The application of virtual reality in art

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Abstract. Virtual reality (VR) is an important technology applied in the field of art in recent years. VR has revolutionized the field of art with its unique immersion and interactivity. At present, there are very few articles that focuses on and discusses the development and limitations of the use of VR in the field of art. This paper will give readers a full understanding of the application of VR in art. Paper summarizes the application of VR in art, including VR exhibitions, VR scenic spots and historical sites, and 3D movie. We have cited the most representative examples in each field, discussed in detail how they are combined with VR, and demonstrated the advantages of VR in these fields. Then, this paper concludes some limitations of the use of VR in art and ends up with a discussion on the future development direction of VR in the art field.

Keywords: visual reality, art, online museum, VR historical sites, 3D movie.

1. Introduction

Virtual reality (VR) technology, referred to as VR technology, is also called "Spiritual Environment Technology", "Virtual Environment" and "Cyberspace". VR technology is an innovative form of human-computer interaction that utilizes the integration of computer graphics, human-computer interface technology, sensor technology, and artificial intelligence technology to create a lifelike artificial simulation environment. This technology enables the effective simulation of diverse human perceptions in natural environments, leading to new ways of experiencing and interacting with the world [1].

VR is a new medium for disseminating artists' ideas. Its immersion and interaction can transform static art into dynamic art that observers can explore, and it plays an important role in the field of culture and art. In this field, VR mainly includes three aspects: places of interest, virtual games, and film and television. Virtual museums, virtual cultural heritage, virtual galleries, virtual actors, and virtual movies are all current achievements of VR. But so far, there has been limited coverage of the use of VR in art, with few articles providing a comprehensive analysis of its applications [2].

Therefore, this paper comprehensively introduces researchers to the application of VR in the art field. First of all, this paper specifically introduces the three main applications of VR in art, which are VR exhibition, VR historical relic, and 3D film. We explained the role of VR in each application and its advantages through specific examples. Next, paper summarizes three limitations of VR in art field and problems that have not been solved yet. They are the limitations on VR hardware, interactivity, and refinement. Finally, we will make predictions about the future of VR in art based on current trends and our previous analyses.

2. The application of VR in visual art

2.1. Online exhibition

VR brings us a more real and convenient way to visit the exhibition. The online exhibition breaks through the limitations of the traditional exhibition including the limitations of time, place, space, and style. With the help of VR, especially the immersive and interactive browsing experience (Figure 1), visitors not only can feel the real scene without being in the exhibition but also enjoy the experience of "walking" from any angle and experiencing diverse virtual interactions in all aspects. The VR presents the realistic exhibition through 3D modeling and real-life shooting technology, and 360-degree restores multimedia information such as the exterior, interior, booth, and exhibits of the exhibition. And it integrates a variety of interactive functions such as rotation, roaming, navigation, and tracking so that customers can have a clear and intuitive understanding and visit the exhibition hall using network communication equipment [2-4]. Users not only can view the panorama of an online exhibition in 360° and from the first perspective, but are also able to control the figure to move in all directions with a wide viewing angle. Moreover, the access to the taste, smell, and touch add to the immersive experience and make the virtual more realistic.

Figure 1. The virtual exhibition hall of the Beijing Capital Museum.

2.2. VR scenic spots and historical sites

VR shows scenic spots and historic sites with realistic images. Combined with network technology, art creation, display and protection of cultural relics can be raised to a new stage. Figure 2 shows the virtual Forbidden City, which is an earlier virtual product in China.

Figure 2. The virtual Forbidden City.

