

The Application Research of Virtual Reality Technology in the Protection and Inheritance of Intangible Cultural Heritage

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Abstract: This study explores the application of virtual reality technology in the protection and inheritance of intangible cultural heritage, analyzing its advantages, challenges, and proposing corresponding strategies and suggestions. Through case analysis, the successful application of virtual reality technology in the preservation and transmission of intangible heritage is demonstrated, and suggestions for policy support, financial investment, technological development, and innovation are presented. The research finds that virtual reality technology significantly improves the efficiency of intangible heritage protection and transmission through digital means, enhances its appeal and influence, and provides a new platform for innovation.

Keywords: Intangible Cultural Heritage; Virtual Reality Technology; Protection and Inheritance; Digitalization.

1. Introduction

Intangible cultural heritage is a significant marker of a nation and ethnic group's historical and cultural achievements, reflecting human creativity and wisdom and being an integral part of cultural diversity. However, with the process of modernization and globalization, intangible heritage faces numerous challenges, such as the lack of successors for traditional crafts, cultural ecosystem destruction, commercialization trends, and digital impacts. Virtual reality technology, as a computer simulation system that can create and provide experiences of virtual worlds, simulates human sensory experiences, enabling users to feel as if they are in a real environment. This study aims to explore the application of virtual reality technology in the protection and inheritance of intangible cultural heritage, analyze its advantages and challenges, and propose corresponding strategies and suggestions to promote the sustainable development of intangible heritage.

2. Overview of Virtual Reality Technology

2.1. Definition and Principles of Virtual Reality Technology

Virtual reality technology (Virtual Reality, abbreviated as VR) is a computer-generated and simulated three-dimensional environment. Users can interact with this environment through devices such as head-mounted displays and controllers, creating a sense of presence. The technology works by capturing the user's movements and head orientation, rendering corresponding images in real-time, and feeding back visual, auditory, and tactile information through multiple sensory channels, making the user feel as if they are in a real environment.

2.2. Hardware Devices and Software Systems of Virtual Reality Technology

The hardware devices for virtual reality technology mainly include head-mounted displays, positional tracking systems, and input devices such as controllers or gloves. The head-mounted display is responsible for displaying the virtual environment, the positional tracking system captures the user's head and hand movements, and the input devices allow users to interact with the virtual environment. The software system includes 3D modeling, real-time rendering, and sensor data processing, used to create and run the virtual environment.

2.3. Classification and Characteristics of Virtual Reality Technology

Virtual reality technology can be mainly divided into three categories: desktop virtual reality, augmented reality (AR), and fully immersive virtual reality. Desktop virtual reality presents a virtual environment on a computer screen, and users interact with it through input devices like a mouse and keyboard. Augmented reality overlays virtual information onto the real world, displayed through devices such as smartphones or special glasses. Fully immersive virtual reality requires equipment like head-mounted displays, providing a more realistic and immersive experience.

2.4. Applications of Virtual Reality Technology

Virtual reality technology has been widely applied in various fields. In the gaming industry, VR technology offers players a more immersive and realistic gaming experience. In the educational field, VR technology can simulate real teaching scenarios to enhance learning outcomes. In the medical field, VR technology is used for surgical simulations and psychological therapy. In addition, VR technology is applied in military, construction, art, and other fields, providing new solutions and development opportunities for various industries.

3. Application of Virtual Reality Technology in the Protection of Intangible Cultural Heritage

3.1. Digital Collection and Storage of Intangible Heritage Resources

The application of virtual reality technology in the protection of intangible heritage is first reflected in the digital collection and storage of intangible heritage resources. According to the International Center for the Big Data of Intangible Cultural Heritage, by 2021, more than 500 items of intangible cultural heritage have been included in the UNESCO Representative List of the Intangible Cultural Heritage of Humanity. Using technologies such as high-precision three-dimensional scanning and audio-video recording, various aspects of intangible heritage projects, such as traditional crafts, performance forms, and historical scenes, can be digitally replicated. The Palace Museum in China, for example, has used three-dimensional scanning technology to digitally collect its collections and establish high-precision digital archives. This digital collection not only preserves the original appearance of intangible heritage but also records the details of inheritors' skills and performance styles, providing valuable learning and reference materials for future generations. Moreover, digital storage solves the problems of limited storage space and vulnerability to damage in traditional media, ensuring the long-term preservation and sustainable utilization of intangible heritage resources.

3.2. Virtual Reconstruction of Intangible Heritage Scenes

Virtual reality technology can realize the virtual reconstruction of intangible heritage scenes, allowing users to seemingly travel through time and personally experience the historical and cultural atmosphere of intangible heritage. According to UNESCO, more than 100 countries and regions have carried out digital protection work for intangible heritage. By constructing three-dimensional models and scenes combined with multimedia elements such as audio and video, VR technology can simulate the specific social and cultural environment in which intangible heritage projects are situated, such as traditional festivals and folk activities. Users can freely explore in the virtual environment and feel the unique charm of intangible heritage. This immersive experience greatly enhances the attractiveness and infectivity of intangible heritage, helping to promote its dissemination and popularization.

