The *Gone Garden* VR Experience – An Impressionistic Representation as Virtual Heritage Reconstruction

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Abstract

In this paper, we outline how we have embraced the unique aesthetics of purposefully flawed photogrammetry and ambisonic sound to provide an impressionistic experience for a virtual heritage application.

Over the last decade, photogrammetry has become particularly useful for 3D reconstruction in the context of virtual heritage applications. Although even inexperienced users can achieve impressive results, flawed reconstructions still occur when, for example insufficient data is being provided. Also, the capture of non-static objects, such as plants, presents manifold challenges. Usually, one would discard such imperfect reconstruction, but arguably such glitches embody a certain aesthetic, by telling a different story.

Keywords

Virtual Reality experience, virtual heritage, photogrammetry, immersive media, digital heritage representation, glitch, ambisonic

Introduction

The initiative for this artistic research in progress derived from the announced refurbishment of a Chinese Garden in Singapore (Fig. 1 and 2).

Comparatively old for the 53-year-old city-state, the garden was built in 1955 as part of the back then Chinese University, affectionately known as 'Nantah'. According to old photographs from the time, it was rather a wide-open space but already contained significant elements such as pavilions, the gate, bridges, stones and a memorial (Pookong & Kwai Keong 2013). [1] In the process, our project generated extensive records involving documentation, preservation, representation and interpretation of the garden. These include photos, videos and circle-panoramic imagery, the 360° film "Secret Detours". The records also included, experiments with CG animation and visual effects as a form of visual interpretation, as well as a 3D reconstruction of the site as a Virtual Reality environment. During the production of the virtual environment, the redevelopment of the actual site began and confronted us with the disappearance of the garden as we knew it. As a group of researchers and artists who work in different fields of immersive media, we decided to explore possibilities of how to visualise the transience of the garden and its transformation from the beautiful arrangement of trees, flowers, pavilions and pathways to a deconstructed, semi-chaotic, broken state with piles of soil, tree trunks and wilderness taking over.

Figures 1 and 2. Yunnan Garden in Singapore, before the reconstruction. © Seide, Reinhuber, Williams. 2017

In the "Parragirls Past, Present" (2017) project, Kuchelmeister et al. explore visual abstraction of a heritage site through "point-cloud representations to simultaneously generate the perception of authenticity and scientific accuracy while presenting a fragmented and broken world". [2] In the "Handbook on the Economics of Cultural Heritage" (2013), Rizzo and Mignosa argue that narrative involvement is crucial for the success of Virtual Heritage applications: "The sense of presence in the virtual

environment is influenced not only by the degree of immersion but rather by the level of […] narrative involvement". [3] We argue that creating a visual narrative through an artistic interpretation of heritage may also successfully benefit the engagement and involvement of the audience. Our project "Gone Garden" explores the use of photogrammetry as a tool to create a non-realistic, impressionistic representation of the garden from data captured at the actual heritage site for the purpose of an emotional and aesthetic interpretation.

Visual Representation

Reconstruction and Approximate Recreation

Virtual Cultural Heritage explores techniques such as laser scanning, CGI animation, 360° imagery and photogrammetry aiming to create photorealistic and accurate representations of historic environments (Zara 2004). [4]

Developments over the last decade made photogrammetry tools accessible and particularly useful for the purpose of 3D reconstruction of heritage sites. For our project, we successfully used photogrammetry and tools such as *Agisoft Photoscan* to create 3D models of the park's monument and rock statues (Fig. 3). While the monument looks convincing from afar, the intensive smoothing of corners is clearly noticeable under closer inspection and required further manual adjustments.

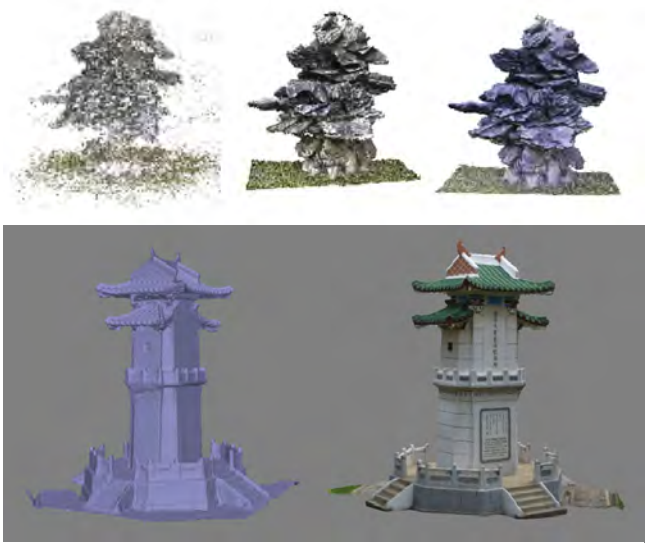

Figure 3. Digital reconstruction of rock and monument in Yunnan Garden, after photogrammetric capture. © Seide, Peixen, Reinhuber, Williams. 2017

Additional structures such as pathways, pavilions, the main gate and details such as benches, lamp posts and trash bins were modelled in *Autodesk Maya*. Achieving a high level of detail in modelling and texturing is crucial in the pursuit of achieving a realistic appearance.

