Virtual Reality for Archeological Maya Cities

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ABSTRACT

Calakmul, declared Patrimony for Humanity by UNESCO, is an important ancient Maya metropolis set deep in the tropical forest of a National Reserve called Calakmul's Biosphere. Partially covered by the untouchable forest, the buildings stand almost hidden from each other, making it very difficult for a large number of visitors to grasp the architecture and length of the site. The solitude of this distant archeological site represents an additional problem for the safekeeping of its priceless findings, so none of them are exhibited and no museum in site has been settled on yet.

The participants have foreseen the building of a site museum with virtual reproductions, to alleviate the difficulty the visitors face for appreciating the urban design of the city as well as the impossibility of exhibition of its priceless findings. In order to accomplish a presentation for the better understanding of Calakmul's culture, the participants will use Virtual Reality (VR), Augmented Reality (AR) and VRML interactive 3D objects.

Keywords: Maya, archeology, heritage, Calakmul, Virtual Reality, Augmented Reality, VRML, Palenque

1. INTRODUCTION

Calakmul's archeological site located in the State of Campeche, Mexico, remained undiscovered until some decades ago, since it was completely covered by the forest. Its impressive findings are not yet well known outside the experts' field. Tourists willing to travel for five hours, to see its marvelous structures above 150 feet, return home with more questions than answers.

Immersed in a protected Biosphere that must be kept untouched, Calakmul's buildings are partially hidden by the trees. The archeological treasures found at the city have been moved to Campeche's capital due to their value.

The participants believe that a walkthrough in a virtual recreation of the city of Calakmul, will better show its urban design and the characteristics of its important structures. At the same time, visualization and interaction with virtual reproductions of its pieces will provide a better understanding about the complex significance of the amazing findings of the site.

The building of a museum with virtual technologies at Calakmul, can additionally be seen as an interesting bonus in the zone that will favor the affluence of visitors through the Maya Route. A route that comprises several other beautiful antique Maya cities of the Classic Period.

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

2. WORLD HERITAGE AND COMPUTERS

2.1 Virtual Technologies applied to a Heritage project

Every year, Virtual Reality technologies and their applications are being more used for cultural heritage purposes because of the flexibility that they provide to archeologists and academics. These useful tools help theorize about the archeological vestiges with recreations of the places they are discovering.

There are important achievements in the VR field that can be helpful not only for the archeologist's research but also in providing them with a better way of showing their findings to people willing to learn about them.

Besides the construction of virtual reproductions, the implementation for real and concrete necessities as it would be a museum set in the middle of the forest, would mean a great achievement.

A museum aided by Virtual Reality and Augmented Reality requires a joint effort of research from complementary fields as archeology, artificial intelligence, human-computer interface technologies and design. Such efforts have continuously been promoted by international organisms as the United Nations Educational, Scientific and Cultural Organization (UNESCO) as means for documentation, preservation management, sustainable tourism and education.

2.2 General Considerations

2.2.1 High-end technology that can have a harmless coexistence with nature

Integrated to the archaeological zone as a tourist facility, a museum implemented with VR technologies would work with solar energy. In order to guarantee the stability of the equipment without any energy demanding air conditioning, researchers are studying the design of cabinets with individual cooling systems.

2.2.2 Respectful integration of technology to the Ecosystem and the protected site for the benefit of a special kind of tourist that arrives to the zone

People that are willing to take a five-hour trip into the wild forest are interested in having the most uncontaminated view of this twenty-acre Ancient City. Many unsolved questions emerge during their visit as, they would like to learn all about what happened there, what lies beneath the buildings, who lived there, what treasures have been found, how was it originally and much more.

2.2.3 A technology that perfectly suits the needs of recreation of a 1300 years old city covered by the wild forest

A virtual visit would be very helpful for visitors that -for now- need to climb to the top of any of the 150 feet tall buildings to see the rest of city from above the treetops.

2.2.4 A Modern tool that collaborates to preserve An Ancient Legacy

The treasures from the past are priceless. Its safety has been endangered for centuries and only reproductions of real objects can be left in the area. Virtual Reality technologies can accurately reproduce the buildings, the museum pieces and the funeral chambers, collaborating with the diffusion of its legacy in a unique way.

2.2.5 Integral solution for the population around the protected area as a trigger of tourism into a widened Maya Route

The protection of 1.7 million acres of the Calakmul's Biosphere in benefit of the planet and humankind, presents a dilemma for the population living there as they have nothing, except for the use of these potentially productive lands for wood and agriculture exploitation. A museum aided by Virtual Reality Technology is been proposed to increase the flow of tourism into Calakmul and other Maya ancient cities around it. This will favor the affluence of tourists through Campeche's Maya route by making them extent the time of their visit to several days, a situation that can generate new sources of income and jobs for the population in the area.

