ARCHAEO VIZ
A 3D Explorative Learning Environment of Reconstructed Archaeological Sites and Cultural Artefacts

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Abstract: In this paper, we present an educationally effective software system based on modelling for cultural heritage objects and landscapes of archaeological sites. The low-cost 'Archaeo Viz' can be easily applied as an extension to pre-existing museum data management systems. Its main contribution is to strengthen the visualized experience of visitors, support educational activities and enhance the communication between archaeologists, researchers, museum curators and the public. It is a concrete, open and evolving model designed to support case studies based on archaeological complex sites in a game like environment.

1 INTRODUCTION

Innovative multimodal visualization technology has opened the possibility of creating VR that integrates 3D content, for example, into a virtual museum's data management system, thus enhancing the experience of learning acquired by a visitor's interaction with an online exhibition, either within the museum or on the Internet (Mourkoussis et al., 2002) (Petridis et al., 2005).

Archaeo Viz has been designed by taking into consideration the key issues when designing museum interactive systems as they have been presented in Petridis et al. (2006). Apart from cost effectiveness, those key issues refer to transforming museums into so called hybrid institutions which support multiple presentation techniques including digital surrogates and reach interaction techniques that reinforce the heritage behind the artefacts. In this contribution, we support the claim that learning activities should rely on multisensory experiences in a form of digital storytelling (Pletinckx et al., 2003) in order to maximize the educational usability and make students to feel part of the virtual exhibition. The first case study refers to an archaeological complex site that dates back to the Late Chalcholithic. This site is located on a hill named Gorgan, near the village of Şeuşa in Alba County, Romania (latitude: 46º 3' 53" longitude: 23º 39' 2").

2 METHODOLOGICAL APPROACH

The development of the proposed project deals with the collection of digital material, evaluation of available scientific information, database development, network maintenance and the design of educational characteristics of the system. The above issues were addressed by a disciplinary team consisted by an archaeologist professor who provided the team with registered information, two computer science students who were responsible with programming and modelling the 3D world and

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one more faculty member with research background on information systems, computer graphics and educational software development. The challenges in generating virtual worlds are connected to performances versus natural behaviour and aspects of the environment. Such requirements are often in contradiction: convincing models and high level physical simulation implies demanding hardware and software requirements, meaning an increased computational load that influence the overall performance. On the other hand, there is the need to manage various types of data such as: temporal and spatial data, vectorial plans, digital photos along with videos and 3D models. To address the above technical issues the design team adopted the Irrlicht Engine along with Autodesk Maya for modelling 3d objects.

3 MAIN FEATURES & SYSTEM FUNCTIONALITY

The main menu of Archaeo Viz contains: 1) 3D maps of study locations, 2) 3D object visualization 3) Options (user preferences such as resolution, video driver, bit depth, language). Other supplementary options include copyright information and help files. In this section, the main features of the system will be described.

3.1 Exploring the 3D Locations

There are two ways to explore 3D locations of archaeological sites: A) Explore now-a–days sites and B) Virtual Tour in past times. The first feature represents the remains of the archaeological sites as can be seen in reality. Using the table of contents as a thematic menu, students can access additional information (learning objects) including description of the site, localization and geomorphologic characteristics, the research of the site and the research objectives.

The virtual tour feature allows students to immerse through the excavations as seen in Fig. 1. for the Chalcolithic settlement case study. This scene contains 7 Chalcolithic houses (representing the village) in which users can enter and examine the interior (Fig. 1-bottom). Also, users can pick surrounding objects (ceramic pots, bone tools) to examine them separately in the object viewer in more detail.

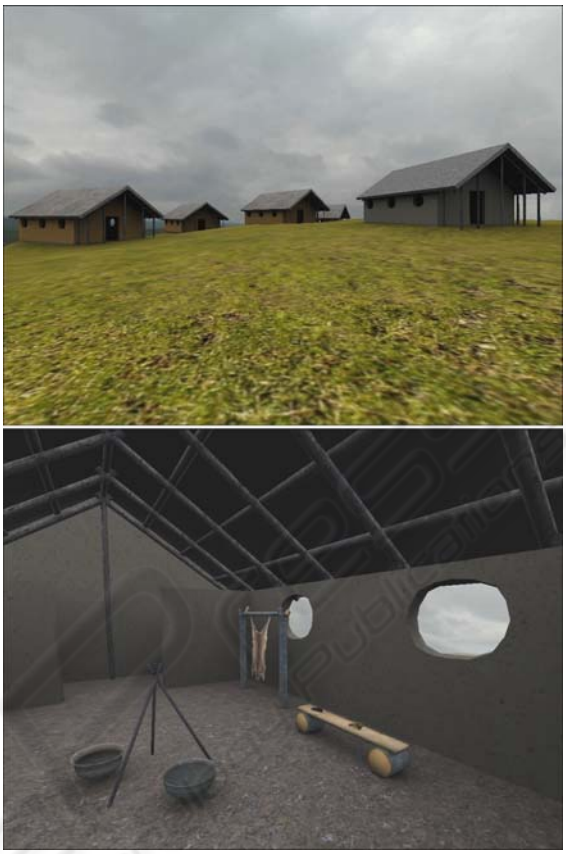

Figure 1: Virtual reconstruction of the Chalcolithic settlement (top) and surface house (bottom).

