Proceedings of CONF-MLA 2024 Workshop: Securing the Future: Empowering Cyber Defense with Machine Learning and Deep Learning
DOI: 10.54254/2755-2721/110/2024MELB0111

# The Application of VR Technology in the Field of Gaming

**Taoze Ying**

Chaminade College Preparatory-High School, West Hills, CA 91304, United States

tying25@chaminet.org

**Abstract.** With the rapid advancement of Virtual Reality (VR) technology, its application in the gaming sector has introduced an unprecedented level of immersion for players. This paper aims to explore the integration of VR technology in game design and assess its potential and challenges in enhancing player experiences. The motivation for this research stems from the fundamental differences between VR and traditional games in terms of immersion, interactivity, and multisensory feedback. The paper provides an overview of the basic concepts and principles of VR technology, compares it with traditional gaming technologies, and discusses its role in delivering immersive gaming experiences, enhancing player interaction, and providing multisensory feedback, particularly in multiplayer online gaming contexts. Despite the rapid growth of the VR gaming market, high hardware costs, lack of content, and technical challenges remain significant barriers to widespread adoption. The conclusion of this paper underscores the significance and potential for future development of VR technology in the gaming field, while also identifying key areas for improvement necessary for mainstream acceptance.

**Keywords:** Virtual reality, game design, immersive experience, interactivity, multisensory feedback.

## 1. Introduction

Over the past few decades, Virtual Reality (VR) technology has gradually gained traction in the mass market, opening up new horizons in the gaming industry [1]. Through specialized hardware, such as VR headsets, this technology offers players an unprecedented sense of immersion and realism. This includes more immersive experiences, greater interactivity, and richer multisensory feedback. Since the inception of the VR concept in the early 1990s, despite the technical constraints that prevented early VR devices from widespread adoption, advances in computer graphics, sensor technology, and display technology have enabled VR devices to enter the consumer market [2]. VR games have become a significant component of the gaming industry and are beginning to showcase their unique appeal in areas such as career simulation and social interaction games.

Due to the high realism and immersion of VR games, they play a role in gaming that traditional games cannot replace. For example, in career simulation games, VR technology enables players to experience the working environments of professions such as doctors, firefighters, and pilots, simulating realistic scenarios and operations to provide a closer-to-reality experience. In social interaction games [3], VR technology creates a more authentic interpersonal interaction environment, allowing players to engage in face-to-face exchanges in virtual spaces, which is significant for enhancing interactivity and sociality among players. However, as VR technology continues to evolve, VR games face numerous challenges. Firstly, the high cost of hardware is a significant issue. High-quality VR devices are

DOI: 10.54254/2755-2721/110/2024MELB0111

expensive, limiting the reach of VR games. Secondly, the development process for VR games is more complex compared to traditional games, requiring additional technical support and development resources. Additionally, the use of VR technology raises concerns regarding user adaptability. Prolonged use of VR headsets can cause discomfort such as dizziness and eye strain, negatively impacting the user experience.

The study of VR technology in the gaming domain holds significant theoretical and practical value. Theoretically, this research deepens our understanding of VR technology and its application in game design, revealing the underlying scientific principles and technical characteristics. Practically, the study provides valuable insights for game developers, helping them leverage VR technology to design and develop more engaging game products. Furthermore, the research into VR games promotes advancements in related technologies, such as sensor technology, display technology, and ergonomic design, which can further enhance the quality and user experience of VR games.

Therefore, this paper aims to explore the specific applications of VR technology in the gaming field, analyze its advantages and limitations, and outline future directions. By examining existing VR game cases and trends, the paper delves into how VR technology transforms game design and player experience, and proposes strategies and recommendations to address current challenges. With ongoing technological advancements and market maturity, VR games are poised to overcome the challenges they currently face and offer players richer and more authentic immersive experiences.

## 2. Basic principles of VR technology

VR is a technology based on computer technology and specific hardware to generate a realistic scene. This technology brings the user a sense of immersion and interaction in a computer-generated immersive environment through visual, auditory and other sensory impacts. VR technology can be categorized into three types of VR: non-immersive VR, semi-immersive VR and fully immersive VR. First of all, semi-immersive VR is usually based on computers and cell phones, which are common electronic devices. Through the sensors and central processor and other parts of the electronic device, information is processed and the virtual scene is displayed on the screen of the computer or cell phone. Users can interact with the virtual scene through the touch screen or keyboard and mouse operation. Among them, on the cell phone terminal, users can manipulate their perspective in the virtual scene by holding the phone to move and rotate, etc. The advantage of this type of VR is that it is popular and requires less hardware, which allows more ordinary people to better understand and experience VR technology. But the immersion and interactivity that this VR technology can give to the user is weak.