2.2.6 A joint interdisciplinary effort in this cultural patrimony for exhibition, information, education and diffusion purposes

A unique group of archeologist, historians, museum experts, designers and computer science experts are teamed to accomplish this project that will serve both as a didactic tool and as a tourist site, for nationals and foreigners. Part of the relevance and usefulness of the VR technology, is that its application can be extend to other forms of worldwide presentations, so people around the planet can learn about Calakmul regardless of their location.

3. Objectives

1.To combine the diffusion of the Cultural Patrimony at Calakmul with the careful use of modern Virtual Reality technologies thus preserving both cultural and ecological values.

2.To promote the safety of the Patrimony in Calakmul by making reliable and accurate digital recreations that would be exhibited instead of real treasures.

3.To increase the access to cultural information about Calakmul's findings, improving the way it is presented with virtual interactive recreations: **Through**

A) A physical installation of a funeral chamber enhanced with Augmented Reality elements.

B) A virtual environment for self real-time walkthroughs and for aided guidance of an intelligent agent.

C) Synthetic VRML recreations of stelae and death masks presented with interactive information while they are manipulated.

4. EXHIBITION ELEMENTS

4.1 Augmented Reality superimposed images from the past and the present

The most interesting finding in Calakmul is a tomb of what seems to be the remains of the main governor of the site during 8th century. The mummy of king *Garra de Jaguar* (Jaguar Claw) was buried with all his jade jewelry and his personal belongings. Extremely careful recovery of this funeral chamber has delivered a reliable theory of how this mummy was laid out.

Augmented Reality works splendidly here, for we can give the visitor two different views of the same situation. We can present a physical reproduction of the actual condition of the funeral chamber and a virtual superposition of the elements as they supposedly were, according to laboratory tests.

The installation will need physical reproductions of the real tomb as it is exhibited in the San Miguel Museum in Campeche City, which shows the chambers as they were found by the archeologist. From certain points, the visitors will have the possibility to look through an AR glass that will show a virtual recreation of how the burial was supposedly laid out.

The simultaneous presentation of both, past and present, will provide the visitors with two delightful experiences, the archeological thrill and mystery of the modern dig, and the learning experience that derives from watching the original conditions of the tomb as the ancient Mayas intended it.

For the explanation of the AR technique, the participants will present a demo-book during the UNESCO conference, with virtual art while attendants read about the identification theory of *Garra de Jaguar's* mummy at Calakmul.

4.2 Guided Walkthrough over a Virtual recreation of Calakmul.

A virtual environment from accurate data from Calakmul can be used by the visitors as:

A) a looped-projection of a pre-established walkthrough around the buildings and structures;

B) a self guided experience with or without immersion devices;

C) a guided tour aided with an intelligent agent. The virtual agent will take the aspect and personality of an archeologist to show any structure that a visitor requests. This intelligent agent is capable of combining pre-programmed code elements to elaborate a plan that accomplish the given orders.

4.3 Virtual Showcases

A virtual showcase could be a useful tool for presenting information to the visitor. The visitor can access information about the virtual object as they are manipulating it through the click of a computer mouse and contents of the showcase can be increased as new objects are created, also serving as a database for the museum.

A huge amount of information can be delivered from the stelae found at the site. One hundred twenty of them located at the site, make Calakmul the city where more of these engraved commemorative stones have ever been found. Among them, at least twenty are very well preserved and provide invaluable information that can be interactively presented in a kiosk through digital VRML reproductions.

Besides stelae, one of the most amazing findings of Calakmul, are the death masks of enormous value that were found in several funeral chambers and that will not be exhibited at Calakmul because of their value. Accurate digital reproductions of these masks are in progress to be exhibited interactively by these "virtual showcases".

These virtual showcases are PC kiosks that present digital tridimensional objects that may be turned around with the computer mouse. They will present 3D movable stelae and death-masks that will permit the visitors to: **A)** visualize them three-dimensionally, **B)** read general information at the same time that they remain movable to be examined, and **C)** interactively search for extra information about any detail over which they click.

5. PREVIOUS WORK

The idea of creating virtual environments and pieces for the introduction of an archeological Maya site was born from a closely related previous assignment of some of the participants. Mtra Ruiz and Dr. Savage have already developed some of the elements that this project promotes for a related archeological zone the Maya city of Palenque.

