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Short and Project Papers

Virtual Romans: Virtual Reconstruction of Roman Leicester (Ratae Corieltauvorum) 210AD

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Abstract

This paper presents preliminary results and progress on the Virtual Romans project. The aim of this project is to explore the potential for creative technologies to present life in Roman Leicester (Ratae Corieltavorum) focusing on the period around 210 A.D. The paper descibes the practical experience of using a range computer graphics technologies to create historically accurate digital 3D models of the known Roman buildings and associated artifacts and then populating the resulting town with virtual 'Roman' characters. It also discusses how the 3D assets created are also being subsequently employed in a range of interactive environments including an innovative location based augmented reality mobile phone application.

1.Introduction

The Romans settled in Leicester during the 1st to 4th Centuries A.D. [Buc11] The Virtual Romans project began in 2008 and its aim is to explore the potential of creative technologies to present our understanding of life in Roman Leicester (Ratae Corieltavorum). [Hug12] It is concerned with the research and development of historically accurate digital models of the known buildings and artifacts and subsequently populating the resulting town with virtual 'Roman' characters. It is also currently exploring the potential of location based mobile and augmented reality technologies in a virtual heritage context. The project is a collaboration between De Montfort University, the Leicester City Arts and Museum Service's Jewry Wall Museum and the University of Leicester's Archaeological Service.

The context for this project is provided by the Museums, Libraries and Archives (MLA) Renaissance project and MUBU Museum programme which both highlight the need to find innovative ways to engage local audiences. [Mla012] [Mub12] Few such digital resources and initiatives exist in the Leicester region yet according to the 'Treasures of the East Midlands' Report (2009) museum visitors like interactive maps, reconstructed buildings and museum objects linked using themes and narratives, timelines, interactive challenges and information about their town. [Mar09]

2. Building Reconstucion

Many virtual heritage reconstruction projects still appear empty and lifeless as they are devoid of inhabitants. However, this reconstruction attempts to build on similar work such as Saxon Norwich and Virtual Pompeii both of which have populated virtual environments. [Ryd05] [Mai07] In terms of the buildings, its aims are to achieve a high level of accuracy and to provide users with full access and freedom of motion to the buildings inside a virtual world. It is also intended that the model will integrate as seamlessly as possible with other end user platforms either mobile or online.

Initially, expert input came from a combination of museologists, archaeologists and historical architects. They played an important part in the early development of this project and in the creation of the first 3D model V1.0. Unfortunately, there was considerable professional disagreement between the various experts involved; for example, in regard to building height, colour and styling. It was finally decided that the model needed primarily to conform to the interpretations of the archaeologists advising the project who had actually been involved in the original excavations.

In addition V1.0 had many technical issues when integrating the model into the proposed 3D gaming environment Unity 3D which would allow user interaction. This was because the model in V1.0 was created using a mix of two 3D modeling tools Autodesk 3DS Max and Google Sketch Up. This created problems including having more and in some case unnecessary faces than required as well as textures whose specular shading provided incorrect

information to the gaming engine and subsequently produced transparent walls. Roman Leicester V.1.0 therefore needed considerable revisions.

A second attempt is currently close to completion. In the revised Virtual Roman Leicester V2.0, all issues from the predecessor are being addressed. In terms of archeological accuracy, V2.0 now features a number of recreated colour textures based on advice and findings from archaeologist's excavations of the walls and ceilings. For example the existing Macellum portrait plaster patterns have been digitally reconstructed using Abobe Illustrator and Photoshop. A combination of image retouching techniques were used in order to restore them. (See Figure 1)
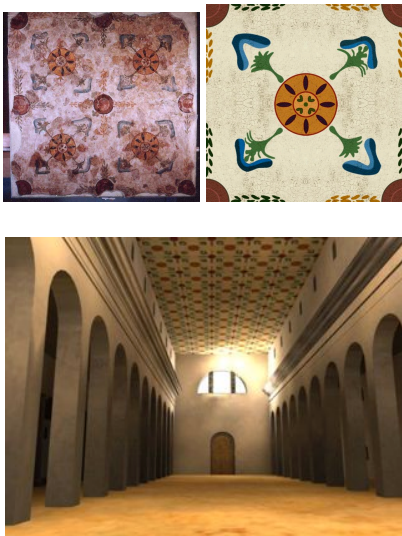

