

## Research on the Application of VR in Games

Siyuan Shen<sup>1</sup>, Jincheng Zhang<sup>2, \*</sup> and Zidi Zhou<sup>3</sup>

<sup>1</sup> Woodstock Academy, Connecticut, United States

<sup>2</sup> Beijing University of Chemical Technology Affiliated Middle School, Beijing, China

<sup>3</sup> Saddle River Day School, New Jersey, United States

\* Corresponding Author Email: liangaimei@feihe.com

**Abstract.** In the context of the popularization of the Internet and the rapid development of modern information technology, more and more advanced technical means have been applied to the design of game scenes, especially the development of virtual reality technology, which makes the design of game scenes more realistic, gives players a richer experience, provides power for the development of the game industry and creates more opportunities. As VR becomes increasingly popular, it is fundamentally changing players' engagement in digital environments, providing unparalleled realism and interactivity. Despite the potential, challenges such as motion sickness and hardware limitations still exist, affecting the user experience. This article delves into the historical evolution, various applications, and impact of VR on player engagement in gaming. It further explores how VR technology can promote immersion, user psychological and physiological responses, and shape its continued innovation for the future. By analyzing these aspects, this study provides insights into the role and future development prospects of VR in gaming.

**Keywords:** Virtual Reality; Gaming; Immersion; User Experience; Game Development.

### 1. Introduction

The gaming industry has witnessed constant evolution with technological progress, and Virtual Reality stands out as a groundbreaking innovation. VR technology allows players to immerse themselves in digital environments, enhancing gameplay and interactivity. The increasing popularity of VR gaming is primarily due to hardware advancements, like head-mounted displays, and software optimizations that enable lifelike simulations [1]. The appeal of VR lies in its ability to transport players into three-dimensional, interactive worlds that deliver realistic experiences. A major factor contributing to VR's growing importance in gaming is its influence on user experience. By allowing players to engage naturally with virtual environments, VR fosters deep immersion and cognitive absorption, resulting in heightened player engagement [2]. However, the widespread adoption of VR gaming comes with its own challenges, such as high costs, motion sickness, and the requirement for specialized equipment. Studies analyzing user satisfaction in VR gaming highlight that these challenges may impact overall gameplay experiences [3]. Despite offering high immersion, VR experiences do not always guarantee prolonged play sessions due to potential discomfort.

The physiological and psychological impact of VR gaming has also attracted substantial research attention. Comparative studies between VR and traditional screen-based gaming show notable differences in user engagement and stress levels [4]. Although VR provides a more intense and engaging experience, prolonged exposure may lead to fatigue and discomfort. Furthermore, research on gaming industry trends highlights the growing investment in VR technology, forecasting continuous growth and innovation within the sector [5]. As developers strive to address challenges like motion sickness, accessibility, and content diversity, VR gaming is poised to evolve further to meet user expectations.

This paper aims to trace the historical development of VR technology, exploring its evolution from early conceptual models to present-day implementations. It then investigates VR applications in gaming, emphasizing key benefits and challenges. Additionally, user satisfaction and engagement levels will be analyzed, offering insights into VR's influence on gaming experiences. Finally, the

study will discuss potential future trends in VR gaming, considering technological progress and market opportunities.

## 2. The Development History of VR

The origins of VR technology can be traced back several decades, with initial applications focused on military training and experimental research. In the 1960s, researchers introduced head-mounted display systems to simulate immersive experiences, with Ivan Sutherland's "Sword of Damocles" in 1968 marking one of the earliest breakthroughs. This development laid the groundwork for modern VR technologies.

During the 1980s and 1990s, VR gained traction across multiple industries, including gaming, medical training, and military applications. The introduction of arcade-based VR systems, such as the *Virtuality* arcade machines, signaled the first commercial attempts at VR gaming. However, technological limitations, such as low-resolution displays and high costs, hindered its widespread adoption during this time [1]. Motion sickness and lack of affordable hardware further slowed down mainstream acceptance.

The early 2000s witnessed renewed enthusiasm in VR due to advancements in computing power and display technologies. The release of consumer-grade headsets like Oculus Rift, HTC Vive, and PlayStation VR revolutionized the industry. These devices offered high-resolution displays, enhanced motion tracking, and intuitive interfaces, making VR gaming more accessible. Studies suggest that user acceptance increased as players experienced higher levels of immersion, driving growth in the VR gaming market [2].

In recent years, VR technology has continued to advance, incorporating wireless connectivity, haptic feedback, and eye-tracking capabilities to enhance user experiences. Research highlights the role of artificial intelligence and cloud computing in expanding the scope of VR gaming, enabling more dynamic and responsive environments [5]. These ongoing innovations indicate that VR gaming will become increasingly affordable, realistic, and widely adopted in the future.

