Application of VR Technology in Games

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Abstract. At present, virtual reality (VR) technology is being used more and more widely and deeply used in the field of games, playing a role in different types of games, and generally improving the user experience. This paper summarizes the application of VR technology in different types of games, including the characteristics of VR technology and the advantages of VR games. In analyzing user experience in VR games, several factors were discussed, including involvement, immersion, presence, and device. The application of VR in different types of games was divided into serious games and electronic entertainment, with examples such as training, educational, medical, action, shooting, and rhythm/music games. Besides, two problems facing VR games were highlighted: the user satisfaction with virtuality and multidimensional perception, as well as the issue of dizziness. These aspects provide an overview of the subject's analysis and development trends. Finally, this paper discusses the hot spots and development prospect of the research topic.

Keywords: game, VR, immersive, interaction

1   Introduction

VR technology is a technology that uses computer technology to create virtual environments (VE), allowing users to immerse themselves in it for interaction and experience, believing that they are in another area [1]. It integrates a number of devices and can create vision, hearing, touch, smell and other perceptions [1]. In 1929, Edward Link created the Link trainer, the world's earliest flight simulator, which can simulate the flight movements of aircraft, and became a commercial flight simulation training program [2]. In 1956, cinematographer Morton Helg invented a simulator called Sensorama (patented in 1962) with 3D display, stereo, vibrating seat, simulated wind and smell. After several twists and turns, from the first headset of VR device Sutherland (1968) failed to get out of the laboratory, to the first commercial VR product eyephone, Until the 21st century, with the development of computer graphics and the progress of image processing technology, the immersion of VR products has been greatly improved, and VR technology has also been widely used in electronic entertainment, education and training, cultural heritage protection and transformation, medical and health care and other fields. According to a prediction by

IDC, the market for VR and augmented reality software would grow by 44 times, from 2.1 billion dollars in 2016 to 92.6 billion dollars in 2021 [2].

VR technology has sensory immersion, action authenticity and good interaction, and games are also highly interactive and virtual. That's why VR is inherently suitable for games. Research on the application of VR in the field of games is of great significance for the targeted and commercial development of the game industry, and for VR to provide more convenient and high-quality services for the audience.

At present, the research content of VR in the field of games is not comprehensive enough, and the application of VR in various types of games has not yet formed a system, which needs further analysis and discussion. This paper mainly introduces the advantages of VR games, clarifies the characteristics of VR after its application in games, and discusses the application characteristics of VR from the perspective of serious games and electronic entertainment respectively, and illustrates them with examples.

2   The user experience in VR games

The most intuitive advantage of VR application in games is reflected in the user experience. The quality of video games and the pleasure of the user experience of video games are influenced by a number of elements, according to previous polls [3]. The three main and direct factors that affect the satisfaction of the game user experience are involvement/engagement, immersion and presence [3].

2.1   Involvement

According to Witmer and Signer, involvement is a mental state in which processing time is devoted to the visual inputs shown in the VE [3]. Participation should also include interactions between the player and the game. VR technology connects the movement of the player's body to the game, thus enhancing the sense of engagement and deepening the player's experience.In an ongoing example, celvers-A Collaboration, the Learning Environment in VR (CLEVR) [4],The game-based structure, which has been linked to deeper learning, offers pupils a high degree of engagement with the concepts delivered in the VR world.The goal of VR games is to transform an often passive theme into an active, embodied experience [4]. It can be seen that games with VR technology can deepen users' experience through their spirit and action.For instance, When interacting with a virtual object in a VE, the hand will feel the weight of the object, have a real grasp, and can see the way the object moves at the same time [5].

2.2   Immersion

For the definition of immersion, Caglar Yildirim et al. concluded: Witmer and Signer subjectively believe that immersion is the attenuation of physical sensory input from the user's environment and the amplification of virtual sensory input generated from human-computer interaction [3]. However, Slater objectively believes that immersion refers to the objective fidelity of the virtual senses obtained in the VR system [3]. It

can be seen that the strength of immersion fundamentally depends on whether the VR system is real and attractive to the simulation of the scene. To make the user achieve the "as if really into another world" state, it is necessary to simulate and close to the real world as far as possible, which is undoubtedly a big advantage of VR games over ordinary plane games.

2.3   Presence

Presence refers to the user's "presence in the game." This is crucial for first-perspective shooting, action adventure, role-playing, etc. We all know that the fact that users do not exist in the game, but in the real space, the sense of existence is a kind of "cheat", if the scene created by the VR system is enough to "cheat" the user's brain, or to go back to the realization of participation and immersion. In addition, factors that can significantly influence the presence also include factors outside the platform [6].

2.4   Device

 VR technology is realized through devices, so it is also important to give full play to the performance advantages of devices and VR technology. Two technologies make up the VR gear that is currently on the market. To create a three-dimensional light path, the first form of VR equipment combines a mobile smartphone with the headgear that holds the phone. The depiction of the VR scene is constrained by the mobile device's processing power. The second category connects a high-performance laptop or personal computer to a headset with an integrated sensory processor. High-quality photographs may be produced in a comprehensive VR environment [7].

