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An Augmented Reality Presentation System for Remote Cultural Heritage Sites

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Abstract

Museums often lack the possibility to present archaeological or cultural heritage sites in a realistic and interesting way. Thus are proposing a new way to show augmented reality applications of cultural heritage sites at remote places like museums. In the exhibition space large wall-filling photographs of the real site are superimposed with interactive contextual annotations like 3D reconstructions, images and movies. Therefore we are using two different hardware setups for visualization: Standard UMPCs and a custom made revolving display.
The setup has been installed and tested at SIGGRAPH 2008, Allard Pierson Museum in Amsterdam and CeBIT 2009. Museum visitors could experience Forum Romanum and Satricum in an informative and intuitive way by pointing the video see through devices on different areas of the photographs. The result is a more realistic and entertaining way for presenting cultural heritage sites in museums. Furthermore our solution is less expensive than comparable installations regarding content and hardware.

Categories and Subject Descriptors (according to ACM CCS): Methodology and Techniques [I.3.6]: Interaction techniques—; Installation [I.3.m]: —;

1. Introduction

Archeologic museums are mostly presenting cultural heritage artifacts from remote places. Excavation sites where the artifacts come from are either far away or not existing anymore. Hence the findings are brought to museums for analysis, restoration, storage and presentation to the public. Thus the findings are disconnected from their original place and context.

With our approach we are proposing a way to reconnect the excavation site with the artifacts in the museum in order to enable contextual awareness of the visitor. Therefore we are bringing the original site back into the museum as a large scale photograph and superimposing it with augmented reality (AR) information layers. These layers consist of contextual informations like text, images and movies on the one hand. And on the other hand of 3D reconstructions and historical drawings positioned seamless into the real view.

The result is a kind of wormhole to the excavation site or the site in its original appearance. Thus it enables not only contextual information of remote locations but also locations of the past.

The visualization method we are using is augmented reality, a technology for presenting locative information superimposed on the real view. It combines the real-world and computer-generated data. Thus computer graphics objects are blended into real view in real time. The results are for example 3D reconstructions of monuments blended over ruins or icons, placed in the environment with contextual information. There are several technologies to display the overlays. A common and immersive way is to use head mounted displays (HMD). There are video see-through HMDs where an integrated camera films the environment and shows it on the micro-displays in front of the user's eyes. Optical see-through HMDs are projecting the digital content onto a semi-transparent layer in front of the eyes. In our solution we are using video see-through tablets. This means that a display or mobile computer displays the image of its camera on the back on its screen in order to get the effect of looking through the display. Our poster tracking [ZPP*08] recognizes the environment, calculates the camera's position and orientation and superimposes the overlays at the right spot.

Our paper is structured as follows: We are starting an overview of related work in section 2. Section 3 is a global overview of our system's components and explaining the authoring of information overlays. In the final section 4 we are presenting projects in museums and trade fairs based on our system.

2. Related Work

There have been many approaches of mobile on-site information systems as well as museum-based 3D simulations of cultural heritage sites in the past. To only name some of them there is the early mobile augmented reality project Archeoguide [VKT*01] where ancient greek architecture and ancient Olympic sports events were displayed as visual overlays through a head mounted display direct at the site. Large and heavy bagbacks with high technology gear, large GPS antennas and heavy uncomfortable head mounted displays were needed in order to reach the goal of positioning the user at the site and displaying context sensitive information on the spot.

Most of the tracking technology and some of the interaction concepts used in our approach were developed within the iTACITUS [iTA08] project funded in 7th Framework Programme of the European Union. Historical media like drawings and paintings were superimposed on real buildings and walls of cultural heritage sites via video see-through on UMPCs. For the positioning of the overlays poster tracking zoellnerRF based on randomized trees [LLF05] and KLT [TK91] was developed.

With Rome Reborn [Fri06] a digital 3D model of the ancient Rome was reconstructed in photorealistic quality. Due to it's manyfold distribution channels, like museum installations, films and Google Earth, it reaches millions of people visiting museums but also at home in front of the TV or computer. Furthermore its availability via Google Earth generates a social network around ancient Rome by adding user generated, locative information layers to the model.

3. Description of the system

Our system consists of three parts. The stationary part consists of one or more large scale images on the walls of the exhibition. While the dynamic part is shown on visualization devices like UMPCs or a revolvable video see-through display controlled by the visitor. Via these interaction devices we are superimposing locative, digital information overlays on top of the background images.

3.1. Static part: Large scale images

The static large scale images on the walls of the exhibition represent the cultural heritage or excavation site. They are bringing the sites' past or present aura back into the museum. The kind of media is dependent on the site, the time and the topic. Photographs, drawings or plans of the area are the most common media in our context. Combinations of images showing different angles and views improve the local perception of the original site. For example two photos arranged on two walls of a corner enable a 180 degrees view of the site. Moreover a panorama photo of the site together with an excavation plan or a satellite map increases the spacial impression of the original place.