Figure 1: Top - Macellum interior ceiling before and after digital restoration. Bottom – Restored texture placed in ceiling of 3D model

The building exteriors have also been recreated based on physical evidence and advice from the archeologists at Leicester University. For example, a still image of the existing exterior wall of the "Jewry Baths" was used to reconstruct the 3D model's wall texture. (See Figure 2)

Figure 2: Top- Photograph of existing Jewry Wall Bottom – Texture mapped onto the Jewry Baths Exterior

In terms of overcoming the technical problems, the buildings were remodeled using software that would seamlessly integrate with the game development tool (Unity 3D). Autodesk MAYA proved to be the most reliable piece of software due to the plug ins available and file integration; particularly its FBX export and import format which allowed texture embedding along with the 3D Model. The goal is to reconstruct the buildings and deliver simple, cleaner models with lower polygon count, that can not only integrate with Unity 3D but can also be used in mobile application development (see section 5) as well as the creation of high resolution rendered stills and animations using MAYA's mental ray rendering engine.

3. Populating the 3D Environment

After several months of work the five main buildings of Roman Leicester are finished and it will soon be ready for the next stage of this reconstruction project; their virtual population with a set of historically accurate digital characters with unique features. The characters will be based on a combination of archeological findings and historical research relating to who lived in Roman Leicester around the period 210 AD. Although this part of the project is still under development it is anticipated that this set of characters will be modeled, animated and integrated into the game environment using the same 3D tools namely Autodesk MAYA and Unity 3D. Additional research is also taking place into the level of programming that may be associated with the characters to enable user interaction. At the moment only one character has been produced "Primus the Tile maker" and is still under revision. See Figure 3. This character is based on the find of a Roman tile with his signature on it and the assumption is that he was the tile maker and this was his trademark. Primus is providing valuable information for the further character creation and ultimately population of the 3D environment.

Along with the character creation it is important to mention that even though there are some digital reconstructions which are populated the goal for this part of the project is to produce a standard character development framework that could easily be adapted to any other Digital Heritage reconstruction and therefore provide the necessary tools to begin populating the environment. In this research, the importance of the characters does not rely on the high quality of modeling texturing or rendering but on the actual process of developing a historically accurate virtual character that can be deployed in a massively multiplayer online game environment with a more complex level of Agent behavior possibly capable of learning from the everyday user interaction.

Figure 3: Primus the Tile maker

4. Virtual Artefact Developemt

The aim of this part of the project was to create and present 3D models of the exisaiting Roman archaeological and museum artefacts for use within the 3D building reconstruction discussed in section 2 as well as the proposed online and mobile applications. This requires files compact enough for quick loading. Photogrammetry is a technique to create 3D models using a set of photographs. [Rem11] Even though this method does have limitations, particularly for artefacts with complex holes, it was chosen. The attraction of this photographic method is two-fold: cost and file size. The large file sizes produced by laser-scanning and its cost (especially that which also records colour for a model's texture and automates the process) are prohibitive. The software 3Dsom Pro was selected [3Ds12] and 15 artefacts were chosen for scanning nine of which produced successful models. Figure 4 shows one of these ; a bronze Pin broach.

