

Scenario based design of augmented reality systems applied to cultural heritage

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ABSTRACT

The objective of this paper is to present an example of the envisioning design technique by using future scenarios as design tools. This example will be used in the near future as the basis to develop a system of augmented reality applied to the visit of an archaeological site. We will see some basics in Augmented Reality and we will also introduce the tools used in the proposed design technique. Finally we will combine the above-mentioned concepts in order to present a future scenario: a video prototype simulating user interaction with the real world by using a device in virtual reality and six degrees of freedom. This approach allows us to design a user-oriented interface centered on users, with no technological restrictions.

KEYWORDS: Envisioning design, augmented reality, future scenarios, storyboards, cultural heritage, video prototypes, focus groups.

INTRODUCTION

Observation is an extremely important evaluation method to fulfil initial requirements from the domain [4], in this case the archaeological one. We have observed that visitors of archaeological sites use audio guides that report on the history and culture of the settlement in specific points or opt for a multimedia presentation after the visit. In our view, audio guides only provide incomplete information, hence a great deal of knowledge remains unknown to most visitors. In addition, multimedia presentations are located out of the archaeological site and visitors need to leave the site to access additional information.

In this paper, we propose a system that establishes a dialog between users and archaeological objects right in place. We are working on an interactive device in an augmented reality system, which might allow visitors to see both real objects and reconstructions of the past at the same time. So, virtual objects are superimposed on the today's fortress aspect and they appear where they are supposed to be from any view point, in all dimensions. This way visitors can see the real world

around them with computer graphics superimposed with it. [1]

This system development is based on user-centered design models like storyboards, scenarios and video prototypes. These prototypes foresee the user's possible acts and supply a simulation of the future system. This method allows designers to explore several ideas, as well as define and develop new knowledge about the user environment and his workplace [13].

According to Preece [11] it is important to think about several scenarios in order to show different situations and viewpoints.

THE ARCHAEOLOGICAL SITE: THE FORTRESS OF ARBECA

The fortress of Els Vilars is located in the northeastern part of the municipality of Arbeca (Catalonia, Spain). It was founded in 750 BC during the Iron Age.



Figure 1: Archaeological site of Arbeca (Spain)

After systematic annual diggings the fortress has become a classic site for research into the Iron Age in the Iberian Peninsula. It can be visited all year round. The projects carried out so far show one of the best preserved defensive systems of that age in Europe.

The foundation, occupation and abandonment of the fortress have been allocated three different cultural horizons on a chronological framework. We have then developed the reconstruction of a virtual fortress using 3D software in a diachronic way, including four renewals: from the Early Iron Age, Vilars 0 (750-650 BC) and Vilars I (650-550 BC); from the Early Iberian Period: Vilars II (550-425 BC); and from the High Iberian Period: Vilars III-IV (425-325 BC).

PROPOSED PARADIGM: AUGMENTED REALITY

Augmented reality (AR) technology allows users seamless interaction between the real and virtual world, in front of the interaction obtained using virtual reality (VR), which immerses users in a virtual world that replaces the real one completely. The objective of AR is to let the user see the real world while seeing superposed virtual 3D objects and similar information that augment his vision of reality.

AR is an interaction paradigm designed to reduce computer interaction using the environment information as an implicit input. Backman [1] describes AR as a combination of the real scene viewed and a virtual scene generated by the computer and a paradigm that augments human perception with supplying information not ordinarily detectable by human senses.

The user's situation is automatically recognized by means of a wide range of methods like time, position, orientation or the object inspection using the computer vision. Specifically, when we talk about orientation and position, the inputs become the six degrees of freedom. The first three directions are the three coordinates needed to determine the position (X, Y and Z). The other three indicate the orientation of the viewer and are known as pitch, roll and yaw. In a simulation model several interface devices can be used to navigate and interact with a virtual ambient with six degrees of freedom, depending on the device and the virtual world design [7].