Although the work already done about Palenque is the result of more than one year's work, the objectives of the researchers were to find an application of their work into a real project for the Mexican National Institute of Anthropology and History (*INAH*).

After understanding the relevance of the academic research involved and the potential uses of the resultant products, the INAH–Campeche Center, chose the national project of "Calakmul" as the most suitable archeological site among the rest of the pre-Columbian cities to be exhibited with VR and AR technologies.

Figure 2. View of the virtual environment of "Palenque".

A three dimensional recreation of the three main *plazas* of the archeological site of Palenque, is ready and it is been used for immersed walkthroughs. The virtual environment is completely textured and enhanced with digital representations of local trees. Shadows beneath them, add a realistic aspect of the weather in Palenque and certainly collaborate for a better feeling of immersion during a walkthrough.

The addition of an intelligent agent as a guide during the virtual walkthrough, was meant to show the building's structures that a visitor requests.

The intelligent agent has been successfully programmed to identify, modify and combine pre-programmed routines (options) and execute a plan that better solves the input to be able to meet the visitor's wishes. As of today, orders given by voice recognition techniques, moving gestures and keyboard commands have been successfully used as human/agent interfaces.

The programming code of this agent has been successfully implemented in virtual and physical robots and it is shown in the next diagram. In it, the human interface is considering the input from the visitor's voice or gestures, while the agent's internal conditions and tasks are the input from its coordinate position and sensors' values, like the one for collision avoidance.

The cartographer is a set of coordinate values obtained from the environment to help the agent to evade obstacles in its path, while

the knowledge representation, is the set of rules that the agent executes whenever a condition is met.

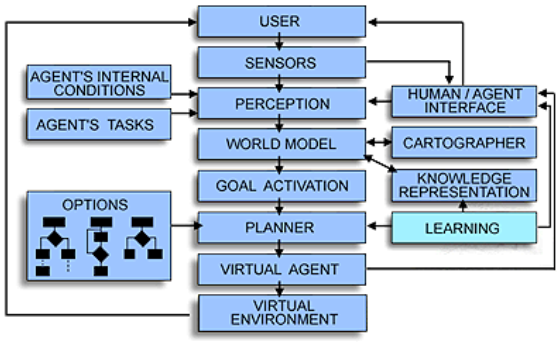

Figure 3. Intelligent agent's code programming.

Other virtual creatures in the shape of animals coexist in the 3D environment of Palenque. For now, these animals can be found walking around the virtual Palenque's temples and a visitor may approach them while walking through the virtual environment. Research is in progress to provide these animals with behaviors of fear, curiosity or hostility towards each other and towards the visitor.

Figure 4. Artificial Life inside the digital environment of Palenque.

This work is the current research of Professor Ruth Aylett and MSc. Carlos Delgado, both from Salford University, UK. Their research targets are intelligent agents implemented with behavioral robot architecture, in which emergent behavior at any given moment, is determined by the synthesis of responses from currently active behavioral patterns. These behavioral patterns are in turn, driven by simple virtual sensors, while groups of behavioral patterns (packets) are activated or deactivated according to the levels set for the creatures' internal drives, seen for these project as hunger, fatigue and curiosity.

6. CONCLUSIONS

The participants in this project believe that the use of Virtual technology products as exhibition elements for a museum at Calakmul's archeological site, is a challenge that can be achieved if all human, technological and ecological elements are met and scrupulously supervised and maintained.

From the archeological cities that may profit from these virtual Technologies, Calakmul appears to be the most suitable because of:

1. the difficulty to visualize the whole site, because it remains partially hidden in the forest,
2. the impossibility of displaying the real treasures found at the site,
3. the need for recreation of ancient art elements and
4. the lack of a museum.

Since Calakmul is indeed one of the most important cities of Classic Maya culture, creating sources of interest in its interior, such as a museum, may favor the affluence of visitors through the Maya Route, a route that comprises several other beautiful pre-Colombian Maya cities of the Classic Period. This could translate into an increased number of days that the visitors remain in the area, generating alternate job sources for the local habitants: providing food and rest lodges for the tourists.

The project includes very important aspects, that, if supervised and implemented correctly, will collaborate to promote Calakmul´s universal value; will provide an interesting site for the tourists and will give broader elements for the development of the local inhabitants. It also meets the recommendation of the UNESCO who have repeatedly encouraged (http://whc.unesco.org/nwhc/pages/doc/ mainf3.htm) local authorities, academic institutions and investors, to contribute with any development strategy to assure the conservation, increase the protection and diffuse the knowledge of the world's heritage properties inscribed.

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