Virtual reality tools for the West Digital Conservatory of Archaeological Heritage

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ABSTRACT

In the continuation of the 3D data production work made by the WDCAH, the use of virtual reality tools allows archaeologists to carry out analysis and understanding research about their sites. In this paper, we focus on the virtual reality services proposed to archaeologists in the WDCAH, through the example of two archaeological sites, the Temple de Mars in Corseul and the Cairn of Carn Island.

Categories and Subject Descriptors
I.3.7 [Three-Dimensional Graphics and Realism]: Virtual reality; J.2 [Physical Sciences and Engineering]: Archaeology

Keywords
Virtual Reality, Archaeology, Digital Heritage.

1. INTRODUCTION

Virtual reality is often considered solely as a field of computer science in relation to interactive digital 3D worlds. It actually holds a special position in the usual scientific scheme by coupling humanities sciences with engineering. According to Fuchs et al. [1] « The purpose of virtual reality is to make possible a sensorimotor and cognitive activity for a person (or persons) in a digitally created artificial world, which can be imaginary, symbolic or a simulation of certain aspects of the real world. » This proposition positions the man and its activity in the centre of virtual reality.

In the context of the West Digital Conservatory of Archaeological Heritage [2], we propose techniques issued from virtual reality domain to help archaeologists in their scientific analysis, either by providing them dedicated tools to work more efficiently in numeric worlds [3] or by easing the understanding of past human activities such as building techniques or site exploitations. In this paper, we present two case studies illustrating different virtual reality techniques use in the WDCAH project. We focus on the tools proposed to archaeologists in these two studies, and present the purposes of these tools, nevertheless our goal is not here to present the conclusions made by archaeologists from their analysis.

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2. VIRTUAL REALITY AND ARCHAEOLOGY

The ability of the RV to immerse a user in historical sites, which can be completely missing or partially ruined, makes it an indispensable tool for cultural heritage and archaeology, with different purposes according to these two domains. Generally, the use of 3D in the field of cultural heritage is limited to the often spectacular view of sites and monuments, with less concern for the scientific coherence. Since recent years, however, we observe the emergence of a trend to streamline the production of these 3D models, use, storage and distribution such as in Koller et al. [4] and London Charter (www.londoncharter.org).

On the archaeology side, more emphasis is set on scientific methodology. Virtual archaeology was introduced by Reilly in 1990 [5], and was initially presented for excavation recording and virtual re-excavation using multimedia technologies. In a similar way, Krasniewicz [6] proposed a 360° visualization infrastructure to help archaeologists in their research work. In this case, virtual archaeology was not used to restore knowledge, but to acquire new knowledge. More recently, Pujol Tost et al.[7], contributed to the interaction, perception and simulation in VR for archaeology, and not only for the visualization of 3D models. Vergnieux [8], considered the simulation for the movement and gesture validation, the physical coherency and the technical feasibility of constructions. According to new trends in the domain, Forte [9] suggests to replace the terminology related to a "reconstitution of the past", by the expression "Cyber-Archaeology" relying on a "simulation of the past".

Several works illustrate clearly the interest of virtual reality for archaeology. Christou et al. [10] used an immersive CAVE-like structure combined with haptic devices and 3D sound for pedagogic purposes in a museum exhibition, but also as a tool for research. The Archave project [11] integrated also a CAVE-like structure and proposed tools for archaeologists to study historical sites. Drap et al. in [12] describe the use of an immersive virtual reality interface for Shawback Castle. The immersive environment consists of a large stereoscopic projected wall, with infrared tracking. The work focuses on semantic annotations of blocks to ensure consistency with a knowledge database associated to the model.

3. The WDCAH Approach in RV usage

The West Digital Conservatory of Archaeological Heritage aims at being a convenience tool, easy to reach and free for archaeologists in the West of France. It provides a technical and technological accompaniment in 3D data production (see Figure 1), digital storage, and data and metadata access. Various access modes to data and metadata, associated to a set of tools based on virtual reality come in support to archaeologists in their scientific work. Scientific process coherency remains directly handled by archaeologists.

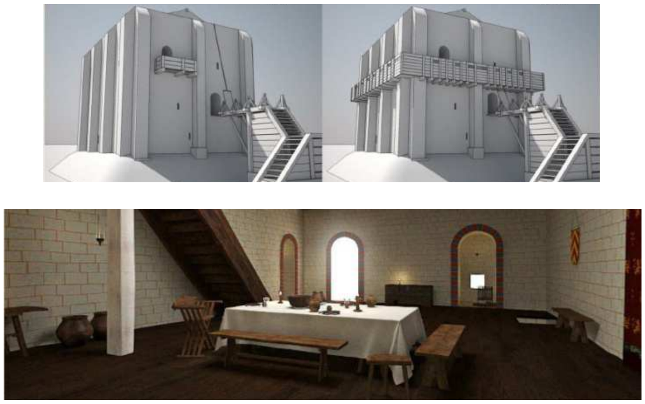

Fig. 1. 3D models of the keep of Sainte-Suzanne. © Y. Bernard

Access to virtual reality environments is proposed as a complementary tool for archaeologists to help their research work, from simple desktop VR equipments to CAVE-like facilities, via head-mounted displays (see Figure 2).

