Jonathan Swift: Augmented Reality Application for Trinity Library's Long Room

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Abstract. This demo paper describes a project that engages cutting-edge free viewpoint video (FVV) techniques for developing content for an augmented reality prototype. The article traces the evolutionary process from concept, through narrative development, to completed AR prototypes for the HoloLens and handheld mobile devices. It concludes with some reflections on the affordances of the various hardware formats and posits future directions for the research.

1 Introduction

This project is an interdepartmental collaboration between *V-SENSE* – a computer science research group in Trinity College, led by Professor of Creative Technologies, Aljoša Smolić, exploring virtual reality (VR) and augmented reality (AR) technologies – and the Library of Trinity College, which, under the leadership of librarian, Helen Shenton, is seeking to enhance its future accessibility programme by harnessing new interactive digital media. The goal was to conceive and build an innovative digital application that employs cutting-edge hard and software to enrich the visitor experience in the Long Room [1]. As an experimental and synergetic collaboration, the project benefits both parties. On one hand, *V-SENSE* gets an opportunity to build digital content on the basis of rich, engaging and famous cultural subject matter, e.g. rare, historical books, artefacts and sculptures, not to mention the breath-taking building itself. On the other hand, the library gets a cutting-edge interactive application that affirms its commitment to innovatively harnessing digital technologies towards constantly improving its accessibility to visitors, while also solidifying its immovable presence as guardian and proponent of Trinity's, and Ireland's, rich academic legacy.

2 Concept Development

From the outset it was agreed that there is no substitute for the real experience of being present in the Long Room. Therefore, the goal was to devise a narrative/concept that augments the visitor experience, and does not try to compete with the library's crucial

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business model, based on real tourist footfall, i.e. a narrative that draws people in, as opposed to acting as a virtual substitute. An AR app suits this demand because, as per Azuma's three-tiered definition, AR merges real and virtual worlds, permits real-time interaction, and perceptually aligns digital information with real objects in geometric space [2]. It emerged that what was needed was a narrative that helps escort visitors through the library by pointing out rare artefacts, books and manuscripts [3]. There are numerous marble busts of famous historical figures – such as Socrates, Bacon, Swift, Hamilton, etc. – that line the central aisle of the Long Room. For the purposes of the prototype, these busts provide an interesting basis for subject matter. The concept that emerged was that an AR avatar would feature beside each bust imparting a whimsical, idiosyncratic anecdote linked to the Long Room and its context. The interactive tour would consist in visitors discovering peripheral stories that help draw their attention to the multitude of historical, architectural and archival details, procuring a deeper, more enriching experience of the world heritage site. The project is a practice-as-research experiment supported by the findings of Sommerauer and Müller, who quantitatively demonstrate that 'museum visitors learned significantly more from augmented exhibits than from nonaugmented exhibits, perceived AR as a valuable add-on of the exhibition, and wish to see more AR experiences in museums in the future' [4].

2017 marked the 350th anniversary of (famous Trinity scholar) Jonathan Swift's birth, so we decided to focus on his character for the prototype. Thus, the objective was to conceive a short, whimsical anecdote about Swift, and to produce the content for interactive AR viewing. Jane Maxwell, Principal Curator of TCD Library, assisted with drafting up a light-hearted yet informative script that engages visitors along the lines of humour interwoven with historical fact. The innovation that this project brings to the discourse on AR apps for museums is that it displays 3D volumetric content using real actors, costumes and video, not animated avatars developed natively in software. Free viewpoint video (FVV) is the technique we used for creating the avatar [5]. FVV is a volumetric video technique that 'offers the same functionality that is known from 3D computer graphics. The user can choose an own viewpoint and viewing direction within a visual scene, meaning interactive free navigation. In contrast to pure computer graphics applications, FVV targets real world scenes as captured by real cameras' [6].

3 Technical Process

The FVV process entails recording live action using multiple cameras that surround the actor, who performs in an enclosed green screen environment. The footage is stitched together, at the post production stage, using optimised computer vision algorithms. Accurate 3D reconstruction demands maximum scene coverage and image overlap. Thus, twelve video cameras were strategically placed in a 360 degree arc. After the footage is captured it is prepared for the complex postproduction stage. Video and audio recordings, from all cameras, are synchronised to ensure all data frames concur, temporally and spatially. The actor is chroma-keyed and then exported as a series of raw images and thresholded silhouette masks. The camera positions are calculated in a 3D virtual geometry, and then all elements are used to reconstruct the 3D geometry based on the following techniques: shape-from-silhouette (SfS) [7], obtained from the

silhouette mask; and multi-view stereo (MVS) [8], via a 3D point cloud. 'All data are then combined using 3D fusion techniques, resulting in volumetrically complete and accurate 3D models' [9]. A separate 3D model is generated for each frame of video. Input images are used to colour the corresponding models using a multi-view texturing technique [10], producing a series of fully textured, photorealistic models [11]. Iterating through these at 30 frames per second constitutes the basis of volumetric video. When the sequence is complete, it is compiled in a game engine. A custom script dynamically loads a textured mesh for each frame. Finally, the app is exported as an executable file, for the Microsoft HoloLens, or a handheld device, such as a tablet or smart phone.

4 Augmented Reality App

The app functions on the condition that the user wanders through the tangible space and uses pattern recognition technology to activate individual stories linked to the artefacts they are viewing. In the case of this prototype, it is the bust of Jonathan Swift that is recognised by the app, which triggers the volumetric video to load and begin playing back, hence the character of Swift appears as an AR hologram beside the original statue. The sequence executes in its entirety, from start to finish [12]. Considered singularly, the prototype video is linear, but the way it is triggered is interactive. It is easy to see how, using a repertoire of such video sequences, this model can be scaled-up as an interactive meta-narrative, involving each of the other busts in the Long Room, not to mention the plethora of books and manuscripts of historical significance.

5 Conclusion

The project was presented to the library's steering committee in May 2018, and we are currently awaiting feedback as to whether the proposal will be adopted to the future digital access programme. The prototype was well received, but we have yet to record qualitative user feedback [13]. The AR solution fulfils the brief by enhancing the visitor experience and does not attempt to offer an alternative to visitors being physically present at the historical site. It would be feasible to deploy iOS and Android versions in the near future, however handheld devices have shortcomings – 'they force the visitor to hold the guide and to look at its screen', thereby tiring the hands and drawing attention from real exhibits [14]. By providing a wearable screen and aligning information with reals object, the version for HoloLens is a richer user experience. However, although impressive for technical demos, its high cost is currently prohibitive of ambitions to furnish the numerous Long Room visitors each with a headset.

The deployment of AR technologies in archival and museological contexts is exciting, but also comes packaged with challenges and shortcomings. Harnessed in the right way they maintain the potential to enhance and enrich human experience; but, if used incorrectly, they can curtail it. The quality of FVV technology that is so beneficial is that it demands human performativity, thus affording collaboration between the performing arts and the computer sciences. By capturing real actors telling human

stories, FVV content conserves a strong presence of humanity in a technology that is so often criticised for creating solipsistic worlds, devoid of human intersubjectivity.

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