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The Application Prospects of Virtual Reality (VR) and Augmented Reality (AR) Technologies in the Sports Industry - Taking Winter Ice and Snow Events as an Example

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Abstract. With the continuous advancement of technology and the expansion of application scenarios, both AR and VR have broad development prospects. Based on the increasingly mature technology, can VR and AR technology be brought into sports, what role can they play in various sports projects, and what prospects do they have in the sports industry. In winter sports, heavy competitive events, and many training events, athletes can simulate training anytime and anywhere to understand their opponents. In theory, promoting VR and AR into the sports industry can bring heavy competitive sports and winter events to the masses, allowing more people to experience the charm of sports more accurately and intuitively. The application of VR and AR technology in the sports industry, especially in winter ice and snow events, not only demonstrates its strong potential, but also heralds new directions for the future development of the sports industry. Through these technologies, athletes have gained more efficient training methods, while audiences can also enjoy a more immersive and interactive viewing experience. Despite some technological and market challenges, with the continuous advancement of technology and the expansion of application fields, the role of VR and AR technology in the sports industry will become increasingly significant.

Keywords: VR Technology; AR Technology; Education Development; Economic Growth; Ice and Snow Sports.

1. Introduction

Reality (AR) is a technology that calculates the position and angle of camera images in real-time, and adds corresponding virtual content such as images and 3D models. AR uses computer technology to overlay virtual information onto the real world, thereby achieving "enhancement" of the real world. Virtual reality (VR) is a more immersive technology that isolates the external environment through head mounted devices, allowing users to fully immerse themselves in computer-generated 3D virtual environments. This technology can provide visual, auditory, and even tactile experiences similar to the real world, making people feel like they are there.

The current AR technology is widely applied in fields such as education, healthcare, and tourism. For example, in the field of education, students can intuitively understand complex concepts or the internal structure of machines through AR technology, and in the medical field, doctors can use AR technology for surgical simulation or remote assistance; In the field of tourism, tourists can learn about the historical and cultural background of attractions through AR guided tours, while the application scenarios of VR technology are more extensive, including games, film and television, education, industrial design, and other fields [1]. In the fields of gaming and film, VR can provide immersive experiences, allowing users to fully immerse themselves in the virtual world. In the field of education, VR can be used for simulating experiments or reproducing historical scenes. In the field of industrial design, VR can be used for product modeling and simulation testing. However, there are still shortcomings. The advantage of AR technology lies in its close integration with the real world, which can provide more intuitive and practical information. Meanwhile, due to the fact that AR technology does not require a completely closed user's field of view, it is more flexible and convenient in practical applications. However, the difficulty of AR technology lies in how to achieve perfect

integration of virtual content and real environment, as well as how to ensure real-time performance and stability. The advantage of VR technology is that it can provide a fully immersive experience, making users feel like they are there. This technology can bring users stunning visual and auditory effects, as well as a more authentic interactive experience. However, VR technology requires expensive equipment and professional developers, and may also cause discomfort such as dizziness to users.

With the continuous advancement of technology and the expansion of application scenarios, both AR and VR have broad development prospects. Based on the increasingly mature technology, can VR and AR technology be brought into sports, what role can they play in various sports projects, and what prospects do they have in the sports industry. In winter sports, heavy competitive events, and many training events, athletes can simulate training anytime and anywhere to understand their opponents. In theory, promoting VR and AR into the sports industry can bring heavy competitive sports and winter events to the masses, allowing more people to experience the charm of sports more accurately and intuitively.

2. Literature Review

In recent years, the application of artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and other digital technologies in ice and snow sports and the ice and snow industry has attracted widespread attention. These technologies not only improve the training efficiency of athletes, but also promote the popularization of ice and snow sports and the development of the ice and snow industry. This article reviews relevant literature and explores the multifaceted impacts of these technologies on empowering ice and snow sports and the ice and snow industry.

Firstly, the impact of artificial intelligence on ice and snow sports, particularly in the field of ice and snow education and training [2]. AI technology can break through the limitations of factors such as venue, equipment, and weather, assist in offline practical teaching, and lower the entry threshold for ice and snow sports. For example, due to the high cost of indoor ice rinks, curling is difficult to promote on a large scale. This paper has built experimental teaching platforms based on curling robots, including digital curling, table curling, and land curling, through digitization, miniaturization, and ground-based methods. The establishment of these systems has made the promotion of ice and snow sports more popular and scientific, laying the foundation for cultivating more ice and snow sports talents.

