Xiangyunsha (Gambiered Guangdong Silk) Art Installation (XAI): Inheritance of Intangible Cultural Heritage with a Cross-Disciplinary Design Thinking Approach

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Abstract

There has been a substantial increase in digitalization of intangible cultural heritage (ICH). Because of ICH's immaterial nature, the manifesting process and craftsmanship are challenging. This paper presents an interactive installation system using emerging technologies, including virtual reality (VR) and laser engraving, to enhance interaction modalities in both intangible and tangible realms. Xiangyunsha (gambiered Guangdong silk) is utilized as an illustrative example of bridging the intangible-to-tangible gap. Like many ICH, Xiangyunsha is lack of resonance with the general public, especially the young generation.

We designed and created the Xiangyunsha Art Installation (XAI) that seamlessly integrates VR experience and AI-generated pattern engraving on tangible Xiangyunsha. This installation intricately integrates the historical, geographical, and craftsmanship dimensions of Xiangyunsha through a linear timeline, transitioning from the virtual to the tangible experience. The main objective is to captivate visitors and the public through experiential and tactile interactions, fostering sustainable cultural inheritance.

Figure 1. The rendering of the Xiangyunsha Art Installation (XAI). © Authors

Keywords

Interactive Installation, Public Art, Intangible Cultural Heritage, Virtual Reality, Tangible Experience, Generative Art

Introduction

Cultural heritage includes both tangible cultural heritage and intangible cultural heritage (ICH). Tangible cultural heritage refers to specific objects like buildings, monuments, etc.. Compared to tangible cultural heritage, ICH is in the form of a process and tends to be more challenging to advocate [10, 12]. Originated in Southern China, Xiangyunsha, also known as Gambiered Guangdong Silk, is a complicated dyeing and coating process that requires a high dependence on climate and a strong spirit of craftsmanship [13].

Xiangyunsha is produced with a mud-coating and dyeing technique. It was selected as a Chinese national cultural heritage in 2008 [13]. Online and offline locations are used to show collections of media, art, and artifacts to exhibit the development of a discipline or culture with technologies, like VR experience and augmented reality (AR) interaction [5, 6, 15, 17]. Technologies are also utilized to enhance the inclusive and interactive design for people with special needs [5, 11]. In Shunde of China, Xiangyunsha private museums provide field demonstrations, but the availability of those is highly influenced by unforeseeable weather conditions. For example, with the observance and experience of experienced masters, the making of Xiangyunsha requires more than 15 consecutive days of strong sunlight, so the process cannot be started unless the weather is stable enough. In an event of bad weather predicted, demonstration cannot be offered.

To promote this technique for cultural inheritance, we applied cross-disciplinary design thinking to develop Xiangyunsha Art Installation (XAI), consisting of virtual reality (VR) experience, generative art, and pattern engraving. XAI interrelates time, place, location and craftsmanship of Xiangyunsha with an immersive experience, which leads to extensive sharing on social media platforms to promote ICH and strive for a sustainable cultural inheritance.

Xiangynunsha Art Installation (XAI)

