

## INHABITING ‘PROSPEROUS SUZHOU’ THROUGH SMART VR

*Interrogating an Ancient Artwork and Documents to manifest Tangible and Intangible Heritage*

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**Abstract.** The research investigates digital landscape heritage. It focuses on the application of Virtual Reality (VR) in a game engine. The aim is to aid the understanding and interpretation of ancient principles relating to sensitive and appropriate interaction of the built form and its associated landscape. The principles have at their root harmony of human inhabitation, the built forms and the landscape they are surrounded. This understanding can lead to re-application within a contemporary context, and the VR environment has the potential to augment and enrich it. For the first time ever, the research has reinterpreted a classical depiction of Suzhou, in an 18th-century handscroll painting, into a three-dimensional immersive virtual environment. It proposes that VR can be a way to experience and increase understanding of heritage landscapes; in our case one that now only exists in an ancient idealised painting. The reinterpretation aims to enhance the users’ experience and understanding of the Tangible and Intangible Cultural Heritage. The spatialised scene is augmented through the integration of other historical information, such as poems and travel notes, to embed intangible aspects into the gardens and landscapes.

**Keywords.** Digital Heritage; Cultural Landscape; Painting Reinterpretation; Immersive Environments; Virtual Reality.

### 1. Introduction

In China today, there exists a particular nostalgia for ancient values and practices. Such desires are often satiated by mental visualisations instigated by indulgence in China’s classic poems, paintings, or by visiting many of its ancient scenic locations. In reaction to this demise, a newfound interest in the resuscitation of these once disregarded entities is arising within contemporary Chinese society. The Built Heritage Journal was launched in China in 2017 noting that “There has been significant interest in both digital heritage and cultural landscapes over recent years, the junction between the two, however, remains essentially

under-explored” (2019). Our case study, Suzhou, is a heritage city; it has the most UNESCO recognised gardens in the world. There are several examples of tangible and intangible heritage, acknowledged by UNESCO, such as Scholar’s Gardens, Suzhou Grand Canal and Kun Opera (Sun, 2004). Suzhou is a landscape city, a picturesque landscape, where the classical gardens reflect the features and character of Suzhou (Chen, 2016). The complexity of the associated cultural history is difficult to depict fully through traditional modes of representation. Virtual heritage, propagated through new-media is able to influence awareness and better understanding of our cultural heritage (Aydin & Schnabel, 2016; Brown et al., 2005; Cameron & Kenderdine, 2007); and the potential for the 2D panoramic city painting as an initial inspiration for a 3D interactive environment has been explored by Brown et al. (2008). Our research seeks to reinterpret a classical depiction of Suzhou in an 18th-century handscroll painting through an immersive, virtual medium. ‘Prosperous Suzhou’, is a product of twenty-four years of Xu Yang’s labour, is an outstanding piece of cultural heritage, illustrating Suzhou’s bustling ancient urban-scape. The handscroll is twelve meters in length. The handscroll vividly depicts the visual appearance of the daily life, natural and urban landscape in an area covering across the city (Qian, 2010). Most of the sites in the painting have disappeared. We focus on the lost heritage garden - ‘Suichu Garden’.

## 2. Methodology

The reinterpretation process can be summarised as being in two components, the site context and the site content. Context refers to the geometry and built forms and landscape in the world, whereas content includes social and cultural heritage. The urban landscape represented in the painting is examined to enable intelligent reinterpretation. ‘Suichu Garden’ provides a particularly good opportunity to spatialise and visualise the tangible, and intangible, traditional design characteristics. ‘Spatialisation’ requires the third dimension, absent from the painting, to be intelligently inferred in the 3D environment created. The spatialised scene is then augmented through the integration of other historical information, such as poems and environmental sounds, to capture intangible aspects. To structure the heritage content and set up the scenes to guide the user in the Virtual Environment, ‘Mise-en-scene’, is used to translate the painting’s sequence and set up content. Additionally, to improve the atmosphere and immersive qualities of the scene, appropriate sound cues, a day-night cycle, animations, and virtual interactions, derived from historical artwork and written information, are added. The additions result in an assemblage of sensory experiences that enhance understanding of the intangible aspects of the culture. Finally, after the context and content reinterpretation, we aim to manifest the rich cultural composition created between context and content, built form and associated landscape, as well as the tangible and intangible aspects. An aim is to enhance the VR-user’s understanding of heritage garden design principles. To transfer these two-dimensional drawings into a three-dimensional space, a range of software including 3DS Max 2019 and Rhino 6 are used. The resulting VR environment involves the embedding of these aspects generated in different software environments into Unity 2018.3. The environment is made

