Virtual Museography for an Archaeological Site

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Abstract

This paper describes a project involving an archaeological museum in which only digital reproductions can be exhibited. The archaeological settlement under study is a Mayan site deep inside an isolated ecosystem where trees cover court yards and structures while archaeological findings cannot remain on site for exhibition. Due to the impossibility of showing the site's real attractions, the participants have developed the first virtual museography in Mexico composed by virtual reality environments as virtual mock-ups, an augmented reality installation to show the hypothetical aspect of one of the uncovered tombs, and several PC kiosks used as virtual showcases to exhibit archaeological findings in an interactive way.

1 Introduction

The project described in this paper has foreseen the design of a site museum with digital reproductions, to alleviate the difficulties that visitors face in the appreciation of the urban design of a Mayan city as well as the impossibility of exhibition of its priceless findings.

The ancient settlement chosen for this project, Calakmul, is partially covered by a protected forest. Its buildings stand almost hidden from each other, making it very difficult for visitors to grasp the architecture and urban layout of the site. The solitude of this distant archaeological site represents an additional problem for the safekeeping of its priceless findings, so none of them are exhibited on site.

In order to achieve a better understanding of Calakmul's culture, the participants have developed Virtual Reality (VR), Augmented Reality (AR), and VRML interactive three-dimensional (3D) replicas.

This document explains the aims of our project, including: the special issues we faced in the process of creating a VR mock-up that would be affordable to a museum, how AR has been used to show one of the greatest findings of the site, options to show archaeological findings in an interactive way, and the seeming future of the project.

2 Project

Calakmul's archaeological site located in the State of Campeche, Mexico, is deep inside the largest protected ecosystem of the country. Its safety and physical conditions are not about to change because no towns are allowed to be built inside the ecosystem and trees are not allowed to be cut down. This means that its solitude will never permit its archaeological findings to safely remain on site for exhibition, and that the structures will remain partially hidden from each other. Therefore, Calakmul has served as an ideal project that joins several visualization problems, which are solved remarkably well by virtual reconstructions.

In this application, VR functions in a unique way because it is the only way for visitors to comprehend the urban design of the site. Even walking by the city with a map and an archaeologist, a visitor can hardly understand the distribution of buildings along the walkthrough. A VR mock-up stands as an extremely useful tool for visitors.

The use of AR in this project has emphasized the temporality of the most important tomb discovered on site. It presents a past view of the tomb with a virtual recreation about its hypothetical original appearance, and superimposes that recreation over a view of the present remains. The rest of the archaeological findings will successfully be exhibited with virtual reproductions in an interactive way. This indicates a solution for both interactive virtual exhibitors and digital archives.

3 Virtual Environments

Figure 1. View of Calakmul's buildings covered by trees.

When a virtual environment (VE) was proposed to serve as a virtual mock-up for visitors to the archaeological site, it was clear that no sophisticated equipment could be used. Previous experience with SGI platform gave us enough feedback to know that it was not reliable for a regular museum (Addison 2004) Equipment costs, maintenance, and the need for qualified personnel to operate it are out of any conceivable budget. Trying something that could work for PCs, we started working with game engines before developing a proprietary visualization tool. Original archaeological surveys were successfully embedded over the editors of two game engines, Unreal and Nebula. The Unreal environment permits us a free wandering all over the structures while Nebula's environment lets us add a user interface with C++ language. For both cases, the same 3D files could be used by paying attention to special considerations during the modeling and texturing process.

3.1 Modeling and Texturing Considerations

Special concern was placed on format compatibility through out the process. We were committed to using the same surveys developed for the archaeological reports and keeping models useful for any further applications. The project pursues the replication of the experience in other archaeological spots by standardizing the use of digital surveys and archiving at the National Institute of Anthropology and History.

The 3D models were made in AutoCAD from accurate archaeological data while texturing was completed in 3ds Max. Absolute coordinates were observed; every building is placed in its exact position, orientation, and scale in reference to an absolute origin for all files. Topographic measurements and GPS data were acquired to place every building in its exact position. Observing absolute coordinates in every individual file allows a simpler handling of the archives, its weight, and eventual upgrades. When VR final files are composed, each imported structure takes its particular position.