Workflow

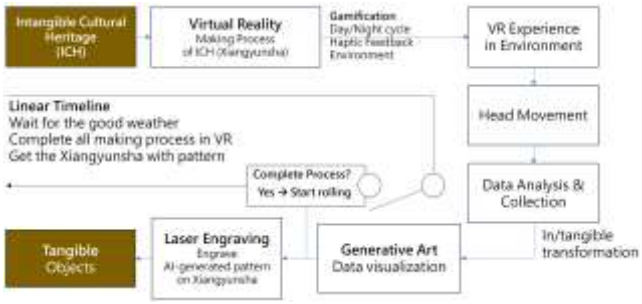

Figure 2. Flow-chart of XAI interaction. © Authors

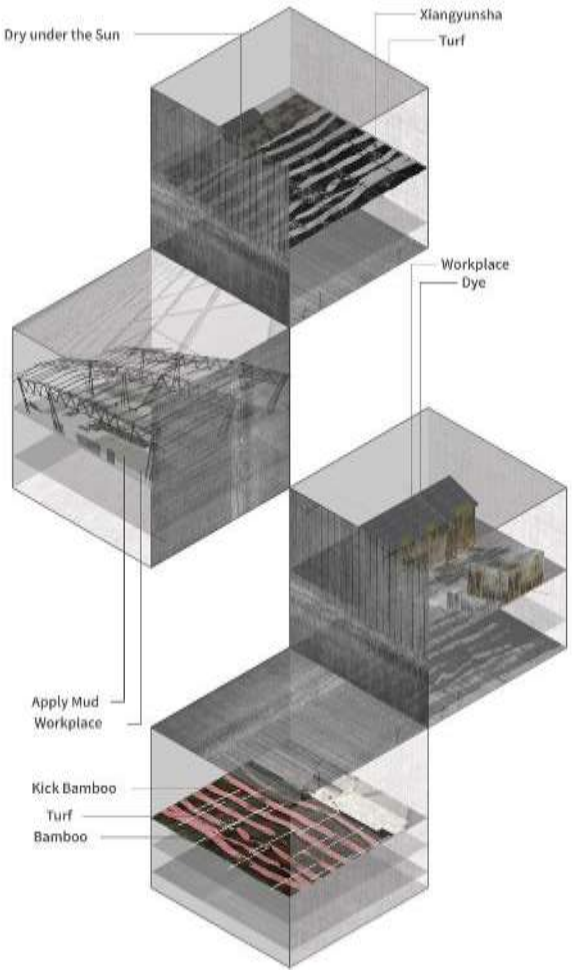

Figure 3. VR Environments that are implemented for audience to experience the process of intangible cultural heritage. © Authors

Xiangyunsha Art Installation (XAI) works as an example of application for the intangible-to-tangible interactive installation system. The linear timeline transcends temporal and spatial boundaries of ICH, seamlessly integrating virtual reality (VR) experiences with AI-generated pattern engraving on tangible Xiangyunsha fabric. The objective is to engage the public through experiential and tactile interactions with understanding of the ICH values. The entire experience summarized in Figure 2 is detailed in the next section.

Taking the three fundamental criteria as detailed below, we design and develop an interactive installation (Figure 2) with three key features: 1) generative patterns with a mechanical installation; 2) cultural creative products that apply Xiangyunsha to different media or textiles; and 3) VR or augmented reality (AR) experience and installation with the process of Xiangyunsha.

Design Process and Decisions

Design thinking is a process of finding out in-depth problems and creative solutions with divergent and convergent thinking [7]. XAI is developed with a cross-disciplinary design thinking approach in 4 stages – empathy, definition, ideation, and prototype.

To explore potential target audience groups, a survey was distributed among school students and teachers. Utilizing an online questionnaire through both the website and the WeChat application, 103 respondents shared their perspectives on Xiangyunsha. The survey mainly circulated within school chat groups, resulting in over 80% (84 individuals) of respondents falling within the 20-30 age group. The survey included questions regarding ICH and emerging technologies (e.g., What is your familiarity with Xiangyunsha? What are the preferred ways to learn ICH?). Despite the status as a national ICH, 69% (72 individuals) had never encountered Xiangyunsha, while 25% (26 individuals) had some awareness but lacked detailed knowledge.

Although many people have inadequate knowledge about Xiangyunsha, they expressed a willingness to learn with intangible and tangible emerging technologies, like an VR, generative art and laser engraving. Around 87% (90 individuals) expressed an interest in exploring traditional culture through VR experiences. Moreover, a significant 79% (82 individuals) acknowledged that immersive experiences could heighten their enjoyment and understanding of traditional cultural elements. VR experience with interactive installation is a direction for the cultural inheritance of ICH with more multi-modal and sensory interaction.

