

# Research on the Development and Application of VR Technology in the Field of Games

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**Abstract.** As VR technology continues to advance as an emerging technology, an increasing number of enterprises are recognizing the extensive development and application prospects of VR technology. This article provides a summary of the development history and principles of VR technology. This paper thoroughly examines the utilization of VR technology in the gaming industry, analyzing the advantages, current status, and challenges associated with VR technology in this field. VR games offer the unique advantage of providing an immersive experience, allowing players to enter a virtual world distinct from reality. However, VR games still face the challenge of immature hardware technology and high costs. Cloud games and mobile games are encroaching on the development space of VR games. As hardware costs and research and development expenses decrease, the expectations and demands of game players continue to rise. As a result, VR games will have a broad application market in the future due to their unique immersive experience.

**Keywords:** VR Game; VR Technology; Virtual Reality; Application; Development.

## 1. Introduction

Virtual reality technology is characterized by immersion, presence, embodiment, free movement, shared space, and dynamic spectating. It offers users an interactive, realistic, and multi-sensory 3D experience. In the realm of game production and film and television entertainment, VR technology provides players with a lifelike visual experience and sensory enjoyment. The surge in VR equipment sales has fueled the momentum for societal advancement of VR and accelerated the rapid evolution of VR technology. The rapid advancement of VR technology reflects the gaming community's demand for enhanced visual aesthetics and anticipates the evolution of future gaming formats.

The VR technology is currently in its early stages, suggesting that it is still lacking maturity in various aspects. However, due to its distinctive and irreplaceable characteristics, VR holds significant potential for further advancement. VR technology is still emerging, indicating that it is not yet fully mature in many respects. In essence, given its unique and irreplaceable traits, VR offers ample room for growth.

## 2. VR Technology Overview

### 2.1. History of VR Games

In 1838, British physicist Charles Wheatstone introduced the concept of stereoscopic vision to the world. When individuals perceive visual stimuli, each eye captures a slightly different image, yet most of the field of vision overlaps. The higher centers of the brain then integrate these visual signals from both eyes in order to construct a comprehensive, three-dimensional image with depth. In 1952, Morton Heiliger developed the inaugural immersive virtual reality apparatus known as the Sensorama. This pioneering device integrated a range of sensory effects, including a 3D display, stereo speakers, olfactory stimuli, tactile vibrations, and airflow simulation to provide users with a multi-sensory experience beyond mere auditory and visual perception. In 1961, Corne and Byen developed the VR headset "Headsight", which incorporated a magnetic tracking system and a remote camera to correspond with head movements. This innovative device was capable of tracking head movements and projecting images onto separate screens for each eye. While lacking computer simulations, it bears partial resemblance to modern VR glasses. In 1975, Milon Kruger presented the inaugural



exhibition of “Videoplace” at the Milwaukee Art Center. The apparatus consists of computer-generated imagery, projectors, positional tracking technology, and cameras. Users are required to position themselves within a designated area in a darkened space, where their movements are captured by the camera and subsequently processed by the computer before being projected as a silhouette. When Jaron Lanier proposed the theory of VR in 1984, it raised the potential of using VR technology in interactive games. With advancements in computer hardware performance and software algorithms, VR has evolved from concept to reality. In response to market demands, the demand for VR has significantly increased across various industries, particularly in the gaming sector. In 1991, the Virtuality Group introduced “Virtuality”, marking the debut of the first VR game console. This groundbreaking development sent shockwaves through the industry. The system, capable of supporting networking and multiplayer gaming, is equipped with a suite of hardware including virtual reality glasses, a graphics rendering system, a 3D tracker, and an exoskeleton-like wearable device. In 1995, Nintendo developed the Virtual Boy, a game console that served as the inaugural home VR device. In 2010, Google unveiled the stereoscopic 3D mode of Street View, also known as the 3D Panorama Map. In 2016, a significant increase occurred in the development of virtual reality, with around 230 companies initiating projects in this field. Currently, VR technology is progressing alongside the concept of the metaverse.

