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Multiuser augmented reality system for indoor exhibitions

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Abstract Over the last years, museums and galleries are looking for new ways to show exhibitions to visitors. For that purpose, new technologies like augmented reality are used. In this paper an augmented reality system for indoor exhibitions is presented. The system is formed by visualization screens that mix exhibition environment, visitors included, with multimedia and virtual 3D objects which visitors can manipulate naturally using a markers system. This system has been used in the exhibition "Valencia, tierra de comarcas: Diálogos con el patrimonio", which deals with a trip through the valencian cultural heritage.

Keywords: Augmented reality, interaction, augmented mirror.

1 Introduction and goals

Over the last years different technologies have provided museums and galleries visitors with a new form to see their stored knowledge. One of these technologies is augmented reality (AR). AR is an interaction paradigm that aims to combine computer-generated information with the real world [1].

Through AR within the indoor exhibition scope visitors can visualize, manipulate and browse exhibition information. Some usage examples of AR in museums and galleries are audio augmented guides [2], head mounted displays-based applications [3][4], interactive museum guides over mobile devices [5][6][7], screen visualization-based systems [8] and video projectors-based systems [9].

The goal of the AR system presented in this paper is to provide an improved experience to the visitors by offering a better interaction with the exhibition contents. In order to do so, the system must immerse visitors into the augmented environment using an interface which allows a natural interaction with these contents. Moreover, the system has to provide to the visitors the educational information of the exhibition in a simple and enjoyable way.

2 System description

The AR system presented in this paper is composed of a Region of Valencia map, 7 pointers and several hosts which can work in an independent way or synchronized on the same exhibition environment. Each host is formed of a PC, two visualization screens and one Kinect camera [10]. The map dimensions are 3x5 meters and visitors can walk on it. This map has a marker printed on it which is used to compute the spatial reference of the system. This map also contains 70 different hot points grouped by colors. Each color refers to a different subject of the Region of Valencia heritage and there is one pointer associated to each subject. Each pointer has a marker printed on it which is used to calculate its position on the map.

The system can be split into 4 subsystems. The communications subsystem communicates all hosts using a Client-Server model. It performs the synchronization between them over the same exhibition environment. The logic subsystem manages the system operation. It selects the subject associated to the active pointer in the system and identifies the hot point when the pointer is placed on it. The tracking subsystem obtains the position and orientation of the elements of the system: map, pointers and Kinect camera. The visualization subsystem shows augmented information over the real exhibition environment content. Figure 1 shows the different subsystems defined.

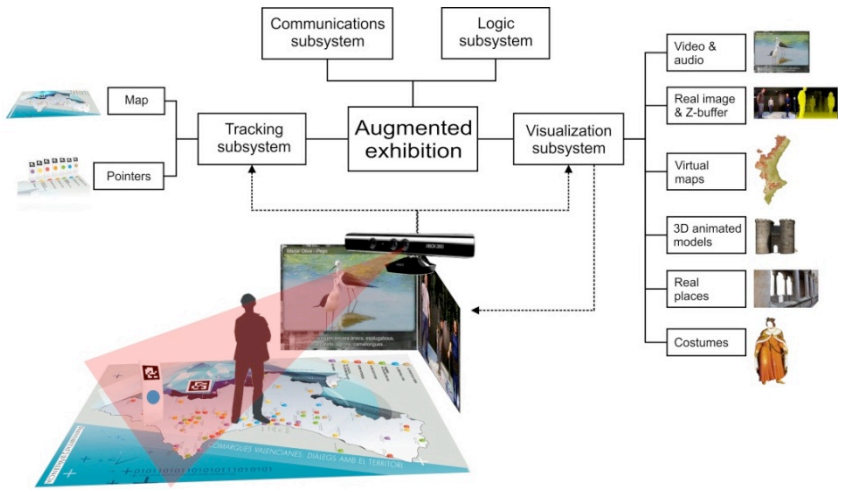

Fig. 1. Augmented reality system components.

In order to mix real exhibition content and augmented reality information, initially the Kinect camera captured information is painted. This image is a reflection of the real exhibition environment. Using the depth map information given by the Kinect camera, the values of the z-buffer [11] for each image pixel are calculated. In this way, the elements of the image, visitors included, can be placed correctly in the virtual scene. Finally, the virtual elements are painted taking into account the z-buffer

information, performing a correct occlusion between real (visitors and exhibition room) and virtual (3D models, maps, etc.) worlds. This process can be observed in Figure 2.

Fig. 2. Augmented reality scene composition using depth information.

3 Interaction process, augmented map

The visitors can walk on the large real map, as if they were traveling through the region of Valencia, using the different pointers to select the place they want to visit. When a visitor catches a pointer the system shows a multimedia resource of the subject selected on one screen. At the same time, on the other screen, an augmented visualization of a subject map replaces the real one. Thereafter, visitors can select a hot point of the selected subject on the map just "travelling" to the desired location and placing the pointer on it. Once the point is selected, a multimedia resource associated to it is showed on one screen, while on the other screen, a virtual 3D object is showed in the augmented visualization. In the same way, visitors can choose another hot point or change the subject selected by leaving the actual pointer and caching a new one. There are 3 different kinds of virtual 3D objects that can be displayed in the augmented visualization: 3D animated models which represent buildings or objects related to the hot point, virtual scenes created using images of real places and costumes to "dress up" the visitor.

4 Conclusions

The AR system presented in this paper has been used in the exhibition "Valencia, tierra de comarcas: Diálogos con el patrimonio". The system has worked properly and has been tested by over 1000 visitors. The visitor's opinions about the system were positive; they learned to use the system very fast, achieving a high level of satisfaction and entertainment.

According to the visitor's experiences, the goals have been met. The AR system was able to provide an improved experience to the visitors, supporting the learning process with the multimedia resources and virtual 3D elements associated to the hot

points of the exhibition. Furthermore, the interface based on selection pointers and hot points located on the map was used by the visitors naturally.

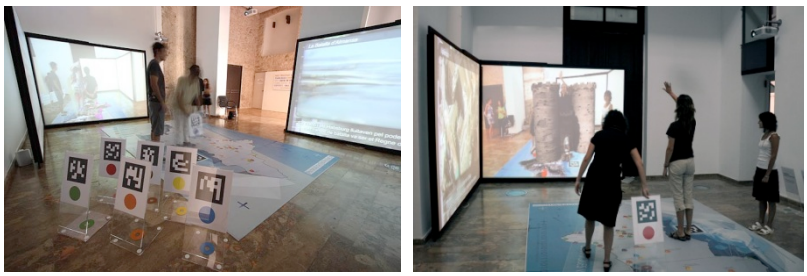

Fig. 3. 7 Pointers and exhibition set (left); visitors using the system (right).

5 Acknowledgements

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