
A. Foni, G. Papagiannakis, N. Magnenat-Thalmann

*MIRALab, University of Geneva, 1211 Geneva, Switzerland - (papagiannakis, foni, thalmann)@miralab.unige.ch

KEY WORDS: Cultural Heritage, Virtual Reality, Modelling, Animation, Real-time VR character simulation

ABSTRACT:

This paper presents the case study of a real-time interactive digital narrative visualisation of the Namaz Pray of a simulated Ottoman Imam in the 16th century virtually restored mosque of Küçükk Aya Sofya (previous St. Sergius and Bacchus church) as well as in the Hagia Sophia mosque (previous cathedral of Hagia Sophia), in Istanbul, Turkey. This case study illustrates that the abandonment of traditional concepts of static cultural artefacts with interactive, augmented historical character-based narrative representations, can propel virtual reconstructions of cultural heritage sites to an exciting new edutainment medium. Furthermore, a reconstruction and real-time immersive visualisation is presented by simulating these edifices both as churches (original form) and as mosques, fully respecting the archaeological, historical and architectural premises.

1. INTRODUCTION

1.1 Character-based virtual cultural heritage

Virtual Reality and its concept of cyber-real space invoke such interactive digital narratives that promote new patterns of understanding. The word "narrative" refers to a set of events happening during a certain period of time and providing aesthetic, dramaturgical and emotional elements, objects and attitudes [Nandi et al]. Mixing such aesthetic ambiences with virtual augmentations and adding dramatic tension, can develop these narrative patterns into an exciting new edutainment medium. The abandonment of traditional concepts of static cultural artefacts with interactive, augmented historical character-based event representation is an important component of this redefinition. For digital narratives realized with Virtual Reality, the conditioned notion of artefact gives away to a far more liberated notion. Illustration of such a transition is attempted here with the real-time ceremonial visualisation in two world acclaimed cultural heritage sites, such as the S.S. Sergius & Bacchus and the Hagia Sophia edifices.

1.2 Previous Work

The most related character-based VR and virtual cultural heritage applications are summarised in the previous work of Papagiannakis et al as well as Foni et al. The historical and non-real time design & 3D modelling methodologies for both the current case study edifices and virtual humans are fully covered by Foni et al. This paper solely focuses on the real-time immersive visualisation and interactive narratives of the recreated ceremony with real-time virtual characters. The present case study illustrates the adoption in virtual heritage of not only architectural visualisation but also high quality virtual character recreation with face, body, cloth and speech simulation. Furthermore, the Cathedral of Hagia Sophia, one of the largest and most significant cathedrals in the world, has never been fully virtually restored and visualised in real-time before. Ponder et al describes the main architecture, requirements, specification and uses of the VHDD++ real-time framework. Finally Ulicny et al presents another application of the same VHDD++ framework for virtual heritage dedicated to crowd simulation and rule-based scenarios.

2. REAL-TIME CHARACTER SIMULATION

2.1 Virtual Namaz pray

The detailed scenario of the Morning Namaz Pray during the 16th century restored Hagia Sophia and S. Sergius and Bacchus edifices, was prepared by the [YTU] historians, architects and scientific personnel. Following that was the motion capture process, defined by [Molet et al] utilising the VICON optical motion capture system and a real person re-enacting the Namaz pray thus being recorded digitally. After the needed post-processing the individual movements that correspond to the various parts of the pray are available as separate keyframe animations, ready to be applied to the H-Anim created virtual characters. After the YTU and DTU (Denmark Technical University) teams provided the simulated echoic 3D sound speeches that correspond to the verses of the pray, it was possible to have a database of matched speeches and body animations ready to be applied to the virtual Imam and other characters.

