Comparative Study of Interactive Systems in a Museum

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Abstract. Museums research new ways to offer positive experience to the visitors and encourage them to return, using modern communication and learning tools. To the effect, technologically advanced interactive ICT systems, are placed in modern-day museums. In this paper we describe and compare six different types of museum exhibits, one traditional and five interactive ICT exhibits. The five interactive ICT systems offer different types and level of digital information, different interaction constraints and different types of activities. The exhibits, which are located in the Leventis Municipal Museum in Nicosia, are the following: a traditional map learning activity, a virtual tour projection, a multi-touch table application and three different augmented reality applications. We evaluated the experience of young users with the exhibits and conclude that the experience scores top marks for the interactive ICT systems.

Keywords: Interaction, Museum, Comparative Study, Video Projection, Multi-touch Table, Augmented Reality.

1 Introduction

Traditionally, museums conveyed information to their visitors through the exhibit of real objects. During the last couple of decades, the new trend is toward active involvement through the installation technologically advanced interactive ICT systems. The systems are installed within the physical space of a museum as a communication and learning tool and as an additional material next to the original objects.

Those interactive ICT exhibits includes applications like VR systems (Roussou, 2001), Augmented Reality systems (Wojciechowski, 2004), haptics displays (Loscos, 2004), multi-touch tables (Averkiou, 2009; Geller, 2006), etc. Generally they allow reality-based interactivity of the user with a virtual 3D representation of objects within virtual or real worlds.

In this paper we present a comparative study between five different types of interactive user interface exhibits (VR tour, touch table, three augmented reality exhibits)

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and a traditional exhibit (real maps). The study has been conducted in a museum with children between the ages of 9 and 11 years of age. We are quantifying high-level interaction qualities such as enjoyment, satisfactions and desire to perform again. Subjective data has been collected through questionnaires targeted to this young age group.

Further we attempt to explain the results. To that effect we classify the interactive systems using previously proposed taxonomy of interactive user interfaces in a broader sense. We classify the interactive systems according to three parameters: First, the digital information that is linked to the interface (2D still/dynamic or 3D still/dynamic). Second, the interaction constraints of the system (3D free interaction in space, 2D interaction on a surface, 1D interaction with touch buttons). And third, the type of activity promoted (open ended, game like, exploratory or passive). Based on this classification and on the results of this experiment, we discuss their effectiveness in providing satisfaction and desire to perform again.

Given the novelty of the investigated interactive user interfaces as a research field, existing literature is limited in providing a specific evaluation method for such a study investigation for a specific age group. Generally, proposed evaluation methods are objective quantitative methodology, for example task completion time, error rate, and memorization time (Jacob, 2002). Those experiments are run usually in laboratory environment. Further studies, which have been evaluated in the field, have been reported to quantify more high-level interaction qualities such as enjoyment, engagement and legibility of actions (Pedersen, 2009). Another adopted evaluation method is interaction analysis from video as used in the field of HCI (Sharp, 2007).

This paper is organized in 6 sections out of which Section 1 is the introduction. Section 2 describes the exhibits, which have been used for comparisons in this paper. Section 4 analyses the preliminary results of the study. Section 5 discusses the results and takes conclusions.

2 Systems Description

In this section we describe the systems that have been used in this comparative study. The authors of this paper have been involved in the development of the ICT systems described below.

2.1 Projection: Virtual Tour

The installation “Virtual Tour in Nicosia of the 19th Century” uses a single wall, front-projection setup and it allows the visitor to get a glimpse of how the city might have looked like around the middle of the nineteenth century, (Fig. 1). The scenario is built on the description given by an un-named English traveler who visited the island at the time and published his report in a British Magazine called “The Home Friend” (Anonymous, 1850). The traveler entered the Old Town at one of the 3 gates, most likely Famagusta Gate, since he was coming from Larnaca, and left again from the same Gate returning to Larnaca. Along the way he crossed the city going through different neighborhoods, poor and rich, points of interest, bazaars, a hammam (Turkish Baths) , administrative quarters etc. Along the way he crossed the city going

through different neighborhoods, poor and rich, points of interest, bazaars, a hammam, administrative quarters etc.

