The Current Situation of Museums Applying VR Technology to Disseminate Traditional Culture

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Keywords: Virtual Reality, Museums, Cultural Dissemination.

Abstract: With the development of virtual reality (VR) technology, many museums have begun to apply this technology to the exhibition of cultural relics to disseminate traditional culture. However, at present, the application of VR technology in major museums has different modes, and there are problems such as “authenticity conflict” and “wearing discomfort” in the application process. This paper will focus on the current situation of museums' application of VR technology to disseminate culture, take the literature analysis method and case study method to analyze the mode of museums' application of VR technology and its impact on the dissemination of traditional culture. It is found that the immersion, interactivity, and telepresence of VR technology also promote the effect of museums in disseminating traditional culture; the more realistic the design of the virtual scene, the more the narrative tends to be user-driven, and the more concise the interaction mode, the more the museum attracts users to come to experience it, and the effect of disseminating traditional culture is better. This paper hopes that museums will continue to develop these advantages, and at the same time, they can combine the “meta-universe” and AIGC with VR technology in the future to disseminate traditional culture.

1 INTRODUCTION

As an institution with a long history of displaying cultural heritage, museums have always used physical exhibitions, but the physical exhibitions are monotonous and dull, lacking interactivity and playfulness. Moreover, the space of museums is limited, which makes it difficult to cope with the huge flow of people. Take the Hubei Provincial Museum as an example, on weekends and other holidays, you need to line up for one to two hours before you can see the cultural relics of the “Sword of King Goujian”, which undoubtedly reduces the museum experience significantly. This may eventually lead to the failure of the museum's function of disseminating culture. However, with the rise of virtual reality (VR) technology, many museums have begun to adopt this technology for their exhibitions, such as the British Museum, the Metropolitan Museum of Art, and the Palace Museum. Academics have also begun to study this phenomenon, but there are still some problems. This paper will summarize the research on “VR technology combined with museum exhibitions for cultural communication”, at the same time, this paper will point out the problems of the current research and give specific solutions. Hoping to show the current situation of museums applying VR technology and provide references for related research.

2 THEORETICAL BASIS OF VR TECHNOLOGY

2.1 Relevant Theoretical Support

2.1.1 Flow Theory

“Flow theory” was developed in 1975 by Csikszentmihalyi, who believed that when skills and challenges are balanced, a person enters a state known as “flow”, where the person is extremely focused and immersed (Csikszentmihalyi, 1990). In a VR scenario, the audience can experience a “telepresence” (Steuer, 1992) through multi-sensory interactions in the virtual scene, which makes the audience feel immersed in the scene and have the

Zhou, R.
The Current Situation of Museums Applying VR Technology to Disseminate Traditional Culture.
DOI: 10.5220/0013995100004916

In *Proceedings of the 2nd International Conference on Public Relations and Media Communication (PRMC 2025)*, pages 496-502
ISBN: 978-989-758-778-8

feeling that “I can cope with these challenges in the virtual scene”, triggering the “flow”.

2.1.2 Uses and Gratifications Approach

The “uses and gratifications theory” means that “audiences choose a medium because they need the medium to satisfy their needs, and their satisfaction can be obtained from the medium” (Katz & Blumler, 1974). In the VR virtual scene of the museum, VR technology satisfies the needs of visitors to “explore cultural relics and learn cultural knowledge”. In this way, VR technology is a good way to disseminate traditional culture for the museum. This paper argues that subsequent research by scholars on the application of virtual reality technology in museums is also rooted in this theory. For example, Economou pointed out in *Heritage in the Digital Age* that virtual reality technology can make users feel that they are in the cultural heritage environment (Economou, 2015), This paper argues that the scholar writes this because VR technology well meets the user's demand for “experiencing the real scene of ancient times”.

