

Overview of the application of virtual reality in the field of visual arts and video games

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Abstract. Virtual reality (VR) is an important technology applied in the field of visual arts and game in recent years. VR has revolutionized the field of visual arts and video games with its unique immersion, interactivity, and has significantly improved the user experience for oneself. This paper summarizes the application of VR in visual arts and video games, including VR exhibitions, VR performances, VR tourism, VR games, etc. and compares them with traditional ways. The aspects of immersion and socialization of VR game are analyzed. At the same time, the limitation of VR interactive content and the defects of VR technology are indicated, including the problems of the gameplay's deficiency, VR input and output devices. The future development direction of VR technology is prospected.

Keywords: virtual reality; immersive VR; interactive visual arts; VR games.

1. Introduction

Virtual reality technology, referred to as VR technology, is also called "Spiritual Environment Technology", "Virtual Environment" and "Cyberspace". Virtual reality technology is an advanced human-computer interaction technology that comprehensively applies computer graphics human-computer interface technology, sensor technology, and artificial intelligence technology to create a realistic artificial simulation environment and effectively simulate various human perceptions in the natural environment [1]. In recent years, the commercial use of 5G technology has reduced the delay of VR products by nearly 10 times, improved the network efficiency by 100 times, and greatly improved the running speed of VR. With the development of the VR industry, it has been widely used in games, social networking, education, medicine, and other fields [2-3].

The emergence of VR is undoubtedly an epoch-making event, which makes many people focus on the field of virtual reality again. VR has great significance to the future. It not only promotes the development of science and technology to some extent but also improves people's lives. VR is a convenient and fast technology; it allows people to experience all kinds of things without leaving home. In the future, more VR applications will permeate people's lives and bring more magical and immersive experiences. In addition, VR has also opened up another field: allowing people to enjoy the release and feeling of satisfaction in the virtual world that aren't able to satisfy in the real world. Immersion and interactivity are advantages of VR; thus, VR is widely applied to visual art and video games. This paper is going to study the different VR applications in the areas of Visual art and VR games, analyze the shortage of VR technology, and give an outlook for the future of VR.

2. The application of VR in Visual art

2.1. Online 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 [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.

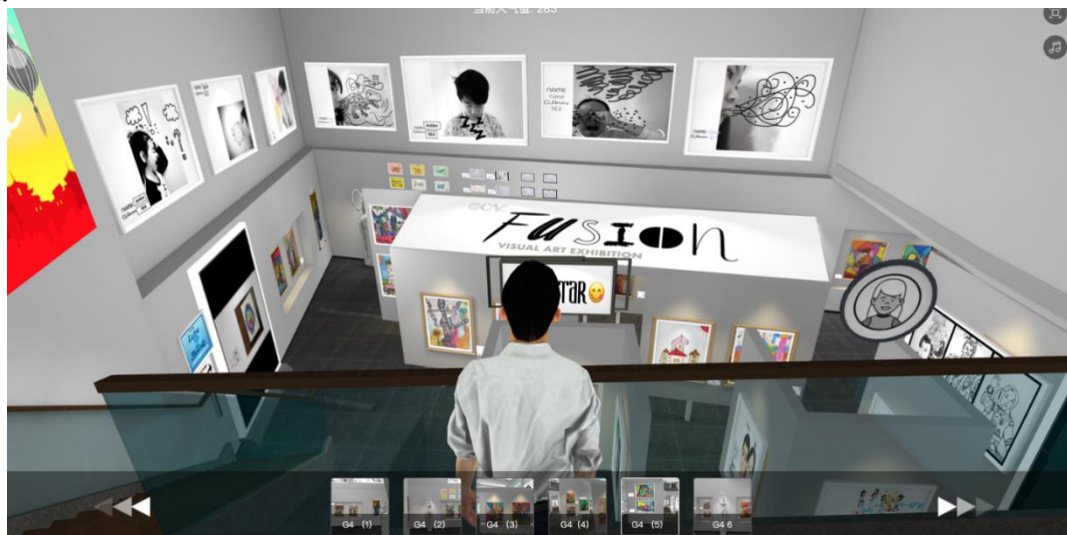


Figure 1. Immersive and interactive browsing experience

Compared with the traditional exhibition, the advantages of the online exhibition are as follows:

It is more novel, and also has some interesting and interactive features which can better provide an educational experience on display, explanation, and dissemination.