Second, semi-immersive VR is immersively displayed through specialized equipment such as large curved screens or wrap-around projections. Compared with non-immersive VR, semi-immersive VR simulates a more realistic virtual environment through a more advanced screen, giving users a better sense of immersion [4]. However, like non-immersive VR, it relies on the processing technology of a computer or cell phone processor, and there are no substantial upgrades to the form of interaction, as the user can still only interact with the virtual environment by tapping on a touch screen, using a keyboard and mouse, etc. The last category is fully immersive VR.

The last category is fully immersive VR, which gives players a new audiovisual experience through its unique hardware, the head-mounted display. Head-mounted displays, in conjunction with their own headset or matching headphones, completely envelop the player's visual and auditory senses in the virtual environment, achieving total immersion in the truest sense of the word. At the same time, the headset contains more complete and sophisticated electronics, including a power-capture system and a more complex, larger number of sensors. This allows the technology to bring a whole new way of interaction to the player. Players can interact directly with the virtual environment through hand movements, abandoning the traditional way of interacting with cell phones and computers through touch screens or keyboards and mice. Fully immersive VR is the most advanced of the three types of VR technology, with the highest degree of immersion and interactivity, and is also the closest to the purpose and meaning of VR technology. But the excessive hardware requirements also directly lead to the limitations of this type of technology. Compared to the first two VR technologies that rely on traditional

DOI: 10.54254/2755-2721/110/2024MELB0111

hardware, the current technical research in the field of fully immersive VR is at a relatively immature stage. The clarity value of the head-mounted display is too low, resulting in a lack of scene fidelity, the immature development of sensors leads to sluggish and rigid interaction, and the production of fully immersive 3D scenes is far inferior to that of traditional computerized scenes, etc. These are the challenges faced by the field of fully immersive VR at present.

## 3. Comparison of VR and traditional gaming technologies

Compared with traditional game technology, VR technology applied in the field of gaming introduces significant differences in user experience, technical requirements, and market orientation. Firstly, from the perspective of user experience, VR technology offers a markedly enhanced sense of immersion and interactivity compared to traditional games. The head-mounted displays (HMDs) used in VR technology allow players to achieve a 360-degree first-person view, creating the sensation of being immersed in the virtual world. Additionally, through motion capture technology, players can interact with the virtual environment via natural body movements such as hand gestures, arm swings, or head turns [5]. For instance, players can grasp items in the game using the same motions they would employ in the real world.

Moreover, VR technology provides players with a genuine sense of spatial presence in the game. Players can move around or perform actions in real space, which translates to similar bodily movements in the virtual space. In contrast, traditional gaming technology is much more constrained. Taking computer gaming technology as an example, although players can achieve higher levels of scene fidelity through more powerful GPUs, the experience remains confined to a two-dimensional computer screen, lacking immersive three-dimensional visual effects. In terms of interactivity, most games still rely on traditional keyboard and mouse or gamepad controls. Although modern gamepads now incorporate haptic feedback and motion sensors to enhance the tactile feedback experienced by players during gameplay, this is still far from the level of realism provided by VR. In terms of spatial experience, the freedom of movement for players is notably restricted; players are typically seated and use a keyboard, mouse, or gamepad to play, which lacks the real-world physical engagement. However, VR gaming technology can cause significant discomfort when worn for extended periods, and the close-proximity display can exacerbate symptoms for players who suffer from conditions such as 3D motion sickness or photosensitive epilepsy [6,7].

From a developer's perspective, the development of VR games is often more complex and more costly. Developers must not only develop standard game content but also consider how to address issues related to immersion and interactivity to better adapt to VR-related hardware, thus enhancing the player's experience. Traditional game development, with more established game engines and development tools like Unity, significantly reduces development costs and difficulties.