2.1.3 Technology Acceptance Model

The Technology Acceptance Model (TAM) was proposed by Davis, which shows that users' acceptance of technology depends on two factors: “perceived usefulness” and “perceived ease of use”. Perceived usefulness refers to “the degree to which users perceive the technology to be useful to them”; perceived ease of use refers to “how difficult users perceive the technology to be to use” (Davis, 1989). The first impression of VR is “real”, the user will think “I want to experience VR, it's useful for me, after all, I'd love to experience an ancient scene”, in this way VR satisfies the user's needs, VR technology is useful to the user. That would be consistent with “perceived usefulness”. At the same time, the user is also likely to feel that “this thing is easy to use, after all, it's almost the same as reality”. That would be consistent with “perceived ease of use”. After that, Venkatesh's *User acceptance of information technology: Toward a unified view* added two factors, “social influence” (others' expectations of users' use of technology) and “facilitating conditions” (objective conditions supporting users' use of technology) to the original TAM. This innovation improved the theory of technology acceptance model (Venkatesh et al., 2003).

2.2 Characteristics of VR Technology

The concept of “museums applying VR technology to disseminate traditional culture” not only needs the support of the theoretical foundation of communication studies, but also should be analyzed from the characteristics of VR technology itself. Explore the question of “Why VR technology can bring promotional factors for museums to disseminate traditional culture?”. The following are three characteristics of VR technology.

2.2.1 Immersion

Sutherland, in *The Ultimate Display*, suggests that the ultimate goal of VR technology is to achieve “The Ultimate Display”, a VR system that creates a “room” where computers can control the existence of matter through a variety of input devices, kinesthetic displays, and multi-sensory experiences (Sutherland, 1965). This paper believes that the current VR technology has already achieved “The Ultimate Display” conceived by Sutherland to a certain extent. The VR application in museum exhibitions allows users to be more immersed in the cultural virtual scene composed of cultural heritage so that they can experience the traditional cultural atmosphere more profoundly.

2.2.2 Interactivity

Fisher in *Virtual Environment Display System* proposed that the interaction of VR display systems will be easier to experience through multi-sensory feedback from vision, hearing, and touch. This not only reduces the difficulty of getting started with a VR system, but also significantly enhances the sense of presence (Fisher et al., 1987). This paper argues that the strong interactivity of VR technology will greatly improve the “communication” between artifacts and audiences in museum exhibitions, shortening the distance between artifacts and audiences. The playfulness and interestingness of exhibitions will also be greatly enhanced. The museums will be more appealing to users to come to visit and experience the atmosphere of traditional culture.

2.2.3 Telepresence

According to Steuer, “telepresence” is a core feature of VR systems. Unlike “presence” (the experience of being in a natural environment), “telepresence” is the experience of being in a virtual environment as

perceived by the user through the medium, which is essentially a substitute for the perception of the physical environment by the medium. “Vividness” and “interactivity” are two important dimensions of telepresence (Steuer, 1992). This paper argues that the “telepresence” of VR technology can bring museum visitors the wonderful experience of “traveling through time and space” - the user can be present at the time of the artifacts and experience the stories that the artifacts have experienced. In this way, it can stimulate users' emotional resonance with the artifacts and enhance their understanding of traditional culture.

3 APPLICATIONS OF VR TECHNOLOGY IN MUSEUMS

3.1 Scenario Design

Scenario design is crucial to the VR experience, a great scenario design can provide users with an immersive and fantastic experience. Museums can achieve as close a reproduction of reality as possible through detailed 3D modeling, laser scanning, light tracing and rendering technologies.

This elaborate scene design gives the VR system a strong sense of presence: high resolution, high refresh rate and delicate texture and light and shadow so that the virtual scene can be close to the real world, deepen the vividness, strengthen the sense of telepresence (Steuer, 1992). Specifically speaking, the museum can accurately restore the surface texture, shape, and texture of the artifacts through laser scanning technology because the artifacts are prototypes in reality. In conclusion, museums today tend to focus more on the “realism” of the virtual scene than on the size and freedom of the scene when building virtual scenes.

3.2 Narrative Design

VR systems not only need a real scene but also need to guide users to be more immersed in the virtual scene by reasonable narrative design. Different from the traditional linear narrative, the narrative in a VR environment tends to be more “fragmented” and “user-driven”. The analogy to the game is the difference between “linear narrative guides the player” and “soul-like fragmented narrative where the player can explore and recovers the storyline”. VR system narratives are often explored and discovered by the users themselves. In the “Digital Dunhuang” project, users can explore the story of each mural and learn about Dunhuang culture. In short, when applying VR technology, museums need to achieve a “user-centered” narrative that allows users to lead the story themselves (Dong Hengshuo et al., 2024).

