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A review of virtual reality technology

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Abstract. Virtual reality technology (VR) is a computer simulation system that can create and experience virtual worlds. It utilizes computers to generate a simulated environment, allowing users to immerse themselves in the environment. Virtual reality technology has been one of the fastest-developing information technologies in recent years. It, along with multimedia technology and network technology, is known as the three most promising computer technologies. As an emerging science and technology, it has been less than 100 years since its emergence, and there is still great room for development in its theory and practical application. This article focuses on virtual reality technology and its applications, based on existing literature and statistical data. The main content includes its advantages, characteristics, technical composition, development history, and applications in different directions. The development process of virtual reality technology is not long, but it has unique advantages and technologies specifically serving it. It does not require much physical participation and has positive implications in applications such as education, entertainment, and healthcare. Its future direction will be towards replacing real hardware with virtual hardware, becoming more practical, intelligent, and refined.

Keywords: Virtual Reality, Speciality, Composition, Key Technologies.

1. Introduction

Virtual reality technology is one of the current research hotspots, and many researchers are committed to developing this technology. With the continuous development of virtual reality technology, its application scenarios are becoming more and more diverse, and it is constantly penetrating various professional fields, including medical, military, education, entertainment, and other aspects, becoming a popular product today. At present, there is limited literature on the development process of virtual reality technology, and previous research on VR technology focuses on the role and theoretical research of virtual reality technology in a specific field. For example, in the medical field, it is used to establish medical plans and treat psychological diseases [1]. In the entertainment field, it is used to create three-dimensional plane games and establish an immersive playing environment [2]. It can be seen that the application of VR technology in various aspects has greatly improved these fields. This article summarises previous literature and completes the research topic on virtual reality technology and its application direction through reading and excerpting literature. This article studies the development process of virtual reality technology and its future development direction. The significance of this study is to summarise and classify the current technological development status and point out the future development direction. Secondly, it provides a fast learning path for beginners and interested groups to understand virtual reality technology.

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2. VR technology

Virtual reality technology is mainly based on information technology, which can immerse people's visual, auditory, and tactile senses in an interactive virtual environment. Users can interact with objects in this three-dimensional environment, giving them a more realistic experience. Virtual reality technology is an environmental simulation technology that has developed with computer simulation, image processing, sensor technology, and other technologies. Currently, with the widespread application of information technology, it brings earth-shaking changes to people's lives and plays an important role in some unique fields [1].

3. The advantages and speciality of VR technology

3.1. Advantages

a. Experience reality

A virtual interaction system is a perfect combination of virtual reality technology and human-computer interaction technology, allowing both parties to have the advantages of each other. By integrating human-computer interaction technology into the virtual environment, users not only gain an immersive experience in the Internet virtual environment, but also a nearly real feeling and experience with the addition of sensory devices, greatly enhancing the sense of reality [2].

b. Multiple modes

The integration of virtual reality technology and human-computer interaction has provided users with more interactive modes. Users can input information through voice, gestures, buttons, and other methods. In addition, the use of head displays and handles can provide users with a more immersive experience.

c. No physical participation required

Virtual reality human-machine interaction is different from traditional technology. This technology can set up virtual scenes through relevant virtual reality devices without the participation of some physical objects and achieve the effects that can be achieved by an object in the real world in a virtual environment. Even if the hardware devices remain unchanged, virtual reality systems can achieve the expected results through the simulation of physical objects, greatly reducing the probability of finished product rework after production and the costs caused by repeated manufacturing [2].