smarter by embedding scripted interaction that explicates Chinese garden design principles. Overall, we observed that the immersive and interactive virtual reality environment enhances the user's experience and understanding through the informed interpretation of both tangible and intangible.

### 3. Chinese Scholar's Garden

Our research showed specifically that it integrates poetic and artistic themes in line with Chen's general observation "The classical garden of Suzhou...it is a 'three-dimensional picture, a silent poem and a frozen music'" (2016). Suichu Garden (figure 1), was notable for its extensive book collection and superb landscape design. It was owned and designed by Quan Wu, and his family had been collecting books for four generations (Yun, 2017). The garden was sited in Mudu town, the last official documentation of the garden was in 1950 when there were just a few original buildings and landscape left (Wei, 2019).



Figure 1. 'Suichu Garden' (section of the painting "Prosperous Suzhou", Xu, 1759).

### 4. Heritage Garden Context Reinterpretation

This section discusses how the context of the heritage garden was reinterpreted. Context refers to the geometry, built form and space. Information was sought for this by interrogating both the artwork and written documents. This reinterpretation process can be divided into three steps: dimension measurement, architecture exploration and landscape exploration.

#### 4.1. DIMENSION MEASUREMENT

To represent heritage carefully and precisely, it was necessary to represent the correct dimensions of each component as far as possible. In 'Prosperous Suzhou' the painter used the oblique perspective projection to draw the buildings; an initial question was whether it is 'cavalier' or 'cabinet' projection. Through the analysis of the painting's techniques, it was discovered that this painting uses 'cabinet oblique' projection. This information assisted us to confirm the distance, scale and proportion of each component to an acceptable level of accuracy. This data was then converted into a plan and from this a 3D model was developed.

#### 4.2. ARCHITECTURE EXPLORATION

The painting is finely detailed; however, it is initially challenging to fully understand the design decisions; for instance, what drove the geometric and spatial relationships, and why were the components arranged in this way? There needed to be more resources consulted to determine the details, such as the areas, functions, and human habitation within the garden. The research discovered six important references: ‘Mudu Magazine’ by Zhang Yuwen, ‘Wenxianjia Tongkao’ by Zhengweizhang, ‘Suichu Garden Journey’ by Shen Deqian, ‘Ivyuan Conghua’ by Qian Yong, ‘Poetry for Collections’ by Ye Changzhi, and ‘Xu’ by Xu Taozhang. These written documents helped us to confirm the name of each component (figure 2) and consequently link built form and landscape designs. After gaining a basic understanding of the garden arrangement and the different segments, it was necessary to understand the associated activities and design details, to improve the user’s experience and understanding in the virtual environment. Analysing precedents, helped in supplementing the details that the painting and written documents were deficient in. The existing physical model of a ‘Complementary Hall’ from the Kun Opera Museum helped inform the modelling of details (figure 3). The ‘Mindfulness Library’ (figure 4) interior design is not seen in the painting, and there are no historic written descriptions. Here, borrowing design elements from appropriate references was a successful approach.



Figure 2. Naming each component of ‘Suichu Garden’.



Figure 3. Painting ‘Complementary Hall’ (taken from the painting “Prosperous Suzhou”, Xu, 1759) and Digital model (by author).

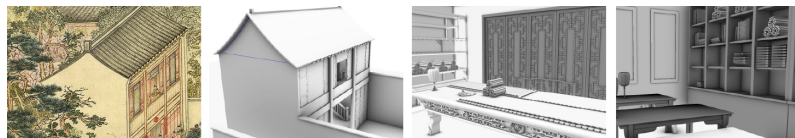


Figure 4. Painting ‘Mindfulness Library’ (taken from the painting “Prosperous Suzhou”, Xu, 1759), and Digital model (by author).