Fig. 2. Large and small immersive platforms.

3.1 A first case study : the Temple of Mars

Ancient Gallo-Roman capital of the Coriosolites, which were one of the five tribes of Brittany, Corseul is a Breton town located in the southwest of St Malo. Its Gallo-Roman sanctuary of the "Haut-Bécherel", [13], otherwise called Temple of Mars was built from 9O AD in Tuscan style and is among the most notable examples of Roman civilization in mainland Britain. It allowed disseminating the Roman religion, to drain pilgrims from all over Brittany and to highlight the power and greatness of Rome.

As the site is almost completely destroyed, a digitalization by photogrammetry or laser scan was not possible. Based on plans provided by archaeologists, a graphic designer produced a 3D model of the site in the CAD tool AutoCAD 3D Studio MAX.

Fig. 3. Temple of Mars – Corseul. ©M. Gautier / Y. Bernard

Virtual reality application implementation: we chose to implement our application in Unity3D combined with MiddleVR in order to face different technical constraints, such as clustering, centralized interaction, active stereoscopy, unified deployment between HMD and CAVE-like environment.

Immersive visualization: the difference between a simple first-person visualization on a standard computer and an immersive visualization is highly significant. During the first experiments of immersive visit (Figure 4) of the virtual reconstitution of the site, many modeling defects, hard to detect in the CAD tool, were revealed. The 1:1 scale visualization allows to strongly feel present in the virtual universe. The user realistically perceives volumes and perspectives of the buildings. In the Temple of Mars, the architecture of the monument is centralized around the imposing pediment of the cella. The immersive visualization enables the perception of this effect sought by the architect.

Navigation: We wanted to provide archaeologists a simple and natural way of exploring the monument. We proposed two navigation modes, one based on a standard two-axes navigation used with joysticks, and one based on points of interests (POI).

Fig. 4. Immersive visualization of Temple and a travel path.

In the first mode, called “free navigation”, camera moves in user’s gaze direction, backward or forward following joystick or 3D mouse tilt. In the Flystick case, the right/left axis entails a camera spin. In the 3D mouse case, we have more navigation possibilities. The right/left axis drives a translational orthogonal to the user’s gaze. Camera spin is associated to 3D mouse rotation. Others 3D mouse degrees of freedom are not used.

In the “POI navigation” mode, a list of points of interest is pre-defined in the application. When clicking on a button of the Flystick or 3D mouse, a path to the next POI is calculated from the current position by the Unity3D path finding functionality. The user automatically travels along the calculated path, at a walking speed. The calculated path is visible to the user and dynamically adapted to his position (Figure 4). When the POI is reached, the travel stops. During the move, the user can shift to the free navigation mode by activating the joystick or the 3D mouse and come back to POI navigation at any time.

3.2 A second case study: The Cairn of carn

The monument of Carn (Figure 5) is located in the western part of Brittany. It has been excavated during the 60´s by Pierre-Roland Giot and published in 1987 [14]. The dating performed for this monument was the first radiocarbon dating in Bretagne, and results show that the monument belongs to the Vth millennium BC.

Fig. 5. The cairn of Carn island.

The cairn central chamber has been digitized by photogrammetry and integrated in an immersive platform in order to enable archaeologists to work in a 1:1 reconstitution of the monument [15]. Two implementations based on two different software were produced. The first one was based on the collaborative virtual reality engine Collaviz [16], with a visual rendering by OpenSG [17]. The second one was based on Unity3D combined with MiddleVR. In addition to the immersive vizualisation in a large CAVE-like structure, several interaction metaphors has been implemented in order to help the archaeologist analysis work:

Navigation: the size of the immersive infrastructure used in this work enables natural walking inside the virtual central chamber. We added a flying mode (Figure 6) in order to ease the exploration of the corbel from bottom to top. The user is flying forward or backward following the direction pointed by a flystick, a tracked peripheral with a little joystick. Left and right directions of the joystick perform a rotation of the camera. This navigation metaphor is very natural for inexperienced users.

Fig. 6. Flying in the virtual cairn / Annotations in the cairn

Mobile lightening: the user has the ability to switch on a virtual lamp (Figure 7) linked to the flystick peripheral. This torch allows the user to focus on a restricted part of the chamber wall. This also enables the study of shadows rendering on the stones, which can be useful in presence of graves.

Fig. 7. Virtual torch.

