

Enhancing Cultural Tourism experiences with Augmented Reality Technologies

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Abstract

This paper describes the development of an interactive visualization system based on Augmented Reality Technologies and the integration into a tourist application. The basic idea is the combination of the commonly known concept of tourist binoculars with Augmented Reality. By means of Augmented Reality, the real scene is enhanced by multimedia personalized interactive information to increase the tourist experience of the user, who can retrieve this information by a user-friendly interface.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [Multimedia Information Systems]: Artificial, Augmented and Virtual realities

1. Introduction

The concept of binoculars on hills expecting people to put a coin in to see the surrounding area for a couple of minutes is widely known. They offer an overview over the buildings and streets of an area, nature and cultural sites as well as the chance to zoom tourist assets close to the spectator. The view can increase the interest of tourists in visiting places and can help them choosing further targets to visit later on.

However, it may often be hard to find anything except the nearby woods or the sky in the field of view of the binoculars. Even when a nice looking attraction is found, it turns out to be sparsely interesting because of a lack of sight and information about the resource. People are used to receiving information in an easier and more entertaining way via different channels such as Internet or TV, using hyperlinks to retrieve multimedia information about the required question.

Information and Communication Technologies are becoming one of the most important information tools in the 21st century. Their impact affects the lifestyle, the way of learning and working of the people, as well as the way in which institutions interact with society. Technology has transformed the search for information into a more interactive and fast process, but also has increased the expectations for an information system.

Furthermore, there is a huge amount of information in dig-

ital format, including audiovisual content, electronic texts, multimedia applications or geographical information systems. Up to now, this information is barely used by electronic guides, staying unreachable for the visitor. Moreover, existing multimedia presentations are far away from the real environment which means that tourists need to leave the tourist site to gain additional information.

If tourist organizations want to reach wider audiences, they would have to build attractive multimedia content that attracts tourists. Therefore, new systems that support these innovative applications and provide added-value content are required.

The main objective of PRISMA is the implementation of augmented binoculars, that combine the needs of tourists in real environments and Augmented Reality technologies. The use of these technologies will allow the users retrieving personalized and interactive multimodal information about monuments and historical buildings of a city.

This paper presents the current state of the on-going development process. Section 1 presents a brief state of the art of Augmented Reality technologies and their application to Cultural Tourism applications. The following section includes a brief description of the PRISMA project, including the architecture and main components of the system as well as a presentation of the validation scenario. The current state

of the on-going work is presented in Section 3. Finally, Section 4 presents some conclusions and further work.

2. State of the art

Until recently, Virtual Reality (VR) technologies were one of the most outstanding technologies. The basic idea was the total immersion of the user in a virtual world generated by a computer. Although this concept is currently one of the most popular with multiple application domains, the main disadvantage of VR is that there is no relationship between the user and the real world. Therefore, Augmented Reality technologies are becoming increasingly popular, not only among the scientific community but also for the general public.

Augmented Reality is a variation of Virtual Reality [Azuma97]. Compared with Virtual Reality, Augmented Reality enhances the real world instead of replacing it. The user can view the real world enhanced with additional 3D graphics superimposed to his/her field of view. The possibility of combining real and virtual objects will allow a huge amount of applications.

This enhancement is achieved by virtual objects added to the environment or by non-geometric information about existing elements. Ideally, the user perceives that real and virtual objects coexist in the same place. These augmented systems combine the virtual and real, are interactive in real time and can handle 3D objects.

One of the most important requirements for the development of Augmented Reality technologies is the development of the required components. Currently, most of the Augmented Reality systems are on an academic stage. An emerging area for the application of these technologies is the open door environment.

Museums and art galleries already use digital technologies for the collection, preservation, exploration and diffusion of Arts and Cultural Heritage. However, parallel to the development of the concept of cultural park, Augmented Reality technologies are gaining a great importance on the virtual reconstruction of historical monuments, helping curators, archaeologists or historians to reproduce on site historical places as they were in their golden period.

It is obvious that applications within the Arts and Cultural Heritage should fulfil different requirements, such as the attractiveness and user-friendliness for the user, an educational value, the reusability of the data and the global availability. In the future, it will be possible to walk without a human guide through an exhibition, museum or historical site, exploring the environment and getting personalized information about the profile of each visitor.

One of the most interesting issues provided by Augmented Reality technologies for the diffusion of the archaeological heritage is the possibility of simultaneous visualization of the real resources and the virtually completed images. This has a great impact on the knowledge about history,

about the effects of time over materials, as well as the preservation of the resources that may have to be reconstructed physically.