#### 4.3. LANDSCAPE EXPLORATION

Rocks, water and plants are three main design elements in the scholar's garden. The main theme of such Chinese gardens follows nature; in particular the harmony between human and nature (Wu, 2017). Extracting the design of the rockery and water is possible from the painting. However, from the historical written documents, it was found there was more planting than are shown in the painting. Therefore, planting study and analysis from the written document is crucial to augment the plant reinterpretation. Through reviewing the references, a possible plant table was made. The plants were then studied to determine which would have been popular in an 18th-century scholar's garden. The researcher then identified the plant species in the painting using the plant tables. The speculative planting plan (figure 5) locates the trees that are shown in the painting. The arrangement of shrubs and herbs have been informed through the analysis of similar gardens. For example, the Hardy Banana plant, with broad flat leaves has been located close to the 'listening to the rain shelter'. Notably, in the 'Humble Administrator's Garden' nearby there are several Hardy Bananas next to a similar pavilion.

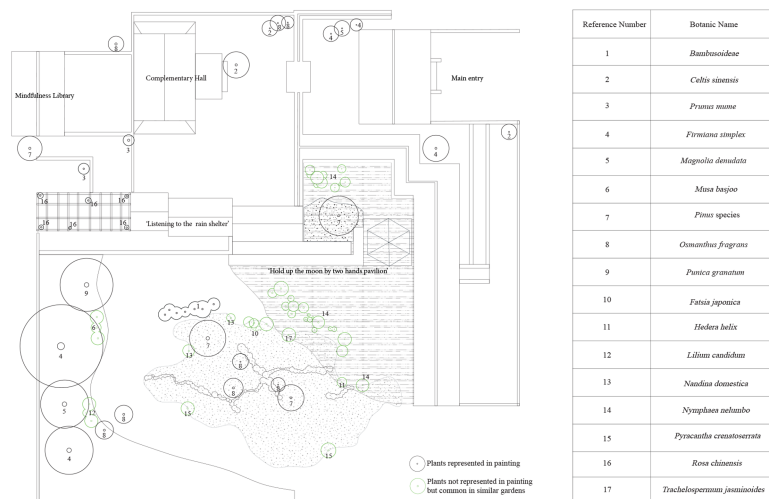


Figure 5. Speculative Planting Plan.

#### 5. Heritage Garden Content Reinterpretation

This section focuses on manifesting heritage content that represents social heritage, human behaviour, along with tangible and intangible aspects. The content is often intentionally designed to form a narrative, the arrangement of a sequence of activities (Chen & Kalay, 2008). As Water (2014) suggested, the narrative is necessary because their value in heritage conservation; they convey the significance of places and it is through stories that people express their identification with heritage (as cited in Hoeven, 2019, pp. 61-68).

### 5.1. VIRTUAL ELEMENTS

This paper borrowed from filmmaking the idea of *Mise-en-scène* to set up all the elements, such as ‘actors’, lighting, sound, and costume, in the virtual environment. Actors and costume were extracted from painting, the lighting system is set by scripting, and the sound is represented by the digital aural landscape.

#### 5.1.1. Aural Landscape

Aural landscape plays one of the most significant roles in the Chinese garden. It is important in the Scholar’s Garden as it follows Taoist concepts of returning to nature and seeking close integration with natural scenery. The ‘Book of Poetry’ (11th to 7th centuries BC) is the oldest existing collection of Chinese poetry; 28% of poetry is related to aural landscape (Wu, 2012), demonstrating the importance of the soundscape. So, the aural landscape, such as insects, birds, rain, music instruments and water, were set up in the virtual environment. Through these intangible aspects, a narrative can be generated for the user in VR.

#### 5.1.2. Animation

In the virtual environment animation is crucial because it enables designers to tell stories and communicate emotions and ideas in a unique way. It can help connect people to the depicted scene in a way that paintings cannot.