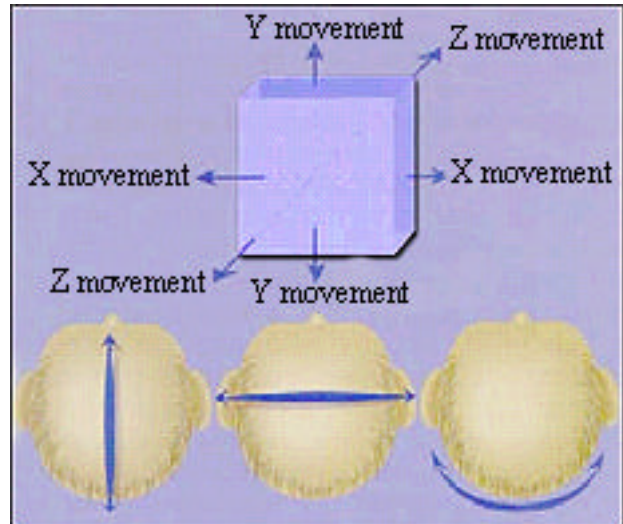


Figure 2: Six degrees of freedom diagram

In this way, AR enables the user to remain in contact with his workspace; his attention focus is set on the real world rather than the computer, which allows users to exploit their own visual and spatial abilities.

AR transports additional information to the user's real world, in front of traditional interfaces that put the user into the computer virtual reality.

This paradigm of visualization and interaction of information stands at the center of a new technology with a promising future and many applications in a wide range of areas like medicine, architecture, interior design, civil engineering, car design and mechanics maintenance. However, the real applications for AR require of a high level of technology and that does not exist in the market yet.

To sum up, with this paradigm a user can interact with the real world, which is augmented by the synthesized information supplied by the computer.

ENVISIONING DESIGN OF FUTURE INTERACTIVE SCENARIOS

The user-centered process model for an interactive system involves users participation at design time. The prototypes are documents, designs or systems that act like the final system or have implemented parts of it. They are very useful tools to make the user participate in the design and allow evaluation from the beginning of the development.

To build a future scenario, we have used until now:

- ? Storyboards.
- ? Device prototypes.
- ? Scenarios in use.
- ? Video prototype.

These tools have definitely shown us that scenarios address key issues in design and technology development and offer fundamental advantages over the traditional decomposition into features and functions. More specifically, they have shown us the efficacy and potential of scenario-based design in developing rapidly throughout the information technology industry and the science and engineering disciplines that support it [3].

Storyboard

A storyboard is a graphic narration made with drawings arranged in a matrix, like a comic strip; we use it, to recreate visually the user’s world and his possible interactions with the future designed system. This concept has been used in the design of one of the first interaction scenarios and to evaluate the system design.

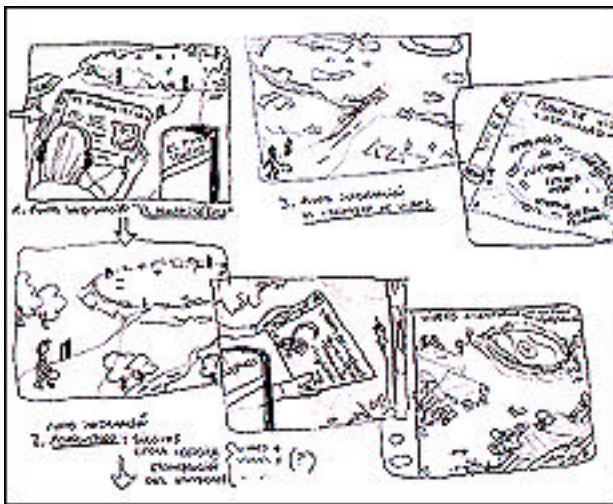


Figure 3: Partial storyboard about a user’s visit.

One of the benefits that storyboards offer for the final application is the possibility to indicate the links between pages from users interaction results. They are low cost methods, the only restriction being our own imagination.

Device prototype

The device prototype includes the system functionalities. Once the prototype is built we can evaluate and change the interface depending on the evaluation results.

Some different prototype devices can be used. Dix [5] introduces the following:

- ? Disposable model: is used to make one user evaluation and be trashed after that.
- ? Incremental: the final product is built by separate components, each time one is tested and finally a last and global one is made.
- ? Evolutive: the prototype is not eliminated, it is used as the base for further design iterations.