Secondly, the introduction of digital technology has brought innovative production methods, promotion methods, and opportunities to the ice and snow industry [3]. The application of digital technology in the field of ice and snow equipment manufacturing is particularly significant, with the development of ice and snow experience products, ice and snow expansion tourism products, and new ice and snow cultural products. The application of these technologies not only improves the quality of products and services, but also drives the overall development of the ice and snow industry chain. Through digital technology, the ice and snow industry has achieved improved production efficiency, improved service quality, and optimized user experience, promoting innovation and sustainable development of the industry.

Once again, the application of virtual reality technology in ice and snow entertainment sports, as a representative experience project in winter tourism, has attracted much attention [4]. Promoting ice and snow entertainment sports through digital technology can meet the entertainment needs of more enthusiasts and reduce travel time and financial costs. The highly simulated visual and tactile effects have made ice and snow entertainment projects more diverse and rich, providing strong support for the innovative development of the ice and snow tourism industry.

In addition, in recent years, China's ice and snow economy has flourished. Since the beginning of the new snow season, China's ice and snow tourism has attracted widespread attention, and the ice and snow economy has released tremendous growth momentum [5]. During the 2023-2024 ice and snow

season, the number of ice and snow leisure tourists in China is expected to exceed 400 million for the first time, with revenue expected to reach 550 billion yuan, injecting new vitality into the local economy and driving employment and infrastructure construction.

Finally, with the application of VR technology in the Olympics, VR technology has continued to develop since its first use at the 2016 London Olympics [6]. During the 2018 Pyeongchang Olympics, Intel provided 360 degree panoramic video viewing and VR live streaming services through True VR technology. The application of these technologies not only enhanced the viewing experience for viewers, but also provided new means for the dissemination and promotion of the event.

However, its shortcomings are that the technology and equipment costs are relatively high. VR/AR technology requires professional hardware equipment and software support, and the initial investment and maintenance costs are high [7]. This may be a significant burden for many schools, communities, and ordinary families, limiting the popularization and application of technology. Although VR/AR technology can save costs in the long run by improving efficiency and reducing on-site training, there is still significant financial pressure in the short term

Through reviewing relevant literature, it can be seen that the application of artificial intelligence and digital technology in ice and snow sports and the ice and snow industry has shown significant advantages and potential. Although VR/AR technology has great potential, its popularity in ice and snow sports is still limited. This is mainly due to insufficient public awareness of this technology, as well as a lack of widespread promotion and publicity. VR/AR technology may face the problem of poor user experience in practical applications. With the widespread application of VR/AR technology in ice and snow sports, athletes and ordinary users may gradually become dependent on these technologies. Legal and ethical issues: The application of VR/AR technology may raise legal and ethical concerns. For example, when using virtual images and scenes, disputes over copyright and intellectual property may arise. Firstly, developing more economical device versions or providing financial assistance programs to help schools and communities acquire these technologies can increase government and business investment. In the future, with the continuous development and improvement of technology, artificial intelligence and digital technology will play a more important role in ice and snow sports and the ice and snow industry, promoting high-quality development of the industry.

3. Case Restoration: User Experience Effectiveness and Application Bottlenecks of Virtual Reality and Augmented Reality Technology in Ice and Snow Projects

3.1. Development and Origin

Virtual reality technology originated from science fiction novels and was later commercialized by game developers such as Nintendo. After years of development, VR technology entered its first year in 2016, with major hardware giants launching consumer grade products and exploring the application of VR/AR in sports. In the early days, VR/AR was mainly used in scenarios such as visual effects improvement, cognitive assistance, and information visualization, such as advertising and marketing, education and training, and healthcare.

3.2. Ice and Snow Projects and Current Status

In recent years, with the development of technology, VR/AR has begun to enter the field of ice and snow sports, used for training, teaching, and popularizing ice and snow sports. The integration of technology in ice and snow sports is a domestic application example [8]. In China, VR technology has been used for skiing training and teaching, achieving cross season and cross regional ice and snow experiences through simulators. For example, Xingtai City in Hebei Province has used VR devices to carry out ice and snow sports teaching, promoting nearly two million people to go ice and snow [9]. Internationally, many ice and snow sports powerhouses have also adopted VR/AR technology to

improve the training effectiveness of athletes, such as training skiers by simulating different ski conditions

3.3. User Experience and Venue Simulation

The user experience and initial results have been widely accepted by users. Villagers who are new to VR ski carts have expressed that the VR skiing experience is very exciting and similar to the real skiing experience, which has a positive effect on popularizing knowledge of ice and snow sports. The establishment of VR ice and snow classrooms in primary and secondary schools allows students to learn ice and snow sports skills in a virtual environment, enhancing their interest and effectiveness in learning. Improving training effectiveness through professional training optimization, VR technology provides an immersive training environment for professional athletes, which helps to enhance training quality and efficiency. For example, VR skiing simulators can simulate various skiing scenes to help athletes adapt to different competition environments.