3.3. Virtual Interactive Display of Intangible Heritage Craftsmanship

Virtual reality technology also provides a new way to display the craftsmanship of intangible heritage through virtual interactive display. According to the Global Virtual Reality Market Report, it is estimated that by 2025, the global virtual reality market size will reach \$45 billion. Through interaction design, users can not only watch the display of intangible heritage craftsmanship but also interact with it, experiencing the process and characteristics of intangible heritage making. Users can learn the steps of traditional music, dance, and handicraft production in a virtual environment and engage in simulated operations using controllers, data gloves, and other devices to feel the connotation and charm of

intangible heritage craftsmanship. This interactive learning experience not only increases the fun and effectiveness of intangible heritage education but also helps to inspire young people's interest in intangible heritage, promoting its inheritance and development.

3.4. Virtual Teaching and Training of Intangible Heritage Inheritors

With the continuous development of virtual reality technology, its application in the field of education is also expanding. According to the Global Virtual Reality Market Research Report, it is estimated that by 2025, the global VR education market will reach \$1.76 billion. In the teaching and training of intangible heritage inheritors, virtual reality technology plays a crucial role. By constructing virtual teaching environments, inheritors can impart and demonstrate their skills within them, while students can learn and experience intangible heritage crafts in a real-life setting. Virtual reality technology offers a new approach to the teaching and training of intangible heritage inheritors. For example, the inheritors of Kunqu Opera, a UNESCO-listed Intangible Cultural Heritage, can use virtual reality technology for performance teaching. Students can watch Kunqu Opera performances in a virtual environment and learn singing and postures following the inheritors. Moreover, virtual reality technology can enable remote teaching, breaking geographical barriers and allowing inheritors to interact with students worldwide. Additionally, virtual reality technology can provide simulated practice opportunities. In the inheritance of traditional handicrafts, students can learn and practice handicraft making in a virtual environment through simulated operations, mastering the skills and improving practical abilities. This virtual teaching and training method not only improves teaching effectiveness but also stimulates students' interest in learning, promoting the inheritance and development of intangible heritage.

4. Application of Virtual Reality Technology in the Inheritance of Intangible Heritage

4.1. Virtual Dissemination and Popularization of Intangible Heritage Knowledge

Virtual reality technology holds significant advantages in the dissemination and popularization of intangible heritage knowledge. According to Statista, the number of global VR content users is expected to reach 67 million by 2024. By using VR technology, intangible heritage knowledge can be spread digitally, enabling more people to understand and learn about it. The Palace Museum in China, for example, has launched the "Digital Palace Museum" project, which uses virtual reality to showcase the historical and cultural significance of the museum, allowing users to experience ancient court life and culture in a virtual environment.

4.2. Virtual Experience and Participation in Intangible Heritage Projects

Virtual reality technology offers a new way for users to experience and participate in intangible heritage projects. According to Greenlight Insights, the global VR entertainment market is expected to reach \$12.8 billion by 2024. Through VR technology, users can immerse themselves in intangible heritage experiences, such as traditional music,

dance, and drama. For instance, the intangible heritage of Kunqu Opera in China, through VR technology, allows audiences to enter a virtual theater to view performances up close and appreciate their unique artistic charm.

4.3. Virtual Experimentation and Exploration of Intangible Heritage Innovation

Virtual reality technology provides a new platform for the innovation of intangible heritage. According to International Data Corporation, the global market size for VR and AR is expected to reach \$72.8 billion by 2024. Utilizing VR technology, intangible heritage projects can be virtually experimented with and innovated upon. In traditional handicrafts, for example, designers can experiment with new materials and techniques through virtual reality technology, pushing the innovation and development of intangible

heritage.

4.4. Virtual Development and Promotion of the Intangible Heritage Industry

Virtual reality technology plays a crucial role in the promotion and development of the intangible heritage industry. According to SuperData, the global VR gaming market reached \$1.1 billion in 2020. By using VR technology, the intangible heritage industry can showcase and promote itself, attracting more audiences and consumers. For example, the intangible heritage of Chinese embroidery, through VR technology, allows viewers to appreciate the artistry of embroidery in a virtual environment and understand its history and culture, thereby promoting the development of the embroidery industry.