2.2 Virtual Characters

After the modelling of the H-Anim virtual characters (as described in Foni et al) the face processing starts according to the processes and tools described in Kshirsagar et al so that the virtual characters are ready for facial animation and speech simulation. Next step in the pre-processing stage is when the virtual body and clothes are being prepared for animation and deformation, according to the skinning process described in Cordier et.al. Finally the fully body-cloth-face-speech enabled virtual character is exported in the H-Anim format. The following figure illustrates some resulted virtual characters.
2.3 Evolution of the edifice throughout time

Due to the need to revive the time-dependent context of the restored edifices, the need has arisen for restitution as churches originally and later as been transformed to mosques. However, the Byzantine restitution of the edifices proved of high risk as not sufficient architectural-historical-archaeological data were at hand. Thus it was commonly agreed after discussions with the CAHRISMA project cultural partners, that the Byzantine interior restitution would have depicted only architectural modifications without image-fresco restorations, which were unobtainable in most cases. Thus the simulations resulted as depicted in the Results section.

2.4 Rapid application prototyping using a real-time framework for VAR character simulation

In order to proceed with the rapid development of such demanding high performance interactive immersive VR application, featuring advanced virtual human simulation technologies we adopted the VHD++ real-time framework as described by Ponder et al. (illustrated in the following figure)

VHD++ addresses the most common problems related to the development, extension and integration of heterogeneous simulation technologies under a single system roof while combines both framework (complexity curbing) and component (complexity hiding) based software engineering methodologies. As a result a large-scale architecture and code reuse is being achieved which radically increases development efficiency and robustness of the final VR and virtual character application. Figure 2 illustrates a graphical overview of the VHD++ framework. Without the adoption of such a framework it would have been extremely time consuming and technically not guaranteed that we would result in such a VR application featuring all these real-time heterogeneous technologies supported by the necessary processing tools: a) immersive 3D real-time graphics, b) immersive 3D sound, c) VR interaction, d) virtual human animation with skinning, e) real-time cloth simulation, f) facial animation, emotion and speech.

3. RESULTS

The following figures illustrate the results of the adoption of the VHD++ framework for the rapid creation of the immersive VR application prototype. A Christie Mirage 1000 wall projector was used to provide both active and passive stereo projection, as VHD++ supports sequential stereo rendering (viewed with either shutter or polarised glasses). Thus the immersive aspect of the VR simulation was ensured. The final VR application was executed in a PC system, rendering real-time environments ranging from 60k to 400k polygons, 10k-polygons humans with deformable skins, while running on a Win 2000, 2GB RAM, Pentium 1.5GHz, with NVIDIA Quadro 4 980XGL graphics card, yielding 25fps performance.
4. CONCLUSIONS

The actual records of culture are constituted from performances to artefacts that have been created in a persistent manner but inevitable decay. That is depicted in the notion of cultural heritage where it consists of what is called “Tangible Heritage” such as buildings, artefacts and media as well as the “Intangible Heritage” containing art expressions (music, dance, literature etc.).

The present paper is a continuation and real-time finalisation of the work that we started as described in Foni et al. Thus hereby we conclude the steps of the real-time virtual realistic inhabited restitution of S. Sergius & Bacchus and Hagia Sophia in Istanbul, both as Byzantine cathedrals and Islamic mosques. The common problems, pitfalls from the modelling and pre-processing stages (Foni et al) and real-time solutions and specific choices have been analysed and explained in order to establish a complete real-time methodology of bringing large, complex and endangered edifices to life and simulating historical characters as well as their architectural evolution.

Finally the use of new immersive VR technologies, in conjunction and with the essential support of traditional sources and materials, has been presented in order to describe a complete methodology for the restoration and renovation process of ancient monuments. Hence with the utilization of the mentioned methodology for the situations where architectural restoration and protection are not available, virtual restoration and conservation is exhibited. Such virtual heritage simulations are a fundamental aspect for the full understanding of the historical and social development of vast communities and form a ‘virtual material witness’ of the process of civilization.

5. REFERENCES


6. ACKNOWLEDGEMENTS

We would like to thank Nedjma Cadi-Yazli for her additional modelling and design contribution and Michal Ponder, Branislav Ulicny, Bruno Herbelin, Sebastian Schertenleib and Tom Molet for their support with the VHD++ framework. The presented work is supported by the Swiss Federal Office for Education and Science in frame of the EU INCO-MED CAHRISMA project (ended March 2003) and the VHD++ real-time framework in frame of the EU IST STAR project.