As the garden is dominated by a huge palette of plants, from tropical palms to conifers, one of the main challenges was to recreate trees, bushes and flowers accordingly. While the process of photogrammetry is ideal for hard-surface static objects, it is unsuitable for small crisscrossing tree leaves, which produce an almost infinite-appearing number of occluded areas. Therefore, we decided to use digital plant assets, which are optimised for real-time projects. Even though these plants were carefully selected and matched according to plans and photos; replicating variety, position and size as close as possible, it means that ultimately the garden is not a true 3D reconstruction but an approximate recreation (Fig. 4). To get closer to a realistic representation, we intend to incorporate some of the CG assets with photogrammetry of existing tree trunks from the garden.

Combining all elements in a 3D environment with a realistic lighting setup has become very much easier over the last few years with software such as *Unity* and *Unreal*. A big challenge for a large environment with such a high volume of assets is the optimisation process required to run the application smoothly as a Virtual Reality experience.

Figure 4. Screenshot of the Yunnan Garden VR experience. © Seide, Reinhuber, Williams. 2018

Aerial Survey

In addition to the terrestrial data acquisition employed to create the 3D reconstructions of the stone rocks and the monument, an aerial survey was conducted.

A camera drone (*DJI Phantom 3*) was programmed to survey the garden from a height of 27m, just enough to avoid tall trees. The camera, while pointing straight downwards, took photos at a pre-programmed short time interval, resulting in 266 images. Processing these images with photogrammetry software produced a very precise orthophotograph of the garden (Fig. 5). An orthophotograph, or orthomosaic map, is a geometrically corrected aerial photograph which represents the Earth's surface accurately and can be used to measure true distances. We used orthophotography for our project as a reference for measurements, and manually positioned objects such as plants, trees, walkways and pavilions. So although it is not a 3D reconstruction, the positions of

objects in our virtual recreation of the garden represent the accurate locations in reference to the actual garden.

Figure 5. Orthophotograph of center of garden. © Seide, Reinhuber, Williams. 2018

Reconstruction with Insufficient Data

As the aerial survey was conducted to take photos pointing straight downwards only, the data set was vastly insufficient to generate a precise 3D reconstruction of the garden.

Processing the limited data set with photogrammetry resulted in a very low-resolution reconstruction, in which details such as trees are reduced to roundish blobs reassembling a rather abstract landscape (Fig. 6).

A Representation for a Disappearing Garden

While working to recreate an accurate and realistic representation as a VR experience, we revisited the actual garden. Even though we knew what would ultimately happen, it was depressing to be confronted with the construction site: a disassembled remembrance of what was once a green locale of recreation and enjoyment of nature.

Structures such as the pavilions, monument and gate were still intact but most of the flowers and many of the trees and shrubs had disappeared; the garden as we knew it was gone (Fig. 7).

Figure 6. 3D reconstruction from insufficient data. © Seide, Reinhuber, Williams. 2018

Figure 7. Yunnan Garden during refurbishment. © Seide, Reinhuber, Williams. 2018

Figure 8. Point cloud visualisation of garden. © Seide, Reinhuber, Williams. 2018

It became apparent to us that we needed a visual representation for this new reality: the transformed and fragmented version of the site. We started to experiment with point-cloud visualisation (Fig. 8), which provided aesthetic attributes to represent the aspect of the garden's fragmentation into small pieces, but eventually, we were not convinced by the high level of abstraction the point-cloud visualisation would produce.

The state of the garden at this time was that parts were still intact while others were gone. This grounded our decision to experiment with a combination of abstract and realistic elements, leading us to merge the low-resolution 3D reconstruction with our accurate recreation. This generated a roundish, almost abstract landscape, resulting in our VR experience "Gone Garden" (Fig. 9), a partially realistic representation, dissolving into an impressionistic dream-like memory of the garden.

Aural Representation

The importance of sound in immersive experiences in virtual reality is well acknowledged and high fidelity is considered essential (Serafin et al 2015). [5]

