Development of a Digital Embroidery Museum Integrated With VR for the Preservation of Intangible Cultural Heritage

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Abstract
Embroidery is an important part of cultural identity, showcasing the traditions, stories, and symbols unique to specific communities. It plays a crucial role in preserving cultural practices alive across generations. This study developed a VR-based digital embroidery museum to innovate the preservation of Yunnan embroidery as an intangible cultural heritage. The platform combined high-resolution visuals and interactive designs to enhance user engagement and cultural appreciation. This research employed a convergent mixed-methods design, utilizing Unreal Engine (UE) software and virtual reality (VR) technology. Five experts were selected through simple random sampling to evaluate the developed digital museum both quantitatively and qualitatively. The assessment employed a questionnaire survey to gauge user perceptions of authenticity within the digital museum, utilizing a 5-point Likert scale for responses. Quantitative data were processed through descriptive statistics, while qualitative data underwent thematic analysis. Expert evaluations suggested that the digital museum had significant potential for preserving intangible cultural heritage, achieving an average score of M=4.73 (SD=0.27). VR offers an immersive and engaging experience that connects users with the cultural heritage of embroidery. Despite some challenges—such as the need for high-quality hardware and software for optimal performance, as well as the necessity for continuous updates and maintenance—the study demonstrated that VR provided a highly immersive experience. This allowed users to engage deeply with the cultural heritage of embroidery, fostering a greater appreciation and understanding of traditional crafts and sparking excitement about the potential of VR technology in cultural preservation.

Keywords: Virtual Reality (VR), Digital Museum, Yunnan Embroidery, Intangible Cultural Heritage (ICH), Cultural Heritage Preservation

Introduction

Intangible cultural heritage, like traditional embroidery, involves passing down skills, rituals, and art forms from one generation to the next. These traditions help strengthen cultural diversity and identity (Zhuang, 2021). However, modernization and globalization have made it harder to keep these traditions alive, especially among younger people. Many young people no longer have the chance or interest to learn these skills (Isa et al., 2018). As a result, digital tools like virtual reality (VR) are becoming important (Zhong & Qi, 2020).

Digital technology is significantly transforming the way we engage with cultural experiences. Virtual reality (VR), in particular, serves as a prime example of this transformation. It enables individuals to virtually traverse museums from the comfort of their own homes, thereby enhancing accessibility to cultural heritage. This technology facilitates global engagement with fading cultures and contributes to the preservation of art from various historical periods. In essence, virtual reality acts as a digital conduit, fostering connections between diverse cultural narratives and contemporary audiences. By offering immersive and interactive experiences, VR technology addresses the challenge of preserving endangered embroidery, which faces a decline in skilled artisans and shifting market dynamics. It allows people from all over the world to experience and appreciate these cultures (Bougaa et al., 2016).

Embroidery transcends mere thread weaving; it serves as a repository of cultural heritage. Nevertheless, the forces of modernization and globalization pose significant risks to these time-honoured techniques, leading to their potential extinction (J. L. Li, 2020). For instance, Yunnan Yi embroidery, characterized by its elaborate designs and profound cultural significance, is increasingly at risk as the number of skilled artisans dwindles and market dynamics shift (Condell et al., 2021). For instance, Yunnan Yi embroidery, characterized by its elaborate designs and profound cultural significance, is increasingly at risk as the number of skilled artisans dwindles and market dynamics shift. It lets us digitally save these works and showcases them in a virtual museum. This way, everyone can appreciate their beauty and history without harming the originals. Think of it like a protective time capsule made of ones and zeros (Cecotti, 2022).

This study looks into the practical use of virtual reality (VR) technology in preserving embroidery-based intangible cultural heritage, focusing on the development process, effectiveness, and user feedback. By making a VR-based digital embroidery museum, the study tries to solve the challenges caused by physical damage to embroidery heritage, create a platform to save detailed embroidery patterns and skills, and promote the worldwide spread of cultural heritage (Rizvic et al., 2019).

This study highlighted the key role of VR in passing on embroidery traditions and closing the gap between culture and embroidery (Yu, 2023).Existing research points out the need for studies that explore how VR can help restore the authenticity of cultural heritage items and how it can connect with users to create emotional and educational bonds (Zhong & Qi, 2020). Also, international audiences and younger generations are not very familiar with these traditions, and there is little research on how VR can be used for different user groups (Liu et al., 2022).This study looks at how virtual reality (VR) technology affects engagement and the perceived authenticity in preserving embroidery, and explores some factors that influence user engagement. The goal of this research is to give suggestions for managing immersive systems, ensuring authenticity, and improving user experience (Siyu & Abdul Ghani, 2023).