Since our application is placed in the museum where many visitors go through every day, we had to maintain the total time spent by each visitor to less than 5 minutes and therefore it was not possible to "walk" through all the streets described in the report. Rather we selected the most representative. In our tour, after entering through the city gate, the visitor goes to a desolated street where the houses are falling down and they are only inhabited by donkeys and cows, if at all. Second stop is the Serai, a rich nicely paved square hosting the administration buildings, mosques, coffee shops and big houses. Then it's the Bazaar, or street market followed by the hammam (steam bath). Exiting from the hammam, the visitor walks to the house of Kornesios, a rich local functionary, where he is hosted, and finally as he exists the city from the Famagusta Gate. Some images from the tour are shown in Fig. 2.

Fig. 1. The virtual tour installation. Projection wall and touch screen serving as user interface for navigation of the 3D graphics.

For certain parts of the route, it was very challenging to be recreated realistically using real-time graphics, so they were filmed using conventional methods. One such part is the Bazaar which is crowded with people. The two others were the house of Kornesios and Famagusta Gate, which they have not been destroyed and still exist in a good condition, therefore they could be filmed. In the current implementation shown at the museum, the video footage alternates with computer graphics (see Fig. 1).

The user of the application in the museum is able to navigate within the virtual world in real time and is allowed to interact with the application in certain pre-defined areas of the tour. An automated navigation with predefined paths occurs from one point of interest to the next, giving the opportunity to the user to watch the route and exterior of the buildings as a passive viewer. At the parts of the route that are done using computer graphics the user is allowed to change the viewing direction, the zoom, and navigation speed using touch buttons on the touch screen mounted next to the projection wall. In Fig. 1, we see on the right of the wall the touch-screen which is used for the navigation.

Fig. 2. Screenshots from the virtual tour system

2.2 Multi-touch Table: The Walls of Nicosia

The installation "The Walls of Nicosia" (Averkiou, 2009) is an interactive application that allows the user to have a virtual tour through the fortifications of Nicosia across the centuries. The target was to explain and present the development of the area and the history of the development of the fortifications of the city – From a Roma and Byzantine Castle to a Medieval Royal Capital and a Venetian Fortified city. The application runs on a multi-touch table (see Fig. 3) which allows for a natural interaction. Three dimensional models of the fortifications of the city, Fig. 4, as well as the most important landmarks are demonstrated for five historical periods: pre-Roman (villages with no fortification), Roman castle, Byzantine castle, Lusignan Walls and Venetian Walls. The users can navigate through time with the help of a menu that appears on the top of the screen of the table. They can then interact and study the 3D models of the historical period they choose using intuitive gestures. The users are able to zoom in/out, pan and tilt the virtual camera. A helping menu exists on the interface of the application, describing how each of these operations can be performed. A compass, on the top-right corner of the interface, assists the users with orientation. Traditional music is played for each historical period, in order to immerse the user (see Fig. 3 and Fig. 4).

Fig. 3. A group of students using the multi-touch table

Fig. 4. Screenshot from the multi-touch table application

The multi-touch table hardware is based on back projection. A projector, connected with the host computer resides inside the table. The final image on the top surface is produced with the use of a mirror that reflects the projector image. This technique is used in order to virtually increase the space within the table and allow us to use a standard DLP project (not a short throw one). The gestures of the user's fingers are tracked using infrared light. 300 LEDs and an infrared camera have been mounted inside the table for the finger tracking. LEDs emit light towards the table surface. When a user touches the surface the infrared light is reflected back and the infrared camera captures that light. Each frame that is captured by the camera is processed in order to detect the position of the user's fingers on the screen.

2.3 Augmented Reality (AR) Exhibits

Places, monuments and buildings of Nicosia that have played or are playing an important role in the development of the history and the social life of the city, are the main idea of these three augmented reality applications.

All the applications are based on circular marker tracking technology with the use of a PS3 Eye camera to capture the real scene. The software system is using OpenSceneGraph for the construction of the augmented scene and the rendering of the 3D models. The augmentation of the real scene is displayed on wide 42" LCD screen hanging on the wall of the exhibition room. In order to achieve accurate tracking, appropriate lights were setup and adjusted to illuminate the markers yet not affecting the visibility on the LCD screens.

AR Puzzle. The AR Puzzle application is using four markers and the user interacts with all of them sliding them over the table. Four photos of the same landmark at different time periods have been cut into four pieces and have been mounted onto four cubes linked to the four markers. By physically displacing and rotating a marker on the 2D surface of the table, the user displaces and rotates the digital 3D cube seen on the LCD display on the wall. The user has to put together the correct pieces to create the picture.