In Shunde, we visited venues including Xiangyunsha and silk museums, stores and workshops. We integrated the insights to identify the following problems: 1) museums provide conventional exhibitions with text, pictures, and antique machines; 2) The lack of synergy between natural dependence and human craftsmanship hinders the conversations between Xiangyunsha and the public audience in the exhibition; and 3) The demonstration of Xiangyunsha in the unofficial Xiangyunsha museum is easily influenced by the weather, so visitors miss the opportunity to have an in-depth understanding of Xiangyunsha. ICH can be integrated with emerging technologies to promote the cultural values for

wider audience using public interactive installations as bridging communication.

Interaction Experience

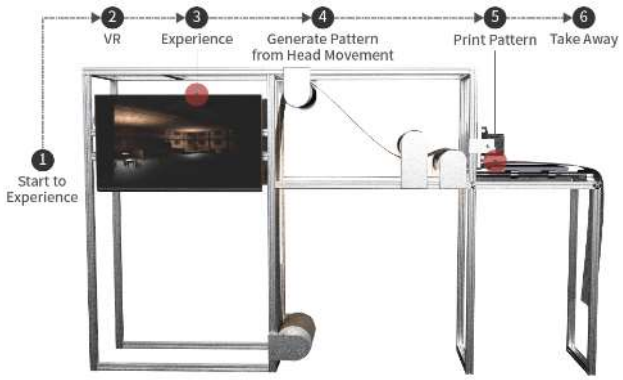

Figure 4. The interaction flow of the interactive installation. © Authors

XAI combines "virtual and reality" to immerse visitors in the dyeing and coating process of Xiangyunsha and combines AI-related technology to generate unique patterns based on the experience process, bringing people a unique cultural experience. XAI promotes the culture of Xiangyunsha and brings the aesthetics of intangible heritage culture to the public.

We utilize aluminum extrusions and customizable laser and CNC modules to integrate tangible experience and structural design for early-stage prototyping. However, an integrated experience and an installation VR experience are important to illustrate and provide an immersive understanding of complicated dyeing and coating techniques. Therefore, we merged initial ideas into a multi-modal interactive installation with a VR and pattern engraving experience.

Structure

XAI is designed to combine the concept of automation with the craftsmanship and process of Xiangyunsha from an intangible VR experience and AI-generated pattern to a tangible piece of Xiangyunsha fabric. With the installation setup like an inspection and rolling machine of silk fabric, the experience works in a linear timeline to show the interrelation among dyeing, coating, drying, and finally the fabric rolling process (Figure 2). The patterns generated during the VR experience are finally printed at the end of the experience.

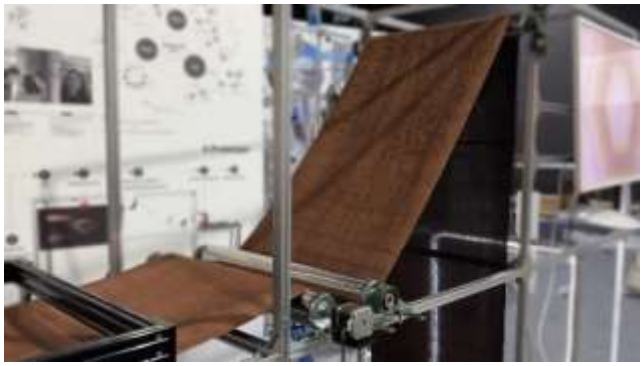

Figure 5. The completion of the intangible VR experience triggers the rolling of the tangible Xiangyunsha fabric for pattern engraving. © Authors

On both sides of XAI, a screen is installed to show the VR experience and AI-generated patterns to attract the audience to explore this experiential installation. Due to the concept of "moving", XAI is equipped with wheels to achieve high mobility for cultural inheritance in a wide range of venues in the future, like schools, airports and shopping malls, as shown in Figure 6.

Figure 6. The rendering of the setting and interaction scenario at the airport. © Authors

Immersive Virtual Reality (VR) Interaction

The VR experience of Xiangyunsha is the beginning of the whole interactive installation experience. As mentioned, a linear timeline is used to illustrate and praise the hard work of Xiangyunsha workers. The VR experience is developed with Unity Engine and Oculus Quest 2. In the VR experience, the audience goes through the whole process, as in Figure 7.