Annotations: in order to assist the archaeologists in his analysis work, textual annotations and graphical lines can be added in the 3D universe and saved at the end of a working session to be reused in a following session. Textual annotations are labels stored in a separate editable configuration file. To pin an annotation on the wall, the user point the target with a ray attached to a wand and press a button once the right label is chosen (Figure 6). Labels are moving according to the user position in order to be always visible. A text file storing the 3D coordinates of the labels and drawings provides persistence of the annotations.

Specific display: We were asked by archaeologists to provide the possibility to hide and display specific parts of the central chamber to visualize the different phases of the building (Figure 8). The purpose is to analyze the human postures and the potential use of scaffolding at each step. For this work, an archaeologist worked with the graphic designer of the WDCAH to identify the different layers corresponding to the building steps. The model was cut according to these layers and integrated in the immersive implementation so that the user was able to successively display the different building phases at 1:1 scale.

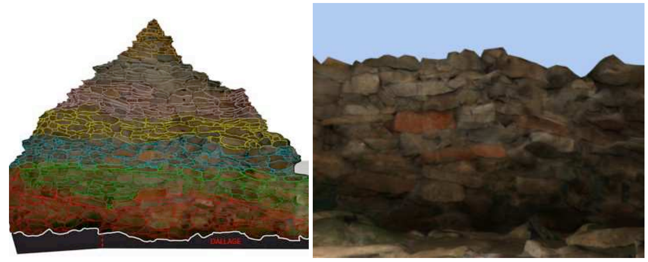

Fig. 8. Visualization of the building steps : archaeologists' description on left, implementation right

Remote collaboration: We successfully experimented a distributed deployment of the immersive implementation of the Cairn between our CAVE-like platform and another CAVE-like facility located in the south of France. This deployment was based on the software Collaviz for the collaborative and interaction part, and OpenSG for the visualization part. The actual version allows to share the same visual universe, with simple avatars representing the remote user's head and right hand.

The Virtual Cairn application has also been deployed on an head-mounted display, and a VR desktop equipment called Leonar3DO (Figure 9). These systems, far lighter and cheaper than CAVE-like structures, enable the use of interactions within virtual reality applications

Fig. 9. The virtual cairn on portable VR equipment.

4. DISCUSSION

An obstacle in the use of virtual reality tools in the archaeology community is technology itself. CAVE-like infrastructures are expensive and uncommon facilities. Interactive peripherals require hardware and software expertise to integrate in VR applications. There has been a great effort of mutualisation of visualization and 3D technologies, with European projects such as 3D-COFORM (http://www.3d-coform.eu/) or Visionair (http://www.infra-visionair.eu) which both aim at promoting and funding the access to digital technologies for a wide range of European researchers. In a similar but less ambitious purpose, the WDCAH is designed as a meeting place where tools and skills join together to better support archaeological works, increase their value and better preserve and disseminate them. Such a space is definitely federative for researchers with different backgrounds. This article is the written proof of this federation through the gathering of different research institutes of both computer science and archaeology. By placing itself in a perspective other regions have long been committed to, western France certainly gives itself the means to boost its archaeological research.

An interesting aspect of the collaboration between computer scientists and archaeologists in the WDCAH is the raising of new problematic for virtual reality. Until now, virtual reality has been essentially focused on industrial applications. In this context, the user interacts with recent, smooth and clean, manufactured objects modeled by well-known CAD tools. In the context of archaeology, manipulated objects may be closer from nature, less steady, thus represented by more complex geometric models. The management of this new kind of data requires the study of new methodologies. As in the Extreme Programming software development methodology, the presentation of these virtual reality tools to archaeologists has helped to initiate a real iterative process in which they will do many frequent, positive and negative feedbacks, to obtain the best tools corresponding to their needs.

5. PERSPECTIVES

In addition to the fourteen current projects, we are working on the organization of seven other reconstruction projects combining modeling and digitization (photogrammetry and / or laser scanning). Some of these projects already identified the need of virtual reality tools in their analysis process. Particularly, the underwater sites represent very promising fields of application for virtual reality, from exploration training to reconstitution analysis.

Our first experiments with path finding in the Temple of Mars were also encouraging and led us to explore the application of this functionality to the study of complex building such as inside of a castel. Another important aspect to develop is collaboration in virtual environments. We have the software technology to set collaborative sessions, but we still have to identify the suitable project in the WDCAH context.

6. CONCLUSION

We presented the virtual reality tools currently set for the WDCAH. The West Digital Conservatory for Archaeological Heritage aims at experimenting the integration of 3D reconstruction and virtual reality techniques in collaboration with a community of archaeologists, who might or might not be aware of such technology but who clearly have many needs. Use of immersive interactive virtual reality as illustrated in this paper improved the work of involved archaeologists. Although the WDCAH is only a few months old, the first feedbacks seem very positive and reconstitution requests come regularly enough to let us believe in the real value of this project.

7. ACKNOWLEDGMENTS

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