Research Questions

One research questions presented to guide the study.

RQ: How to develop Digital Embroidery Museum Integrated with VR for the Preservation of Intangible Cultural Heritage?

Methods

This study used research methods combining quantitative and qualitative data. This method takes the good parts of both research types and helps fix their weaknesses. Because of this, it provides a deeper and more complete look at the research questions. The study thoroughly examines how virtual reality (VR) can help preserve embroidery as an essential cultural tradition by gathering both data types. A survey was done using WeChat and the WenJuanXing platform to collect information about how users interact, feel immersed, and understand the culture.

Participants and Sampling

The study included five university professors, with various level of experience from 5-25 years. They also came from several levels of professorship, from assistant professor till full professor. They come from different fields, like digital media art, art and design, digital media technology, and landscape architecture from two universities; Yunnan Technology and Business University and Kunming University of Science and Technology. They all have much experience and knowledge in using digital technologies to help preserve cultural heritage. These experts were selected using purposive sampling. This method ensured they could give valuable ideas and suggestions for the VR Enhanced Digital Embroidery Museum project. By choosing experts with the right skills, the study could focus on the most essential areas and collect valuable data on using VR technology to preserve embroidery.

Instruments and Data Collection

This research examined the application of virtual reality (VR) in conserving intangible cultural heritage within the embroidery sector. It employed a mixed-methods approach, integrating both quantitative and qualitative techniques. In the quantitative part, the study used a questionnaire created by Li et al. (2024) to look at the VR user experience in a virtual museum. The survey encompasses 12 dimensions, such as functionality, design, performance, and interactivity, to thoroughly assess user experiences within the VR embroidery museum. Critical areas of emphasis include emotional authenticity and the acknowledgment of cultural value, aimed at investigating the role of VR in cultural transmission. These 12 areas are the main parts of the system.

Each part of the questionnaire has several closed-ended questions. Participants rate these questions on a 5-point Likert scale. The qualitative part of the study is also based on these areas. It uses open-ended questions to gather more detailed insights from participants. These questions explore their thoughts and suggestions on the dimensions discussed.

The questionnaire was shared online through the WenJuanXing platform. WeChat contacted participants and gave them a link to the questionnaire. The research tool was designed to

cover several areas. This helped to understand better how VR-based museums influence cultural heritage preservation. It also made the study broader and the analysis more thorough.

Data Analysis

Quantitative Data Analysis: Descriptive Statistics.

The quantitative analysis used simple statistics, like the Mean and Standard Deviation, to look at participant feedback on three areas. These areas were (1) heightened enjoyment, (2) experience needs; and (3) the intention to visit.

Qualitative Data Analysis: Thematic Analysis.

Qualitative data were gathered through open-ended questionnaires and subjected to thematic analysis to uncover significant patterns, such as 'increased user engagement,' 'effects on cultural preservation,' and 'practical obstacles.' The process involved initial coding, categorization of themes, and validation to guarantee systematic and dependable results.

Results

The results are presented in two sections, quantitative result section and qualitative results sections (See section 4.1 and 4.2).

Quantitative Results

Table 1 shows what experts said about the VR-based Digital Embroidery Museum. The overall score was 4.73, which is very positive. One clear strength is the immersive experience (M=4.80). Users felt very engaged and emotionally attached. Another important point is the strong desire to visit the real museum locations shown (M=4.87).

These results show how well VR technology works to keep and share intangible cultural heritage. The enjoyment part got a Mean of 4.60, which is good overall. But some areas, like the museum tour enjoyment, had lower scores. This shows the content can still be improved. Even so, the feedback shows that the project balances cultural preservation with modern digital tools well.

The consistent scores and small differences show that VR has great potential to help people appreciate culture and boost tourism. It gives a lasting and new way to protect intangible cultural heritage.