## **2.2. Principle of VR Technology**

Virtual reality, abbreviated as VR, is a technology that integrates computer technology with 3D graphics and multimedia. It relies on external devices to provide sensory experiences in the virtual world, including visual, tactile, and olfactory perceptions. The most core part is computer simulation technology, which simulates feelings of users in reality, and allows users to bring their consciousness into the virtual world. Unlike traditional 3D films, VR offers a 360-degree panoramic interactive experience. VR head-mounted devices are capable of tracking users' eye movements and detecting their head movements, allowing the computer to render the scene in real time based on the user's point of view [1]. Furthermore, VR devices incorporate additional sensory sensing equipment, such as exoskeleton-style suits, to enhance user mobility within the virtual environment. These exoskeleton devices typically feature posture perception and simulated force capabilities to facilitate seamless interaction in the virtual world. Moreover, they are commonly utilized in conjunction with motion capture technology. Augmented reality technology utilizes computer technology to overlay experiences onto the physical world, thereby enhancing human sensory perception. In contrast, VR technology is designed to provide users with immersive virtual experiences that are distinct from actual reality. Overall, VR technology submerges individuals into a simulated environment.

## **2.3. Future of VR Game**

The utilization of VR technology is predominantly observed in the realms of game production and film and television entertainment. The amalgamation of VR technology with interactive and 3D technologies will empower game developers to fabricate visually immersive, highly interactive, and more realistic gaming experiences, thereby significantly augmenting the verisimilitude of games [2]. In the future, as computer technology continues to advance, there will be a steady improvement in the quality of graphics and rendering. Future VR devices are expected to support higher resolution and smoother rendering, resulting in more realistic models and immersive animations. While current VR experiences are limited to vision, hearing, and posture, it is anticipated that future VR technology may incorporate additional sensory experiences such as smell and touch. Furthermore, with advancements in recognition technology, VR tracking devices may offer more natural and intuitive interaction methods for users to engage with virtual environments seamlessly. The integration of cloud computing and big data streaming will significantly enhance the social and collaborative capabilities of VR games. This enhancement in social and collaborative capability reduces reliance on local device performance, thereby facilitating the broader market expansion of VR technology.

### 3. VR Game Application

#### 3.1. Regular VR Games

Half-Life: Alyx received widespread acclaim from players for its realistic models, robust lighting, intricate shadow details, and immersive physical interaction experience in the VR domain. These elements serve to blur the demarcation between the virtual and real worlds. According to data from the Steam platform in 2020, Half-Life: Alyx reached a peak of 42,858 concurrent online users. In 2021, the VR adaptation of Resident Evil 4 developed by Armature achieved sales exceeding \$2 million within the first 24 hours. Through the application of VR technology, the iconic Resident Evil franchise has been revitalized, offering enhanced immersion within the horror genre [3].

Players, as active participants, are not simply passive observers of the game's protagonist. In traditional games, players manipulate characters to complete missions and accomplish objectives within the constraints of actions predetermined by the game's developers. These regulations, such as utilizing "W" for forward movement and "S" for backward movement, are established to govern player actions. Players depend on screen feedback to assess their performance. The mode of expression is unidirectional, restricting players to perceiving events solely through the perspective of the character in the story. This parallels traditional films, where viewers occupy different physical locations but share a common visual perspective and narrative framework. However, in VR games, the player assumes the role of an interactive agent within the narrative, possessing the capacity to steer and potentially alter its course. This heightened level of interactivity engenders a palpable sense of presence and immersion for players, facilitating their deep engagement with characters and storylines. Consequently, it results in a more expansive narrative structure with multiple branches. Players are engaged in continuous interaction with characters and objects, thereby mitigating monotony and enhancing enjoyment. If the immersive game enables players to physically immerse themselves in both the virtual environment and narrative context of the game in real time and space, then VR games have achieved a pioneering integration of these two domains within cyberspace [4]. Therefore, certain gaming companies are endeavoring to integrate virtual reality technology into role-playing games and open world games.