It is more environmentally friendly. Traditional exhibitions produce pollution from raw materials and transportation, but online exhibitions do not require an actual place to be built and visitors to be at the actual site, so zero pollution was produced.

It is more convenient. The online exhibition was not restricted by place, time, or outside factors. The number of exhibitions held in China declined rapidly between 2020 to 2022 because of the local Covid policy. However, online exhibitions will not be bothered by this, viewers can visit the online exhibition anywhere at any time with a VR device.

Online exhibitions provide a better experience for viewers. The traditional exhibition usually cannot achieve a good viewing experience due to a large number of visitors, but online exhibitions are not bothered by this problem, and exhibitors can achieve real-world exhibitions without leaving home.

2.2. Catwalk

The catwalk is the main way for designers to display their works. For the traditional catwalk, a clothing show will require a huge investment of time and energy in the early preparation, including the venue infrastructure, the employment of professional models, and other on-site service staff,

which will require huge capital costs to support a clothing show. For the audience inside the venue, the fixed viewing angle and the difference in seats lead to an unsatisfactory viewing effect. For the audience outside the venue, they cannot watch the live performance in person and experience the beauty of the costumes on the stage [5]. In the context of the new coronavirus, few offline exhibitions can be held. At present, although people can enjoy the fashion show through the network, most of them are presented in the form of pictures and videos. The size of the screen limits the display effect of the screen, which makes the audience unable to feel the beauty brought by the clothing in real-time. However, virtual catwalk activities through VR technology can not only save costs but also enable more people to participate in the new epidemic, to achieve better publicity and communication effects. In addition, VR technology is a new and high-tech technology that can highly integrate information in a large comprehensive environment. it can generate a variety of realistic virtual environments to act on users' vision, hearing, and touch so that users can feel immersive. Due to the characteristics of immersion and realism, the virtual reality show can save time, space, and cost, and let the audience have a better viewing experience.

2.3. Tourism

Tourism, as an emerging field of the tertiary industry, enjoys a good momentum of development in the world. However, environmental pollution and tourism resource overloading have become prominent questions. With the development of GIS (Geographic Information System), 3D visualization, virtual reality, 3D Internet, and other technologies, people are not only able to use computers to process graphics, images, videos, sounds, animation, etc., but also display 3D entities, 3D environments, etc. in the form of virtual reality to generate interactive 3D animation and dynamic simulation. Therefore, VR panorama emerges as the times require. VR panorama can "move" real objects online through 3D virtualization, and restore the real scene 1:1 so that people can watch the scenic spots they want to visit without leaving home (Figure 2). The advantages of using VR in tourism are listed in the following:

Virtual tourism, expanding the influence of tourist attractions

Based on the panoramic images shot in real scenes, the 1:1 landscape is built through web3d development and VR technology. Viewers can freely choose the tour content and route for an interactive experience, breakthrough time and geographical constraints, visit the scene anywhere at any time, and increase the breadth of cultural communication.

Restore the scenic spots and historic sites that were gone.



Figure 2. Schematic diagram of VR tourism scene

With the increase in pollution, many historic sites were gone due to human destruction or disappeared with time. But VR provides a chance for that historic site and landscape to restore and people can visit them online [6]. The online VR tour of Dream of the Old Summer Palace, independently developed by Guangzhou Huarui Interactive, restores the original appearance of the Old Summer Palace through VR virtual reality technology, 3d, and augmented reality technology. It provides a wonderful VR experience of the Old Summer Palace during the glorious period for users. The VR tour solves the problem of restoring ancient architectural sites and improves the depth of ancient architectural civilization.

