

# *Virtual Reality in Ancient Village Cultural Heritage Protection: Zhen Shan Village Case Study*

Ke Fu<sup>1,a,\*</sup>, Sharul Azim Sharudin<sup>1,b</sup>, Yuping Wang<sup>2,c</sup>, Zhong Huang<sup>2,d</sup>

<sup>1</sup>*Shool of Media, Guizhou Minzu University, Guiyang, China*

<sup>2</sup>*Graduate School Office, City University, Menara, Malaysia*

<sup>a</sup>*kefu.my@gmail.com*, <sup>b</sup>*sharul.azim@city.edu.my*, <sup>c</sup>*22610666@qq.com*, <sup>d</sup>*22324522507@qq.com*

*\*Corresponding author*

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**Abstract:** Virtual Reality (VR) is a transformative technology that simulates a 3D environment, offering users an immersive experience [1]. Since its 20th-century inception, VR's potential in cultural heritage protection has grown [2]. This paper examines VR's role in preserving "Zhen Shan Village", an ancient Buyi village in Huaxi District, Guiyang City. We discuss VR's processes, benefits, and challenges in heritage protection. The article outlines VR's history, its applications in heritage both locally and globally, and its specific impact on Zhen Shan Village. We conclude by analyzing VR's pros and cons in heritage protection and suggest future improvements. This research aims to guide similar heritage projects and champion ancient villages through VR.

## 1. Introduction

Cultural heritage preservation is crucial in today's era, given the rich history and traditions passed down over time. Yet, these legacies face threats from natural disasters, human activities, and cultural erosion. Recently, virtual reality (VR) has emerged as a potent tool for conserving and sharing cultural heritage. Renowned museums like the Louvre and the Palace Museum have adopted VR to expand their reach, and many initiatives use VR to protect intangible cultural assets.

This study focuses on VR's role in preserving Zhen Shan Village's heritage in Huaxi District, Guiyang City. Known as the 'Stone Kingdom' [3], the village, with a history of over 400 years, is home to the Buyi and Miao communities. It boasts stone structures, historical artifacts, and annual traditional events. However, it faces threats like natural calamities and human-induced damages [4]. This research aims to harness VR to offer a comprehensive solution for preserving Zhen Shan Village's essence.

The paper unfolds with an introduction to VR, its application in cultural heritage, a deep dive into the Zhen Shan Village initiative, and concludes with an evaluation of VR's potential and challenges in heritage conservation, along with future recommendations.

## 2. Virtual Reality (VR) in Cultural Heritage Protection: A Shot Overview

### 2.1. Introduction to Virtual Reality Technology

Virtual reality (VR) uses digital modeling and graphics to create realistic simulated environments, offering users an immersive experience akin to the real world. Its strong simulation and interactivity make VR a valuable tool in cultural heritage conservation.

For instance, the British Museum employs VR for its "World Museum" exhibit, letting visitors virtually explore collections from Neolithic ceramics to renowned artworks like Van Gogh's "Irises" and Renoir's "The Promenade" [5]. Similarly, the Smithsonian National Museum of Natural History uses VR to showcase its vast collection, from dinosaurs to butterflies, providing a comprehensive virtual learning experience for its audience [6].

### 2.2. VR's Role in Safeguarding Cultural Heritage

Recently, VR's role in cultural heritage conservation has gained academic traction. Its core advantage is creating immersive experiences, enhancing users' connection to cultural heritage.

- **British Museum's Initiative:** The museum employs VR to capture HD images of its collections, ensuring comprehensive data storage and offering the public an interactive way to engage with artifacts [5].

- **Palace Museum's Historical Journey:** Taipei's Palace Museum uses VR for a time-travel experience, deepening users' understanding of the Forbidden City's history and culture [7].

- **Han Embroidery Digital Museum:** This project utilizes VR to showcase the Han embroidery creation process, giving users an insight into its cultural significance [8].

In essence, VR provides a novel approach to cultural heritage conservation, facilitating digital preservation and creating interactive experiences for broader audience engagement.

## 3. Development of Virtual Reality Scenarios in Zhen Shan Village

### 3.1. Research Background and Objectives

In Shibian town, Huaxi District, Guiyang City, Zhen Shan Village represents the deep heritage of the Buyi and Miao groups. Known for its unique stone structures and cultural practices, it's dubbed a "National Ecological Museum". [9] Yet, time threatens its cultural gems. This study aims to use virtual reality to protect and highlight Zhen Shan Village's legacy, enhancing its cultural impact and preservation.