Table 1. Examples of virtual reality technology in non-genetic inheritance

order number	application area	Technical application examples	Data support
1	Virtual dissemination and popularization of intangible cultural heritage knowledge	The Palace Museum uses VR technology to display the history and culture of the Palace Museum	The number of VR content users worldwide is expected to reach 67 million by 2024
2	Virtual experience and participation of intangible cultural heritage projects	Chinese Kunqu Opera allows the audience to experience the kunqu opera performance up close together through VR technology	The global VR entertainment market is expected to reach \$12.8 billion by 2024
3	Virtual experiment and exploration of intangible cultural heritage innovation	Use VR technology to design and make it in the traditional handicraft production	The global VR and AR markets are expected to reach \$72.8 billion by 2024
4	Virtual development and promotion of non-heritage industry	Use VR technology to let the audience appreciate the Chinese embroidery art, understand its history and culture	The global VR gaming market reached \$1.1 billion in 2020

5. Advantages and Challenges of Virtual Reality Technology in the Protection and Inheritance of Intangible Heritage

5.1. Analysis of Advantages

(1) Enhancing the Efficiency of Intangible Heritage Protection and Inheritance

Virtual reality technology can efficiently replicate and disseminate intangible heritage content. Through digital means, intangible heritage projects can be preserved in a permanent state as three-dimensional models, audio-visual content, and the like, greatly improving the efficiency of their protection and inheritance. Traditional oral traditions and performing arts can be recorded and reenacted using VR technology, removing limitations of time and space, making these intangible heritage projects more widely accessible and longer-lasting.

(2) Enhancing the Appeal and Influence of Intangible Heritage

The immersive experience provided by VR technology can attract more young people to become interested in intangible heritage, increasing the interactivity and fun of these projects, thereby enhancing their appeal and influence. Users can intuitively experience the charm of intangible heritage in a virtual environment, which helps intangible heritage gain more attention and recognition in modern society.

(3) Expanding the Communication Channels and Audience of Intangible Heritage

Through VR technology, intangible heritage can transcend geographical boundaries and reach global users. The

widespread availability of online platforms and mobile devices makes virtual experiences of intangible heritage more accessible, expanding its communication channels and audience reach. Whether it's traditional crafts in remote areas or cultural celebrations in urban centers, VR technology allows for global sharing.

(4) Promoting the Innovation and Development of Intangible Heritage

Virtual reality technology provides new avenues for the innovation and development of intangible heritage. Artists and designers can utilize VR technology for creation, combining traditional elements with modern design, developing new cultural products and services. This cross-boundary fusion not only enriches the forms of expression of intangible heritage but also opens up new paths for its inheritance, promoting its sustainable development.

5.2. Analysis of Challenges

(1) Technological Difficulties and Cost Issues

While virtual reality technology holds great potential, its application faces technological challenges and cost issues. High-quality VR experiences require expensive hardware and complex software support, which can be a considerable investment for many intangible heritage projects. Additionally, the rapid pace of technological updates and the associated maintenance and upgrade costs are also significant factors.

(2) Balancing Authenticity and Virtuality in Intangible Heritage

Maintaining a balance between the authenticity of intangible heritage and its virtual representation is a challenge. Over-virtualization can alter the essence of intangible

heritage, while an over-emphasis on realism can limit the creativity and appeal of the virtual experience. Finding a way to respect the original form of intangible heritage while providing a rich experience through virtual technology is a delicate matter that requires careful consideration.

(3) Acceptance and Participation of Intangible Heritage Inheritors

The acceptance of new technology and the willingness to participate vary among intangible heritage inheritors, affecting the application of VR technology in heritage inheritance. Some traditional artisans may adopt a conservative stance, worried that virtual experiences may dilute the traditional value of intangible heritage. Encouraging and guiding inheritors to actively participate in the application of virtual reality technology is a challenge that needs to be addressed.

(4) Legal Regulations and Intellectual Property Protection

Intellectual property protection becomes an important issue in the virtualization of intangible heritage. Intangible heritage often involves unique cultural symbols and traditional knowledge. Establishing legal regulations and regulatory mechanisms to protect these contents in the virtual environment from infringement and abuse is crucial. This requires the joint efforts of policymakers, cultural institutions, and technology companies to ensure that the virtual transmission of intangible heritage is conducted within a legal and compliant framework.

6. Case Studies of the Application of Virtual Reality Technology in the Protection and Inheritance of Intangible Heritage at Home and Abroad

6.1. Domestic Case Analysis

The intangible heritage of "Nanyin," a traditional musical form in Fujian Province, China, has been protected and inherited using virtual reality technology. Nanyin, with a history of over a thousand years, is an ancient music form. Through virtual reality technology, the performance scenes and music of Nanyin have been digitally recreated. Audiences can experience the atmosphere of Nanyin performances through devices such as head-mounted displays. According to the Fujian Provincial Center for the Inheritance and Protection of Intangible Cultural Heritage, the project showcasing Nanyin through virtual reality technology has attracted more than 100,000 participants to experience it.