As VR technology advances, its applications in gaming continue to expand, offering players richer and more engaging experiences. The following sections will explore VR's current utilization in gaming, its influence on user satisfaction, and the challenges that need to be addressed to ensure its long-term success.

Nowadays, major markets for Virtual Reality can be divided into education and Entertainment. VR games as a new market platform, might be very welcomed in the future. In the entertainment field, more and more devices exist through the time. Lots of video-gaming companies have entered in the motion control market. In the education field, there are three applications: *Newton World*, *Maxwell World* and *Pauling World*. They mainly focus on teaching students' physics, explore electrostatic forces and fields, and enables the user do visualize molecules in different forms.

## 3. The Application of VR in Games

The early concept of virtual reality can be traced back to simulation systems. Edwin Link invented it at the end of 1920 and used it to simulate vehicle systems. Over time, VR began to be applied to flight simulators and head mounted displays. Early head mounted displays used 3D visual, audio, tactile, and olfactory stimuli to enrich the viewing experience of 3D photography slides. In most cases, people use them to track head direction and create immersive experiments. Until 1968, the existence of the "ultimate display" advanced knowledge of visual reality, and Ivan Sutherland developed the hardware VR "Sword of Damocles". In the 1990s, people relaxed their rigid views on VR and accepted a broader definition of VR. It allows for the development and emergence of computer systems, which, when combined, can support real-time imaging of 3D environments that interact with navigation. The development of VR systems cannot be separated from the collection of technical hardware, including computers, head mounted displays, headphones, and motion sensing gloves. As

a VR system, it provides a more advanced way of learning knowledge. Therefore, VR may provide a huge market in the education sector. For example, some companies integrate VR into wearable devices and use it for military purposes.

At the same time, virtual reality has also been widely applied in the gaming field, developing various types of devices. The main types of VR include Kinect, Oculus Rift, and smartphones as input devices. By using specialized equipment to run Kinect, it can track skeletal images of people moving within the Kinect's field of view. The Oculus Rift DK2 is the latest development kit for the Oculus Rift. This device can render two different viewpoints for the left and right eyes respectively. Therefore, Oculus Rift can provide players with better graphics quality and gaming performance. However, since Oculus Rift is based on a right-handed coordinate system, when data from Oculus Rift is transmitted to DirectX 11 using a left-handed coordinate system, it needs to be corrected to compensate for differences. Another type of device is an input device, for example, KOS games use smartphones as input devices. Because of its built-in sensors, players' gestures and movements can be captured using only their mobile phones.

In addition to head-mounted devices, many interactive devices have also been invented to assist in their use. They are mainly remote-control devices, such as glove remote controls, joysticks, etc. Wired gloves are capable of measuring joints angles, pressure, tracking and haptic feedback. They use light and photo sensor to capture people's movement and gestures. Other gloves use an electric conductive ink and as the user makes movements, however, this kind of technology are worse than the fiber-optics wired gloves, but they are cheaper as well.

Dexterous Hand Machine is a more precise technology. Controllers are another form of controller, they are usually equipped with infrared sensors and gyroscopes to calculate angles, gravity, and distances. In the early days, Nintendo used the controller as a motion sensor.

Immersion is a major characteristic of VR games. Through high-resolution display, 3D sound effects, and precise motion tracking, VR games can provide players with a gaming experience that is highly similar to reality. For example, in "Black Myth: Wukong", the development team pays attention to the reproduction of details and authenticity, striving to shape a worldview full of Eastern mythological colors, successfully integrating modern technology into traditional stories, creating a mysterious and realistic game world for players, allowing players to experience different emotional fluctuations at every stage, thus achieving a highly immersive virtual reality experience for players. [6]

#### **4. Challenges and Prospects**

However, there are still some challenges in terms of VR gaming experience. Firstly, some players may experience discomfort symptoms such as dizziness and nausea after prolonged use of VR devices. Research has shown that the main cause of this symptom is the inconsistency between visual perception and brain perception. Secondly, there is the issue of device comfort. Despite continuous advancements in hardware technology, wearing head mounted devices for extended periods of time may still lead to fatigue. In the future, by optimizing hardware design and developing smarter interactive technologies, the user experience of VR games will be further improved [7].

VR games have not only had a profound impact in the gaming industry, but also demonstrated enormous potential in social, educational, and cultural dissemination. In terms of social interaction, VR games provide players with a brand-new way of interaction. For example, games such as "Rec Room" and "VRChat" allow players to gather, chat, and interact in virtual spaces, breaking spatial limitations. This virtual social form is particularly popular during the pandemic and has become an important way for people to interact remotely [6].