Better protect cultural heritage and ecological environment

With the help of multimedia and AR augmented reality technology, the ancient cultural heritage is digitally displayed and effectively protected, so that tourists can visit the cultural relics at zero distance without causing any damage. Moreover, it reduces the environmental damage and extent of the preserve time of this precious cultural heritage.

3. The application of VR in video games

3.1. How console games and pc games interaction on immersion and socialization

Most traditional video games are in the form of console games and pc games. These games, usually having a console (gaming console or a pc) which runs these games, and a display equipment to display the video of those games (such as television or monitor). As a result, these games, in order to engage them with more immersion, the iteration of gaming consoles and computer hardware, and the popularization of higher resolution, different display type (such as oled or mingled) of display equipment is necessary [7]. And in the recent 20 years, the progress and development of video games usually focused on vision aspect of immersion, which includes higher display resolution, the advance of lighting, improved of texture resolution, draw distance and shadow, and enabling ray tracing.

In 2022, existing next generation gaming console can achieve a native 4k resolution 30 frame rate per second (fps), or dynamic 4k resolution 60fps, or 1440p 60fps in most of huge triple A games, some of them can even achieve a native 4k 60fps. While a personal computer (pc) with top level hardware can achieve native 4k 60+ fps with ultra-graphic setting.

In the last two decades, with the advance and popularization of the Internet, more and more online games appeared. Players are able to interact with other player even though they are in different regions. And more and more games have multiplayer mode, allowing players to join in as a member of a team against another group of players, or cooperative together [8]. Some games can even provide players with more socialization opportunities, such Animal Crossing: New Horizons, which is a game that allows players to construct their own island and exploring, crafting, fishing, talking to animal neighbors and most importantly, inviting friends to play together such as holding a birthday party or celebrate real-world festival in this video game.

3.2. VR video games in immersive aspect

Compared with traditional form of video games (console games and pc games), VR is able to fulfill more immersive experience when players playing VR games. When players playing traditional video games, they usually sit in front of monitor or TV, using a controller to control the main character in video games. However, VR is similar and different from traditional form of video games from different point of view. On the one hand, VR is also needing a pc or a gaming console to run the game, which means the headset of VR has the same function of other display equipment like monitor and TV. On the contrary, VR have plenty of features that traditional form of video games does not have, which makes it more immersive.

Firstly, VR headset is fully fit with human eyes, which means that VR can block all vision from real world, only the graphic of video games can be seen when VR headset is equipped, as a result, it can provide players with more realistic first perspective and multiple perspectives gaming experience, allowing players automatically switch perspectives in VR games [8]. As a result, players can gain similar perceptual experience in the virtual world as in the real world. Secondly, VR games have stronger fidelity because the environment and 3D models in VR games are 1:1 while traditional games might not, players will be more familiar with the virtual world. Thirdly, VR games are engaged with more interaction because VR games enables gesture tracking, motion sense and capture, allowing players to interact in VR games while moving real-world body such as swing a sword in VR games while players swinging their arms with their controller in their hands. Compared with traditional video games that provide splendid graphics, all these features in VR provide players with more realistic and immersive experience to make players to gain sense of reality in the virtual world.