The construction of models was made by layers, dividing items by the color of their surfaces in the VR application. All items sharing a common finishing or material were placed in a specific layer. This meant a layer for red walls, another for white walls, a layer for floors and stair steps, and so on. Splitting layers by final materials in AutoCAD files obeys texturing criteria. When files are imported into 3ds Max, each layer is identified as an individual item. During the mapping procedure, when a material is assigned to each item, all surfaces (e.g., walls) in a same layer automatically take on the same material. Only "Standard" materials were used since the "Multi-Sub-Object" type does not work. The resolution of the images used to texturize the surfaces of buildings and billboards depends on the final program planned as a visualization tool. Both Unreal II and Nebula read only bicubical 8-bit images.

3.2 Game Engines as a visualization option

Figure 2. Interactive map to choose a structure to visit.

Nebula. The open source nature of Nebula permits the use of C++ language. This gave the project a unique opportunity to build a useful application for a kind of visitor that is not very confident with computer interaction. Instead of walking around the environment by moving a mouse or joystick, the user only needs to click over a sensitive map on a touch screen to select a building and the environment, which takes him/her automatically towards the selected point. The action is taken by the camera which follows the path to the selected pyramid pointing to the guide's head.

The application works with two computers connected by sockets; one shows an interactive map (computer A) while the other displays an immersive view of Virtual Calakmul (computer B), which is a view that represents the player's view at eye level standing in front of the buildings. This view is usually called "camera view" or just "camera."

Instead of using artificial intelligence to move the camera-view from one point to another, NURBS paths were placed from each structure to all of the rest. This trick moves the camera-view from one structure to any other emulating a smooth walkthrough. The camera is ordered to point towards the center of the building while steady, and it is programmed to keep the path direction while in movement. As soon as the camera arrives at its final location, it is programmed to release the guide and focus once again on the structure at the end of the path.

Unreal II. Unreal's environment is suitable for a visitor who is willing to climb temples and wander all over the site. It presents a nocturnal version of Calakmul complemented with fire torches that give the scene a sense of being inhabited. As well as torches, moving water and grasses are part of Unreal II realistic features, which is why this game engine is a splendid tool for work teams without programmers. Adding these features allowed us to show the attractiveness of a part of the ecosystem and emphasize the aims of preservation.

To import models to Unreal's level editor, 3ds Max should be exported to .ase format. The textures used to map the geometries within Max are separately saved as .pcx files in Photoshop or any similar software and imported to Unreal's editor to constitute the Texture Library. The Texture Library needs to be done before importing geometries. Unreal II reads only images saved in .pcx and .tif format (.tif images for those that have an alpha channel to provide transparent areas), which is why images should be translated to .pcx format before importing them into Unreal's editor. Unreal only reads the name of the image file so, even though the texturing within 3ds Max has been done with another format (e.g., brick_1.jpg), there is no need to repeat texturing with .pcx images. As soon as models are imported to Unreal, the program recognizes the texture file name and applies it without changing its UV coordinates.

The process to import geometries to Unreal starts by

Figure 3. VE view while the automatic walkthrough approaches the chosen structure.

Figure 4. View of Unreal's version of Calakmul.