3.2. Dynamic part: User controlled visualization devices

In this section we are describing two video see-through devices we are using to visualize the digital information overlays on the background images. For the positioning of the overlays on the screen we are using markerless poster tracking based on randomized trees [LLF05] and KLT [TK91] like described in our previous work [ZPP*08].

3.2.1. MovableScreen: A revolvable AR display

With the MovableScreen we developed a stationary augmented reality see through device. It consists of a 24" iMac mounted on a revolving aluminum pillar. Visitors are standing in front of it and can grab the display's edges to rotate it around 360 degrees. The image of a camera on the back of the pillar is shown on the screen and thus enables the video see-through effect: It's seems like one can look through the display and the pillar. Thus the visitors see the large photograph in the background and the screen superimposed with information overlays.

Interaction with the points of interest is simple: While the visitor looks around by rotating the MovableScreen, the POI in the middle of the screen pops up a bubble with an image slideshow or a movie. Furthermore a description text appears on the screen.

3.2.2. UMPCs: Mobile augmented reality tablets

The UMPC simulates how these applications are working on the real site outdoors. It features video see through effect, too. Looking on the UMPCs screen seems like seeing though it and looking at the two photographs. When focusing a POI with the cross hair in the middle of the screen, again a bubble with a preview of the underlying information pops up. Touching that bubble enables a full screen view of movies, image slideshows and description text about the POI. Thus the visitor can put down the UMPC and take his time in order to read the information and start focusing the next POI afterwards.

3.3. Information overlays

Applications with information overlays are written in the industry standard X3D [Web08] of the Web3D consortium.

Figure 1: *The revolvable display MovableScreen (left) and a UMPC (right) showing superimposed digital information layers on the two photographs in the back.*

This is very convenient for content producers who are familiar with web content like HTML. In order to keep scenes short we encapsulated often used functionalities in X3D Prototypes. X3D Prototypes are comparable to classes in other programming languages. Once instantiated, they can be reused with different parameters. This shortens the length of the scenes and thus provides a better overview. Furthermore this helps the AR authoring to produce X3D code from future visual editors or template engines.

Our prototypes provide common features of augmented reality overlays in a single X3D node. Our Actor prototype produces a character in the AR scene at a certain position that plays an audio file once the user points at it. The author has to define the parameters of the node like the character?s picture (texture), an audio clip and the position relative to the background image.

```
<Actor image="Textures/character_01.png"
sound='Sounds/character_01.wav'
position='100, 0, 15' />
```

The View Master prototype adds the metaphor of old tourist plastic cameras [Saw39] with a disc of photo slides of attractions inside. We are using it for example for visualizing urban grain plans of Berlin on a satellite image (see section 4.2). Once the user touches the plan on the screen another overlay slides over the satellite image from right to left. In the declaration of the prototype the author defines different overlay textures, text per overlay and the position.

```
<Viewmaster image='"Textures/overlay_01.png",
"Textures/overlay_02.png"'
position='-200 0 0' />
```

OverlayBubble is a prototype for locative annotations in the scene. They are spread over the background image as icons. Pointing at an icon opens an information bubble (see figure **??**) next to it with images, slideshows or movies with further information about the spot. The author defines one or several images or a movie for the content of the bubble. If no icon is defined a standard icon will be used. Furthermore the position of the icon has to be defined. Otherwise it will be placed in the centre of the background image.

```
<OverlayBubble image='"Textures/bubble_01.png",
"Textures/bubble_02.png"'
icon='Textures/icon_information.png'
position='50, 15, 0' />
```

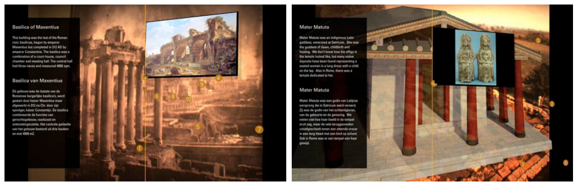

Figure 2: *Two large photographs of Satricum and Forum Romanum in the exhibition are superimposed with contextual informations*

4. Results

4.1. Rome Reborn at SIGGRAPH 2008

The outcomes of Rome Reborn project were presented at an own booth in the exhibition area of SIGGRAPH 2008 [SIG08] in Los Angeles. In the center there was a large floor map of the ancient Forum Romanum. We presented 3D models of roman monuments via UMPCs on this floor map. User's walked around and pointed with the UMPCs camera on the floor. As soon as the poster tracking recognized parts of the map a 3D model was rendered in the right position on the video see-through screen (see figure 5). It seemed like monuments like the Colosseum stood knee-high in front of the visitors. Thus it enabled the visitors to explore Forum Romanum on a walkable map of the site.