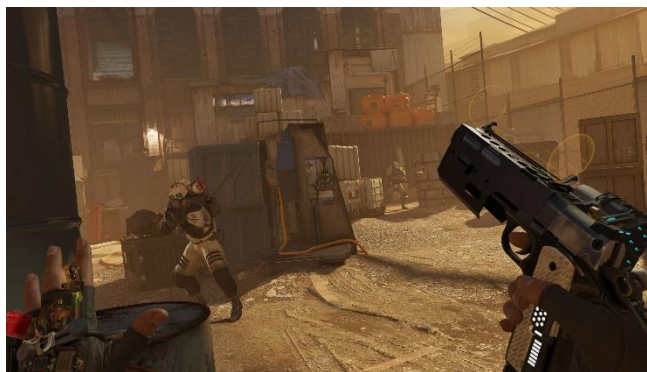


Figure 3. Schematic diagram of VR game scene

In March 23th, 2020, a VR game called Half-Life Alyx was released by Valve. It was not only a huge triple A game, but also a VR game which enables 360 degree surrounding sounds, and action outside games such as swinging, reaching, turning and ducking will be translate into the virtual world, and it has splendid graphics even as huge triple A games in consoles and PC (Though this game is launched on PC), and it have an about 8 hour game play for the main mission (standard time for a normal huge triple A games), it was a breakthrough in VR games [9]. And compared with Horizon Forbidden West, though both games have beautiful graphics, Half-Life Alyx made it possible to take players bodies into the virtual world instead of pressing buttons on a controller, which shorten the distance between players and characters thus providing more immersive gaming experience.

3.3. VR video games in socialization aspect

Another feature that VR have is socialization. Traditional forms of video games' effect on socialization are mostly limited, though players are able to socialize such as joining a party by accessing the internet, they are communicating behind screens. On the contrary, in VR games, players are able to build their own avatars realistically in the virtual world, while controlling them in the real world (Figure 4).

To be more specific, the reason why VR can be more socialize is depending some of features that VR have. First of all, because VR can block all sense of vision and audio in real world so that players can immerse themselves into the virtual world. And the use of horizontal positioning system to simulate visual angle, upgrading traditional plane display to a 360-degree panoramic display with high resolution quality, the visual angle changes with the direction of the head and the line of sight, and 360-degree stereo audio effect makes it more immersive. All these features contribute creating an immersive experience that no other form of video games' socialization can provide. Secondly and most importantly, in VR games, players can create their own human-like avatars, which makes them able to express themselves freely with speaking, motion, gestures and even facial expression. In traditional form of video games, though internet made it possible for people socializing in different spaces, typing and speaking are only options they have, which deprived of the interpersonal transmission of the sense of presence. In contrast, VR is more anthropopathic and social authentic.

The most obvious example is VR chat, compared with all other forms of game, this game does not have any level, any story, any splendid graphics... It only contains an environment that allow players creating their own avatar and chatting with each other. It uses multi-person audio, video and motion capture technology to dynamically restore the human entity image; and the creation of holographic scenes can achieve a high degree of realistic world. Surprisingly, in one year after VRchat was released, it was popular that achieved 1.5 million downloads, which proves that socialization is one of VR's feature.



Figure 4. Players build their own avatars realistically in the virtual world

3.4. Comparison

Compared with traditional video games in the form of console games and pc games. VR games have several advantages and shortcomings.

Advantages:

VR can provide player with more interactive gaming experience, character's movement is corresponded with player's movement which is easier for players substitute themselves into characters.

VR can provide players with more interactive socializing experience, making it possible for players to communicating with both verbal and non-verbal communication in the virtual world.

VR can provide players with more realistic gaming experience.

VR can provide players with more realistic socializing environment

VR can provide players with more immersive gaming experience.

Shortcomings:

Lack of huge triple A games while traditional video games' platform is able to provide plenty of video games with brilliant graphics.

Lack of socializing games with plenty content such as animal crossing.

The number of users is far less than users of traditional video games' platform, which cause VR's socializing environment is niche.

Less affordable. For example, Valve index VR Kit price is 999 US dollars while a next gen gaming console is 499 US dollars.

4. Analysis of limitations

There are still many problems in the interaction of virtual reality. For example, the interaction lacks authenticity, the difference between VR games and ordinary games is small, the advantages of VR media cannot be exploited, etc.