The 360-degree panoramic perspective enhances the player's perceptual abilities of their surrounding environment. In flying action games, such as Ace Combat, virtual reality is applied to a first-person perspective mode, resulting in a more realistic effect. Players are able to physically raise and turn their heads from east to west in search of enemies, simulating the experience of piloting fighter jets. In the traditional third person mode, players are required to adjust the fighter's orientation and maintain direct focus on the target in order to engage with enemy aircraft. However, when utilizing VR equipment, players simply need to shift their gaze to alter their field of view, thereby easily locking onto the enemy aircraft target. From a VR perspective, players are able to experience a genuine sense of scale within the hangar and with respect to the fighter, transcending any semblance of a mere model toy and instead perceiving them as authentic structures and aircraft.

VR provides game producers with a wider range of options for game design. In comparison to traditional displays, VR technology brings the players' visual perspective closer to the virtual environment, allowing for enhanced concentration. This heightened level of observation necessitates an increase in the number of elements within the VR game scene. The increased freedom afforded by VR gaming presents a challenge for producers in terms of guiding player experience. Increased freedom of perspective does not necessarily result in heightened player awareness, particularly with regard to the elements that producers intend for them to perceive. Rather, it presents a challenge for producers in directing players' attention towards their intended focal points. Players often possess unique perspectives that may diverge from those held by producers. Furthermore, striking a balance between challenge and entertainment presents a significant hurdle for producers. Excessive limitations may lead to player disengagement and waning interest in game continuation. Conversely, increased freedom poses design challenges, particularly in terms of player guidance. Despite these

obstacles, VR technology offers unparalleled creativity and gameplay that can be applied to traditional games.

### **3.2. VR Serious Games**

In addition to its entertainment applications, VR technology has been increasingly utilized in diverse fields such as education and, more recently, healthcare. Don Carson, a former designer at Disney, draws on his expertise in environmental design within the context of theme parks. He stated that narrative components are integrated into the tangible environments traversed by visitors on foot or bicycle. This theory pertains to “Environmental Narrative”, where VR is utilized to construct a perceptive, immersive, and isolated environment that elicits emotional responses through virtual scenes.

Due to the unique environmental narrative capabilities of virtual reality, there is a growing recognition within the healthcare sector of its potential application in cognitive-behavioral therapy for addressing a range of mental health conditions [5]. Recent studies have illustrated the multifaceted applications of VR in healthcare, highlighting its capacity for analyzing clinical symptoms, facilitating cognitive rehabilitation, and guiding social skills training. VR has the capability to simulate scenarios that are unfeasible to replicate in real life, thereby enhancing the efficacy of patient rehabilitation. Furthermore, the utilization of VR equipment for rehabilitation not only improves treatment outcomes but also fosters greater patient engagement and enthusiasm. Additionally, VR offers a realistic clinical environment that enables surgeons to adequately practice procedures prior to actual operations, ultimately reducing surgical errors without posing any risk to real patients.

Similarly, VR immersive experiences have been implemented in museum settings and practical teaching environments. Incorporating game design elements into non-game contexts has the potential to transform mundane scenarios into engaging experiences. Users can expect to receive feedback and incentives in non-game situations that mirror those found in gaming, ultimately fostering active and voluntary participation. Virtual reality possesses the capability to reconstruct historical settings and facilitate users in engaging with immersive experiences transcending time, space, and geographical boundaries [6]. This form of immersive learning has the potential to revolutionize traditional pedagogical approaches and offer students an enjoyable, engaging, and efficacious means of honing their musical abilities. Furthermore, this method obviates the need for direct teacher oversight or regulation, rendering it particularly advantageous for at-home training and adaptable to a variety of contexts including self-directed study and remote learning [7]. The primary objective is to enhance visitors' perception of virtual identity, integrating the virtual identity of the environment and encouraging engagement in virtual interactions. In practical education, the reusable and traceable nature of virtual environments significantly reduces trial and error costs for students, allowing them to rapidly improve their practical skills. Consequently, many educational institutions are now incorporating VR technology into their curriculum.