Figure 3: *Visualization of the Colosseum on a floor map of Forum Romanum via video see-though on an UMPC.*

4.2. 20 Years Fall of the Berlin Wall

Urban grain plans are visualizing the urban development of cities. They show black areas covered with buildings and white empty areas. An animation of urban grain plans of different years renders a stop-motion movie of the cities development and changes over time. For this years anniversary of "20 Years of the Fall of the Berlin Wall" we created an installation at CeBIT 2009 showing Berlin's urban development from 1940 - 2008 and the course of the Berlin Wall. Therefore we mounted a satellite image of Berlin's center on the surface of a large knee-high table. Via video see-though augmented reality on UMPCs we were superimposing the digital grain plans on the satellite image. The user may switch through the different year's visualizations by touching the screen. Thus he recognized the situation of Berlin before and after the destruction during World War II, after the separation and construction of the wall and the current situation of Berlin after 1989. Next to the grain plans we were showing a 3D model of the Berlin Wall to describe the differences of the eastern and western parts.

Figure 4: *Urban grain plans superimposed on a satellite image of Berlin's center.*

4.3. A Future for the Past at Allard Pierson Museum

Allard Pierson Museum in Amsterdam hosts exhibitions about archaeology and the ancient civilisations of Egypt, the Near East, the Greek world and the Roman Empire. The exhibition "A Future for the Past" marks the museum's 75th anniversary. It is bringing together the past, present and future by using state-of-the-art visualisation techniques for reviving archeology. For this exhibition we created an installation to present two excavation sites with augmented reality technology in the museum: Satricum and Forum Romanum.

In order to tell the stories about the two sites we put two large photographs on the walls of the exhibition space and superimposed them with information via augmented reality. We used a copy of one of the oldest photographs of the Roman Forum from Allard Pierson's collection, with visible excavations, preserved as a glass negative. The picture has been dated in 1855. On top of this photograph several points of interest (POI) are superimposed: Temple of Saturn, Via Sacra, Colosseum, etc. Each POI reveals information via context sensitive media like photographs, slideshows or rendered images of Rome Reborn reconstructions.

Satricum is situated 60 km south of Rome and started in the 9th century BC as a Latin village on an acropolis, a higher place near the river Astura. It had a temple hut, that was converted into a small stone building. Around 540 BC, a first temple was build. It was replaced only 40 years later by a larger temple, that probably existed another four centuries, although the city had already been destroyed by the Romans in 346 BC. A 3D reconstruction of the first temple augments today's photograph of the excavation site in the background. Several points of interest around the temple are showing media overlays and information about excavations, artifacts, the temple construction, and records. Both applications are presented on a stationary and a mobile hardware device: the MovableScreen and UMPCs (see section 3).

Figure 5: *Two large photographs of Satricum and Forum Romanum in the exhibition are superimposed with contextual informations*

5. Conclusions

In this paper, we have presented a system for a better showcase of information about cultural heritage and excavation sites inside museums. Therefore we described our setup consisting of large static images superimposed with digital information layers via augmented reality interaction devices like UMPCs and MovableScreen. In the end we showed the resulting projects and our experiences. In future versions we will port the system on smartphones like the iPhone, the Android platform and Palm's Pre. Thus museums would not have buy custom devices or lend UMPCs but the information would be available on visitor's own handsets.

6. Acknowledgments

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References

[Fri06] FRISCHER B.: New directions for cultural virtual reality: A global strategy for archiving, serving, and exhibiting 3d computer models of cultural heritage sites. In *Proceedings of the Conference, Virtual Retrospect 2005 (Bordeaux)* (2006), pp. 168–175.

[iTA08] ITACITUS: Intelligent tourism and cultural information through ubiquitous services, 2008. http://www.itacitus.org.

[LLF05] LEPETIT V., LAGGER P., FUA P.: Randomized trees for real-time keypoint recognition. *Conference on Computer Vision and Pattern Recognition 2* (2005), 775–781.

[Saw39] SAWYER'SPHOTOSERVICES: View-master, 1939. http://en.wikipedia.org/wiki/Viewmaster.

[SIG08] SIGGRAPH2008: Evolve, 2008. http://www.siggraph.org/s2008/.

[TK91] TOMASI C., KANADE T.: Detection and tracking of point features. *Carnegie Mellon University Technical Report CMU-CS-91-132* (Apr. 1991).

[VKT*01] VLAHAKIS V., KARIGIANNIS J., TSOTROS M., GOUNARIS M., ALMEIDA L., STRICKER D., GLEUE T., CHRISTOU I. T., CARLUCCI R., IOANNIDIS N.: Archeoguide: first results of an augmented reality, mobile computing system in cultural heritage sites. In *Virtual Reality, Archeology, and Cultural Heritage* (2001), pp. 131–140.

[Web08] WEB3DCONSORTIUM: *X3D*, 2008. http://www.web3d.org.

[ZPP*08] ZOELLNER M., PAGANI A., PASTARMOV Y., WUEST H., STRICKER D.: Reality filtering: A visual time machine in augmented reality. *VAST 2008. Proceedings* (December 2008).

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