of the study were published on (Lozano et al., 2007).

Finally, to obtain more detailed information about interface design and usability, we also presented interface to at least five experts on HCI.

Next, common problems people faced using the system will be exposed.

First issue users complained the use of stencil to interact to application. The usage of stencil demands the user to use both hands to manipulate PDA. Visitors usually do not have both hands free (they usually carry some bags).

Second, users do not have the possibility to go back and forth while they are navigating across exhibitions. Users usually comply about having to turn the whole around to get the previous exhibition.

Third, people mentioned they usually get confused about their position and orientation.

It was difficult to people to identify their physical position on PDA map and vice versa.

Accessibility issues are really important on applications that are part public spaces, as museums for instance.

Although audio was available for users, they were unable to note where such piece was placed. Piece location is very important to contextualize it. If a blind user is listening a description about the knife, and he knows that this knife was placed on XVII Century knives room, and user is aware of this information, he/she may leave the room or not according to his/her wishes.

As navigation is performed with stencil, blind people need assistance to manipulate the artefact.

Text is displayed on a fixed size, people that have sight constraints, may have difficulties to read textual information. To sum up problems to be solved, and identify them explicitly, we composed the following list:

1. Usage of both hands to control PDA
2. Navigation on one way only
3. User orientation and position
4. Accessibility problems
    a. Space perception
    b. Navigation
    c. Text size

4 PROPOSED USER INTERFACE

To overcome with problems described on previous section we applied HCI design patterns for SSA.

This section begins describing HCI design patterns purpose and categories. Then a proposal of user interface for the application is described and patterns application is explained. Finally, problems described in previous section are analyzed according to resulting interface and results of evaluation are exposed.

Based on Christopher Alexander idea of “pattern language” as “nothing more than a precise way of describing someone’s experience of building” (Alexander et al., 1977) (Alexander, 1979) applied in architecture and the experience of defining design patterns in computer science, firstly in programming community (Gamma et al., 1993), later in HCI (Tidwell, 1999) (Tidwell, 2005) (Van Welie, 2007) (Borchers, 2001) (Van Duyne et al., 2002), etc.; a pattern language for SSA was defined. SSA defines an environment where patterns should be applied.

The pattern language was presented in (Tesoriero et al., 2007) and it was divided into four categories. Each category grouped design patterns that solved related problems.

Orientation category introduces HCI patterns that help users to get oriented into a physical space. They improve virtual/physical synchronization of space in order to locate users into the space.

Design patterns on Guide category are used to model routes or paths that users may follow. Paths can be used to guide users through physical space based on user preferences.

Layout patterns were introduced to organize space structured applications. Screen resolution on mobile devices is restricted, information to be displayed is increased due to virtual / physical space relationship, and extra information related to object dwelling there. So, it is important to know how to layout and present this information.

Museums should be available to everyone, including disabled people. Accessibility category groups patterns that can be applied to improve information access to disabled people.

A full catalogue of these patterns can be found at (Tesoriero R., Montero F., et al, 2007).

User interface of PDA system at MCA is mainly depicted in figures 9 to 14.

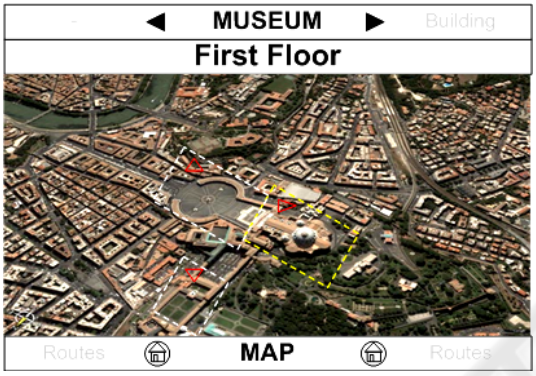

Figure 9: Museum screen.