#### 5.1.3. Painting Extraction

Mixing 2D and 3D environments is a classic technique in Virtual Reality design. A rendered background in 2D complements the 3D and can be more detailed, or more painterly. Extracting some elements directly from the 2D painting (figure 6), such as characters, and landscape can help heritage reinterpretation be more precise. But importantly, it is easier to render than GPUs that would otherwise handle hundreds of megabytes of 3D models for incidental art. To compensate, the 2D elements are made to be smart by setting up a ‘Billboard’ script that enables the 2D elements always to face the camera in the Virtual environment.



Figure 6. Characters, Trees and Rock extracted from ‘Prosperous Suzhou’.

#### 5.1.4. Lighting System

Lighting is an essential part both of visual communication, and of design intentions. To develop the atmosphere and visual identity in the VR environment,

a dynamic lighting system was developed. The system is designed by scripting and it gives the ability to set the time of day and automatically control the light position, reflection, shadows, and light colour.

## 5.2. SERIAL VISION

Cullen (1961, 2015) developed the principle of serial vision, and it describes the experience of a continuous and first-person journey through space. This technique was linked to Mise-en-scène (figure 7) to structure the journey when individuals are moving through the garden in the VE.

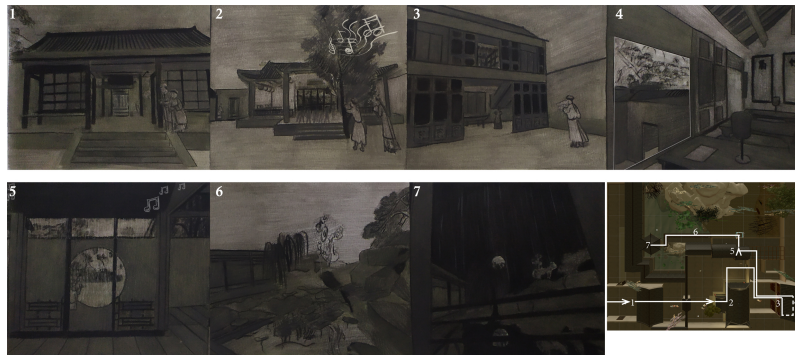


Figure 7. Using sketches to manifest the experience in the garden.

## 5.3. COMPOSITION

'Composition' represents the arrangement of parts of a scene to form a particular atmosphere and outcome. Scholar's gardens are a poetic landscape; a composition of different design elements that makes a direct appeal to the emotions and are devoted to serving all the senses (Johnston, 1991). Our VE construction techniques allowed discovery of such features not apparent otherwise, as noted below.

### 5.3.1. Borrowed, Hidden and Framed Scenery

Borrowed, Hidden and Framed scenery are significant design techniques used in the scholar's garden, and manifesting these compositional principles can enhance the user's experience and understanding. Figure 8 shows the reinterpretation of the 'Borrowed Scenery' principle in the VE. From the window, individuals can get an expansive view of the garden and distant scenery. This explains why this building is the only two-story building in the garden and is called the 'Mindfulness Library'. An animated book on the table next to the window is introduced to guide the user to look out through the window. The 'Hold up the Moon by Two Hands pavilion' also adopts this technique. The 'Suichu garden journey' by Shen Deqian (1673-1769), notes: "There is a pavilion on the pond, which is called Hold up the Moon by two Hands pavilion, reflecting the sky; the shadow is shaking, just like playing with the moon". By modelling the natural features, such as the day-night cycle, and water rippling in the VE, the name 'Hold up the Moon by two Hands'

can be appreciated.

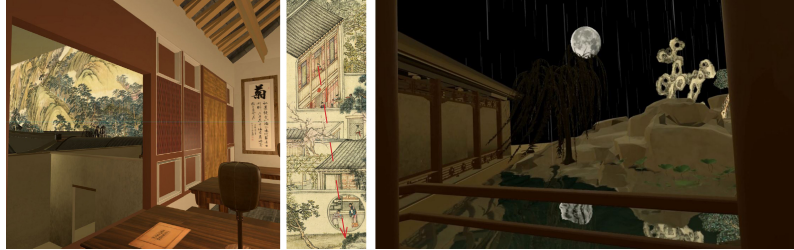


Figure 8. Reinterpreting the Design Principle ‘Borrowed Scenery’ for ‘Mindfulness Library’ and ‘Holde up the Moon by two hands Pavilion’ in the VR.

