X3D-based Virtual Reality Stereo-Rendered Human Heritage Exhibitions

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Abstract

This paper discusses the work undertaken by the Archaeology Technologies Laboratory (ATL) of North Dakota State University to develop X3D-based stereo rendered Virtual Reality (VR) experiences for the purpose of educating the public on human heritage issues within an informal museum setting. Any plan to implement VR heritage exhibits must address the concern of museum administrators that such exhibits are risky, expensive ventures not guaranteed to bring visitors to the door. Through its research, the ATL seeks to leverage the advantages offered by the X3D specification to address issues of development, maintenance, and staff training costs.

Keywords: Archaeology, Virtual Reality, Graphics Editors, Animation, Digitizing and Scanning

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1 Introduction

Over the last two decades, human heritage has emerged as a major concern for nations around the world [6]. It is well understood that a sense of history and an insight into shared humanity, past as well as present, significantly contributes to our understanding of the experiences and worldviews of people of diverse cultural backgrounds. Monuments, sites, and artifacts provide a means of access to this understanding; they serve as conduits by which people today can learn of the richness and diversity of human lifeways.

By their very nature, however, the remains of past lives and cultures are fragmentary. Archaeology is critical to the uncovering of these fragmentary remains and archaeolgists provide the interpretations of what the remains tell us about the past. Archaeological data—often taken in conjunction with information from cultural anthropology, history, architecture, ethnic studies, and other fileds—provides the basis for our interpretations of the past. Many of the objects revealed through archaeology are made available to the public at museums and historic sites. Yet, even at the world's great museums, visitors have access to objects divorced from their original physical, social, and historical contexts. And at the vast majority of sites and monuments, there are only faint traces of past life, ruins stripped of their original decoration and furnishings. Typically, visitors have only limited information about the site, such as occasional signs or leaflets or, at best, guidebooks with small amounts of text or illustrations. Thus, visitors are provided only a fraction of what is known about the site, the people who lived there, their daily lives, and the surrounding environment.

2 Virtual Reality in Archaeology

The worlds of education and human heritage are currently poised to benefit from a convergence of technologies and archaeology. The potential now exists to harness previously inconceivable advances in digital-image capture, manipulation, and display to transform both the informal teaching of archaeology and the documenting of the world's cultural heritage. Through Virtual Reality (VR), we are now able to rebuild and refurnish archaeological sites digitally, to virtually restore artifacts to their original condition within their original contexts, to explore in detail the original grandeur of these testaments to the talents, labors, beliefs, and daily existence of past peoples. With immersive, interactive, computer visualizations, learners of all ages can virtually experience the world's cultural heritage in learning venues that can compete with video games for immediacy and involvement.

By employing computer technology we can make the objects, sites, and monuments that are crucial to the history and ethos of peoples of the world accessible to a national audience for informal educational purposes. Advances in digital asset management, computer graphics, digital image capture and manipulation, and new forms of electronic display technology now make possible not only the digital preservation of cultural heritage sites and objects but also a deeper and qualitatively different enhanced experience of past peoples, cultures, and places. Sites, buildings, and people can be re-created with immersive realism that virtually brings the observer into the presence of historic places and events. Images of previously unfamiliar cultures can be experienced with an immediacy and interactivity that has not been possible with traditional educational methods.

3 Virtual Reality in Human Heritage Museums

But if VR has such a strong potential to educate the public, its potential has not yet been recognized by museum administrators. Officials of historical and natural history museum (a.k.a. human heritage museums) are highly reluctant to invest in VR exhibitions. While no formal study has been conducted on this topic, Donald Sanders, President of Learning Sites, Inc. and Richard Levy, Directory of Environmental Design School, University of Calgary, relate that the problem is anecdotally understood. Those who have built VR systems and understand the needs of human heritage museums identify three main issues: 1) lack of understanding of VR technology by museum officials, 2) fear that development costs will exceed benefit, and 3) difficulty and cost of providing exhibition maintenance [2], [5].

At a recent session on the use of VR in archaeology at the 2006 Computer Applications and Quantitative Methods in

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Archaeology (CAA2006), participants discussed concerns of museum officials and debated solutions. There is no question that three-dimensional (3D) exhibits can be expensive. The stereo-display pre-rendered 3D documentary film, “On-A-Slant Virtual Village”, developed for the North Dakota Lewis and Clark Bicentennial Celebration cost around $200,000 to model, pre-render, and install. Production costs for “This Old Digital City” (TODC), a historical VR exhibit that focused on the downtown district of Cedar Rapids, Iowa at the turn of the century, were reported to be $300,000 [2]. While cost is a hindrance to adoption, those at the CAA2006 session felt that issues one and two were closely related in that a better understanding of the capabilities of VR should serve to alleviate the funding concerns of museum officials by demonstrating the benefit to museum attendance.