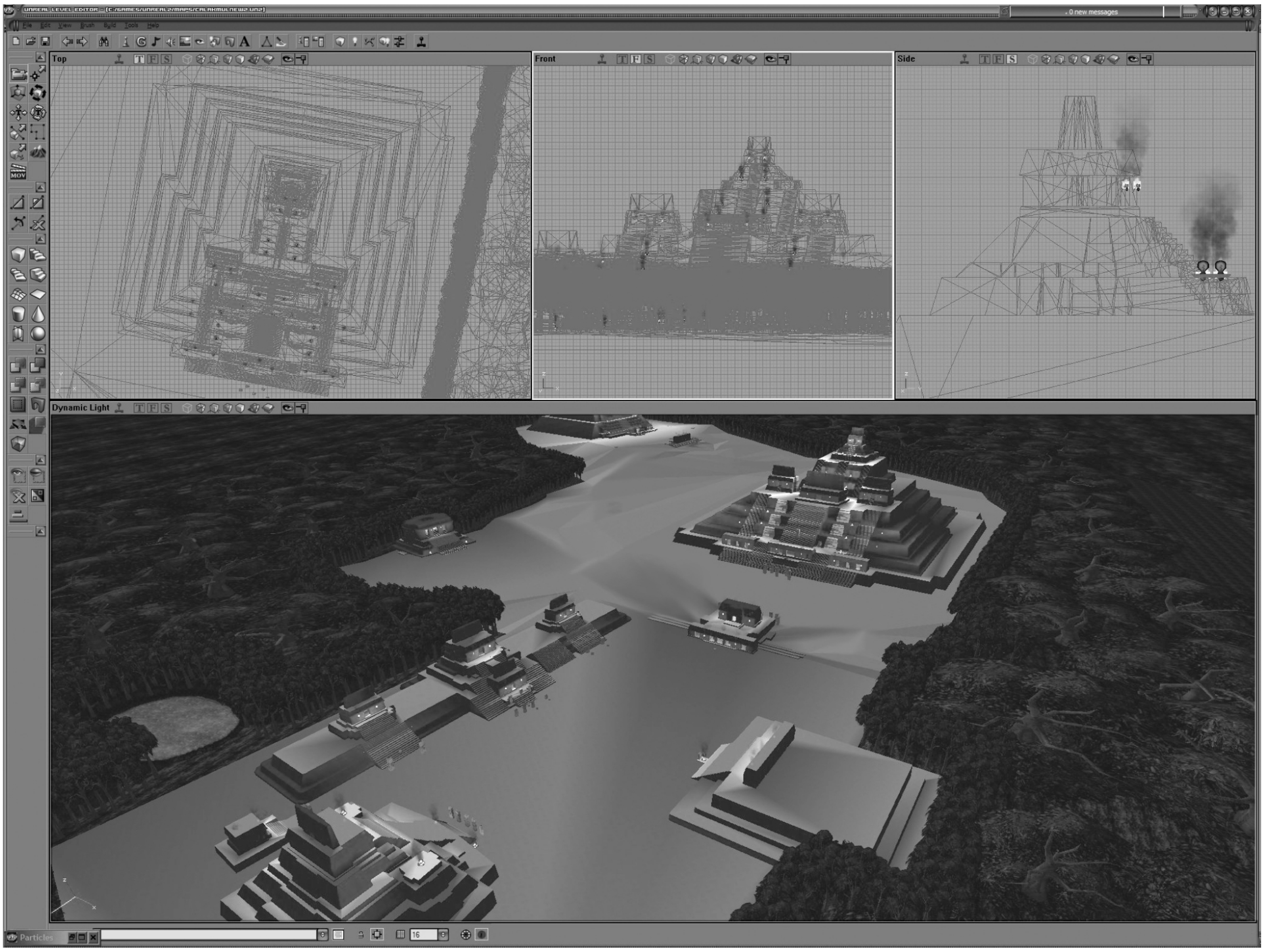

Figure 5. Static Meshes from accurate files as seen is Unreal's level editor.

exporting each object that constitutes the environment inside 3ds Max. These objects are exported to .ase format and consecutively imported to the Unreal level editor. Unreal arranges geometries in a package or library called Static Meshes. Each item from the Library is taken to the game's level where it will automatically take its own position according to its absolute coordinate reference.

Scale is something that needs to be mentioned. In order to keep the player eye level to a real proportion, the source files should be enlarged 65 to 1.

Regardless of the engine's great look, there is still a huge disadvantage to the use of Unreal. Even though the level editor of Unreal 3.0 is the same for Unreal II, Unreal Tournament 2003 and Unreal Tournament 2004, the environments made within an engine cannot be opened in another version. Since lights, shadows, special effects, and vegetation are added inside Unreal's editor, too much work must be repeated to transfer an environment.

4 Augmented Reality Tomb Recreation

Among the 18 tombs discovered so far in Calakmul, the funeral chambers of King "Jaguar's Claw" is one of its main findings. The king was buried with all his jade jewelry and his personal belongings. Extremely careful recovery of this burial has delivered a reliable theory of how this mummy was laid out during 8th century.

Augmented Reality works splendidly here, for we can give the visitor two different views of the same situation. Over a physical reproduction of the actual condition of the funeral chamber, AR places a digital superposition of the no-longer-existing elements as they supposedly were.

The installation uses ARToolKit software developed by Hirokazu Kato and Mark Billinghurst (Billinghurst nd). ARToolKit calculates the position and orientation of a webcam relative to a pattern inside a square of specific proportions. The input information from the environment is provided to the computer by a webcam and the video data is converted to a high contrast image. The software's algorithm searches the high contrast video input for possible patterns. It also identifies the orientation that this pattern has in relation to the original orientation saved for it. Once the pattern, its relative position and orientation, are identified, a corresponding model is placed on top of it with the same position and orientation.