Nowadays, a great number of institutions is facing the challenges of Augmented Reality. Among them, the Institute Fraunhofer for Computer Graphics (Fraunhofer IGD), Centre for Computer Graphics (ZGDV), University of Munich, University of Hannover, and more other institutions; in the USA, the MIT, the HRL Lab, Carnegie Mellon University, Columbia University, Rockwell Research and for Japan Sony Computer Scientific Laboratory.

Examples of Mixed Reality systems are the following.

- Augmented walks. In these walks, visitors are placed in the real environment and are able to view the real world and 3D reconstructions of monuments. This can be achieved by screens that receive the real scene via a camera and add the 3D models, or by HMDs so that visitors that walk through the real environment can see the virtual monuments.
- Ename 974. This project uses the TimeFrame technology to generate the 3D models of the monuments of the archaeological sites and allows the presentation of these environments to different profiles of users. A kiosk protects the system and the visitors. The system superimposes the real scene with 3D reconstructions of monuments and displays the result on a visualization device.
- Archeoguide. This IST European project provides the user with a walking experience through a cultural environment so that he/she can observe the real world, visualize 3D reconstructions of monuments and gain additional information during his/her visit by a multimedia virtual guide [GleDah01].
- Several national parks in the US have also added Augmented Reality stations to view archaeological sites on far distant cliffs and other inaccessible locations. The telescope-like device superimposes animations, virtual recreations and other information over real fossil remains.

3. The PRISMA project

The aim of PRISMA is the design, development and implementation of a new 3D visualization device based on Augmented Reality technologies for Cultural Tourism applications. The prototype will be validated and evaluated in a real Cultural Tourism destination.

The key issue of PRISMA is the combination of the commonly known concept of tourist binoculars and Augmented Reality technologies. By means of these technologies, the real scene can be enhanced by virtual information in order to increase the experience of the user and to provide added value interactive personalized multimedia about the current view.

The proposed Augmented Reality techniques are highly

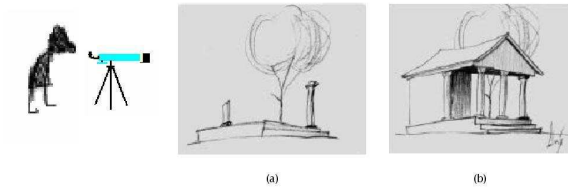


Figure 1: Augmented Reality visualization system: a) Real image; b) Augmented image shown in the binoculars.

visual and interactive in order to access and understand Cultural Tourism information. These technological approaches are not an alternative to real environments but an added value, so that the visitor could experience the story behind the real environment in a personalized way.

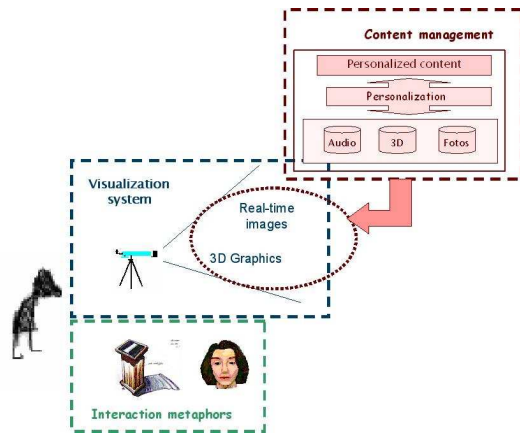


Figure 2: Schema of the application from the user point of view.

Our emphasis within this project is focused on developing experimental user interface software, not on designing hardware. Therefore, we are using commercially available hardware throughout. PRISMA presents the information related to tourism from a new point of view, allowing tourists interacting with multimedia information. Therefore, another objective of PRISMA is the assessment of the acceptance of the new Information Technologies in tourism environments, implementing different user profiles and typologies. A further benefit of the project is the generation of knowledge about human behaviours in tourism environments, identifying the usability of technological tools.

Cultural Tourism is supposed to be one of the upcoming key areas for launching and reinforcing cultural industries. PRISMA includes the validation of the prototype in a real scenario, in order to evaluate the user behaviour and satisfaction when facing a new concept in tourism and leisure.

3.1. Architecture

PRISMA is basically a video see-through visualization system composed of a camera to record the real time video stream, binoculars as the visualization device and an inertial sensor to track the point of view and rotation of the binoculars.