2.2.1. Publicity of historical sites. VR allows us to better publicize our cultural heritage. Those who are limited by physical conditions can comfortably choose any path to visit various scenic spots through the

Internet at home without having to travel long distances, and the fun is endless. One of the highlights of the 2010 World Expo in Shanghai was the Online Expo. It uses 3D VR, multimedia and other technologies to design the virtual platform of the World Expo, digitizes the Shanghai World Expo Park and the exhibition hall space in the park, and reproduces them on the Internet in a 3D manner. Global netizens can obtain an unprecedented 360° space without leaving their home. Travel and 3D interactive experience [5]. It not only shows the lives and cultures of various countries to hundreds of millions of audiences around the world but also demonstrates the innovative ideas of the Shanghai World Expo. For example, in the online World Expo, the French Pavilion undoubtedly displayed the theme of "Sensitive City" in the virtual space. Visitors can freely visit 360° in the virtual pavilion with just a click of the mouse. Figure 3 shows the virtual corridor of the French Pavilion. People can enjoy the classic paintings of the Musée d'Orsay and the beautiful French gardens in the museum. At the same time, people can also enjoy an incredible 3D interactive experience, and even "walk into" Gauguin's "Meal" and other famous artists' Paintings, as shown in Figure 4, "Shuttle" among them and listen to the introduction of the works. Visitors who like 3D interactive games can even interact with the mascot "Lele" of the French Pavilion in real time, and experience sensory enjoyment including sight, smell, touch, taste and hearing in the game. Therefore, the Shanghai World Expo is also known as the "never-ending" World Expo.

Figure 3. The virtual corridor of the French Pavilion.

Figure 4. Gauguin's "Meal" in VR.

2.2.2. Protection and restoration of historical sites. Moreover, the arrival of VR brings new possibilities for the protection and restoration of cultural heritage. For cultural heritage, researchers have created virtual replicas of world cultural heritage such as famous archaeological sites, buildings and nature reserves. For example, the production of virtual models of British prehistoric Stonehenge, Chinese Terracotta Warriors and Horses, Old Summer Palace, Notre Dame de Paris, etc. Figure 5 shows an Egyptian temple [6]. The production process is as follows: firstly, the cultural relic entity is collected by means of image data, and various architectural details that cannot be displayed in the blueprint are recorded, and used as material textures, and the brightness is measured again, and the 3D model of the

object is established using modeling software, and stored in the corresponding database. In addition, VR allows for the preservation of crucial resources such as the original data forms and spatial relationships of cultural relics, facilitating their scientific, high-precision, and permanent preservation. Furthermore, this technology enables the integration of cultural relic resources on a large scale through computer networks, providing a comprehensive and realistic display of cultural relics that can be accessed from anywhere in the world. By freeing cultural relics from geographical restrictions, VR technology promotes resource sharing and ensures that these valuable artifacts are accessible to people everywhere. Figure 6 (a) shows the original picture of the Western Scenic Area in the Old Summer Palace, and Figure 6(b) shows the preliminary digital reconstruction results of the Western Scenic Area.

Figure 5. An Egyptian temple in VR.

| (a) | (b) |

Figure 6. (a)The original picture of the Western Scenic Area and (b)the preliminary digital reconstruction results of the Western Scenic Area.

2.3. 3D movie

Three-dimensional stereoscopic film is one of the applications of VR technology, and it is a film combined with VR technology. When shooting, first in the early stage of shooting, the stereo photographer combined with the storyline to create a "depth script". Depth script is a means of displaying the creative intention of a 3D movie and the basis for shooting. It determines the 3D depth of each scene and plays an important role in making comfortable and clear 3D images, shots and frame sequences. When shooting, a 3D camera for shooting stereoscopic images and a virtual camera for combining virtual and real images are usually used, which not only realizes real-time capture of movements and expressions, adds overall dynamics to the scene, but also reduces shooting costs. Its shooting principle widely adopts polarizing glasses method. It uses the method of human eyes to observe the scenery, and uses two movie cameras arranged side by side, representing the left and right eyes of the person respectively, to simultaneously shoot two movie images with slight horizontal parallax. The main production process of a 3D film involves loading two film films into separate left and right film projectors during projection. Additionally, two polarizers with polarization axes that are mutually perpendicular are installed in front of the projecting lens. Both projectors must run synchronously,

projecting their respective images onto the metal screen to create a double image. This process is essential for producing a 3D film.