### 3.2. Crafting the Virtual Experience for Zhen Shan Village

- **Requirements & Objectives:** Based on Zhen Shan Village's history and architecture, this step outlines the VR project's goals and specifications.

- **Data Collection:** Historical documents, photos, maps, and other relevant materials from Zhen Shan Village are systematically gathered and verified through on-site visits.

- **Digital Modeling:** 3D modeling techniques are employed to digitally recreate the village's architecture, culture, and landscape, ensuring model authenticity, as shown in Figure 1.



Figure 1: Digital modeling and Texturing

- **Scenario Creation:** Using the 3D models, virtual scenarios reflecting the village's history, culture, and traditions are developed.
- **VR Application Development:** Digital assets are optimized and integrated using the Unreal Engine 5, adding interactive features to the virtual environment, as shown in Figure 2.
- **User Feedback & Iteration:** Users test the virtual environment, and their feedback is used for further refinements.

In essence, this process ensures a comprehensive and authentic VR representation of Zhen Shan Village.



Figure 2: VR Application Development

- **VR Application Development:** Digital assets are optimized and integrated using the Unreal Engine 5, adding interactive features to the virtual environment.
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In essence, this process ensures a comprehensive and authentic VR representation of Zhen Shan Village.

### 3.3. Technological Advancements and Addressing Challenges

In developing Zhen Shan Village's virtual environment, we faced technical hurdles. To address these, we:

- **Balanced Model Precision & Efficiency:** Leveraged model baking techniques and normal maps.

- **Boosted Interactivity:** Added dialogue systems with NPCs and tasks for cultural exploration.
- **Optimized Performance:** Used LOD, Occlusion Culling, and pre-calculated lighting for seamless operation on different devices.

Overall, these methods enhance virtual environment quality and offer guidance for future cultural heritage virtualization endeavors.

## 4. Case Study: Implementing Virtual Reality in Zhen Shan Village

### 4.1. Zhen Shan Village: A Historical and Cultural Overview

Situated in Huaxi District, Zhen Shan Village stands as a testament to Guiyang City's rich historical tapestry in Guizhou Province. The village is a vibrant repository of local folklore, traditional architectural designs, artisanal craftsmanship, and offers a window into the religious practices and daily lives of its inhabitants. Yet, the passage of time has brought challenges, including environmental degradation, structural decay, and demographic shifts, which threaten its invaluable cultural legacy.

### 4.2. Virtual Reality's Role in Preserving Zhen Shan Village's Heritage

To preserve Zhen Shan Village's cultural heritage, we embraced virtual reality technology with key features:

- **Digital Reconstruction:** Using drone imaging, 3D modeling, and game engines, we accurately replicated the village's historical setting, serving both academic and public interests.
- **Interactive Exploration:** Virtual reality allows users to intuitively explore the village's history, culture, and folklore.
- **Public Engagement & Education:** VR provides a tangible experience of the village's culture, deepening public appreciation for its heritage.

In conclusion, VR offers a novel way to understand and conserve Zhen Shan Village's cultural legacy, setting a model for preserving other historical sites.

## 5. Virtual Reality in Cultural Heritage Preservation: Opportunities and Challenges

### 5.1. Opportunities Ahead

VR, with its immersive capabilities, is making strides in cultural heritage preservation. It not only accurately represents cultural assets but also provides a unique experience. As technology advances, VR's integration with AI and data analytics is anticipated, expanding its role in heritage conservation. Sectors like education, research, and tourism stand to benefit immensely.

### 5.2. Challenges and Mitigations

Despite its potential, VR faces challenges like high costs and complexity, potentially limiting its adoption. The sustainability and adaptability of VR solutions are crucial for a lasting impact. Addressing these requires interdisciplinary insights and innovative approaches.

## 6. Conclusion

This inquiry offers an in-depth exploration of VR's role in safeguarding the cultural tapestry of ancient settlements in Huaxi District, Guiyang City, Guizhou Province. Through VR, we can furnish the public with a tangible, immersive platform, while also serving as a robust reference for scholarly pursuits. As we gaze into the future, with the maturation of technology, VR is set to unlock even more

avenues in cultural heritage preservation. However, it's imperative to concurrently address inherent challenges, ensuring VR's indelible mark on heritage conservation.

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