   One successful case is this: Users' displays on the HMD (Helmet Mounted Display) are far more mobile than those on desktop computers since they can be worn [3]. The user may perceive the environment in three dimensions and feel a feeling of depth in the virtual world (i.e., stereo vision) because to the HMD's capacity to display separate pictures to each eye. HMD also gives users the chance to track their head movements and location. By merely moving the head, the player may alter the game's perspective thanks to its tracking capability [3]. It shows that the device has an important impact on the realization of the "immersive" functions of VR technology.

3   Application of VR in different types of games

Before discussing the examples of VR application in games, the author divided the game into two parts according to the different purposes of the game： serious games and electronic entertainment.

3.1   Serious games

"Using amusement to advance government or business training, education, health, public policy, and strategic communication objectives is known as a serious game. It is a mental contest played with a computer in accordance with set rules. "[8].

Training by the government or by the enterprises. The game commissioned by the US Army: The U. S. Army, as a government game for training, has achieved good results [8]. And it's a big innovation in applying virtual scenarios to serious situations. In 2011, the US military launched the simulation system 一 VR military training system（DSTS）uses VR technology，it comes with a VR headset with 60 degrees of view，like serious games, it's purpose is training, and the essence is simulation. So it illustrates the great potential of VR technology to be used in games for military training.

EPICSAVE Lifesaving Decisions Is a sketch of the collaborative VR training games provided for caregivers (Fig.1). Anaphylactic shock signs are seen in a 5-year-old child. The girl's grandfather steps in as a bystander and questions the players' authority as they start their diagnostic procedures [9]. The game is highly interactive and can simulate real scenarios, largely solving the problem of serious emergency training.

Fig. 1. EPICSAVE Lifesaving Decisions [9]

Education games. Traditional education relies on language and action expression, while the authenticity and interactivity of VR technology can make many scenes that are difficult to describe to be displayed more directly and accurately to students. The application in the form of games will increase the efficiency of education. VR simulations that engage learners as explorers shift the focus from content acquisition to active inquiry [4]. Steam's language learning game, Mondly: Learn language in

VR, uses VR to build virtual scenes based on different languages players are learning. Players choose behaviors, such as dating, traveling, and there are different characters in the game to talk to them to learn. Players can switch between scenes and characters through a gamepad.In addition to deepening the immersion through space construction, the immersive design of VR technology in the application of educational games, the fun of its characters and the story background of the game also affect the appearance of the teaching effect. This VR game fully simulates the real life scene, provides convenient conditions for foreign language learning that is difficult to achieve in reality, and undoubtedly improves the learning efficiency. At the same time, taking the game as the carrier, it has a stronger attraction, and can enhance the autonomy of learners.

Medical simulation games. Medical simulation games are not only highly playable, but also have profound and serious implications. When VR is used in medical simulation games, it makes the authenticity of the game progress. Scenes created by VR allow players to immerse themselves in surgery, anatomy, and motion sensing devices to make the movements in the game real. For non-medical professionals, this can deepen the understanding of medical treatment, get a new life experience; for medical professionals, it has a stronger training significance.3D Organ on VR Anatomy is a VR anatomical atlas game. Players can manipulate blood vessels, organs, muscles, bones and other structures in the virtual space, and observe them from various angles. Humans want to know themselves, and VR medical simulations are undoubtedly more accessible, more convenient, more efficient, and more interactive than traditional human anatomy maps or real human specimens.

In short, VR in serious games mainly aims to simulate the scene, with high interactivity and high sense of reality. Compared with real training, it can reduce the training cost and threshold, and is more efficient and labor-saving.

3.2 Entertainment games

Table 1. 2022 PSVRGame download list top10 Sony's published

	US/Canada	type	EU	type
1	Beat Saber	rhythm	Beat Saber	rhythm
2	Job Simulator	simulate	Job Simulator	simulate
3	SUPERHOT VR	shoot	SUPERHOT VR	shoot
4	Creed:Rise to Glory	action	Creed:Rise to Glory	action
5	Swordsman VR	action	Sniper Elite VR	shoot
6	Astro Bot Rescue Mission	action	Swordsman VR	action
7	Rick and Morty:Virtual Rick-ality	action	Rick and Morty:Virtual Rick-ality	action
8	GORN	action	Batman:Arkham VR	puzzle
9	Batman:Arkham VR	puzzle	Arizona Sunshine	shoot
10	The Walking Dead:Saints & Sinners	action	Astro Bot Rescue Mission	action