Table 1: Questionnaire Items

Questionnaire Items	M	SD
The heightened enjoyment		
1. In this virtual tour, time seems to pass quickly	4.6	0.89
2. In this virtual tour, I forgot about time flow	4.6	0.55
3. In this virtual tour, I felt even happier	5	0
4. In this virtual tour, my emotions were aroused	4.8	0.45
5. In this virtual tour, I enjoyed museum tourism more	4	0.71
Overall	4.60	0.37
Experience needs		
6. I feel like I am in the environment displayed by the VR	4.6	0.55
7. It seems I really participated in the action in the VR system	4.8	0.45
8. My real location seems to have been transferred to a VR environment	5	0
9. I feel like I am personally in the scene presented in the VR environment	4.8	0.45
Overall	4.80	0.16
The intention to visit		
10. I am willing to visit the places shown in my virtual tour in the near future	4.8	0.45
11. I will strive to visit the places shown in my virtual tour	4.8	0.45
12. I plan to visit the places shown in my virtual tour in the near future	5	0
Overall	4.87	0.12
Overall	4.73	0.27

Qualitative Results

The expert feedback collected during the evaluation process highlighted several important insights and areas that need improvement in the VR-based digital embroidery museum. Based on their qualitative assessments, experts found out key aspects that influenced the overall user experience and suggested ways to improve the system for future versions.

1) Visual and Functional Features: Experts praised the system's clear and vibrant visual effects, stressing how important these are for creating an immersive cultural experience. The system successfully captured the elaborate details of the embroidery, making the cultural value of the art visually striking. However, they recommended changing the control features to better meet individual user needs and improve personalization.
2) User Familiarity with Virtual Museums: Familiarity with virtual museum systems was important for users to adapt. Experienced users found the platform easier to scout, while new users indicated that they needed more guidance and support to improve their experience.
3) Emotional Engagement and Enjoyment: The system performed well in terms of enjoyment and emotional engagement, with interactive storytelling and immersive design fostering strong emotional connections. However, experts noted that the system should balance interactive complexity and simplicity, especially in terms of stimulating curiosity. An easy-to-use design is vital, especially for users from different backgrounds.
4) Cultural and Emotional Authenticity: Experts appreciated the system's accurate representation of artistic details and historical content, which contributed to the cultural and emotional authenticity of the experience. However, they suggested

improving the community interaction features to help users feel more connected to the culture and engaged with it.

Discussions

Experts say the VR-based Digital Embroidery Museum has clear strengths and some areas that need improvement. When looking at these results, we need to think about factors that influence how happy users are. These factors include how it looks and works, how used to virtual museums users are, how much they enjoy and connect emotionally, and how real the culture feels.

Visual and Functional Features

The success of a VR museum mostly depends on how it looks and works. Experts rated "Experience Needs" (average score 4.80) highly. This shows the Digital Embroidery Museum is immersive and looks good. Good visuals, simple navigation, and quick responses are important for keeping users happy. Banfi (2021) says that designs focusing on users, like moving visuals and smooth interactions, are vital for better experiences. Improving features, like faster loading and fewer tech problems, can make users happier(Cecotti, 2022).

User Familiarity With Virtual Museums

How well users know VR technology also affects how satisfied they are. Experts gave high ratings for immersion and presence. This could be because of their technical knowledge and experience with VR. But new users might find it harder to use the system. This could make their experience less enjoyable. Cecotti (2022) says it’s important to make user interfaces simpler and give tutorials to help new users. Making the virtual museum easier to use can attract more people, including experts and everyday users.

Emotional Engagement and Enjoyment

The lower scores for "Heightened Enjoyment" (M=4.60) show that while users liked the VR experience, emotional satisfaction could be better. Emotional involvement is connected to how good the storytelling and interactions are in the virtual tour. Yang et al. (2023) says emotional engagement is vital for keeping users interested in VR cultural heritage platforms. Using interactive storytelling, gamification, or personalized experiences can make the experience more enjoyable and emotionally engaging.

Cultural and Emotional Authenticity

Cultural and emotional authenticity is an important part of making users happy in virtual museums, especially for intangible cultural heritage projects. The high "Intention to Visit" score (M=4.87) shows that the VR museum keeps and shows culturally real experiences well. Cecotti (2022) says that showing traditional embroidery designs correctly and adding cultural stories helps users connect deeply. This method not only helps people learn but also makes them feel more connected emotionally. Working with cultural experts and local groups can keep the museum's content real and valuable.

Conclusion

This study looks at the important role of virtual reality (VR) technology in keeping intangible cultural heritage, focusing on the digital preservation of Yunnan embroidery. The findings showed that VR-based digital embroidery museums helped users saw and enjoyed embroidery culture through immersive and interactive experiences, while building emotional connections. The study found out that this system clearly showed the artistic value and cultural truth of embroidery. Experts said that the system could bring in different user groups, helped with cultural education, and grew cultural tourism. The research points out that it was vital to meet different user needs when designing and to keep making the technology easier to use and maintain. This study gave a useful way to keep embroidery culture digital and helped with new ideas for passing on and sharing intangible cultural heritage worldwide.

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