In the field of education, VR games are used to simulate historical events, scientific experiments, and vocational training. For example, Titans of Space popularizes astronomical knowledge to players through virtual space exploration. In terms of cultural dissemination, VR games provide a new way

to digitize traditional culture. For example, the Chinese developed VR DunHuang allows players to immerse themselves in the artistic charm of DunHuang murals. [8]

Although the virtual reality (VR) gaming market has shown great potential for development, it still faces many challenges at present. Firstly, the main issue is the technical bottleneck problem. Although VR technology has made significant progress in recent years, there is still room for improvement in terms of real-time graphics rendering, device portability, and battery life. For example, high-quality graphics rendering requires powerful computing power, and existing hardware devices often struggle to balance lightweight and portability while ensuring high frame rates. In addition, the battery life of VR devices also limits the long-term user experience, especially in wireless devices, making this issue particularly important. Secondly, public acceptance is another important challenge. The high equipment prices and lack of content are the two major obstacles that limit the popularity of VR games. Taking the high-end VR device "Valve Index" as an example, its price is as high as \$999, far higher than the price of ordinary game consoles. Especially for ordinary consumers, VR devices are still considered luxury goods. In addition, the quantity and quality of VR game content are relatively limited, making it difficult to meet the needs of many players. Although some well-known game developers have started to enter the VR field in recent years, overall, the content ecosystem of VR games is still not mature enough [9].

However, despite these challenges, the future development prospects of VR games remain vast. Cross platform interoperability is also one of the important directions for the future development of VR games. With the continuous integration of VR technology, players will be able to enjoy a richer gaming interactive experience. For example, future VR games may be integrated with computer devices, allowing players to interact with virtual elements in the real world and break the boundaries between virtual and real. This cross-platform interoperability not only enhances the fun of the game, but also provides players with more diverse ways of playing. Overall, although the VR gaming market still faces challenges in terms of technology and market acceptance, with the continuous upgrading of hardware devices, deep integration of AI technology, and the promotion of cross platform interconnection, VR games are expected to become one of the mainstream forms of the gaming industry in the future. With the continuous advancement of technology and the gradual maturity of the market, VR games will gradually move from a niche market to a mass market, bringing more immersive and diverse gaming experiences to global players [10].

## 5. Conclusion

The article explores the application of VR technology in games and its impact on user experience. VR has improved the interactivity of games and player satisfaction through immersive experiences, but it also faces challenges such as high costs, device discomfort, and insufficient content. VR games have significant differences in physiological and psychological responses compared to traditional games, and there is still a need to address technological bottlenecks and public acceptance issues in the future. With the continuous advancement of hardware and software, VR games are expected to become a mainstream form of entertainment and play a greater role in fields such as education, social interaction, and cultural dissemination. In the future, the deep integration of cross platform interoperability and AI technology may further drive the development of VR games, bringing richer and more diverse gaming experiences.

## Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

## References

- [1] Bian S J. Research on the Application of VR in Games. Highlights in Science Engineering and Technology. 2023.

- [2] Kari T and Kosa M. Acceptance and use of virtual reality games: an extension of HMSAM. *Virtual Reality*, 2023.
- [3] Shelstad W and Barbara S. Gaming on the Rift: How Virtual Reality Affects Game User Satisfaction. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 2017.
- [4] Vatsal R. An Analysis of Physiological and Psychological Responses in Virtual Reality and Flat Screen Gaming. <https://arxiv.org>, 2023.
- [5] Morgenroth T. Virtual reality in gaming. *Virtual-reality-in-gaming-industry*, 2023.
- [6] Li B. Research on the Application of Virtual Reality Technology in Game Design. *Toy World*, 2024, (10), 83-85
- [7] Boas Y A G V. Overview of virtual reality technologies. In *Interactive Multimedia Conference*. 2013.
- [8] Onyesolu M O, & Eze F U. Understanding virtual reality technology: advances and applications. *Adv. Comput. Sci. Eng*, 2011, 1, 53-70.
- [9] Radianti J, Majchrzak T A, Fromm J, Stieglitz S, & Vom Brocke J. Virtual reality applications for higher educations: A market analysis. *Proceedings of the 54th Hawaii International Conference on System Sciences*. 2021.
- [10] Li Z Y & Zhong X. Research status of gamified interaction methods in VR museums *Mechanical and Electrical Product Development and Innovation*, 2024, 37 (02), 207-210.