In the list, there are 12 VR games in the US / Canada and the UK, and the author made a pie chart based on the proportion of different types of games (Table 1 and Fig.2):
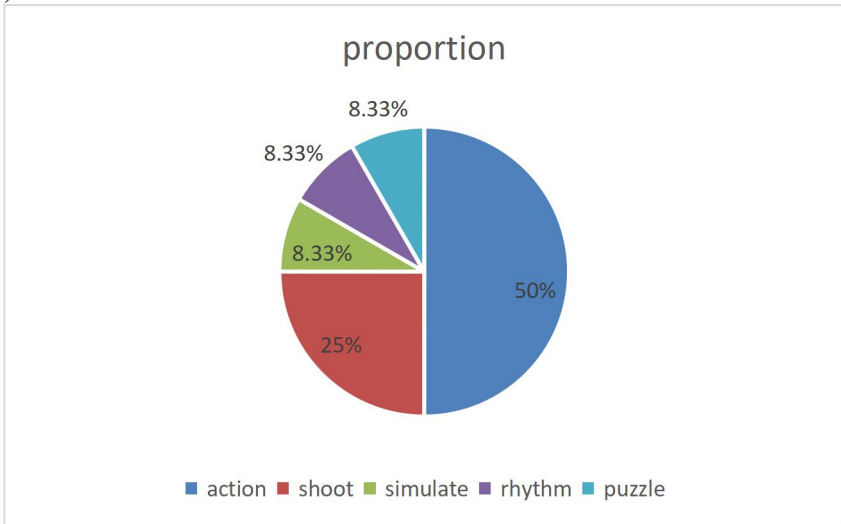

Fig. 2. Pie chart of the proportion of different games in the list (Original)

Action games &shooting games. According to the data, of all types of VR games, action games are the most popular, followed by shooting games. This has a lot to do with the characteristics of VR technology. The interactive function provided by VR technology significantly improves the expressive force of the game action, not only the visual effect from false to true, but also the player's action from false to true, which is undoubtedly a big difference from the games which do not use VR technology. Action games are naturally suitable for changing from flat to VR, and cannot be replaced by flat games.

The core gameplay of the game is simple, relatively fixed: aim + pull the trigger. Similar to action games, it is important to build a real scene to let the player quickly get into a state of tension tense quickly, which is more suitable for changing from flat games to VR games.

A virtual shooting action simulation system was developed by Yong Wu and colleagues utilizing the Vega framework and is based on intelligent VR technology. Finally, Vega establishes the viability of the system architecture by offering a productive operating environment for system development.Eventually their design can make the users satisfied [5]. This shows that VR action games or simulation systems have good effects and can break some of the real life restrictions on movement conditions.

In the study by Elena Kalina et al., 214 undergraduate subjects were asked to play a butterfly catch game using a Oculus GO (V1) VR headset and a 15-inch (diag) MSI laptop, the results show that,Participants who played in 3D VR environments often felt more present than those who played in 2D PC environments (Fig.3). Playing this

STEM game on a 2D PC display often produced a lower sensation of presence than playing it in a VR headset which has a greater immersion (Fig.4) [6].

Fig. 3. Screen shot from the VR headset [6]

Fig. 4. Screen capture of the interactive bar chart [6]

Shooting games. Rhythmic sound game itself has high requirements for visual and auditory feelings, and the multi-sensory and high immersive characteristics of VR technology are also suitable for application in rhythmic sound game.In the study reported by Orestis Georgiou, a VR rhythm sound game that controls symbols coming on the highway through two interactive gestures: clicking and swiping is introduced, and realizes aerial touch through ultrasonic technology. Generally speaking, rhythm games demand close synchronization between tactile, aural, and visual inputs [10]. VR's immersive and multisensory features have given rhythm games a new direction.

Not only for action games and shooting games, but also for such interactive entertainment, decryption, rhythmic sound game, for an interactive entertainment like games, puzzle game, rhythm and sound game and so on, all can achieve an immersive leap through VR technology.

4   Facing problems and development trends

Although the application of VR technology in games has achieved positive results, it still faces some problems.

4.1   The virtuality and multi-dimensional perception

For the current VR system, the degree of reality is still not enough, especially for the construction of realistic scenes, there is still not real enough, there is a strong visual virtual problem. Secondly, can not fully mobilize more senses, can not make every sensory simulation is real, will also lead to the decline of the sense of reality.In Yong Wu's study of Virtual Shooting Action Simulation System, the user satisfaction data results suggest that,The virtual and multi-dimensional perception satisfaction of that VR system is over 30%,explain that the virtuality and multidimensional sensing performance of that VR system need to be improved [5].

4.2   Dizzying problem

One disadvantage of VR games in applications is mentioned in the study of Caglar Yildirim et al: when VR does have certain negatives, such as the effect of cybersickness, which causes users to experience motion sickness when engaging with a VE , it also gives users a sense of complete control over their surroundings [3].

5   Conclusion

This paper analyzes the application of VR technology in the field of games, including the advantages of VR games over flat games, and analyzes different types of VR games according to the classification of serious games and electronic entertainment. Outlines the engagement, immersion, presence, and device needs of VR games. This paper summarizes and compares the application of VR technology in simulation games, educational games, medical games and action simulation and shooting.

   With the popularity of the game market and the continuous development of computer technology and image processing technology, the reality and immersion of VR games will be improved, the user satisfaction of VR games will be improved accordingly, and VR technology will also have considerable development in games. However, if VR games have high requirements for devices and price threshold without reducing the cost, the scope of the audience will be limited, and vertigo and other problems in the process of users also affect the experience and satisfaction, which need to be solved urgently.

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