It is precisely because of the use of this unique and innovative technology that 3D movies are very immersive and attract a large audience. The 3D viewing experience is made possible by the use of special polarized glasses worn by the audience. These glasses allow the left eye to see only the left image, while the right eye sees only the right image [7]. The images are then superimposed on the retina through the binocular convergence function, creating a three-dimensional visual effect that is perceived by the brain's nerves. By presenting a series of coherent three-dimensional pictures, the audience is able to feel as if they are being drawn into the scenery, resulting in an immersive experience that is both captivating and memorable.

Figure 7. A scene in "Avatar".

Figure 8. A scene in "Ice Age 5".

Three-dimensional stereoscopic movies have had a huge impact on human vision, which is an epoch-making progress in the film industry. The application of VR in three-dimensional movies is mainly to create lifelike characters, fascinating grand scenes, and add various shocking special effects. The movie "Avatar" released at the beginning of 2010, the scene is magnificent, ethereal fairyland, and the romance on earth, which makes people unforgettable for a long time. In addition to the use of more than 3,000 special effects shots, its success lies in the fact that the film has moved from flat to three-dimensional. The whole shooting process uses a new generation of 3D cameras to create a three-dimensional effect. Figure 7 shows a scene from Avatar. At present, the technology of 3D stereoscopic movies is relatively mature, and 3D movies come out every year, such as "Ice Age 5"(Figure 8), "Up", etc. People are called to the cinema again and again, which shows that virtual 3D movies are popular in the film industry. Blooming dazzling brilliance.

3. Analysis of limitations of VR in the field of art

Although VR technology has brought us many surprises, it still has many problems that have not been solved. Here are three main problems.

3.1. Experience limited by VR hardware

VR interaction can be divided into two aspects: the information input of the experiencer and the output of VR content. It is difficult for the mechanical hardware of the output to be unified with the hardware of human body [8]. VR head-mounted displays are the mainstream VR display device, but it is difficult to make up the gap between human eyes and displays, and the inconsistency of space leads to a decrease in the sense of immersion. Also, 3D glasses are required to watch stereoscopic movie. Every time after people watching 3D movie, there will be red marks on the bridge of everybodies' nose.

3.2. The limitation on interactivity

It is interaction that allows humans to perceive their own existence. It can greatly enhance VR's immersion and attraction to people [3,9]. Therefore, it is very necessary to bring better interactivity to the audience through immersive VR. However, most of the use of VR in the art field is very lack of interactivity. For example, most online exhibition halls now only allow visitors to walk back and forth just like looking at a three-dimensional picture. If we can add some interaction, such as triggering some voice explanation or interacting with other online visitors, then the online exhibition will be more popular with everyone.

3.3. Limitation on the degree of refinement

Different from the application of VR in other fields, the application of VR art field requires a very high degree of refinement of the scenes presented. One of the main challenges faced by most VR applications is scene construction [10]. The accuracy of the modeling and the performance of the graphics engine are critical factors that determine the level of refinement achieved in constructing these scenes. But the maturity of these technologies is not enough to support the creative needs of most artists and the reproduction of large ancient architectural scenes. In the virtual scene of the Imperial Palace, we are not enough to see the calligraphy on the plaque of the Hall of Supreme Harmony and the dragon carving on the stone pillar in front of the main hall. Therefore, there is still a lot of room for improvement in the refinement of VR technology.

4. Conclusion

To sum up, this article specifically introduces and analyzes the innovation and application of VR in art field. It focuses on the introduction of online exhibitions, VR cultural heritage, and 3D movies, these three current main applications. We use specific examples to introduce in detail how VR is combined with this field. Also, we have analyzed the advantages of VR for various arts, which can be mainly summarized as facilitating publicity, bringing immersive and shocking experience to the audience, and bringing more possibilities to art. Then, paper summarizes three limitations of VR in art field: the limitations on VR hardware, interactivity, and refinement.

Based on all the above, it is clear that VR technology has boundless potential in the art world. As VR technology continues to evolve, the limitations we previously discussed are likely to be overcome, making it even easier for artists to create artworks using this technology. This process will be mutually beneficial, as artists will continue to push the boundaries of what is possible with VR technology. Moving forward, it will be important to stay up-to-date on the latest developments and innovations in VR, particularly as they relate to the field of art.

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