There are four columns, one on each marker with one piece of a different photo on each side. The user finds the four pieces of the picture and then puts them in the correct order to solve the puzzle. This can be repeated for all the four pictures of the application. There are two AR exhibits with this puzzle application, one with the Famagusta gate photos and one with the Eleftheria square photos (see Fig. 5).

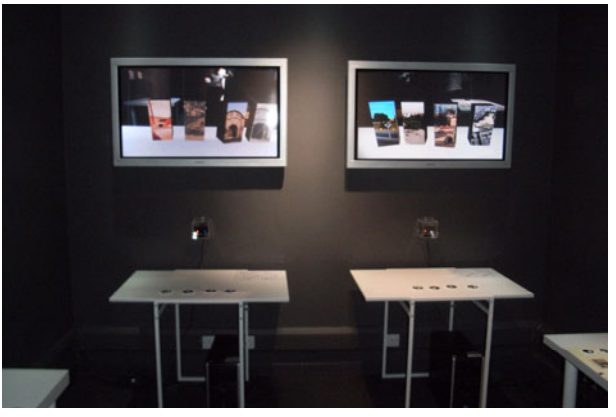

Fig. 5. The AR Puzzle installations

AR Map. In the second AR application the user explores the location of four monuments in the city of Nicosia. With the use of a printed map and four markers he tries to place the monuments on the correct location on the map by sliding the marker onto the 2D surface of the map. Each of the four markers corresponds to one specific monument. In order to see the 3D model of a monument the marker must be placed on the correct position on the map. The application uses models of the Phaneromeni church, the City Hall, the Leventis museum and the Pankiprio gymnasium (see Fig. 6).

Fig. 6. The AR Map installation

Touch History. The last application uses only one marker and by presenting that marker to the camera a 3D object appears on it. In our case the 3D object is a 14th century chalice with engraved decoration. The user can move the marker freely in all special dimensions and see the object from all the perspectives, inside and outside (see Fig. 7).

Fig. 7. The Touch History installation

Real Maps. A control group was given a tour of one of the more traditional exhibits of the museum, the room with the maps of Nicosia (see Fig. 8). The teacher used the maps, some of them several hundred years old, to provide the group with information about the fortifications of Nicosia over the centuries.

Fig. 8. A group of students at the maps room

3 Method

This paper evaluates the subjective user experience of the children and more specifically aspects of fun such as engagement, endurability and returnance (Read & MacFarlane, 2000). 36 children participated for each exhibit except for the touch table and real maps where the number of participants was 25. The age range of the children was 9-11 years.

As already mentioned there are several evaluation methods with interactive exhibits; here the main emphasis was to compare the user experience of the children while interacting with the exhibits. Therefore we employed the Smileyometer and the Again-Again table, which are tools of the FunToolkit method. The latter is a well-known and

validated tool for assessing user experience with technology when the users are children (Read, 2008). Right after the interaction of the children with the exhibits, children were asked to tick one face in the Smileyometer and fill in the Again –Again table. These tools are presented in the Fig. 9.

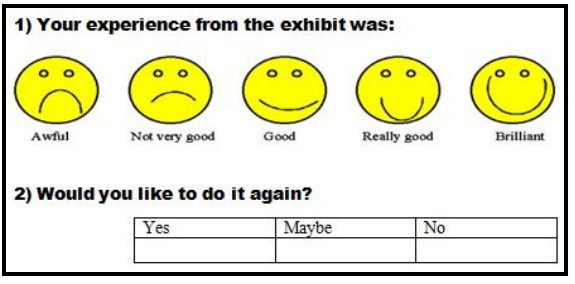

Fig. 9. Questionnaire to estimate subjective satisfaction from exhibit

The interactive ICT systems and traditional way of exhibition (real maps) have been classified as shown in Table 1. The rational was to illustrate the similarities and differences within the investigated systems using interactive interface taxonomy (Shear, 2009). In the table, the column digital information refers to the type and amount of content in each application.

