A Brief Analysis of Postprints on 3D Animation and Virtual Reality Technology

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Abstract

In recent years, hardware and software related to computer graphics (CG, Computer Graphics) technology have achieved breakthrough developments, with computer three-dimensional technology becoming increasingly sophisticated. The application of computer graphics can utilize a large number of virtual three-dimensional objects to represent complex information and reproduce the real world through three-dimensional technology. Both three-dimensional animation and virtual reality (VR, Virtual Reality) technologies have evolved based on three-dimensional graphics, thereby enriching our lives. This paper primarily focuses on theoretical research regarding three-dimensional animation technology and virtual reality technology.

Full Text

Preamble

Analysis of 3D Animation and Virtual Reality Technology

Abstract: In recent years, hardware and software related to Computer Graphics (CG) technology have achieved breakthrough developments, and computer 3D technology has become increasingly sophisticated. Computer graphics applications can represent complex information using numerous virtual 3D objects and recreate the real world through 3D technology. Both 3D animation and Virtual Reality (VR) technology have evolved from 3D graphics, enriching our lives. This paper focuses on theoretical research into 3D animation technology and virtual reality technology.

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Humans live in a three-dimensional world where all objects are three-dimensional. 3D animation technology developed from 3D graphics, and later gave rise to virtual reality technology. These advancements have enriched the means of recreating the real world and made life more colorful. Designers using computer software enjoy considerable creative freedom, allowing them to fully realize their visions. Virtual reality technology combines 3D graphics with hardware devices, sensor technology, and multimedia to create a virtual world. This paper analyzes and discusses 3D animation technology, virtual reality technology, and the relationship between them.

1. 3D Animation Technology

3D animation is an emerging technology that has developed alongside advances in computer technology, benefiting from rapid progress in computer hardware and software. The process of creating 3D animation essentially involves establishing a virtual world within a computer using 3D software. Technicians can create scene and character models according to requirements, apply specific materials and lighting effects, and then produce character animations, define motion trajectories, and set camera movements and other animation parameters as needed. Once the entire process is completed, the computer enters the rendering stage, automatically calculating and generating the final output images.

3D animation can accurately imitate and reproduce real objects, and with improving computer hardware and software capabilities, its operability is virtually unlimited. Consequently, it has been widely applied in military, medical, educational, and entertainment fields. Particularly in film and television, its strong operability and cost advantages in special effects production have made it the preferred method for creating difficult-to-film scenes such as explosions, lightning, glowing effects, and disaster sequences that are challenging to capture in live-action footage.

Created through computers and software, 3D animation manifests digital virtual characters through various media including television, film, and games. In this virtual world, animators control every element: character forms and movements, environmental lighting, camera angles, and more. Unconstrained by objective conditions and possessing nearly unlimited operability, 3D animation enables creators to achieve their artistic vision with exceptional fidelity.

2. Virtual Reality Technology

Virtual reality technology, also known as “spirit mirror technology,” is essentially a computer simulation system that creates and provides immersive experiences in a virtual world. This technology combines 3D animation with sensors and modern technological hardware to provide users with realistic virtual environments that engage vision, hearing, touch, and even smell. Virtual reality offers immersive experiences that enable interaction between users and the system.

2.1 Multi-Sensory Perception

A complete virtual reality system is typically equipped with visual, auditory, tactile, and motion sensors, allowing users to obtain sensory information across multiple dimensions including sight, sound, touch, and movement trajectories. Through multi-dimensional sensory experiences and human-computer interaction, users can achieve a sense of presence within the virtual environment.

2.2 Strong Interactivity

Strong interactivity represents another crucial feature of virtual reality technology. Interaction refers to the dynamic exchange between users and the system—the interaction between real-world humans and computer-generated virtual environments. Users' movements and commands receive real-time feedback within the virtual world. Such interaction can be achieved through conventional keyboards and mice, but some VR systems also incorporate specialized equipment such as VR headsets, VR glasses, data gloves, and joint sensors, enabling more intuitive and natural interactive experiences. Computers continuously monitor users' body, eye, and finger movements through various sensors, integrating these movements with the virtual environment through computational processing to allow users to execute commands and operations in the virtual world as they would in reality.

2.3 Deep Immersion

The final characteristic builds upon the previous two: virtual reality systems provide stronger immersion. Computers generate three-dimensional images and simulated environmental sound effects through computational processing. Users transmit their movement information to the computer via hardware sensing devices, and the computer synthesizes this data and feeds it back to output devices such as headsets and glasses, completely immersing users in the virtual environment. This interactive experience aligns with human physiological characteristics of vision, hearing, and sensation, thereby producing a more powerful sense of immersion. This technology has developed rapidly in countries such as the United States and the United Kingdom, particularly achieving breakthrough results in military and gaming applications, and has also gained widespread attention in China with numerous experimental research initiatives underway.

3. The Relationship Between 3D Animation and Virtual Reality Technology

Both 3D animation and virtual reality are founded upon 3D graphics technology, differing in the degree and direction of their development from this common base. Virtual reality technology combines 3D graphics with hardware sensors, Internet of Things technology, and other innovations, emphasizing immersion and realism. Users employ interactive devices to engage with the entire VR system, enabling real-time interactivity. While 3D animation technology does

not directly provide interactive functionality, it serves as the foundation for virtual reality by providing visual displays and presenting the computer-processed virtual world through animation.