3.2. Speciality

Every development of VR technology revolves around its three characteristics. These three features are immersion, interaction, and conceptualization. These three important features are used to distinguish between adjacent technologies such as multimedia technology and computer visualization technology [3].

a. Immersion

Immersion refers to the degree to which a user, as the protagonist, exists in a simulated environment. Users immerse themselves in the virtual environment through the use of specialised devices and can communicate with objects in the virtual environment through language, actions, and other means, just like in the real world, giving people a sense of immersion. The main factor affecting immersion is multiperception. The human body's senses include visual, auditory, tactile, and olfactory senses. Multiperception simulates the various senses of the human body. The more sensory stimuli a user receives, the stronger their sense of immersion and initiative in the virtual environment. The ideal virtual reality is to have all the perceptual functions of humans. However, due to current sensing technology limitations, it does not yet have the ability to simulate all senses [4].

b. Interaction

Conceptivity refers to the various results provided by virtual reality environments to users, and comparing these results can lead to the best execution plan. For example, in architectural design, different designs can be placed in simulated environments to facilitate architects in selecting the design that best complements the environment. At the same time, some things cannot exist in reality, and we can also present them. Extinct organisms such as dinosaurs can be constructed and displayed in virtual

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environments to satisfy people's curiosity about them [4]. Virtual environments enable users to immerse themselves in new knowledge and help them learn about or understand existing or unknown transactions [5].

4. Composition of virtual reality systems

In virtual reality systems, the necessary hardware must be present in order to facilitate peaceful interaction between people and computers and immerse people in the virtual world that computers have created.

4.1. Tracking system

The task of a tracking system is to detect the position and direction of a person's head, body, and hands in real-time in a virtual reality system in order to feed back this data to the control system and generate images that vary with the line of sight.

4.2. Haptic system

In virtual reality systems, the key factor that produces the "immersion" effect is that users can manipulate virtual objects with their hands or other active parts of the body, and feel the reaction force of the virtual object while operating. Mechanical feedback gloves are the most commonly used tactile system, which uses two gloves and installs 20 pressure sensitive elements under the first glove. When wearing the gloves, users feel the resistance generated by the pressure sensitive elements with the force of their hands. After analog-to-digital conversion, the output of the pressure sensitive element is transmitted to the host for processing. The second glove has 20 air chambers, which are controlled by 20 air pumps for expansion and contraction, thereby exerting a sense of force on the user. Usually, the implementation of the tactile system uses data gloves to transmit data.

4.3. Audio system, auditory environment system

Consisting of speech and sound synthesis equipment, recognition equipment, and sound source localization equipment, auxiliary information provided by auditory channels can enhance users' perception of the environment. In order to produce realistic environmental sound, people have started to use a 4-channel system, using the spatial sound synthesis method, and testing the response through sound reaching the left and right ear channels from different directions

4.4. Image generation and display system

In VR environments, image generation and display technology are particularly important. The work of generating visuals by computers mainly includes three steps:

(1) Compute realistic graphics that have color, lighting, a stereoscopic feel, and a sense of motion.

(2) Compute or directly obtain compressed and realistic background images from the image library.

(3) After scanning and transformation, the graphics and background images are uniformly arranged in the same coordinate system. The generated images are displayed through a large screen stereoscopic display system or a three sided display system.

4.5. Visual display device

In order to generate an immersive virtual reality environment, it is necessary to integrate the above four technologies. HMD (Head Mounted DISP) is the crystallization of this technology. It not only integrates the essence of the above technology, but also combines the physiological characteristics of human visual perception. Its display screen is set in front of a special helmet, and the computer generated images are sent to two screens of the HMD to produce a three-dimensional image. The corresponding images sent by the computer image generation system also change accordingly [10].

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5. Key technologies of virtual reality

The core technologies in virtual reality systems mainly include dynamic environment simulation technology, real-time 3D graphics technology, and so on. One of the research objectives of dynamic environment modelling technology is to obtain 3D data in a real environment according to the requirements of practical application scenarios and use the obtained 3D data to create suitable realistic environment models. The core of 3D technology is real-time creation, and 3D display and touch technology are the core of interaction in virtual reality [8].

Real time 3D computer graphics

If there is a sufficiently accurate model and sufficient time, using computer models to generate graphic image technology, we can generate accurate images of various objects under different lighting conditions.