Area	Process
Dye	Squeeze the juice of dioscorea cirrhosa Boil and soak the silk in the juice
Dry	Put the silk under the sun Kick the bamboo to make even exposure
Coat	Coat the iron-rich soil on the silk Wash the silk in the river
Roll	Put the silk under the sun Roll the silk layer by layer

Figure 7. The VR experience is divided into 4 main areas according to the intricate processes in XAI. © Authors

Figure 8. The real-time VR experience and generative patterns projected on screen to attract the audience around; (Top) The participant explores the VR experience of the drying process with bamboos on the silk; (Bottom) The generative pattern is shown on screen after the VR experience. © Authors

Figure 9. The virtual environment of the factory is made with modular village models according to the photos taken during the visit. © Authors

Figure 10. The virtual environment of the workshop referred to the field trip at the Xiangyunsha museums in Shunde. © Authors

Participants wear an Oculus Quest 2 headset to experience the environment starting from midnight, where the workers need to work before sunrise. Rather than making the environment realistic, a particle system is utilized to enhance the imaginative and dreamy experience for the audience to enhance its uniqueness. Assuming the audience may have seen an in-person demonstration of Xiangyunsha before, the imaginative approach is used in the environment with aesthetical concern. The distinction between a realistic and virtual environment can improve impressions with the interaction design for the Xiangyunsha making process in VR.

Figure 11. Once the audience begins the VR experience, the initial starting point is at the area of the dyeing workshop. © Authors

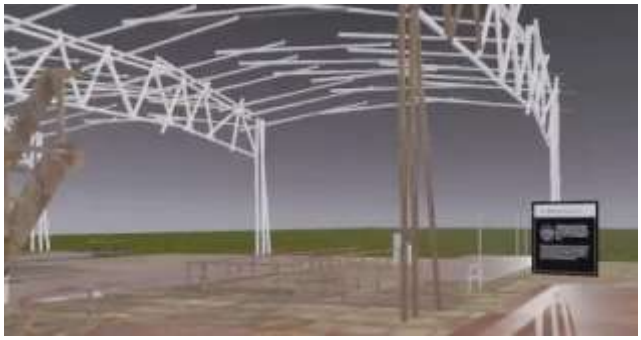

Figure 12. The audience can explore in coating workshop, applying soil on the silk. © Authors

AI-Generated Artistic Patterns

Originally, Xiangyunsha featured two colors—black and brown on each side [18, 19]. However, in responding to market demands, sellers and manufacturers employ digital printing techniques to apply intricate and mature patterns to the silk (figure 13). This patterned Xiangyunsha, crafted through dyeing and coating techniques, has become a prevalent attraction.

With the current pattern design for relatively mature target customers, the website Leonardo.Ai leverages Artificial

Intelligence-Generated Content (AIGC) to present a series of floral patterns for inspiration [2].

Figure 13. Existing patterns on Xiangyunsha clothing with digital printing. © Authors

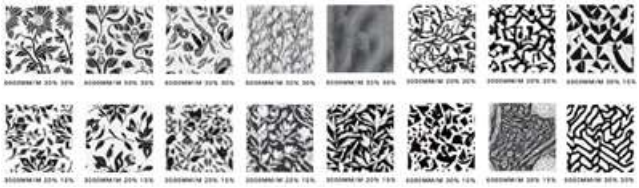

Figure 14. AI-generated images of floral patterns using text prompts with keywords such as line, pattern, and nature Leonardo.Ai. © Authors

To enhance the handling of real-time data, sketches are developed from scratch rather than modifying the open-source sketches in p5.js. In the exploration of the pattern designs, both organic and geometric lines and shapes are developed in the experiment. Inspired by the silk fabric, hair-like designs were generated with modifications of sketch examples available online [14]. The hair-like design is relatively chaotic and complicated for fabric engraving. The adjustment with movement parameters is limited because random Perlin noise has to be applied in the sketch.