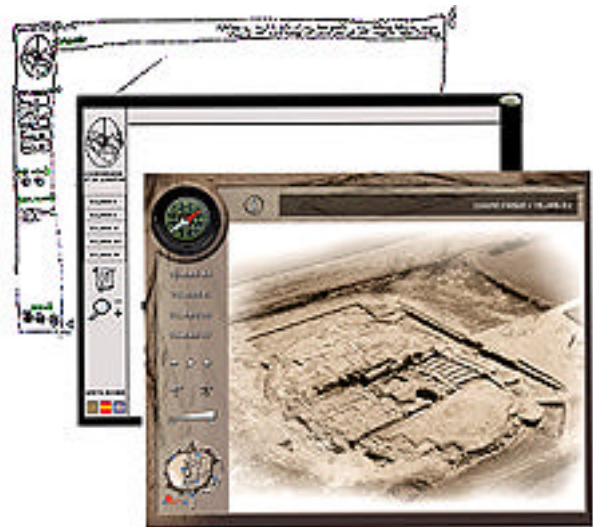


Figure 4: Device prototypes

Scenarios in use

Preece [11] describes a scenario like a fiction story with characters, facts, products and environments. The scenarios help designers to take decisions and to explore ideas and possibilities for specific situations. Like other aspects in design, it is hard to achieve correct scenarios on the first attempt.

The objective of the tasks analysis is the formal description of all the actions users could do to reach a certain goal. Their knowledge, understanding and intentions are modelled. This analysis is focused on usual behavior. Even so, it is good to think of scenarios that represent several situations and points of view. It is important to consider the representation to see what happens in specific situations. Tognazzini [13] states that the use of scenarios allows designers to define and develop knowledge about the users’ scene and their workspace.



Figure 5: Visualization in AR of the “chevaux de frise”

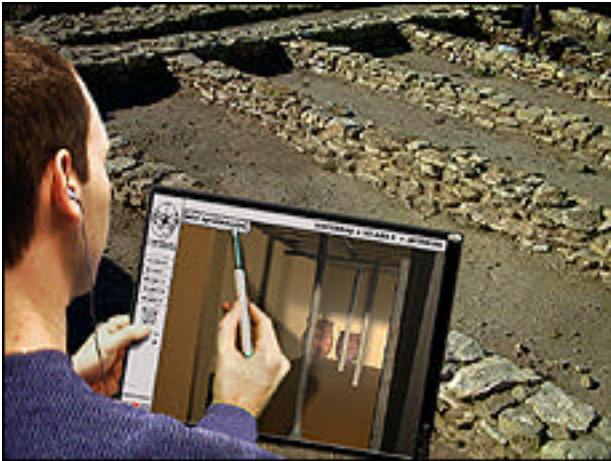


Figure 6: Visualization in AR of a house interior reconstruction

Video prototype

Computer prototypes allow designers to see into a future system in a relatively economical way. But it would not be useful to impress the user's feelings in front of the new experience, simply because the hardware for the new system is not yet available or because it is difficult to make an interactive model for a large system ([9], [3]). In front of these limitations, a video prototype allows us to make the demo without hardware restrictions. Everything works correctly every time the user plays the video. An interesting example of a video prototype is *Starfire* [12] made by Sun [13].

Video prototype allows us both to film a future scenario that we can manipulate during postproduction and to simulate some of the design characteristics that we do not know yet. These postproduction manipulations allow the integration of a multimodal system (multimedia, audio, augmented reality, etc.) and any technology that is still unavailable, which is especially interesting for the development of AR environments.

VISIT TO THE FORTRESS OF ARBECA IN AUGMENTED REALITY

Introduction

In this section we present a future scenario in an augmented reality environment, by means of a video prototype made from a storyboard and its subsequent evaluation. This prototype shows a visit to the archaeological site of Arbeca, previously described.

The device

To represent the scenario, we have designed a computer with the appearance of a tablet; light enough to be carried by the visitor during his tour around the site. With this system, users can choose the language, the kind of visit depending on their knowledge (guided or not); and select the diachronic reconstruction to visualize, also providing further information about the

selected age. The users' orientation and position can be consulted anytime thanks to the six degrees of freedom supported by the tablet; the route they have followed can also be known anytime. To provide the information, the system uses virtual and real pictures, video clips such as text and sound.