## **4. State of the Art and Technical Challenges of VR Games**

### **4.1. State of VR Game**

VR has demonstrated significant potential for development in the public eye, with an increasing number of VR games leading to a growing user base. According to statistics released by the Steam platform in 2021, there was an 11% growth rate in new VR users, resulting in a total of 1.887 million new users and a monthly active user count of 2.7984 million for Steam VR. This indicates that the VR gaming ecosystem continues to thrive as new VR devices are continually introduced, which will also drive the production of VR games. In China, the consumer-level VR content market reached 27.89 billion yuan in 2021, with games accounting for 35% and reaching a market size of 9.76 billion yuan. VR technology is highly favored by various companies in industries with a demand to simulate real scenarios. Specifically, VR enables learners to immerse themselves in situations or setups that

would otherwise be inaccessible due to security, cost, size, and other constraints. As a result, VR finds widespread application in education, scientific research, and other fields.

#### **4.2. Challenge of VR Game**

The emergence of the metaverse concept has given rise to numerous VR user experience stores, yet these establishments have proven to be transient [8]. This phenomenon suggests that VR game players remain a minority within the broader gaming population, likely due to the continued high cost of VR devices. The prohibitive pricing may deter many potential players from engaging with this technology, despite their interest and willingness to participate in VR gaming experiences. Compared to traditional phenomenon games, the VR world still lacks the richness found in traditional games. The current VR market has yet to fully satisfy simulation needs, primarily due to the high level of difficulty in creating VR games and the limited content available in current VR offerings. In addition to the unique immersive experience offered by VR, VR games currently lag behind traditional action games in terms of content. Whether on a portable device or an all-in-one system, there is a lack of compelling content that truly engages players.

The VR gaming model is currently facing competition from other types of games, particularly mobile and cloud-based games. Both mobile and cloud gaming options alleviate the hardware requirements for players, as they only need a terminal with a screen to access and play these games, thus significantly reducing the entry threshold. Consequently, individuals who are not equipped to engage in VR gaming may opt for mobile or cloud-based alternatives. Mobile games continue to maintain their dominance in the market, while numerous gaming companies are actively pursuing the development of cloud gaming projects. This prevailing market phenomenon may potentially diminish the incentive for game makers and companies to invest in the development of VR games.

The current VR hardware does not sufficiently meet the requirements for simulating teaching environments in many serious games. As a result, most experimental projects in universities and research institutions continue to rely on real environments unless absolutely necessary. In certain domains, such as medical training and physical therapy, the real-world practices that achieve the same effect are often considered superior and more cost-effective compared to the virtual practices offered by VR. However, in other areas like architecture and design, VR technology has proven to be incredibly useful in simulating environments and testing designs before they are physically constructed. Therefore, while all walks of life are actively applying VR technology in various capacities, it is important to note that the proportion of VR application in all walks of life is not yet the majority. This may be due to factors such as cost, accessibility, or simply a preference for traditional methods in certain industries. Overall, it is clear that VR technology has made significant strides in its applications across different fields but still has room for growth and further integration into everyday practices.

While VR technology holds significant potential in addressing the issue of sedentary behavior among young individuals, it is important to note that VR devices may pose greater harm to ocular health compared to traditional displays. Prolonged use of VR has been associated with an increased risk of myopia, eye fatigue, and potential damage to the retina. The integration of a gravity sensing system and visual effects in VR glasses can induce a sensation of weightlessness in users, leading to symptoms such as vertigo and nausea. This underscores the critical importance of ensuring optimal comfort provided by VR equipment. The current hardware of VR equipment is evidently inadequate. The monitoring protocols for the physical well-being of VR game participants are still in need of further development. However, research has indicated that EEG presents a viable objective method for evaluating VR experiences, with potential to replace the lengthy and imprecise subjective evaluation methods in the future [9].