The field of view of the spectator is captured by the camera mounted on the binoculars and sent to the processing unit, where graphical data is added and the augmented stream is sent back to the binoculars screens.

The tracking of the system is achieved by inertial sensors, which capture and record the current location and orientation of the binoculars. The central processing unit converts these data in an orientation vector. The virtual camera is controlled by means of this vector, allowing the synchronization of the images according to the real world. This synchronization allows composing the real and the virtual parts of the augmented view.

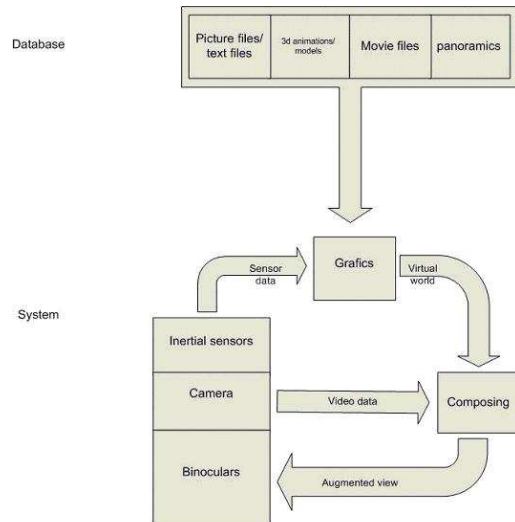


Figure 3: Architecture of the PRISMA project.

One of the main aspects of the scientific research is devoted to the way in which the virtual world is better built in order to achieve optimal results in the composition with the real scene. Displaying just 2D or other rather simple objects avoids the considerations of a very precise perspective rendering of these objects. However, the virtual objects still need to be fixed at the corresponding spots in the real scene and resemble the distance of the objects from the point of view of the user. Due to these reasons, a method to place objects into the virtual part of the scene has been developed.

3.2. Validation scenario

A tourist is typically a person with little or no knowledge of the environment. However, tourists have a strong interest in their environment and also want to navigate through their surroundings to visit different locations. An overview from one of the hills of Donostia-San Sebastian city in the North of Spain has been chosen as the real validation environment.

The binoculars will be placed at the middle height of the hill to allow tourists and also local citizens to "visit" some of the interesting cultural and tourist resources of the city and to gain personalized multimedia information about these resources. The prototype provides a navigation aid that directs the user to a target location and an information browser that displays icons that can be selected to gain more detailed location-based information in a variety of multimedia formats.

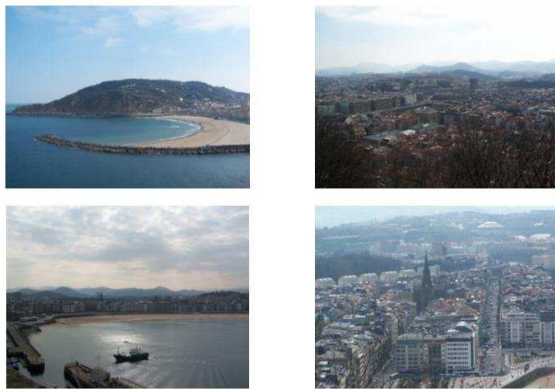


Figure 4: Panoramic overviews from Urgull hill (Donostia-San Sebastian, Spain).

As it can be seen in Figure 4, two of the main tourist attractions and resources of the city are the Cathedral and Santa Clara Island in the middle of the bay. PRISMA will allow tourists to gain multimedia personalized information about these and other tourist resources, including textual information (timetables, directions, telephone numbers), 2D photographs and maps, or even videos and 3D reconstructions.

4. Augmented Reality System

4.1. Technical description of the system

PRISMA is basically a video see-through visualization system composed of a camera to record the real time video stream, binoculars as the visualization device and an inertial sensor to track the point of view and rotation of the binoculars. Our current setup uses a 5DT HMD 800-40 Head

Mounted Display fixed to the structure as an output device. An Intersense Inertiacube2 orientation sensor for inertial tracking is also mounted on the structure.

We use ARToolKit as a software platform for developing the applications. ARToolKit is a software library for building Augmented Reality applications. It offers the possibility to augment a video stream with graphical objects. The graphics supported are principally OpenGL ([Shreiner04]), but also a VRML import exists which gives the possibility to import 2D as well as 3D objects and animations.

The ARToolKit is based on marker tracking that detects special markers in the video stream by means of computer vision algorithms and calculates the real camera position and orientation relative to the physical markers in real time. As the tracking used in PRISMA depends on inertia sensors fixed to the binoculars, the ARToolKit has been modified.