The design techniques of hidden and framed scenery cannot be properly appreciated by viewing the original painting. After the site modelling it was easy to ensure that individuals could see the interior from the entry door. Through analysis of the planting, we discovered the use of a tree to block and then reveal this view. We discovered from the process of framing scenery to tell the story; a specific viewpoint is selected by the Scholar Garden designer. He used a circular door to frame the view, which in effect creates a three-dimensional picture embedded within a frame. We also noted that this particular arrangement also enhanced the experience in the ‘Listening to the Rain Shelter’.

## 6. Notes on Interaction

Figure 9 shows the virtual environment of the heritage garden, and this can be seen as a virtual sketch as well. This section outlines the different technologies used for creation and interaction; Headset based VR and Social VR (Figure 10), to allow users to experience the virtual heritage singly or as a group.



Figure 9. Virtual Garden Overview and First-person Perspective in a Pixelated Virtual Environment.

### 6.1. HEADSET-BASED VIRTUAL REALITY

‘Touchpad Locomotion’ was employed via a script to enable the user to have a continuous walking experience through the virtual heritage environment. This form of moving through the scene mimics a ‘natural’ walking movement. Since

the immersive experience is headset-based the VR is a single user one; however, the user has primary control of movement and experience.

## 6.2. SOCIAL VIRTUAL REALITY

Based on earlier research of Digital Heritage dissemination (Silcock et al., 2018, Schnabel et al., 2016) our research also employed an immersive VR system using the 'Hyve' system that allows multiple users to simultaneously experience the virtual environment in a common social setting.

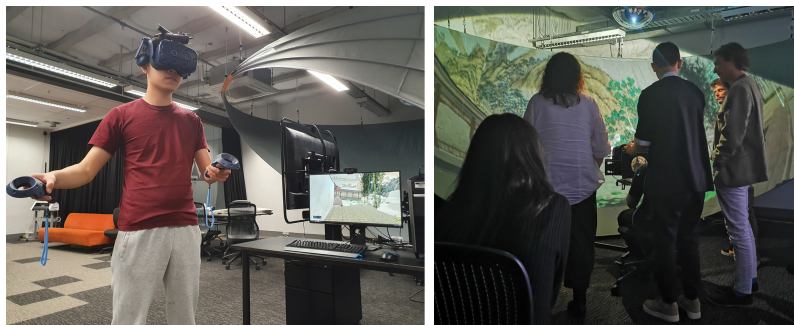


Figure 10. Singular Experience and Social Immersion.

## 7. Conclusion

Overall, the research explored the potential for creating a productive symbiotic relationship between Digital Heritage and Cultural Landscape. The method developed enables users to experience and better understand the cultural value of the Scholar's Garden. It represents both heritage context and content, and the outcome manifests tangible and intangible heritage. Reinterpreting the painting in VR enables an immersive, continuous, first-person journey through the designed space where the environment and experience changes as the viewer move through it. This immersive experience enables users to gain a greater understanding of the design intentions embedded in the idea of a Suichu Scholar's Garden. Reinterpreting a painting into a virtual environment has been undertaken elsewhere. However, reinterpreting a historical painting into a 3D virtual environment with a landscape application is novel and unique, and offers a fuller understanding of the garden. We have gone beyond making a virtual copy of the painting. The painting is a key reference to reinterpreting the landscape design ideas and principles, which was augmented by examining historical written documents. Using computational means to capture and link all of the information, we assimilated it first, then brought the findings together into the 3D environment. The research has explored the role of Digital Landscape Heritage, and it is unique in the way Chinese garden design principles are represented in VR. One application is intended to be in augmenting heritage education. Also, our work has value to reconstruct the lost Suichu garden in an informed way. Finally, the technique supports contemporary landscape design processes, i.e. in the urban context of

modern Suzhou. The Social Virtual Environment allows the development of a respectful, and informed, new scheme with collaboration across all stakeholders.

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