3.4. Technical Parameters and Advantages

In terms of safety and controllability, using VR devices for training can reduce the risk of accidental injuries during actual training. At the same time, different parameters can be set to control the difficulty of training and break through regional limitations [9]. Through VR/AR technology, snow and ice sports can also be easily learned and experienced in southern areas with less snow, promoting the popularization of ice and snow sports nationwide and the enthusiasm for public participation. With the promotion of VR ice and snow sports, more and more people are participating in ice and snow activities.

3.5. Viewing Experience and Visual Perception

Enhancing the viewing experience: Through VR technology, viewers can enjoy an immersive viewing experience, not only being able to watch the game from multiple angles, but also experiencing a tense atmosphere and exciting moments similar to those on site [10]. For example, in the Beijing Winter Olympics, VR technology was used to provide a free perspective and 360 ° playback, allowing viewers to capture every exciting moment of the competition more comprehensively.

3.6. Integration of Sports Training and Industry

VR and AR technology can provide simulated ice and snow environments and tracks, helping athletes train in non-snow seasons or places far away from ice and snow fields. This efficient training method can increase the number of training sessions, help athletes better master skills and prepare for competitions, and promote talent cultivation. Through VR simulators, athletes can be trained in both theory and practice, especially in complex skills training. VR and AR technologies make ice and snow sports no longer limited by geographical and climatic conditions, which also promotes the development of ice and snow sports equipment and related service industries, and promotes industrial integration and innovation.

3.7. Promotion and Maintenance

The purchase and maintenance costs of VR and AR devices are relatively high, which limits their popularity among ordinary consumers and their application in small training facilities. Creating realistic virtual ice and snow environments and tracks requires complex technical support and a large amount of data processing, which puts high demands on technical teams. High quality VR content production requires professional skills and creativity, and content updates and maintenance are also a continuous challenge. Long term VR use may cause users to experience dizziness or other discomfort, affecting the user experience. Although VR and AR provide new training and viewing methods, traditional training methods and viewing habits are still the main forms, and the promotion of new technologies takes time.

4. Driving Factor Analysis: The Internal Logic, Technical Challenges, and Driving Factors of Applying VR and AR Technologies to Ice and Snow Projects

4.1. Cost Input and Scale

In terms of technical costs, the research and manufacturing costs of VR and AR devices are relatively high, which makes the initial investment large and may limit the popularization and widespread application of these technologies. Maintaining and upgrading these high-tech devices also requires corresponding technical support and financial investment, which may be a burden for some small-scale application scenarios.

4.2. Technical Complexity and Adaptation

The implementation of VR and AR technology requires specific technical support and professional talents, which may limit the wider application of technology in ice and snow sports. The complexity of this technology lies not only in the construction of equipment, but also in the creation and maintenance of content, which requires continuous technological innovation and content updates. Although VR and AR technology provide new ways of experience, user acceptance and adaptability may affect its popularity. Some users may avoid using VR devices due to motion sickness or discomfort during the use of technology, especially in sports scenes.

4.3. Venue and Equipment

Although VR technology allows users to experience ice and snow sports even without snow, the authenticity and fun of the experience are still limited by the performance of existing technology devices. Virtual reality cannot fully replicate certain dynamic sensations in real skiing, such as changes in wind speed and temperature, which may affect the overall realism of the experience.

4.4. Safety and Health Issues

Health issues that exist in VR experiences are also one of the factors that restrict their long-term use, such as visual fatigue, dizziness, etc. During VR skiing and other experiences, the slight delay between machine response and user movements may also pose safety issues.

4.5. Driving Factors and Applications

The national policy supports the government to actively promote the development plan of ice and snow sports, provide policy and financial support, popularize the application of VR and AR technology in ice and snow sports, and increase market demand. With the increasing demand for healthy sports activities, especially among young people, the exploration and application of new sports experience methods are also constantly expanding.

4.6. Industrial Development and Demand

With the hosting of major sports events such as the Winter Olympics, it is necessary to use high-tech methods to enhance the viewing experience and training efficiency. The promotion of VR and AR technology can further demand and develop, and with the increase in market demand and people's demand for healthy sports activities, especially among young people, the exploration and application of new sports experience methods are constantly expanding. With the development of international competitions and technology exchanges, China's VR and AR technology has gained an international perspective, further promoting the application of these technologies in ice and snow sports.