Figure 3: *Bronze Pin Broach*

Some of the failures were due to photogrpahic inexperience while other failures were due to the complexity or awkwardness of the artefact One Samian ware bowl fragment proved too complex for the software to create an easily-editable model. Depsite these issues, the outcomes have been 'good enough' for use within the project. The finished models so far can be seen online at their findspots on an interactive map of Leicester at: www.ioct.dmu.ac.uk/research/current/3d-roman-artefacts/

5. Location Based Augemted Reality Phone App.

Research is also currently taking place into the design and development of a Virtual Roman Leicester mobile application which utilises the 3D buildings and artefacts that have been created in earlier stages of the project. Initially, it is being programmed for *iPhone* and *iPad* to allow the visual recreation of key Roman sites and artefacts in their correct location. This will utilise augmented reality technology [Azu97] such that virtual 3D models will be visually superimposed on the view of the sites as seen in real-time through the mobile device camera. Figure 5 shows the prototype in action. The iPad display shows the interior of the Roman Jewry Wall Baths actually on the site of Baths in Leicester. This is right next to the Jewry Wall Museum.

Figure 5: Augmented Reality Phone App.

To populate the system, the existing three-dimensional building and artefact models discussed in sections 2 and 4 have had to be simplified but in some cases completely rebuilt in order to significantly reduce the polygon count. GPS location-finding is used as the primary, initial means for locating. Accelerometer, gyroscope and magnetometer data fusion is then used to refine accuracy and maintain overlay location. Initial field testing indicates that GPS accuracy may be an issue. In the future therefore it is also planned that sparse feature tracking of the real scene will be employed to improve 'locking' of the overlay position to the real world. The initial system has been developed using Objective-C, OpenGL-ES and OpenCV [Ope12].

From a research and development point of view, it is planned to use this application to develop further enhancements that will be applicable generally to other augmented reality systems. It is envisaged that this will include harnessing parallax motion to recover sufficient real-world depth information [Yoo11], and thus to provide real-virtual occlusions, so that virtual objects can be obscured by closer real entities and vice-versa. There is also a wide range of possible other avenues to pursue, using this system as a base, to add realism to the visual relationship between the real world and superimposed virtual objects; for example, light interactions between the real and virtual worlds, relating to light quality and direction, shadowing, reflections and transparent object refraction.

6. Conclusion

Much of the work discussed in this paper is clearly work in progress and has involved a great deal of experimentation to find the most approriate method or technical solution. It is hoped however that it will provide a valuable resource and case study for other researchers and developers working in the rapidly evolving field of digital heritage. It is anticipated that within the next year the results of this project will be fully available through a 3D enabled website, mobile phone app and interactive museum installation.

7. Acknowlegements

8. References

[3Ds12]3Dsom, 2012, 3D Software Object Modeller Pro (software), available from http://www.3dsom.com/

[Azu97] Azuma, R. (1997) A Survey of Augmented Reality. In *Presence: Teleoperators and Virtual Environments 6*, 4 (August 1997), 355-385.

[Buc11] Buckley et al (2011). Visions of Ancient Leicester: Reconstructing Life in the Roman and Medieval Town from the Archaeology of the Highcross Leicester Excavation,. Leicester University

[Hug12] Hugill, A. (2012) http://www.ioct.dmu.ac.uk/research/current/virtualromans.html

[Mai07] Maim, J. et al (2007) Populating Ancient Pomei with Crowds of Virtual Romans, VAST2007 Conference proceedings, pp.109-116

[Mar09] Marshall, M. (2009), Treasures of the East Midlands: Feasibility study, Renaissance East Midlands

[Mla012] (2012) http://www.emmlac.org.uk/

[Mub12] (2012) http://www.mubu.org.uk/

[Ope12] OpenCV (2012) http://opencv.willowgarage.com/wiki/.

[Rem11]Remondino, F., Heritage Recording and 3D Modelling with Photogrammetry and 3D scanning, Remote sensing Journal, Issue 2001,3

[Ryd05] Ryder, G et al, (2004), A Framework for Realtime Virtual Crowds in Cultural heritage Environments, VAST 2005 Conference

[Str12]Strata, 2012, Strata Foto 3D CX (software), available from http://www.strata.com/products/strata_3d_cx_suite/strata_foto_3d_cx/

[Yoo11] Yoonessi, A. and Baker, C. (2011), Contribution of motion parallax to segmentation and depth perception. Journal of Vision (2011) 11(9):13, 1–21.