How the sound should or might relate to the visual world of Gone Garden and what those sounds should consist of, is an evolving process. Sound that occurred in the garden at the time of the acquisition of the visual data was not considered for use in any form of representation, as adjacent noise sources rendered useful recordings impossible [6]. The aural representation shares the same aesthetic of incomplete, fragmented and transformed data as the image. Distorted sound memories of imagined soundscapes and fragments of sonic recollection are the starting point, as if the user is experiencing the memory of another. Ambience recordings are transformed and distorted leaving hints of their origin in a way similar to the incomplete visual reconstruction based on photogrammetry. Audio processing that requires software to interpolate sound from "incomplete data" was explored, specifically the use of time expansion. With time expansion, the audio file is made longer in time, but the spectral content of the file maybe maintained. In simple terms, the audio file is made longer without changing its pitch. Audio processing algorithms create the required extra audio samples to achieve the increase in length. So, it is in this sense that the original data is "incomplete", and the audio processing "completes" it. When significant time expansion is employed, as was the case in the manipulation of the ambience recordings, audio artefacts (spectral content not present in the original recording) are usually generated, transforming, sometimes significantly, the original recording. Often considered undesirable by-products of this kind of audio processing, these artefacts or "errors" contribute to the otherworldly aesthetic and were applied to most sounds in the soundscape. As the user moves through the garden, the soundscape layers change and reflect the impressionistic nature of the virtual images. Some melodic elements are tied to specific objects and are only audible at close proximity, encouraging the user to approach. The soundscape of "Gone Garden" is an exploration of the use of sound in the impressionistic representation of virtual heritage.

Conclusion

As the garden site ceased to exist in its pre-2018 manifestation, our documentation in the form of photography, audio and video, 3D reconstruction and a VR experience offers a unique and comprehensive archive for future academic research and study.

Beyond the preservation aspect of the Yunnan Garden, the aim of the "Gone Garden" VR experience was to develop an interpretation of heritage with the aim of benefitting the audience's involvement. This challenged the project team to explore new visual and aural forms of representation. The foundation of our visual representation

Figure 9. Screenshots of the Gone Garden VR experience. © Seide, Reinhuber, Williams. 2018

is based on the data set of the garden itself, a technically imperfect reconstruction from insufficient data, which one would usually discard, but which can embody meaning to a recipient when put into context. Because we added trees and flowers that matched their appearance and position as accurately as possible, our visual representation constitutes a combination of a reconstruction and an artistic interpretation.

As the project is a work in progress, we, at the time of writing, invited the audience to explore two separate VR experiences, one being the realistic recreation of the garden, the other being the "Gone Garden" interpretation. A future plan for the project aims to create one united experience, in which the audience find themselves in a realistic replication of Yunnan garden which then over time transforms into an impressionistic fragmentation, allowing the viewer to experience and explore a culturally and historically significant place and an interpretation of its disappearance.

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Authors Biographies

Benjamin Seide, Associate Professor – Nanyang Technological University (Singapore), educator, researcher and media artist, lives in Singapore and Berlin and researches in the field of animation and immersive media. In the 1990s, Seide shot his first interactive 360° film with a self-developed camera and explored representations in virtual space in his work "Paramatrix". His work as a visual effects artist from the 2000s contributed to Art House and Hollywood films, including Wim Wender's "Don't Come Knocking", Roman Polanski's "Oliver Twist" and Martin Scorsese's "Hugo". 2009–2013 Seide lived and worked in Shanghai and created the award-winning immersive experience of the General Motors World Expo pavilion.
Currently his projects investigate artistic interpretation of cultural and film heritage in immersive media, including the full-dome installation "Fellini: Circus of Light" and "The Spirit of Pontianak", a VR installation of the lost horror film "Pontianak" from 1958.

Ross Adrian Williams, Assistant Professor – Doctor of Musical Arts – Nanyang Technological University (Singapore). Australian composer/sound designer Ross Adrian Williams has

written music and designed sound across a range of styles for theatre, feature film, concert hall, dance, museum installation, VR and interactive media. His works have been performed internationally by groups such as the West Australian Youth and Symphony Orchestras and the Australian String Quartet, his music and sound design for award winning abstract, documentary and narrative films have been shown in festivals around the world. He holds a BMus (honours) from the University of Western Australia and a Masters and Doctorate in Musical Arts from Rice University, Texas.
As an Assistant Professor of Sound Design at the School of Art, Design and Media (NTU) his research interests range from implementation of audio stimuli to improve effectiveness of robotic motor training and improving the detection of volcanic events in infrasound to multichannel sound design for experimental film.

Elke Reinhuber, PhD, Assistant Professor – Nanyang Technological University (Singapore). The German media artist, researcher and educator teaches currently at the School of Art, Design and Media at NTU Singapore as Assistant Professor for Expanded Photography. She holds a PhD from COFA/UNSW, Sydney for her exploration on choice, decision making and counterfactual thinking in media arts.
Her interest in immersive representations of architectural cultural heritage via digital media started in the early days of laser scanning and panoramic imaging with QuickTime VR for web and interactive museum installations. Projects reaching from early Coptic to medieval and renaissance churches in Egypt, Germany or Mexico were a starting point for her artworks which add a narrative to historical or architecturally relevant sites. Her most recent pieces are closely connected to the rapidly changing city state of Singapore, where her award-winning stereoscopic video "Venomenon" was realized.
Her artistic research was presented internationally, at conferences, exhibitions, group shows, festivals and biennials.