Table 1. Systems classification

	Digital information	Interaction constraints	Type of activity
Touch History	3D still, low	3D free	exploratory, non-challenging
AR puzzle	2D still, low	2D free	game like, challenging
AR map	3D still, medium	2D free	game like, highly challenging
VR tour	3D dyn, very high	1D buttons	passive
Touch table	3D still, high	2D free	exploratory, challenging
Real Maps	2D still, medium	N/A	passive

4 Preliminary Results and Analysis

Preliminary results, Fig. 10, reveal that the interactive ICT exhibits have been rated higher and that they are very popular with this age group of children. We note though that within a similar group of application, namely here AR, the scores differ greatly.

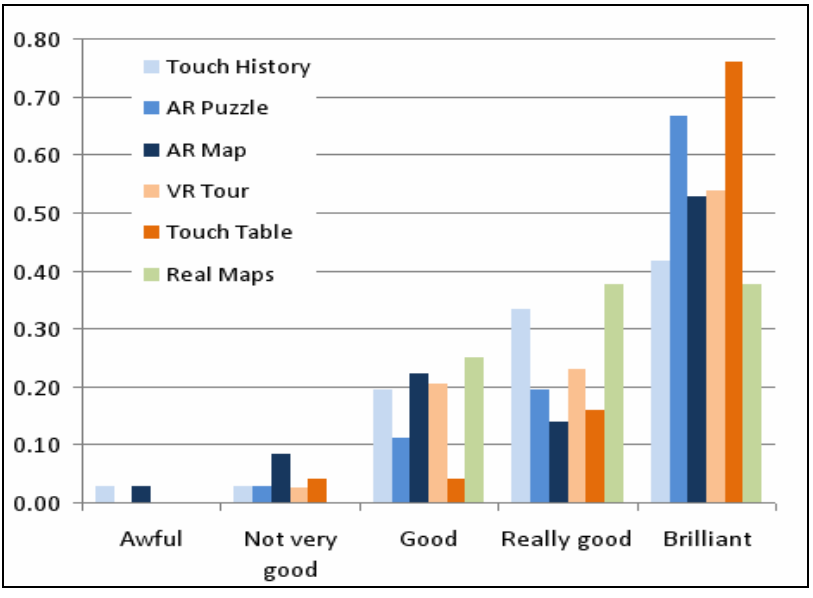

Fig. 10. Results for the smileyometer for the 6 exhibits visited by the school children. The y-axis shows the percentage of children giving a certain answer.

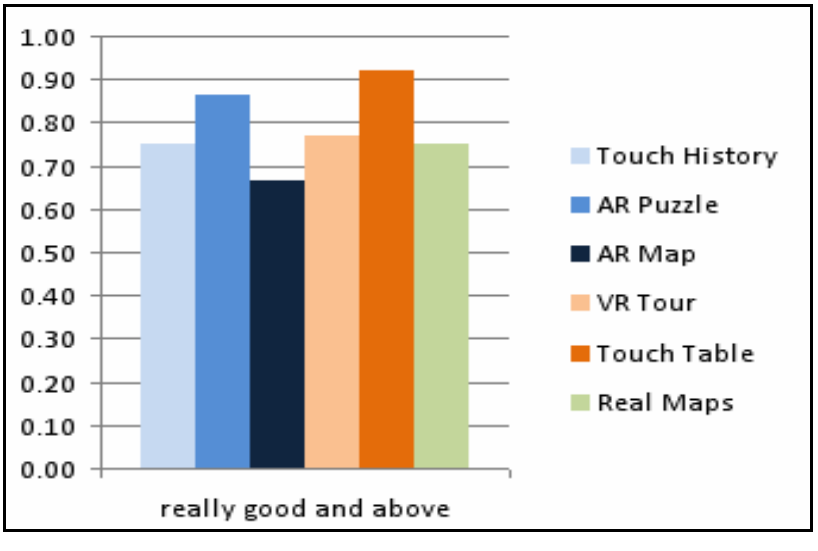

Fig. 11. Summarizing the cumulated results having scored above very good

The AR puzzle scores over 67% while Touch History scores only 42% in brilliant score category. Overall the touch table is leading with 72% of children giving it a brilliant score.

In the next chart, Fig. 11, we show the cumulated results having achieved a score of "really good" and above. All the exhibits score above 67% and again the touch table is leading with 92%. A basic remark here is that the AR map scores even lower than the real map exhibit. From our observation of the children during the experiment, we attribute that, to the fact that the AR map application requires knowledge of the city and special understanding that most of the children did not possess. Although the interaction constraints are the same as the highly popular AR puzzle, they would get tired and frustrated after a while.