3.3 Interaction Design

Interaction design is the key to VR systems, which will directly affect the “telepresence” of the virtual scene (Steuer, 1992). VR systems can generally interact with the user through gesture recognition (manipulating objects in the virtual space by recognizing hand gestures), somatic interaction (providing feedback such as vibration, images, and sound effects), voice interaction (manipulating the virtual reality system by voice) (Fisher et al., 1987), and eye-tracking (tracking eye movements to produce perspective changes) and other technological ways to achieve the interaction with users.

Simple interaction logic is necessary. In *Exploring the suitability of Virtual Reality interactivity for exhibitions through an integrated evaluation: the case of the Ename Museum*, scholars studied the “Timeline” exhibition at the Ename Museum in Belgium and found that cumbersome interaction logic is counterintuitive, which directly affects the user's sense of immersion. The simplicity of the interaction logic is positively correlated with the user's sense of immersion (Tost & Economou, 2007).

This paper argues that the interaction between the virtual scene and the user must be kept as real-time as possible to reduce the latency of the system's response, which may lead to lag, thus seriously weakening the immersion of the virtual scene.

4 THE IMPACT OF APPLICATIONS OF VR TECHNOLOGY IN MUSEUMS ON CULTURAL COMMUNICATION

4.1 Impact Based on the Theory of Virtual Reality

As mentioned above, the VR system has the characteristics of strong immersion, interactivity, sense of telepresence, the point of view has been demonstrated through the articles of other scholars, VR technology through these three characteristics attracts the public to experience the virtual space. In

this way, the user does not have to stare at the cold artifacts but can directly "communicate" with artifacts.

From the point of view of "learning cultural knowledge", users can travel to the era in which the cultural relics are located and can personally experience the stories behind the cultural relics, which is certainly more impressive than watching the introduction of the cultural relics outside the booth.

From the point of view of "stimulating interest", the main reason why many people are reluctant to go to the museum is that the traditional museum exhibitions are boring and tedious. However, the exhibition through the emerging technology of virtual reality can greatly stimulate people's interest in entering museums to experience traditional culture.

Not only that, VR technology allows visitors from different parts of the world to interact and explore in the virtual space. This is a feature that museums can take advantage of (Slater & Sanchez-Vives, 2016). This paper argues that museums can try to integrate their traditional culture into the virtual space and attract tourists from all over the world to experience it through both online and offline channels. This is a better way to disseminate their traditional culture.

4.2 Impact Based on Communication Theory

From the perspective of communication theory, the application of VR technology in museums can also promote the dissemination of traditional culture. This paper will introduce a classic theory of communication – cultivation theory. Cultivation theory was proposed by G. Gerbner, which means that people are exposed to the "pseudo-environment" constructed by TV media for a long time, thus their values will be influenced by the media. This process is long-term (Gerbner & Gross, 1976).

Based on the theory of Cultivation, this paper argues that VR technology can build a more realistic "pseudo-environment" than traditional media (newspaper, television, etc.) through immersive experience. The reason for this is that it transforms the audience from the "third person" to the "first person" and puts them in the perspective of the news parties. Such role-playing may accelerate the assimilation of values, and the media can influence the audience faster and deeper. The *New York Times* has launched a VR news client, "NYT VR", which allows users to come to the scene of the news through immersive reporting, an experience that may enable the audience to accept the information promoted by the newspaper and the hidden values behind it in a short time. From this point of view, the museum itself is a more ceremonial and serious cultural communication place, through the application of VR technology. The application of VR technology can better transform the medium's "long-term cultivation" to "instant resonance", well stimulate the users' awareness of "protecting cultural heritage and valuing traditional culture".