6.2. International Case Analysis

The intangible heritage of "Craftsmanship in Florence," Italy, has also been preserved and passed down using virtual reality technology. This heritage includes sculpting, painting, jewelry making, and other crafts that have been passed down from generation to generation, rich in history and cultural value. Through virtual reality technology, viewers can enter a virtual studio and experience the making process of Florence's craftsmen firsthand, learning the details and techniques of the craft. According to the Italian Ministry of Cultural Heritage and Activities, the project showcasing the craftsmanship of Florence through virtual reality technology has attracted more than 50,000 participants to experience it.

6.3. Insights and Lessons from the Cases

These cases demonstrate the successful application of virtual reality technology in the protection and inheritance of intangible heritage. They not only provide audiences with immersive experiences but also promote the dissemination and popularization of intangible heritage. At the same time, these cases provide valuable lessons. To showcase intangible heritage using virtual reality technology, it is important to focus on user experience, providing intuitive and interactive interface design, as well as accurate and rich content presentation. Additionally, virtual reality technology can be used for the education and training of intangible heritage, inspiring young people's interest and participation.

7. Recommendations for the Application of Virtual Reality Technology in the Protection and Inheritance of Intangible Heritage

7.1. Policy Support and Financial Investment

To effectively utilize virtual reality technology for the protection and inheritance of intangible cultural heritage, the government and society should provide corresponding policy support and financial investment. The government can formulate policies to encourage and support the integration of intangible heritage projects with virtual reality technology, providing financial support for technology development, content creation, and promotion. Additionally, special funds can be established for virtual reality projects related to intangible heritage protection, encouraging participation from various sectors of society in the preservation and inheritance of intangible heritage. The government can also collaborate with enterprises and academic institutions to jointly promote the application and development of virtual reality technology in the field of intangible heritage.

7.2. Technology Research and Innovation

The application of virtual reality technology in the protection and inheritance of intangible heritage requires continuous technological research and innovation. Firstly, increase investment in virtual reality technology research to enhance system performance and user experience, including improving image rendering quality, reducing latency, and providing more natural interaction methods. Secondly, explore new technological applications, such as augmented reality and mixed reality, to enrich the forms of intangible heritage display and user experience. Additionally, focus on content innovation, combining the characteristics of intangible heritage to develop creative and attractive virtual reality applications that provide unique user experiences while maintaining the authenticity and traditional features of intangible heritage.

8. Conclusion

8.1. Summary of Research Findings

This study has thoroughly explored the application of virtual reality technology in the protection and inheritance of intangible cultural heritage, analyzing its key role and the challenges it faces. The research finds that virtual reality technology, through digital means, significantly enhances the efficiency of intangible heritage protection and inheritance, achieving the permanent preservation and widespread

dissemination of intangible heritage projects. Additionally, it strengthens the appeal and influence of intangible heritage, especially among younger generations, expanding its communication channels and audience reach. Furthermore, virtual reality technology provides a new platform for the innovation of intangible heritage, driving its innovative development and promoting the deep integration of culture and technology, injecting new vitality into the sustainable development of intangible heritage.

8.2. Implications for the Protection and Inheritance of Intangible Heritage

This study offers important insights into the protection and inheritance of intangible heritage. The government and society should increase policy support and financial investment in virtual reality technology to provide necessary resources for the digital preservation of intangible heritage. They should continuously promote the research and innovation of virtual reality technology to enhance system performance and user experience. Moreover, they should develop creative and appealing virtual reality applications that are uniquely tailored to the characteristics of intangible heritage. Through these efforts, there can be a deeper understanding of the application of virtual reality technology in the protection and inheritance of intangible heritage. This will provide new perspectives and methods for the preservation and inheritance of intangible heritage, while also

promoting the deep integration of culture and technology, and driving the sustainable development of intangible heritage.

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References

- [1] Yang, L., & Xu, L. (2023). Application Research of Virtual Reality Technology in the Inheritance of Intangible Cultural Heritage: A Case Study of Hainan Li Ceramics. *Ceramics*, (1), 185-187.
- [2] Yang, J., Ma, C., Qiu, C., & al. (2022). Research on the Application of Virtual Reality Technology in the Museum Tourism Industry. *Manlv*, (007), 9.
- [3] Wu, Z. (2023). Research on the Protection and Development of Intangible Cultural Heritage Dance Based on Motion Capture and Virtual Reality Technology: A Case Study of Tibetan Dance. *Dance*, (4), 90-96.
- [4] Li, Q. (2023). Design Research of Virtual Reality Technology in the Inheritance of Intangible Cultural Heritage Culture. *Packaging Engineering*, 44(18), 337-340.
- [5] Lü, P., & Cui, J. (2023). Application of Multisensory Design in the Virtual Experience of Traditional Handicrafts Intangible Heritage. *Design*, 8(4), 7.