4.2. Main matrix transformations

A crucial issue in graphics programming is the transformation process between the 3D coordinates of the scene onto the 2D screen. This process is similar to the process of taking a photograph with a camera or also to the process of recording a video. This is a very important aspect in augmented applications, because both of the previously mentioned aspects are merged.

Four steps are required for all vertexes in the scene:

- Viewing transformation by setting up the tripod and pointing the camera to the scene;
- Modelling transformation by arranging the scene to be photographed into the desired composition;
- Projection transformation by choosing the lens of the camera or adjusting the zoom; and finally
- Viewport transformation by determining how large the final photograph will be.

The transformations are performed by means of matrix multiplications.

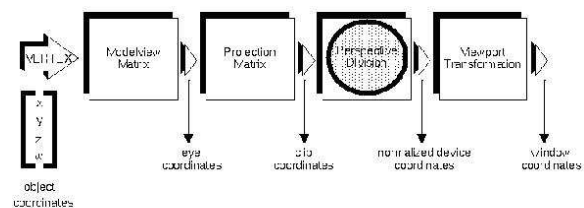


Figure 5: Stages of vertex transformation.

4.3. The Augmentation process

The considerations about the way in which the virtual world should be preferably built to achieve best results in the composition with the real scene led to the following conclusion.

The virtual objects need to be fixed at the corresponding spots in the real scene and resemble the distance of the objects from the spectator. Therefore, the perspective rendering from all point of views can be guaranteed.

Due to these reasons, a method to place graphical objects into the virtual part of the scene by means of a spherical surrounding has been implemented. This method allows adding the virtual objects into the scene, providing information about the angles they differ from a fixed Zero-View-Vector and their approximated distance from the spectator.

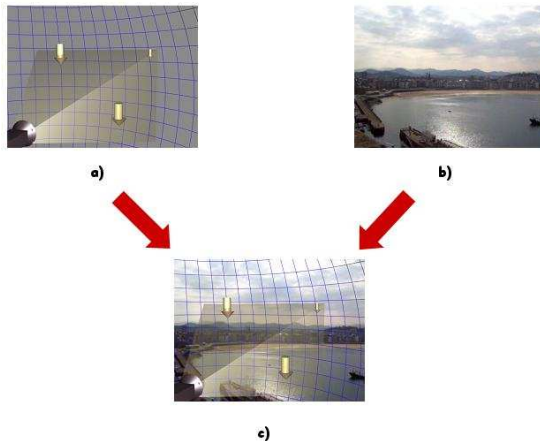


Figure 6: Building the Augmented view: a) The virtual world; b) The real world; c) The Augmented view.

Afterwards, the virtual world built in such a way is merged with the real one and the virtual camera is controlled by the inertial sensor data in order to move the same way as the real camera does.

As mentioned before, the virtual camera movement is controlled by the data received from the inertial sensors to synchronize it with the real camera. Sensor data is plainly transformed into two float values corresponding to the horizontal and vertical shifted angles from a reference position. These values are added to a simple "Cameramove" method which is called before all other drawings in the scene.

The demo has been tried without any sensor data; instead, the movement of the virtual camera is emulated by some time function to synchronize it with the velocity of the real camera. Since hand cameras in general are not that stable in their velocity, the demo is still a little shaky but gave an impression of how the system would be working later on.

4.4. Interaction

PRISMA provides different added value multimedia content, so that the user can choose what kind of information he/she is interested in among a previously personalized content. By clicking on the screen, a pop-up menu appears that

provides choices among different fields of interest, displaying the proper augmented content.

As the user sees an interesting object about which he/she would like to get more information, it is enough to click on the marker of the object and the possible choices are shown in a menu that provides information about the possibilities. The information provided is completely multimedia, including texts, 2D pictures (maps, old photographs), movie clips or even 3D models of existing and non-existing tourist attractions.

5. Conclusions and further work

Further considerations are to add the option to for example see the surrounding area in different states of the year, i.e. with snow, or in summer, or without clouds. The system also gives the possibility to combine the augmented reality aspect with a virtual immersive enhancement.

By selecting an object of interest for example a cultural building in the area an virtual walkthrough could be started. That would port the user from the real position into the building letting him move around there and contemplate the virtual interior of the building.

Also thinkable is the possibility to by choosing special marked positions in the area to virtually zoom there and offer a panoramic view from that position, in which the user can navigate using the binoculars.

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