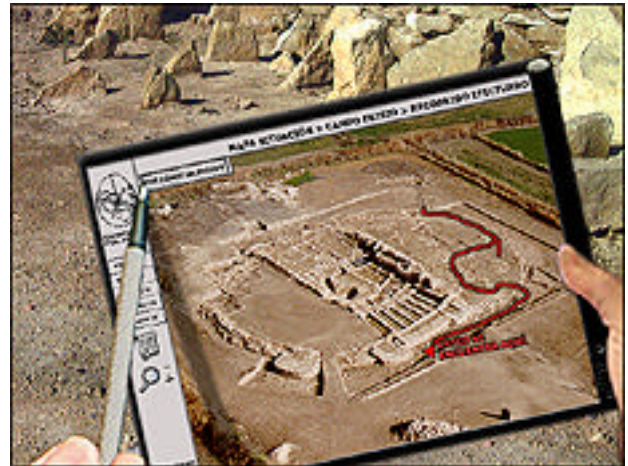


Figure 7: Situation and path visualization

Storyboard and scenario

One of the storyboards recreates the story of a potential visitor of the Arbeca's fortress web site. A map shows where the site is placed and the routes to get there. Through the web site he can also obtain data about the fortress of Arbeca and how to visit it with the help of an augmented reality device.

A proposal of visit to the site in augmented reality:

The visitor decides to go to the fortress. Once there, he approaches the information point placed at the parking where an assistant shows him how to use the tablet.

First, he selects his language and a guided visit, specially indicated for beginners. At the starting point the system offers some information about the Iberian world. The visitor starts his visit.

While the visitor approaches the fortress, the tablet shows the paleo-landscape (a virtual representation of the area surrounding the site at the Iberian age) from the selected time age. He can choose to compare different eras, zoom in and out, acquire more information about Neolithic agriculture, etc.



Figure 8: Visualization of the paleo-landscape in Vilaros 0

Following the path, the visitor arrives at the main door of the fortress. Close to there he can see some stone aligned on the ground, so he decides to consult in the tablet that what is. The device shows that the stones are known as "chevaux-de-frise" and offers the user a computer generated reconstruction and the possibility to obtain further archaeological information about it.



Figure 9: Visualization of the entrance reconstruction

While he is making his way around the site, the visitor can ask the tablet for his exact position at the fortress and the path he has followed so far.

When we reach the main door, the device offers a computer-generated 3D image from the location at the age chosen by the visitor. He can see a more detailed image or a more general one using the zoom tool.

As the user steps through the door, he faces three small walls, not higher than one meter. Interacting with the tablet, it tells him they were houses and provides views of them in the different epochs: how they were internally, the kind of tools used by Iberians, etc.

Once the user understands how people lived in the site, he follows his travel until he reaches the cistern at the center well; there, he sees the square reconstruction in the desired age and zooms out to have a more global view.



Figure 10: Visualization and zoom out facing the cistern

All these actions are reflected in our video prototype, which has allowed us to explore specific situations, analyse them and make an evaluation of this first try.

EVALUATION METHOD

The first loop of the process has been closed evaluating the video using focus group and thinking aloud methods ([2], [6]; [7]; [10]).

First have shown the device prototype

In the first one, a user device design discussion was held with six computer science hardware experts and ergonomists, outlining six different design directions.

The second focus group evaluation was held with five visitors and three archaeologists to address the issue of how to set up the visit.

In both cases, experts, archaeologists and visitors saw the video and device prototypes. Afterwards, they expressed aloud their opinion and discussed about the system and the main idea. Meanwhile, designers took notes about the modifications suggested and the parts of the interface that were not understood by the evaluators.

The results are to be considered in the new prototypes.

CONCLUSIONS

In this paper we have presented a new approach to visit an archaeological site using a future interactive system based on augmented reality paradigm.

Envisioning design is a good methodology in the early design stages of future interactive systems. Based on

that, we have used storyboards, device prototypes, scenarios in use and a video prototype in the design process.

As evaluation methods we have employed observation as a way to get initial requirements from the visitors and two focus group evaluations to get some conclusions to be applied on further prototypes.

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