The entire burial is recreated with all its offerings as a solely 3D model to be rendered in an empty physical reproduction of the original funeral chamber.

Since museum visitors will be placed in different positions around the installation, three different patterns will call the same model (whole burial) saved in three files from different origins.

Since the ARToolKit software turns the whole image

Figure 6. Virtual reproduction of the funeral chamber.

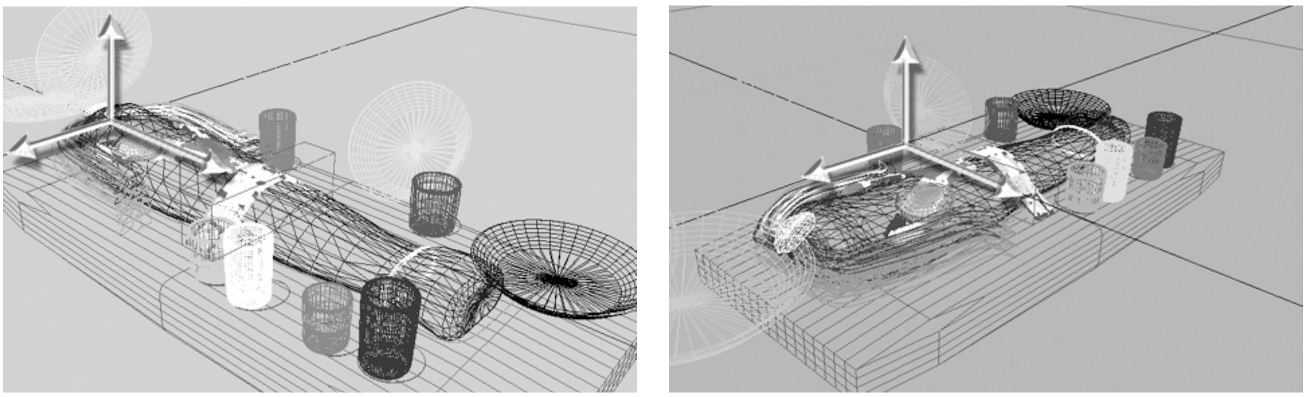

Figure 7. Digital reproduction of the burial saved with two different origins.

into a high contrast one, color and grayscale images can be transformed into patterns by working with its equivalent in black and white (Ruiz 2004).

The project logo worked properly without affecting the museography appearance. Its colors were slightly adjusted so they could blend into a black and white square whenever the software converts them to high contrast images.

5 Virtual Showcases

Given the impossibility of displaying real artifacts, PC kiosks with digital reproductions are currently being used. Six virtual showcases were designed to display Calakmul's discoveries. They consist basically of 3D digital reproductions of the archaeological findings on VRML format displayed over Internet browsers.

The interactive VRML models remain movable while short amounts of dosed information is presented every time the user clicks on specific hotspots within the virtual objects. The work has started with the tombs' offerings and stelae. At present, 18 tombs have been uncovered, some of them

Figure 8. Color palettes and high contrast transformation of patterns.

with unique pieces from which interesting information can be presented. Most of what we know about the Maya comes from stelae. One hundred twenty of these engraved commemorative stones have been located at Calakmul. Among them, at least 20 are very well preserved and provide invaluable information that can be interactively presented in a kiosk through digital VRML reproductions.

3D scanning has been an option for jade death-masks and stelae, though too much work is needed to merge all the meshes obtained from this procedure.

Virtual interactive objects are now used also as a digital inventory of local cultural authorities.

6 Conclusions

Attention to format compatibility throughout the project has prevented extra work for our team and has given us the opportunity to use the same files for several applications. This procedure can be applied to replicate the result in other archaeological sites.

Game engines are an interesting visualization option for didactic purposes. This experience demonstrates that accurate surveys of real projects can be embedded in this kind of

Figure 9. Example of a Virtual Showcase.