Results reported at VSMM 2001 by the developers of TODC demonstrated that the first few months of the exhibit’s operation showed an increase in that museum attendance by as much as 89%, and over 100% increase in museum revenue [2]. TODC has demonstrated that VR exhibitions can do more than recuperate their development costs and provide funds for exhibit maintenance, they also assist a museum in completing one of its main missions: educating the public. Those drawn to visit museums because of a VR exhibit, not only are exposed to that exhibit’s content, but visitors are exposed to the content presented by many of the traditional exhibits as well. In effect, VR exhibits allow museums to educate many more members of the public that would not otherwise visit the museum.

Museum officials must be educated on these topics if VR is to reach its full potential as a tool for presenting human heritage information to the public in the informal setting of museums. VR, pre-rendered 3D scenes, and stereo-rendered content are all interchangeable in the minds of most museum officials. This education is especially necessary as those officials who have been exposed to VR are often drawn to the more glamorous stereo-rendered technologies. Thus, at the suggestion of participants in the CAA2006 session on VR, an effort has begun to inform museum officials on the benefits and capabilities of VR stereo-rendering technology. The first step in the education process is to bring the discussion to conferences that are attended by museum curators and administrators. In that sprit, the authors have organized a panel discussion on the use of VR in museums for the 2007 Mountain-Plains Museum Association annual conference .

4 3D Standards in Archaeology

No matter how much education is conducted on the capabilities of VR, the cost of development and maintenance will always be an issue. One method by which human heritage researchers can reduce the cost of VR projects is to embrace open standards, in particular those of the Web3D Consortium including the Virtual Reality Modeling Language (VRML97). The VRML97 specification was the first of the consortium’s specifications to be widely embraced by the archaeological community. There were two reasons for this. First, the VRML97 specification was, and still is, widely supported by many 3D modeling and authoring software applications. The second reason was that, as an open standard, there were no licensing fees associated with content delivery. In disciplines like archaeology, where funding for technology applications is limited, low-cost entry-level software with no content-delivery licensing is the key to adoption by many archaeologists and human heritage specialists who just do not have the ability to purchase more expensive, proprietary VR solutions.

4.1 X3D Adoption in Archaeology

The Web3D Consortium's successor specification to the VRML97 format is Extensible 3D (X3D) . This specification is an extension to VRML97 and offers many enhancements over the previous specification including multitexturing, character rig support through H-Anim, rigid body physics, particle effects, and layering components. Though X3D offers an increased feature set over VRML97, the community of archaeologists and human heritage professionals interested VR have not embraced the new specification as widely as VRML97. The reasons for this were outlined in an X3D/Archaeology Access Grid panel discussion that was held as a joint session during the overlapping CAA2006 Conference and Web3D2006 Symposium. Implementation of the X3D specification is not as widely supported by 3D modeling and authoring applications as VRML97. Additionally, many VRML97 archaeology applications depend upon freely available HTML browser plug-ins to communicate effectively between browsers such as Internet Explorer and Netscape. Until recently, no X3D plug-in that is freely available has been able to offer this functionality.

5 Archaeology Technologies Laboratory (ATL)

The mission of the ATL is to investigate the use of 3D visualization technology for the purposes of preservation, education, and research on objects and sites of concern to human heritage disciplines such as archaeology, cultural anthropology, physical anthropology, and history. Activities of the ATL include the virtual reconstruction of archaeological sites, educational and 3D authoring software development, and 3D digitization of fossils, skeletal elements, and artifacts. The laboratory is equipped with a variety of hardware and software that includes a dozen graphics workstations, an SGI Infinite Reality3 system, a Fake Space ROVR stereoscopic projection system, three 3D laser digitizers, a contact digitizer, and a variety of 3D authoring applications that include a significant software donation from Alias (now Autodesk) of Maya Unlimited.

6 On-A-Slant Virtual Village

The ATL has experience constructing both web-based interactive 3D educational environments as well as pre-rendered stereoscopic exhibitions. The On-A-Slant Virtual Village (OAS) project has been implemented in both types of environments [4]. This has provided us with a background for evaluating the use of X3D for stereo-rendered VR human heritage exhibits.