5 THE STATE OF PRACTICAL APPLICATION OF VR TECHNOLOGY

5.1 Application of Virtual Reality Technology in the Palace Museum

The Palace Museum, for example, the Palace Museum at the same time using VR and AR (Augmented Reality) technology, VR technology is mainly used to build the virtual scene, and the Palace Museum uses Unity engine to complete the construction of the virtual scene, improve the sense of presence by the dynamic water, light rendering and panoramic weather. The museum provides visitors with two modes of operation to experience virtual reality: keyboard and mouse, and somatosensory devices. The keyboard and mouse allow users to roam around the Forbidden City and even "fly" up to look down on the Palace; the VR somatosensory devices, which further enhance the sense of immersion, allowing users to experience immersive tours through somatosensory interactive devices (Chen, Feng, & Wang, Feng, 2020).

However, at present, the virtual Forbidden City still has some defects. For example, for visitors in the virtual scene the degree of freedom is low: "Cloud Tour of The Forbidden City" provides a "V Forbidden City" and "Panoramic View of The Forbidden City" two kinds of modes to explore the virtual scene. No matter what the difference between the two, visitors need to click on specific points in order to move in the virtual scene, the distance between the two points has been omitted, rather than "moving", it should be called "transmission", which leads to the immersion brought by VR technology is greatly reduced. This article suggests that the VR application can refer to most 3D games that use keyboard buttons (such as WASD) to allow the character to move.

5.2 The Virtual Exhibition Application of Dunhuang Academy

The Dunhuang Academy launched a "Digital Cave of Sutras" game in 2023 to showcase Cave 16 of the

Mogao Grottoes. Although the game application does not use head-mounted displays and various types of somatosensory devices for the virtual scene experience, the high degree of freedom of the virtual scene and the narrative approach is considered worthy of reference by other museums.

The "Digital Cave of Sutras" adopts the Photogrammetry technology, which is used by many 3d games in the market for scene restoration. Photogrammetry technology refers to the use of multiple angles to capture the scene in reality, thus improving the efficiency of scene restoration (Ding, 2025). In this way, the "Digital Cave of Sutras" utilizes beautiful mapping and textures to greatly reproduce the scene of Cave 16 of Mogao Caves in reality. The "Digital Cave of Sutras" uses rockers and keyboards to maneuver the characters on the PE and PC respectively, which has significantly improved the immersion of the display compared to the VR project of the Palace Museum.

From a narrative point of view, the "Digital Cave" adopts a first-person perspective, and the users can experience the story of the cultural relics *Guiyijun Nga Fu Wine and Broken Calendar* by interacting with a number of historical figures. Users can freely explore the scene and collect props to complete the task with a strong sense of immersion. As mentioned above, the first-person immersion will accelerate the influence of the medium on the audience. Therefore, this paper argues that the game immerses players in a virtual environment full of Dunhuang cultural aesthetics, which enhances the players' goodwill towards Dunhuang culture and their desire to explore, achieving the cultural dissemination purpose of "spreading Dunhuang culture and Buddhist culture".

6 OPTIMIZATION RECOMMENDATIONS

6.1 Limitations of Current Research

The first limitation is that virtual reality-generated content may conflict with cultural authenticity. This issue has been partially addressed by scholar Economou in *Heritage in the Digital Age*. The limitation may be caused by two reasons. First, the artifacts in the virtual scene lack the examination of details in the process of production by the designer, and such insufficient professional operation also lacks the authoritative audit in the whole VR system development process. Secondly, modern aesthetics and the aesthetics of the era in which the artifacts are located may be completely different, and modern bias may have an impact on the generation of cultural relics in the virtual environment, which leads to the developers attracting users and deliberately tamper with the original image of the artifacts in accordance with the modern aesthetics so that the virtual generation of the artifacts and the real artifacts is different.

The second problem is that the current VR headset equipment at present still has obvious wearing discomfort. For example, the user may feel the pressure on the eyes when wearing and experience a 3d effect in the process of vertigo nausea. Users wearing comfort will greatly affect the degree of immersion in virtual reality.

6.2 Recommendations

For the conflict between virtual scene content and cultural authenticity, this paper argues that the Museum of Cultural Relics Protection experts should be required to participate in the development of a virtual reality system to ensure the authenticity of cultural relics in the virtual scene, balancing the commercial value of VR technology with the value of cultural protection and dissemination. At the same time, the development process should be published on the museum website so that the public can participate in the process of supervision of the design of cultural relics in virtual reality.