Fig. 12 presents the results of the Again-Again table which is about returnance. Most children want to do again the several activities. AR puzzle and Touch table are the most popular in this rating. On the contrary the traditional way of exhibition (real maps) has been rated with high scores in "no" responses.

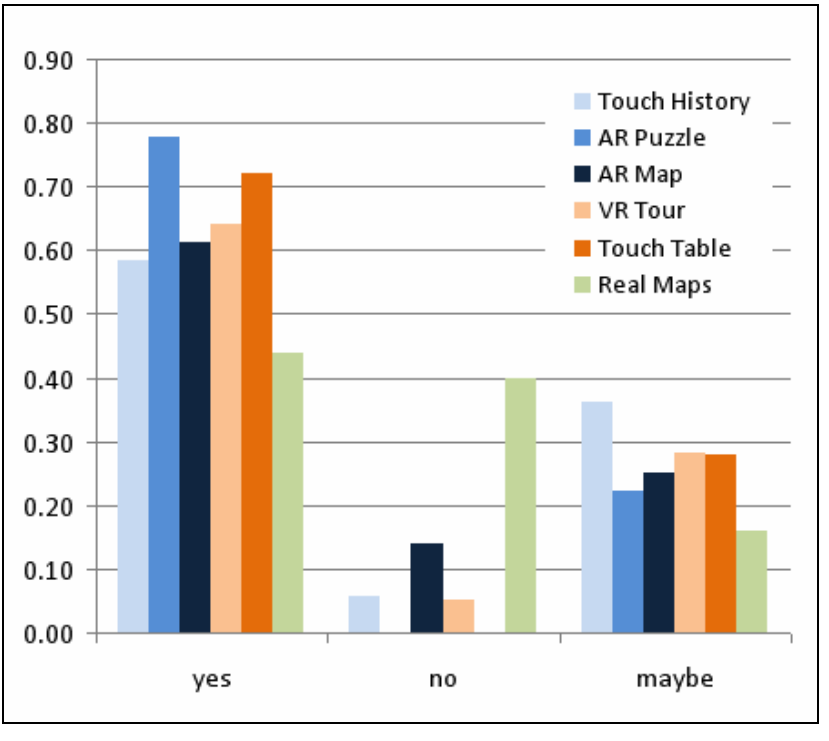

Fig. 12. Results of the questions asking if the school children would like to repeat or not the activity

5 Discussion and Conclusions

In this paper we present a comparative study of interactive museums exhibits with main emphasis on assessment of user experience. Preliminary results have shown that interactive ICT exhibits have been rated higher than the traditional teaching methods (real map) and that most of the school children would want to do it again, especially

for the interactive ICT exhibits. Similar findings have been reported by other studies (Wrzesien 2010, Pujol 2007, Pujol 2009). When cumulating the "really good" and "brilliant" scores together, it is evident that there is less discrimination between all the exhibits.

According to the preliminary results it seems that the puzzle game initiates the wish to repeat the same type of interaction. The VR tour does score high on the Again-Again table, which might be due to its enjoyable entertainment similar to a movie theatre.

If we assess the augmented reality exhibits alone, we see that the experience of the children varies considerably across the three exhibits. The AR puzzle is most appreciated, even if the content was 2D images mounted on a 3D cubes and even if the interaction was constraint to a 2D surface. It would thus seem that it is the type of activity rather than the level of detail of the information or the degrees of freedom of the interaction that governs experience with schoolchildren. Touch history, with its detailed models of 3D objects and 3D interaction scored much lower, possibly due to its non-challenging type of activity. To this end, it seems that the type of activity promoted by the exhibit seems to be the main factor when assessing the wish to repeat the experience with the exhibit, here game like puzzle activity scored highest. This result supports the work proposed by (Marshall, 2003) to categorize frameworks for interfaces in this domain according to the types of activities they promote.

A limitation of this study is that only one traditional method of exhibition has been assessed, limiting the validity of the claims that interactive ICT exhibits are better than traditional methods. A future study will have to address this issue by including other traditional methods of exhibition as well. In addition, it is quite interesting to investigate for further correlations between the classification of the exhibits and the user experience results.

There is also a need for a macro-type of a comparative evaluation, since perceived novelty of technology sometimes wears thin after time. Accordingly a future study can address issues regarding an evaluation of multiple experiences of the same ICT exhibits vs traditional activities over an extended period of time.

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