The pre-rendered stereoscopic version of OAS was constructed to require as little maintenance as possible. The OAS site was reconstructed using Maya Unlimited, after which a separate video file was created for both the left and right eye perspectives. This video was encoded for DVD playback by synchronized professional-grade DVD players using a method described by Dave Jones Design [3]. This method allowed us to eliminate the need for a computer to control the stereoscopic playback, thus ensuring that an average museum volunteer with minimal training could operate the exhibit. All the museum worker needed to do was push a button.

6.1 Interactive X3D On-A-Slant

Once the pre-rendered version of OAS had been completed, the project team sought to use that resource as a base for a new educational application. With funding from the National Science Foundation, we moved ahead with development of an interactive, online version of OAS for use in K-12 classrooms. Because there are no licensing restrictions with X3D, and sincee we already had a significant amount of experience with VRML97, we decided to adopt the X3D specification for our interactive implementation. We felt that X3D was a better choice than VRML for our project because it offered multitexturing and character animation. Our renderer of choice, the Xj3D browser, also allows for content to be displayed in a stereo-projection mode.

Unfortunately, at that time the Maya software did not provide an easy path for X3D export of Maya authored content. Maya still offers a VRML97 exporter, but the process of converting that content to X3D after export would require editing of the exported files. On past projects, ATL modelers had found this VRML exporter difficult to use, and it often produce undesired results. Additionally, the old VRML exporter did not support the export of character rigs to the H-Anim, a feature of X3D we wanted to use. When conducting surveys of the TODC audience, the developers realized that the 2D cutout representations of people within the TODC environment detracted from the immersive experience [2]. Although we modeled mesh representations of villagers within the OAS pre-rendered exhibition, anecdotal feedback from the audience members agreed with the TODC findings. Whether the representations of people within these environments are cutouts or static mesh models, the stationary nature of avatars detracts from the visual experience.

All of these issues motivated the ATL to develop its own open-source X3D authoring plug-in for Maya called RawKee [1]. The exporter supports most of the features that the old VRML97 exporter provided, plus multitexture support, texture export of any image as an X3D compatible texture file (PNG, GIF, or JPEG), export of character rig content as X3D H-Anim, X3D scripting, and export support for all three X3D encodings as well as the old VRML97 standard.

7 Limits of X3D Stereo-Rendered Exhibitions

While we have demonstrated that it is possible to take content created for a pre-rendered exhibition and convert it into an X3D-based stereo-rendered VR human heritage exhibit, there are limitations to what can be done with the technology. Issues of cost are at the heart of every human heritage project. Currently, there is only one freely available X3D viewer that supports stereo-rendering, Xj3D. But the components of Xj3D that allow for this type of rendering are based on an older, slower Java3D implementation of the application. As such, only smaller, less dynamic X3D worlds can be displayed stereoscopically in this manner.

As discussed above, costs of installation and maintenance must be taken into account when designing a stereo X3D exhibit. Will a room need to be dedicated to the VR exhibit? How much will the renovation cost? How advanced should the stereo unit be and what will it cost? Will staff be able to maintain the system and fix it if it breaks down? Will special technicians be required to operate and repair the system? Can the equipment be quickly repaired or replaced should it break down? Questions like this need to be asked before administrators can evaluate whether a VR exhibit or a pre-rendered exhibit is right for their museums.

Unlike pre-rendered exhibits, X3D VR exhibits require interaction with the audience. Regular interaction with the exhibit makes the chances of an equipment failure much more likely as Input devices can break. So what, then, would be the ideal exhibit? The ideal X3D-based, VR, stereo-rendered, human heritage exhibit would be one where the users need not touch an input device to interact with the 3D scene, and one where the users need no glasses to view the exhibit in stereo.

8 Conclusion

By acknowledging the importance of educating the public about our shared human heritage, we significantly contribute to our understanding of the experiences and the many worldviews of our diverse cultural backgrounds. The 3D technology now has the ability to rebuild archaeological and restore artifacts to their original condition. Through the use of computer visualizations the public can virtually experience the world's cultural heritage in a medium that evokes feelings of immediacy and involvement.

Yet, immersive VR experiences have not become a fixture of human heritage museums. Administrators are reluctant to take on the cost necessary to implement and maintain VR exhibitions. Certainly, information on the benefits of such museum exhibits can go far in changing this attitude, but the lowering of implementation and maintenance costs should still be a goal of those interested in the technology.

Use of the X3D specification is a robust, low-cost method for implementing stereo-rendered VR exhibits that addresses the cost needs of the human heritage fields. However, more work needs to be done with infrastructure to make widespread adoption of stereo-rendered VR exhibits a reality.

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