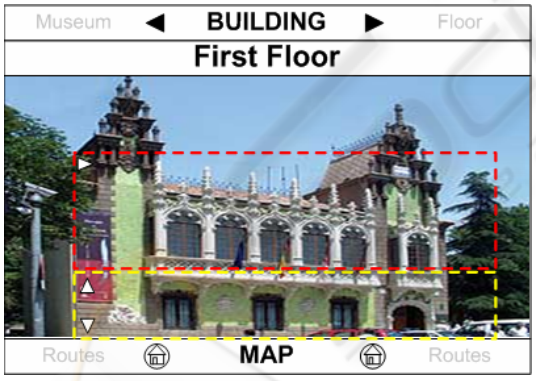

Figure 10: Building screen.

As previous version of the system, interface is organized in levels. First and upper level represents the whole museum (see Figure 9). A museum can be composed by several buildings. A building may be composed by several floors (Figure 10). A floor may be composed by several rooms (Figure 11) and a room may contain some terminals (Figure 12). A terminal is a term used to define an object container, as a showcase. A showcase contains objects as depicted in Figure 13. Finally, the lower level is defined by piece information, as shown in Figure 14.

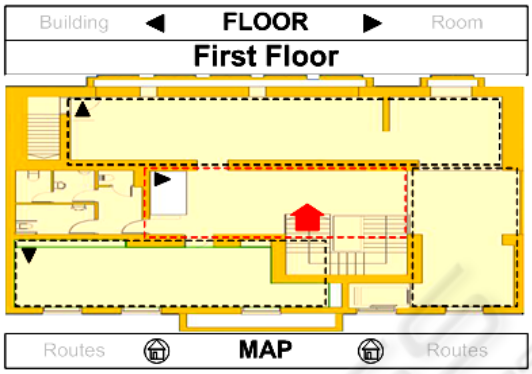

Figure 11: Floor screen.

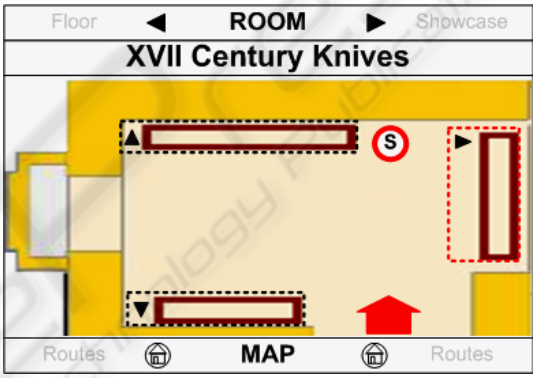

Figure 12: Room screen.

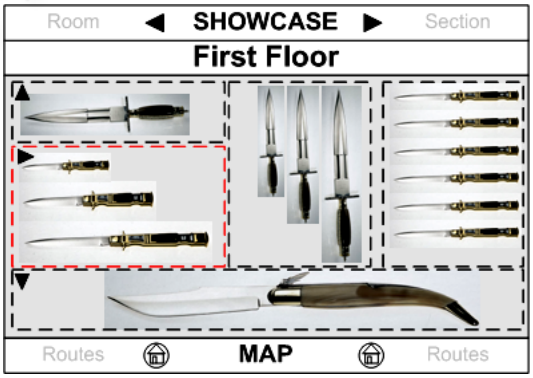

Figure 13: Showcase screen.

To navigate across spaces we applied *Free Will Navigation*. This pattern intent is the provision of a method to access spaces at any level through application using cursor keys only.

Up and Down cursor keys are used to select a space, a piece or a resource in a list. It provided intra-screen navigation.

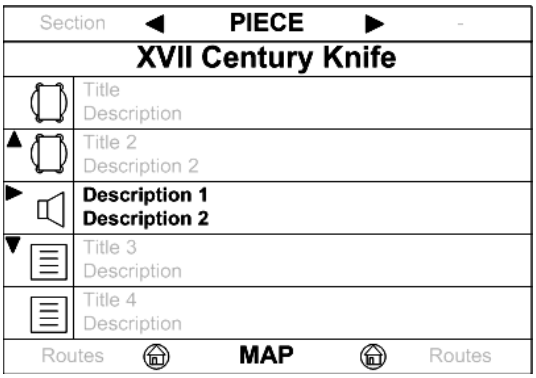

Figure 14: Piece resources screen.