In terms of market orientation, VR games have a higher market entry barrier, and the demand and user base are currently much smaller compared to the traditional gaming market. This is because VR gaming requires specialized hardware, specifically VR headsets, which tend to be more expensive due to the inclusion of high-performance graphics processors, high-resolution displays, various sensors, and more. Additionally, VR games also necessitate a certain amount of empty physical space to facilitate gameplay. Overall, the higher hardware costs and spatial requirements have resulted in a smaller audience for VR games, and the market size is not as extensive as the more mature and popular traditional gaming market [8].

The table 1 provides a comparison between VR games and traditional games in terms of immersion, interactivity, spatial experience, market accessibility, and the developer's viewpoint.

DOI: 10.54254/2755-2721/110/2024MELB0111

**Table 1.** The comparison between VR games and traditional games

| Category | Immersion and Interactivity | Sense of Space | Market Positioning | Developer's Perspective |
|---|---|---|---|---|
| VR Games | 360-degree head-mounted display, along with compatible headphones and controllers, providing stronger immersion and interactivity | Body movements replace keyboard and mouse operations, enhancing the sense of space and physical presence | Higher entry barrier, smaller user base | Less mature development tools and platforms, making VR game development more challenging |
| Traditional Games | Traditional 2D screens with keyboard and mouse operations, offering weaker immersion and interactivity | Posture remains unchanged, with only keyboard and mouse operations, limiting the sense of space | Lower entry barrier, larger user base | Mature development tools and platforms, with more established success stories and experiences |

## 4. Applications of VR technology in the gaming field

The development of VR technology has brought a whole new area to the gaming industry, namely VR gaming. In this section we will look at the three main applications of VR in gaming, which are immersive gaming experiences, player interactivity and multi-sensory feedback, and multiplayer online gaming.

Unprecedented high level of immersion is the characteristic of VR technology, but also the biggest selling point of the derived VR games. Compared to traditional games that limit their platforms to 2D displays, VR games completely immerse players in the game world through their unique hardware platform, the VR headset devices such as PlayStation VR, HP Reverb, etc., which use high-resolution LCD or even OLED displays and more advanced 3D surround sound, making the visual and auditory effects more Realistic. What's more, with the support of sensors, players can realize 360-degree observation without dead angle, which greatly improves the game's sense of reality and sense of immersion. Taking FPS games as an example, in the traditional first-person shooter "CS:GO", players can only use the keyboard and mouse to maneuver the character's movement, crouch, and aim and shoot. In VR versions of first-person shooters, such as "Half-Life: Alyx", also published by Valve, players can move their bodies through the real world, crouching and lifting the gun aiming to launch a series of actions to play the game. In contrast, VR first-person shooters greatly enhance the experience and realism, providing an excellent experience for the majority of shooters and weapons enthusiasts.

In addition to auditory and visual immersion, VR offers gamers an unprecedented level of interactivity and multi-sensory feedback. VR controllers are devices that gamers hold in their hands to control, and these devices are often equipped with haptic feedback, such as the controllers for the HTC Vive. As the player plays and interacts with objects in the game, the player can feel the weight and vibration of the objects through the controller [9]. In "Beat Saber" this kind of VR music game, VR game interactivity and multi-sensory feedback unique advantage can be played out to a large extent. Players listen to the music, along with the rhythm of the music swing chopping the oncoming square, the controller in the player cuts to the square in time to send vibration feedback, giving players a real sense of touch, together with the visual, auditory composition of a complete multi-sensory feedback system, so that players feel like they are really using the lightsaber to fight. For individual players, VR technology brings an interactive experience far beyond traditional games. In VR games, the player's body movements are closely related to the game operation, which is truly highly interactive.

In addition to bringing the ultimate immersion and gameplay interaction experience to individual players and single-player games, VR gaming is also notable for its use in multiplayer online games. After all, Internet-based virtual socialization is one of the important contemporary developments. In traditional online games, players interact only through typing and voice communication. In VR games, players can set their own appearance and image in the VR world, and when interacting with other players,

DOI: 10.54254/2755-2721/110/2024MELB0111

each other can see the virtual image set by the other, and communicate through voice and gestures and even facial expressions, which is undoubtedly more in line with the way of socializing in the real world. For example, Horizon Worlds by Meta (formerly Facebook) is a VR online social game. The platform allows users to create virtual characters and virtual worlds and invite friends into them, forming a virtual social network. However, with the development of virtual social games, some problems are emerging. For example, legislation on the virtual world is not perfect, and some people seem to regard it as a haven for virtual crime, with numerous scandals of "virtual molestation", which is a new form of cyberbullying.