### 4.3. Prospect of VR Development

Despite the numerous limitations of VR technology, its unparalleled immersive and sensory experience presents vast opportunities for further development. The advancement of cloud technology and streaming media is also poised to drive the evolution of VR technology, with traditional resource storage transitioning to the cloud. Many gaming companies are now exploring strategies for managing the substantial volume of resources required for VR [10]. The successful implementation of 5G technology in China has provided a significant boost to the development of VR technology. The integration of 5G and VR technologies facilitates cultural exchange and enhances the experience of sporting events, creating an immersive platform that combines visual display, auditory communication, performing arts, and social interaction for audiences. This convergence blurs the line between reality and virtuality, expanding users' sensory experiences and lifestyles [11]. Hence, in contrast to augmented reality, VR technology is primarily focused on creating immersive virtual environments that have the capability to transport users to entirely new worlds and experiences. By harnessing advanced graphics and interactive technologies, VR provides users with the opportunity to explore and interact with these virtual worlds in ways that are not feasible in reality. This emphasis on generating alternate realities distinguishes VR from AR, which primarily enhances the real world with digital overlays. Consequently, VR has the potential to offer users experiences that surpass what is achievable in the physical world, thereby opening up new possibilities for entertainment, education, training, and beyond.

## 5. Conclusion

Since the late 19th century, there has been a longstanding aspiration for virtual reality, which is now progressively materializing. The rapid advancements in computer technology have propelled the emergence and ongoing development of VR technology. Currently, VR technology encounters challenges associated with immature hardware and high production costs, which have also contributed to a limited market development for this innovative technology. However, with the advancement of science and technology, an increasing number of emerging technologies can be integrated with VR, presenting new opportunities for the field. This is particularly evident in the gaming industry, where there is a continuous push for higher quality games and a growing demand for diverse gameplay and increased freedom. Players are in search of experiences that deviate from and transcend reality, providing them with an opportunity to escape and indulge. The advancement of technology is expected to result in reduced costs, which will drive the continuous evolution of VR technology and VR games by meeting the increasing expectations of players.

## References

- [1] S.T.Luo, Talk about the principle of VR display technology, Inner Mongolia Coal Economy, 2019(16):58+89.
- [2] J.M.Liu, X.H.Kang, Discussion on the status quo and development Trend of VR Virtual Reality in China, Research on Transmission Competence, 2020,4(13):188+190.
- [3] Z.H.Xu, VR gaming: The future is full of possibilities, China Electronics News, 2022-11-08 (005).
- [4] Y.Gao, The performability of immersion game and virtual reality game, China Book Review, 2024(05):101-107.
- [5] Miranda B., Rego P.A., Romero L., Moreira P.M., Application of Immersive VR Serious Games in the Treatment of Schizophrenia Negative Symptoms, Computers, 2024;13(2):42.
- [6] Z.Y.Li, X.Zhong, Research Status of Gamification Interaction in VR Museum, Development & Innovation of Machinery & Electrical Products, 2024,37(02):207-210.
- [7] Pesek, M., Hirci, N., Žnideršič, K. et al, Enhancing music rhythmic perception and performance with a VR game, Virtual Reality 28, 118 (2024).
- [8] Z.Li, Gaming hardware market diversification - VR prospects, China Business, 2023-06-05.
- [9] Škola F., Rizvić S., Cozza M., Barbieri L., Bruno F., Skarlatos D., Liarokapis F., Virtual Reality with 360-Video Storytelling in Cultural Heritage: Study of Presence, Engagement, and Immersion. Sensors, 2020; 20(20):5851.
- [10] H.L.Huang, Z.W.Zou, The Method for Cloud VR Resource Storage Based on the Interest Measure, Science & Technology Information, 2023,21(16):43-50.

[11] J.X.Li, Mobile cloud VR - Enabled by Technology - Opens the era of cloud life, China Press and Publication News, 2022-03-29.