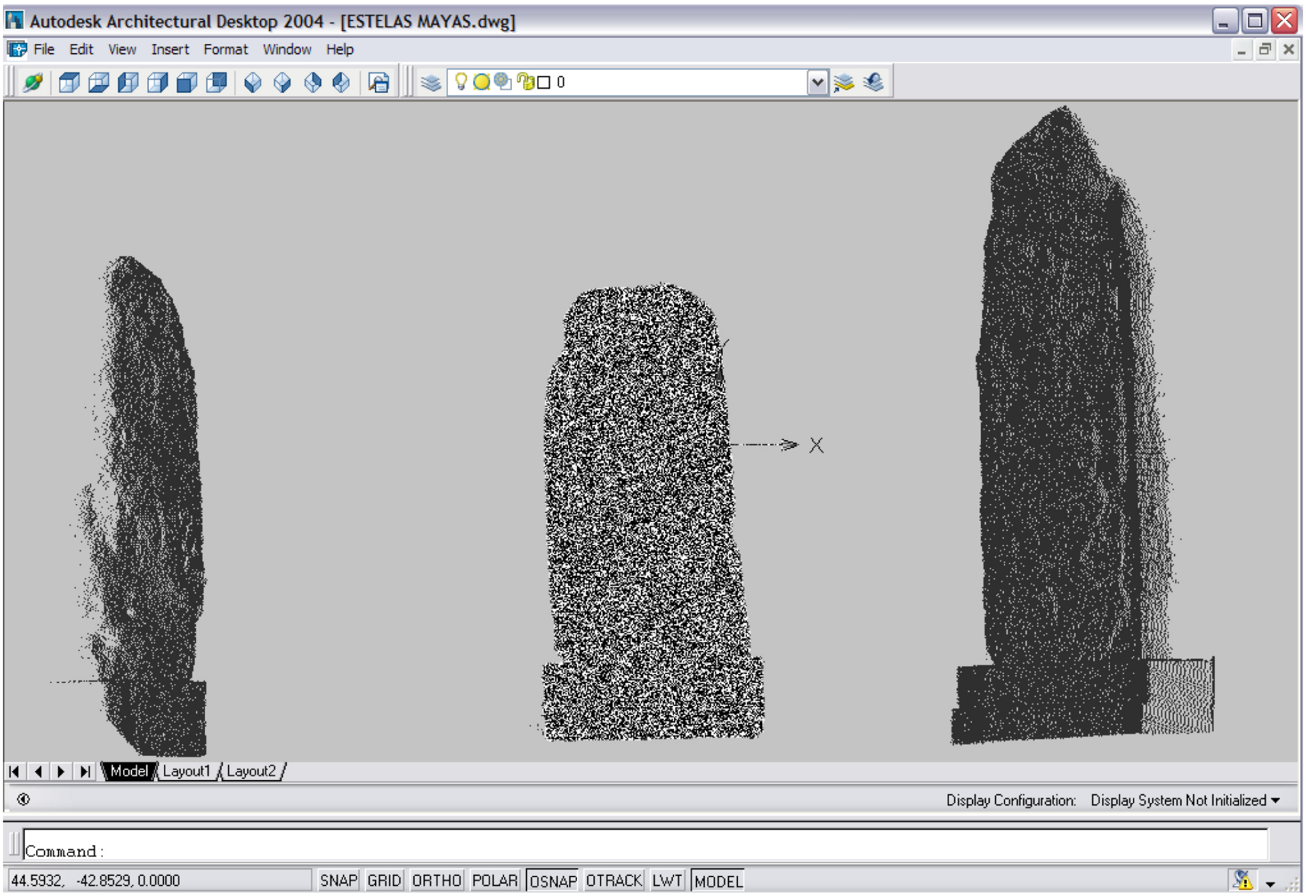

Figure 10. View of 3D scanned stelas of Calakmul.

software to increase cultural content.

The use of augmented reality has creatively expressed the concept of temporality by complementing what time has destroyed with what can currently be seen as a didactic device at museum exhibitions. Although virtual showcases with VRML models constitute a very simple application, their implementation could help to keep together pieces from the same context that would usually be spread in different museums. The use of VR and AR in archaeological sites could easily mean a difference in archiving and inventory methods.

The amount of archaeological pieces found in this site has caused the team to consider photogrammetry as an option to 3D Scanning

Acknowledgements

This project is partially supported the Ambassador's Fund for Culture Preservation from the US and by some departments of the National Institution of Anthropology and History in Mexico: National Coordination of Museums, INAH; National Coordination of Diffusion, INAH; INAH- Centre at Campeche; and Archaeological Project of Calakmul, INAH.

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