Overall, the application of VR technology in the field of gaming has brought players an unprecedented experience, which shows great potential in terms of immersive gaming experience, high interactivity and multi-sensory feedback. It is believed that in the future, with the continuous development and improvement of related technologies and research platforms, VR games will continue to develop and bring players more and more rich and realistic gaming experiences!

## 5. Status and challenges of VR game development

In recent years, the VR gaming market has grown rapidly, driven by increasing popularity and the maturation of hardware and development tools. Statistics indicate that the global VR gaming market is expected to reach billions of dollars by the end of 2023, with a projected growth rate of over ten percent in the coming years. The release of next-generation head-mounted displays like Sony's PlayStation VR2, along with popular titles such as "Half-Life: Alyx" and "Beat Saber," signals the emergence of VR gaming as a genre that is moving from niche to mainstream, attracting more attention.

Despite the very bright market outlook, VR game development faces more technical difficulties than traditional games. First, the performance limitations of head-mounted displays are one of the main challenges that developers must overcome; VR games require high frame rates and low latency, which puts extreme demands on the graphics processor [10]. In addition, due to the high interactivity and multi-sensory experience of VR games, developers need to install a series of complex sensors. And due to the volume limitations of the head-mounted display, how to compress the volume and weight of these parts as much as possible and fit them into a compact head-mounted display is also a problem that developers have to study.

In addition, there are some unavoidable bottlenecks to the mass popularization of VR games. First of all, high-quality VR head-mounted displays are usually around $2,000-$3,000, and the high price of the hardware has become the threshold that prevents the public from accessing VR games. Secondly, the lack of VR game content is also a major problem. Although there are already some excellent VR games, the quantity and quality of games in the entire VR gaming field still cannot be compared with traditional computer games that have been developed for decades.

## 6. Conclusion

In summary, this paper introduces the development history of VR technology in games, analyzes the basic concepts and principles of VR technology, and discusses the application of VR technology in the field of games from three aspects: immersive experience, interactivity and multi-sensory feedback, and multiplayer online games. Overall, VR technology has made remarkable development in the gaming field, bringing players a brand-new gaming experience. However, despite the broad prospects of the VR gaming market, it still faces a series of challenges and bottlenecks, including the high price of hardware equipment and its own performance limitations, the difficulty of game software development and so on. But in the future, with the further maturation of the technology and the continuous development of the market, VR games are expected to break through a series of bottlenecks and become one of the mainstream entertainment as traditional games.

## References

[1] Mao, W. (2022). Application of VR technology based on image core in digital media art design. *China Media Science and Technology*, 12, 65-68.

DOI: 10.54254/2755-2721/110/2024MELB0111

[2] Fu, C., Zhang, G. (2022). Design and development of a VR shooting game based on cyberpunk style. *Computer Programming Skills and Maintenance*, 1, 151-153.
[3] Zhang, C. (2021). Discussion on the application of VR technology in art design. *Shoe Technology and Design*, 19, 72-74.
[4] Chen, Q., Zhong, J. (2021). The development issues of VR technology and China's game industry. *Dongyue Forum*, 42(9), 93-103 + 2 + 191-192.
[5] Zhao, J. (2021). A brief analysis of the application of VR technology in game brand communication. *News and Cultural Construction*, 12, 139-140.
[6] Tan, S. (2021). Application of VR technology in digital media art game design. *Materials Protection*, 54(2), 202-203.
[7] Li, F. (2021). Research on the development of 3D shooting games based on VR technology. *Automation Technology and Application,* 40(1), 163-166.
[8] Ji, H. (2019). Exploring the advantages and practical applications of VR technology in game design. *Computer Knowledge and Technology*, 15(33), 221-222.
[9] Tang, B., & Wang, Y. (2018). Exploring modern teaching methods based on VR technology from a gamification perspective. *Journal of Jilin Institute of Engineering and Technology*, 34(5), 70-72.
[10] Xu, Y., Zhou, J., Wang, D. (2018). The collision and integration of VR technology and game art. *Chinese Literary Artist*, 2, 167.