3.2 Object Viewer

The object viewer (Fig. 2) was designed to function as a separate application because it has a complex menu with many options and facilities.

Figure 2: Chalcolithic bone chisel in the object viewer.

The artefacts are categorized by large classes such as material, type of object, or its usage. Some of the data access services that are integrated into the

object viewer include visualization and manipulation of three-dimensional (3D) objects, where the user can rotate, move and resize selected objects; multiple levels of detail can be activated from the main menu; playback of high quality 3D video of artefacts and access to textual content (basic information, attributes, description) about artefacts can also be acquired in the object viewer.

4 MOVE AND FEEL

'Look and Feel', a term that prevailed in discussions about graphical user interfaces (GUI) during the last decades, includes issues regarding graphic design, colour code, shape, fonts and dynamic visual control's behaviour such as buttons, drop-down menus, navigation methods and other. Later, it was extended to webpage design as well. It can be implied that 'Move and Feel' (Paliokas and Kekkeris, 2007) works similarly in Virtual Reality applications. As one of the most abstract VR software characteristics, it can be used for two main reasons: (a) to facilitate the user in using tools with similar function and navigating in a specific style, (b) to identify products of a certain creation team. In Archaeo Viz, 'Move and Feel' is characterised by a general realistic feeling of presence in past times and interaction with reconstructed 3D artefacts. It consists of the following: repetitive form characteristics of space such as architectural elements, wallpapers and object textures, panoramas, furnishing of Chalcolithic houses, etc; kinetic characteristics (navigation style), such as avatar motion in space and use of cameras; interaction characteristics between avatars and cultural artefacts, physical lows, collision detection, obstacle overcome. The user explores the virtual environment with continuous experimentation using different actions, receives system messages in a game like style and at the same time he/she receives a specific feeling by doing so.

5 EDUCATIONAL EFFECTIVENESS

The model describing educational activities was based on the fact that an important element of any educational process is the conceptual change (Posner et al., 1982) by the means of new knowledge and the reconstruction of pre-existing attitudes. The use of VR in the exploration of past archaeological sites, apart from providing more information, locates artefacts at their physical environment enabling users to recognize the depth of every concept related to artefacts. For example, the traditional way artefacts are exhibited in museums can distort the initial identity and real nature of a given artefact in student's mind (depending on personal pre-existing attitudes). This initial identity refers to properties and way of everyday use before the artefact became worth seeing and a subject of scientific research.

Traditionally, there are two ways of placing artefacts in their physical environment: A) the skilled physical reconstruction of small parts of the past world (usually expensive and space consuming), B) the use of a computer-generated reconstruction of the past physical environment. In this project, the design team used the second way to explain to visitors how they would see specific artefacts and what concepts they would have about them if they were born at Seusa-Gorgan in the Late Chalcholithic. Students can create multiple concepts about artefacts, and the knowledge they finally construct is the result of first-person experiences using the immersion capabilities of Archaeo Viz.

6 USABILITY TESTING

A revised version of Archaeo Viz was described. For evaluation purposes of the first version, 3 members of academia with related research background (expert group), 16 students of ATEI of Thessaloniki attending Computer Graphics class (winter semester of 2008) and a few members of wider public were asked to evaluate the system after 10-15 minutes of presentation and actual use. The Thinking Aloud Protocol was used as a method of gathering data in usability testing (Lewis and Rieman, 1993), where future users expressed their opinion aloud during the system testing. At that time, pragmatic user actions (Ozmen and Balcisoy, 2008) were asked to be refined, as well as the texture details of the 3D explorer. Users were impressed by the realistic representation and really enjoyed the virtual tour as an alternative game-like way to have contact with educational material. This game-like environment does not require much effort to understand the operation of the interface because it was designed to be closer to student's culture. Research findings in literature imply that those are important issues positively affecting the learning cue (Economou & Pujol, 2006).

From the engineering point of view, the system architecture was requested to be more structured and

better documented. The entire application has added the major requirements in order to meet the users' demands.

Finally, more than 50% of users asked if services of automatic content enrichment could be possible from non-experts. Even after the revised version presented in here, this demand is estimated difficult to be addressed because design process of new content demands specialized knowledge on 3D modelling, VR and Computer Graphics.

According to the overall evaluation, in Archaeo Viz the user understands immediately and without paying much effort the kind of activities that will follow. The Move and Feel of the application is considered as the most interesting part of the visualization and navigation subsystems. All users appreciated the detailed content and the game-like alternative way of exploring reconstructed archaeological past sites.

7 CONCLUSIONS AND FURTHER WORK

Archaeo Viz, a system to support reconstructed archaeological landscapes in immersive environment in order to offer multisensory first-person experiences and to maximize the interest of visitors was presented. Using common Internet protocols for information distribution, it can be easily adjusted to the typical school environment and to common e-learning platforms. Archaeo Viz provides a stimulus environment that can lengthen the time students-visitors normally spend on learning activities related to archaeology. It does so by integrating archaeological data and artefacts into a simulated physical environment of archaeological sites to allow users to explore meaningful places and become active learners.

Improvements to the way of use will be based on stereoscopic imaging using low-cost stereoscopic glasses (e.g. NVIDIA 3D Vision Stereoscopic Glasses). As for the content, the design team is currently working on more case studies. Through the 3D reconstructions of Prehistoric and Historic sites we approach a suggestive interpretation that involves the public and transmits the importance of cultural heritage and thus its preservation.

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