The interrelationships among the virtual scene, time and spatial experience are considered in the interaction design. Using p5.js and ml5.js, features of the human are recognized with the PoseNet skeleton detection from real-time data collection on the webcam [1]. The pattern on the fabric is affected by the head movement of the audience during the VR experience. 17 pose key points can be extracted from PoseNet, with 5 key features of PoseNet available on the head: left eye, right eye, left ear, right ear, and nose [4]. While the left and right eyes are hidden due to the wearing of the VR headset, the left and right ears may be covered by hair. Thus, the nose is chosen as the key point to determine the position of the head.

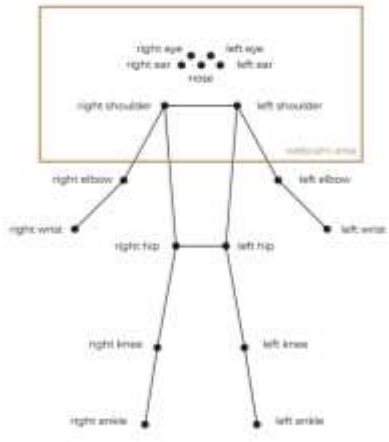

Figure 16. PoseNet key points and webcam area. © Authors

Prior to the laser engraving on actual Xiangyunsha, brownish fabrics are utilized to test the possible results with presets of settings with the generated patterns and parameters (i.e., dimensions of patterns, engraving speed, and engraving laser power) to preserve the precious fabric of Xiangyunsha. Geometric patterns are selected for pattern development to create a contrast with the existing mature patterns on Xiangyunsha products, like red roses and repetitive floral patterns.

Inspired by the weaving patterns of silk and the mesmerizing symmetries, we generate patterns with geometric shapes, such as circle and hexagon, for experimentation. Hexagons are used as the main visual element of the generative patterns because of the connection with weaving patterns and aesthetical concerns. To encourage the audience to explore the VR environment, the generative patterns are personalized by the movement of the head, used to analyze the feature point of the nose. If the relative position of the nose is closer to the center of the webcam recording image, more hexagon shapes are generated on the relatively centric area. Reversely, if the audience explores a different area, he or she can get a larger coverage of hexagonal shapes as a pattern.

Figure 18. Finalized Geometric patterns generated according to the nose feature point regarding the head movements.© Authors

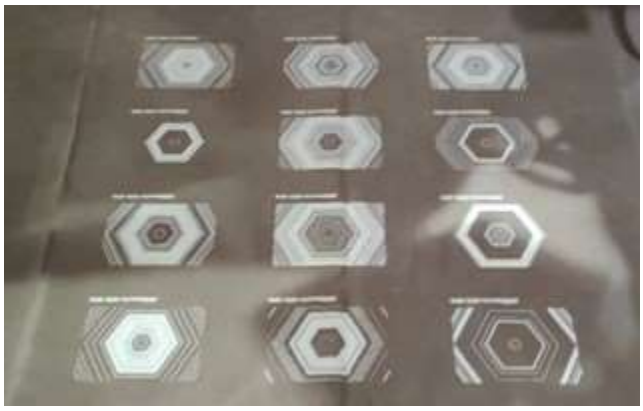

Figure 19. Hexagonal patterns that are engraved for prototyping and testing for laser engraving settings. © Authors

Conclusions and Future Work

Concerning cultural inheritance to the young generation, XAI integrates emerging technologies with the artistry and traditions of ICH, specifically Xiangyunsha. It involves a transformation of an intangible VR experience and AI-generated patterns into a tangible Xiangyunsha fabric through a crafted process.

In the implementation of XAI, the interactivity in the VR experience is limited, so the participants may still find it difficult to remember the steps of making. The mechanisms of the in/tangible interactive installation system will be developed as a modular methodology, which can be applied to a variety of ICH and techniques related to tangible cultural heritage involving virtual and augmented processes and data visualization with other interaction methods like AR connecting the environment in reality [15]. For instance, applications on watertight-bulkhead technology and Dunhuang mural restoration can extend the value in the context of not only cultural inheritance and public art but also other aspects like tourism [3, 8, 9, 16].

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