5. Theoretical Extraction: Future Prospects of VR and AR Technologies in the Sports Industry (How to Break Through Technological Bottlenecks)

5.1. Technological Innovation and Development Technology

With the continuous maturity of VR and AR technology, the cost of related devices is gradually decreasing. The future development focus should be on optimizing key technologies such as near eye display technology and rendering processing technology to improve device performance and user experience, while reducing production costs. At the same time, establishing standardization and mass production industry standards can further reduce equipment manufacturing costs.

5.2. Content Innovation and Diversification

In order to enhance the attractiveness of VR and AR technologies, it is necessary to develop more diverse and rich content. This includes application directions such as virtual experiences of sports competitions, sports skill training programs, and virtual sports coaches.

5.3. Expanding Scope and Cooperation

Collaborate with sports organizations, educational institutions, and health organizations to jointly develop application content that meets practical needs. This collaboration can provide more authoritative and professional sports training content, while also expanding the application scope of VR and AR technology in the sports field.

5.4. User Experience and Health Considerations

In order to enhance user experience and reduce health risks, future VR and AR devices need to be more comfortable and safer. This includes reducing device weight, optimizing design to accommodate different user groups, and increasing user health monitoring capabilities. Developing more advanced display technologies and faster response times to address dizziness and visual fatigue caused by long-term use of VR devices to provide a more natural and comfortable user experience. Multi industry integration and innovative applications are expanding application scenarios. In addition to traditional sports training and viewing, VR and AR technologies can also be applied to sports medical rehabilitation, sports education, and mass fitness, developing new sports application models and promoting innovation and development in the entire sports industry.

5.5. International Cooperation and Global Market Expansion

By collaborating with top technology research and development institutions and sports organizations abroad, introducing advanced technology and management experience, exploring international markets, and using international sports events as display platforms to promote mature VR and AR applications in China, these international platforms can enhance the international visibility of technology and expand overseas markets.

6. Theoretical Framework Construction: Innovative Positioning of VR and AR Technologies in the Sports Industry and Solutions to Technological Challenges

6.1. Role Positioning

By providing an immersive viewing experience, VR and AR technology enhance the attractiveness and viewing value of sports events by making the audience feel as if they are in the field. For example, through VR devices, viewers can watch the game from a 360-degree perspective, and even experience the tension and speed of the game from the perspective of athletes.

6.2. Innovative Methods and Experiential Sports Training

VR and AR technology provide athletes with new training tools and methods, such as simulating environments and opponents, helping athletes improve their skills under safe conditions. AR technology can display athletes' performance data in real time, helping them better understand their own performance and make adjustments.

6.3. Integration and Promotion of Sports and Education

With the development of ice and snow sports, VR can simulate complex sports skills, helping students understand and learn. AR applications enhance user brand memory by increasing interactivity and fun, utilizing VR and AR to create unique advertising and experiential marketing activities, such as virtual brand experiences and interactive product displays, providing opportunities for deep integration of sponsored brands and sports events, and creating more attractive brand exposure.

6.4. Plan and Strategy

Lowering the entry barrier for consumers. Optimize the current hardware design to reduce discomfort caused by devices, such as reducing weight, improving interface design, etc. Content innovation and ecological construction: Develop more customized and interactive VR/AR content to meet the needs of different users, establish a cooperative network between content developers, technology providers, and sports organizations, and jointly promote the richness and diversity of sports VR/AR content.

6.5. Multi Domain Integration and Cooperation

Integrating VR and AR technology with other technological fields such as artificial intelligence and big data to improve the overall performance and intelligence level of the technology. Collaborate with academic institutions and research centers to conduct interdisciplinary research, promote technological innovation and application expansion, international development and policy support: strengthen international exchanges and cooperation, introduce advanced foreign technology and management experience, enhance the international competitiveness of domestic VR and AR technology. Utilize government policy support, such as funding support and tax incentives, to promote the research and application of VR and AR technology.

7. Conclusion

The future development prospects of VR and AR technology in the sports industry are broad, but they also face many challenges. Through strategies such as technological innovation, diversified content, improved user experience, multi-industry integration, and international cooperation and market expansion, existing technological bottlenecks can be effectively overcome, promoting rapid growth and widespread application in this field. In the future, with the continuous advancement of technology and the increasing market demand, VR and AR technologies will play an increasingly important role in the sports industry, from enhancing the viewing experience, innovating sports training, promoting sports education and popularization, to driving sports marketing and advertising, their influence will become increasingly significant. However, in the face of technological bottlenecks and market challenges, continuous technological innovation, content ecosystem construction, user experience optimization, and international cooperation have become key solutions and innovative strategies. With the continuous maturity of these technologies and the expansion of application fields, VR and AR will show greater potential and value in the sports industry in the future.

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