4.1. The Content is shallow and the gameplay lacks innovation

The construction of the virtual environment in the interactive content is very important. The real information of the virtual environment can provide the experienter with a higher sense of immersion, but at the same time, the combination of visual, auditory, tactile and other perceptual information in the virtual environment brings game designers a huge challenge. For example, in scene design, traditional games can limit the perspective of game characters to a certain range to reduce the workload of refinement modeling, but doing so in VR games will increase the sense of inconsistency. When the reality disappears in the virtual environment, it is difficult for the experienter to obtain the sense of existence in the virtual reality game [10].

The interaction between the experienter and the virtual environment is also a part of the VR interactive content. The term Avatar refers to the player of the experienter in the VR game, and it is

the carrier for the experienter to interact with the virtual environment. It can be the player's character model, a creature different from the player's body, or even a cartoon character. Avatar can also provide players with substitution through action mapping. Creating a sense of immersion in VR interactive content does not require a real physical environment. This is a topic that game makers often misunderstand.



Figure 5. VR video

In general VR works, such as the VR video of riding a roller coaster in Figure 5 on the right, the audience can control Avatar by wearing a VR device and then turning their heads to obtain a roller coaster experience from different perspectives, but other than that, there is no more interactive contents. Therefore, the audience gets a weaker sense of immersion.



Figure 6. VR chat

In the interactive VR game VR chat, see Figure 6 on the right. VR chat does not have a realistic picture, but its special feature is that Avatar can move freely in the game scene, and can have a dialogue with the surrounding players, and even dance through motion capture equipment, which greatly enhances the game's interactivity and Audience immersion.

The information that can be drawn from the virtual environment is not necessarily a perfect simulation of the real world, under certain compensation conditions. For example, an enhanced interactive experience, a sense of immersion in tasks, and social attributes can improve the quality of VR interactivity, instead of only taking into account the authenticity of the model which is shallow.

4.2. Experience limited by VR hardware

VR interaction can be divided into two aspects: the information input of the experienter 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. 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. A series of parameters such as the frame rate, resolution, and FOV of the display will also affect the experienter, causing discomfort (dizziness, headache, nausea, etc.), preventing players from playing for a long time.

When the experienter enters a VR world whose space is closer to the real world, and has a more acute sense of auditory space, the experienter put forward higher requirements, such as the upgrade of the game sound effect engine, the production of sound effects, etc., compared with ordinary 3D games, the sound effect design of VR is very important for related practitioners.

The operation logic of the input is not direct enough. VR controller is the most widely used input device at present. The VR controller has interoperability with ordinary controller, the learning cost is

low, and it can be easy to begin with. At the same time, there is a tracker on the VR controller that can map the user's movements into the virtual world. However, the input process of the VR controller is not to directly map to the actions of the experienter to the virtual world. There is still process of transformation. The experienter controls the interaction logic and existing input methods by pressing the buttons on the controller or turning the joystick.

VR gloves can be understood as an evolutionary version of the VR controller, which directly maps the hand movements of the experienter to the virtual character, which is more in line with human intuition, and even some existing expensive advanced equipment can pass the sense of touch in the game through. Electrical stimulation is fed back to the experienter to realize the combination of the virtual world and reality. VR gloves are one of the most excellent VR input methods currently without considering the factors of price and device adaptation.

5. Conclusion

This paper summarizes VR and its application in visual arts and video games, and analyzing VR's shortcoming. In conclusion, because immersion and interactivity are advantages of VR, thus VR is widely applied into visual art and video games. In visual art aspect, VR can not only apply in online exhibition, but also in tourism, giving users unique experience apart from the real world, eliminating limitations of time and space. In video games aspect, immersion and socialization are usually applied in VR games, giving players more realistic gaming and socializing experience in the virtual world. However, current VR technology is not advanced enough, the difficulty of constructing and designing a environment and more technological problems such as the unity of mechanical hardware output and human body are still remain to be solved. In further studies, the history of VR and its technological development, and how VR in different years engages with its users. And details of features of VR especially immersion and interactivity will be focused and deeply excavated.

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