For the problem of wearing discomfort of VR equipment, this article suggests that developers should put user experience in the first place. The museums can optimize the structure and display effect of the headset equipment: adopt a more scientifically reasonable ergonomic design to make the structure of the VR headset equipment fit the head better. The museums should synchronize the image transformation with the human eye movement as much as possible to prevent motion sickness caused by the incongruity between the screen and the human eye.

7 PROSPECTS

7.1 "Metaverse" Extension in VR Technologies

Since the 2020s, virtual reality technology has introduced the concept of "metaverse" in its development. Xiao Zhang and Deling Yang have explored the potential of the metaverse in the field of cultural heritage communication and preservation in *Metaverse for Cultural Heritages*, where Zhang and Yang mention the concept of metaverse as a way to recreate the plot of "The Eight Immortals Crossing

the Sea". The users can participate in the scene interaction with the plot from their first perspective, which can greatly enhance the interactive experience and deepen their understanding of the connotation of "The Eight Immortals' Culture" (Zhang et al., 2022).

Although *Metaverse for Cultural Heritages* does not directly mention the application of metaverse in museums, this paper believes that museums can learn the metaverse application mode from the cultural heritage of "Eight Immortals Crossing the Sea". The reason is that both museum exhibits and "Eight Immortals Crossing the Sea" culture belong to cultural heritage and both can utilize metaverse based on virtual reality technology for cultural heritage protection and cultural dissemination. At the same time, there are many exhibits in museums, so it is necessary to design different virtual scenes for different exhibits and use the metaverse to show the stories and values of different cultural relics. Since 2020, several museums, including the British Museum, the Dunhuang Academy, and the Henan Museum, have had their own metaverse projects.

7.2 Application of AIGC in Building Virtual Reality Scenes in Museums

Artificial intelligence technology has been developing rapidly in recent years. This paper argues that museums can also combine it with VR technology, which may become a future development trend.

The current cost of operating a VR system is huge and unaffordable for many museums (Dong Yunuo & Zhu Xiaoyi, 2022). In *Prospect analysis based on the current application of VR exhibitions*, the author Dong Hengshuo argues that the development of Artificial Intelligence Produced Content (AIGC) can help reduce costs and increase efficiency in the application of VR technology in museums. Dong mentions that AI can help generate 3D modeling, mapping, texture generation and so on. In this way, the scene design, which is the costliest part of VR scene building, can take advantage of AI's assistance and thus reduce costs. With the continuous development and progress of AI technology in the future, the mapping, modeling, and texture generation will be more elaborate and realistic, and museums will be able to pay less cost to build a virtual scene with better content (Dong Hengshuo et al., 2024). For example, museums can use Deep Learning Super Sampling (DLSS) technology to increase the number of frames played in the virtual scene and improve the image quality at the same time, and the resolution of the image can be improved through AI calculation. In this way, the hardware requirements for museums to build virtual scenes are also reduced and at the same time can bring users a more immersive and realistic experience (Chen & Cao, 2024).

Combining VR technology with AI technology also holds great promise. This paper believes that museums will be able to utilize a combination of the two in the near future.

8 CONCLUSIONS

This study finds that the communication theory of "museums applying VR technology to disseminate culture" and the characteristics of VR technology itself enable museums to utilize this technology to better disseminate traditional culture. At the same time, the more realistic the scene design, the more user-oriented narrative mode they adopt, the simpler the interaction design, the more the museum attracts users to come to experience it so that the scope of dissemination of traditional culture will be wider and more deeply rooted in people's hearts. However, the current application of VR technology in museums still has the problems of "authenticity conflict" and "wearing discomfort". Therefore, this paper hopes that museums can continue to develop their own advantages when applying VR technology and solve the defect of "authenticity conflict" through more authoritative and professional supervision, solving the problem of "wearing discomfort" by adopting more reasonable and advanced hardware design at the same time. This study summarizes the current application of VR technology in museums and points out the impact of this application on the dissemination of traditional culture. It is hoped that this study will be helpful for related research. In the future, when museums apply VR technology, they can combine "metaverse" and AIGC technology to create a more real, more inclusive, and more attractive virtual world. The public can experience the charm of the traditional culture in this virtual world.

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