Left and right keys provide inter-screen navigation. Right arrow retrieves the screen related to the space selected in actual screen. And left arrow retrieves the "parent" of selected space, i.e. the screen representing the space that contains actual space.

For instance, if a user stays in a room, up and down keys allows a user to select a showcase within the room, while left takes the user off the room to show floor view and right get the user into selected showcase.

This pattern application leads to solutions several problems stated in previous section.

Free Will Navigation allows the user to navigate across any space level homogeneously. So navigation can be performed on every way dealing with problem 2 (navigation on one way only). Besides, user may query any level of space at any time keeping him/her located somehow (this situation covers problem 3 user orientation and position).

Free Will Navigation is manipulated by cursor keys only. Cursors can be used by blind people; so if we combined this pattern with *Space Audio Perception* pattern by adding sounds on space transitions the application can be used by blind people (problem 4.2, navigation and 4.1, space perception for blind people are solved).

Free Will Navigation can be combined with *Landscape* pattern too. So, PDA can be used with one hand only. *Landscape* proposes to design PDA application in landscape. A user can handle PDA with one hand and command cursor keys (and other keys) with fat toe.

Although *Free Will Navigation* solves many problems, it adds a new accessibility problem. Left-handed and right-handed people should use the application. To cope with this situation we apply *Right-Left handed users*, design pattern. This pattern proposes control keys switching and screen mirroring.

To improve user orientation and localization (problem 2), we applied *Signs* and *Door at back* design patterns.

Signs help users to get oriented when he or she spends a long a time into a space and get lost there. A physical sign and a mark in the map are used to synchronize virtual and physical space get the user oriented. An example is exposed in Figure 12.

Door at back help users to get oriented when a space transition occurs. A space transition happens when a users moves virtually and physically from one space to another; for instance form a room to another. The door that was used to get into the room can be calculated and pattern aim are marking the door that could have been used and rotate the map to get probably used door in front of the user, in the PDA map. An example is exposed in Figure 12, too.

When a text document is reached, *Zoom* pattern proposes to use left and right cursor keys to change font size (bigger and smaller, respectively) and up and down cursors to scroll text.

5 CONCLUSIONS AND FUTURE WORK

This article presented problems and possible improvements for a concrete SSA, the MCA application.These problems or improvements were:

1. Usage of both hands to control PDA
2. Navigation on one way only
3. User orientation and position
4. Accessibility problems (mainly for blind people)
    a. Space perception
    b. Navigation
    c. Text size

To cope with previous situation, we applied HCI design patterns for SSA. These patterns provided us solutions to most of issues exposed before. They were *Free Will Navigation*, *Door at Back*, *Signs*, *Landscape*, *Space Audio Perception*, *Right-Left Handed Users* and *Zoom*.

One of the most interesting issues we learned about these patterns was simultaneous pattern application. This characteristic allowed us to combine patterns in order to solve some specific problem. For example, *Free Will Navigation* and *Space Audio Perception* allow blind users to navigate across application.

Another interesting issue we found is how a combination of patterns may lead to a problem but it can be solved applying another pattern. An example can be examined on *Free Will Navigation* and

Landscape pattern combination that lead to a problem with *Right-Left handed* people that is solved applying *Right-Left handed* pattern.

At last, based on analysis performed on previous section we can conclude that patterns were successfully applied on this situation and provided us with solutions to HCI problems discovered on usability evaluations and expert suggestions.

As future work, an implementation of this interface is planned. Once application is implemented, we think that a usability evaluation will be very useful to compare application performance against old version.

We are also studying location and positioning technologies to minimize "clicks" and synchronize user physical position with user virtual position in the map automatically.

Finally, we think that once new system becomes in production, we will be able to find new HCI design patterns for SSA applications to increase our experience and reuse more solutions easily.

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