Reconstructing the Past: Outstanding Student-Created Virtual Heritage Experiences

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Figure 1: *Screenshots of the virtual heritage experiences. Left: Discovering the Tomb of Tutankhamun; Centre: AR reconstruction of Maiden Castle in Dorset; Right: Stonehenge Past and Present experience.*

Abstract
In recent years, Computer Graphics (CG) and related techniques have become increasingly important for the preservation and dissemination of Cultural Heritage (CH). Here we present a set of three excellent CH reconstructions and virtual heritage experiences created by final year undergraduate students from several computer animation related programmes of study in the course of an optional course on "CG and Animation for Cultural Heritage". The three projects discussed here are interactive heritage experiences, including a reconstruction of the tomb of Tutankhamun, an Augmented Reality (AR) reconstruction of the Iron Age hillfort Maiden Castle, and a Virtual Reality (VR) reconstruction of ancient Stonehenge.

1. Introduction

The past two decades have seen increasing use of computers in areas of cultural heritage preservation, with one of the main uses of computers in this field being the digital preservation and reconstruction of cultural heritage objects and sites, allowing such artefacts and sites to be viewed as well as examined in context. There exist, however, only a very small number of university-level courses that explicitly cover CG in CH contexts that are aimed at computer graphics and animation students with both technical computing as well as art and design backgrounds. One such course is our new "CG and Animation for Cultural Heritage" course, which aims to provide students with knowledge of and insights in methods and techniques used in the development of cultural heritage applications, enabling them to select advanced image synthesis, animation and interactive techniques appropriate for particular CH applications.

2. A Course on "CG and Animation for Cultural Heritage"

The outstanding student projects presented here were completed during the 2019/2020 academic year (during the 1st UK lockdown of the Covid-19 pandemic) within the "CG and Animation for Cultural Heritage" course, a 10 ECTS optional course in the final (third) year of the undergraduate (computer animation) framework of the National Centre for Computer Animation at Bournemouth University [CMA10]. The course is informed by current research and investigates the different forms of cultural heritage that exist, i.e. tangible as well as intangible, and different manners in which methods and techniques of the visual computing domain, especially computer graphics and animation techniques, have and can be applied to their interpretation and aid both digital and physical preservation and dissemination of cultural heritage objects.

The main focus of the course is on virtual heritage and methods that can be employed to aid public presentation of CH. This encompasses games technologies [AML*10], and relevant 3D modelling and rendering approaches, especially relating to methods and tech-

niques relevant to interactive visualisation in museum contexts such as (on-site or online) virtual museum exhibits, but also extending to recent developments in human-computer interaction and relevant uses of digital fabrication techniques such as 3D printing.

Students are assessed by individual coursework, comprised of the presentation of a domain-specific case study, discussing an existing application of CG to the CH domain, worth 30% of the course grade, as well as a portfolio consisting of a 3D Cultural Heritage object, accompanied by supporting background research and designs to provide a rationale for decisions made during the artefact production, worth 70% of the course grade.

3. Outstanding CH Portfolio Submissions

The following are the results of the three best interactive coursework portfolios created by in the context of the "CG and Animation for Cultural Heritage" course during the 2019/2020 academic year.

3.1. Discovering the Tomb of Tutankhamun

This virtual heritage experience (Figure 1, Left), implemented using Unreal Engine 4 (UE4, https://www.unrealengine.com) aims to recreate this iconic Egyptian tomb in the state it was in at the moment of its discovery by Howard Carter in 1922, allowing users to relive this historic moment and to interactively explore the tomb's antechamber, burial chamber and treasury. The main references consulted by the student were Howard Carter's notes and Harry Burton's photographs [MHF*] and more recent colour photographs used to guide the development of material properties of the artefacts in the tomb, with high-resolution images created by the Theban Necropolis Preservation Initiative [The09] used as reference for the wall paintings of the burial chamber.

3.2. Maiden Castle Iron Age AR

Maiden Castle in Dorset is Britain's largest Iron Age hillfort. Using a Digital Terrain Model (DTM) of the site created from the UK's Department for Enviroment Food & Rural Affairs and based on the archaeological findings [Sha91], a mobile web-browser based AR heritage experience (Figure 1, Centre) that allows users to explore Maiden Castle as it might have looked in 400 BC was developed using WebXR (https://immersiveweb.dev/) with the ramparts and roundhouses located on the site reconstructed using Blender (https://www.blender.org).

3.3. Stonehenge Past and Present

After four millennia of decay, only a few of the stones of this world-famous megalithic stone circle remain standing, with many stones having fallen over or having been removed, and although the remains are impressive, it is not easy to visualise how this Neolithic monument would have looked like when the site was still in use around 2200 BC. Using UE4, 3D assets created using ZBrush and based on recent archaeological excavation findings [PCM*07, PPS12], combined with a publicly available Digital Surface Model (DSM) that allowed the creation of an accurate height map of the site and its surrounding landscape, this immersive virtual heritage experience (Figure 1, Right) for desktop PCs

(and extensible to VR) allows users to experience not only the ruins of Stonehenge in their current state but also the ancient completed monument, with an intermediate transition version that displays translucent outlines of missing stones within the modern ruins of the monument, allowing users to compare modern Stonehenge with a best-guess reconstruction.

4. Discussion

Each of the three coursework projects presented here were very well executed and based on solid research of the archaeological record, demonstrating great attention to detail and competent application of CG asset creation techniques acquired by the students during the course of their studies. The projects were created in line with the guidelines of the 2009 London Charter "For the Computer-Based Visualisation of Cultural Heritage" [BND09] and are each of a very high quality, easily comparable to commercially available virtual heritage experiences. Despite the complications created by the closure of the university campus due to the Covid-19 pandemic, the end results (although interactivity is limited) are among the most polished interactive applications that have been produced by students of the National Centre for Computer Animation to date.

5. Acknowledgements

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