Virtual reality products have been widely applied in gaming, architectural design, landscape design, and other fields requiring virtual interactive experiences. VR can provide users with 24/7, all-angle live demonstrations and dynamic experiences unconstrained by time, environment, or perspective limitations. 3D animation technology can be viewed as the integration of computer 3D graphics and art—a synthesis of computer graphics, mathematics, fine arts, biology, and other disciplines. While 3D animation offers strong artistic expressiveness, it has significant limitations in interactivity; users can only watch and cannot interact with the animated content. Virtual reality technology precisely compensates for this deficiency, excelling in both expressiveness and interactivity.

In essence, virtual reality technology originated from the desire for free interaction with 3D animation technology. The two share formal similarities, and VR can be considered, to some extent, an alternative and upgrade to 3D animation technology. The primary difference lies in the fact that 3D animation consists of sequential images forming dynamic footage without any interactivity—viewers can only passively receive information provided by animators. Virtual reality technology, however, uses users' dynamic information as input to computationally generate and output in real-time the visual, auditory, and tactile sensory information they require, truly manifesting the user's own will. Therefore, interactivity represents the most significant difference between 3D animation and virtual reality.

Nevertheless, the two technologies share inherent connections. Establishing a virtual reality system first requires creating 3D models of the virtual world using computer 3D software—a process very similar to 3D animation production, often employing the same software such as Maya and 3ds Max. However, specific requirements differ. Current VR scenes must satisfy real-time performance demands, sacrificing some realism for computational speed. While maintaining basic visual authenticity for real-time dynamics, models often need simplification, sometimes replacing complex objects with basic shapes and frameworks to reduce computational load and improve processing speed. In contrast, 3D animation modeling prioritizes realism and artistic expression over processing speed, with many animated characters featuring exaggerated body proportions and facial expressions, and sometimes depicting entirely fictional worldviews such as aliens and spaceships. Virtual reality pursues realistic representation, while 3D animation pursues artistic expression, yet their implementation processes and methods share similarities.

At the technical level, 3D animation provides ideal methods for VR model creation and image output.

4. Rapid Development of Virtual Reality Technology in China

In the past two years, with the rapid popularization of VR devices, virtual reality is no longer a concept distant from everyday life. Although the most advanced VR hardware manufacturers are Oculus (under US-based Facebook), Japan's Sony, South Korea's Samsung, and Taiwan's HTC, and the best VR gaming and film software is developed by companies in California, USA, China—as the world's largest producer of VR devices—has built complete infrastructure for consumers to access VR experiences. In theme parks, shopping malls, and experience centers across China, consumers can access premium VR equipment such as HTC's sleek Vive headset. Over 100,000 internet cafés in China offer VR services for just a few dollars per experience, and dozens of Chinese manufacturers are producing affordable VR adapters for smartphones.

The year 2016 was hailed as the "Year Zero of Virtual Reality." During this year, VR hardware devices underwent frequent upgrades, and various VR-related games, software, videos, and news broadcasts emerged intensively, attracting tremendous attention.

While Western markets have focused primarily on consumer applications such as gaming, China's VR market growth is driven directly by commercial applications and profit channels. Real estate developers such as Vanke are using VR technology to sell high-priced properties located overseas or still under construction, and architects are employing VR technology for design purposes.

The widespread adoption of virtual reality products by China's real estate industry, combined with Chinese consumers' enthusiasm for high-tech products, constitutes one of the primary reasons why the Chinese market has embraced VR products ahead of other regions. Thanks to rapid adoption by real estate companies and other industries, China has quickly become the world's most important VR market buyer, allowing consumers to select properties for sale worldwide from the comfort of their homes with an immersive experience. Goldman Sachs predicts that by 2025, the global VR market value will soar from its current negligible level to $60 billion, with hardware and software each accounting for half of the market share. Goldman Sachs also forecasts that this year, VR device sales in mainland China will account for one-third of global VR device sales.

Additionally, education represents a highly promising field. In 2015, China's NetDragon Websoft gained widespread attention for acquiring the UK-based online education company Promethean World for approximately $100 million. NetDragon is now experimenting with applying VR software and hardware to school education in mainland China. Various forms of online education and network resources are emerging endlessly, while traditional education is showing clear signs of internet integration. Online education serves as an effective extension of traditional education, and VR technology can provide students with highly integrated, experiential knowledge that aligns with the demands

of information-based teaching. Humans obtain over 80% of their cognitive information through vision, and information acquired visually tends to be more lasting and solid. Meanwhile, VR's interactivity can provide students with more engaging practical experiences.

5. Conclusion

With continuous development of computer hardware and software, both 3D animation and virtual reality technologies have made significant progress. In film, television, and computer games, realistic scenes created using 3D animation technology are widely popular. Virtual reality technology can provide real-time interaction, diverse forms, and multi-sensory experiences. However, VR visual display content appears somewhat rudimentary compared to pure 3D animation in terms of both detail and expressiveness. How to leverage 3D animation technology to achieve more perfect VR output and deliver better visual experiences has become a challenge before us. Virtual reality technology presents new challenges for animation technology while also providing new auxiliary methods. We must seize this historical opportunity and utilize accumulated 3D animation production techniques to provide more efficient, richer, and more textured visual content for virtual reality.

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Note: Figure translations are in progress. See original paper for figures.