Dynamic Environment Simulation Technology

In VR systems, binocular stereo vision plays a significant role. Separately generated and displayed on various displays are the various images that the user's two eyes see. Some systems use a single display, but when users wear special glasses, one eye can only see odd frames of images, while the other eye can only see even frames of images. The difference between odd and even frames, which is the parallax, creates a sense of stereoscopic effect. Eliminating the correlation between the direction of sound and the movement of the user's head in virtual reality systems, while generating three-dimensional graphics in real-time in complex scenes.

6. The developing history of VR technology

In the current theoretical system, the development history of VR technology is mainly divided into four stages: acoustic, physical, and dynamic simulation is the first stage containing virtual reality ideas; virtual reality sprouts into the second stage; the emergence of virtual reality concepts and initial theoretical formation into the third stage; and the further improvement and application of virtual reality theory into the fourth stage [6]. The predecessor of virtual reality technology can be traced back to simulation technology. Humans have gained inspiration from animals and invented many simulation objects, such as airplanes and sonar. It has promoted the development of simulation technology, embodied the idea of virtual reality, and promoted the development of virtual reality technology.

From the early 1980s to the mid-1980s, the basic concept of VR technology began to evolve from experimentation to practical use. An important symbol is that the VIEW virtual reality system, completed under the leadership of Michael Mc Greevy in 1985, was equipped with data gloves and a head tracker, providing interactive means such as gestures and language, making VIEW a true virtual reality system and the architecture for later development of virtual reality. Other companies, such as VPL, have developed RB2 software for generating virtual reality and DataGlove data gloves, providing development tools for virtual reality [3]. In the field of aerospace, astronauts use virtual reality systems to simulate the space operation of removing objects such as telescopes from transport modules in space; In the field of aircraft manufacturing, virtual reality technology has played an important role in the design process of Boeing 777 aircraft. In particular, the British company Superview has developed a "super city" stereoscopic image that can be viewed on computer screens, which can simulate real-life environments and scenes. So far, virtual reality technology has been widely and deeply applied in fields such as medicine, industry, and design [7].

7. Main application subject of VR technology

7.1. Entertainment

Virtual reality technology can establish virtual board game scenes in the real world. In specific games, participants can enhance interaction through the application of corresponding props, which not only effectively enrich game stages and content, but also enable people to obtain a more realistic and smooth interactive experience. It is possible to establish interactive anime, in which VR technology is used to create virtual anime images while also creating design relevant interactive forms to achieve interaction

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between anime characters in the virtual world and real operators, forming a more realistic interactive experience [9].

7.2. Military affairs

The application of virtual reality technology in the military field has become increasingly widespread in recent years. Virtual reality technology can enable soldiers to train in a virtual environment that is similar to a real battlefield. The tactical training simulator can provide soldiers with real battlefield tactical training. The use of virtual reality technology can also simulate real military exercises and improve the collaborative combat capabilities of soldiers [7].

8. Discussion

In various fields of design, the research and development of products in a virtual environment can improve the innovation ability of enterprises, improve the speed of design and manufacturing, reduce the number of developers and all hardware resources used for development, and reduce costs for enterprises. The multi-channel interaction technology based on VR, meeting the needs of different users, is one of the development directions of VR. Simple, convenient, intelligent, high-precision, practical, and economical VR hardware devices, modelling, and human-machine interaction are hot topics in the application and research of this technology. The innovation and development of VR-based hardware devices have great potential, and intellectual property protection and talent cultivation are key points for the development of VR technology in China [6].

9. Conclusion

This article briefly discusses the advantages and characteristics of virtual reality technology. It is interactive and immersive and does not require too much physical participation. The main components and key technologies include three-dimensional modelling technology, dynamic environment simulation technology, tactile systems, and tracking systems. The development process of this technology and the possible future development direction have finally been determined, which is to replace some hardware with virtual technology, intelligentize, and refine programmes in various fields. The article focuses on theoretical research, outlines the significance and popular application directions of developing this technology, and concludes that virtual reality technology has a wide range of applications and broad prospects in many fields. With the rapid development of virtual reality technology, VR will be more integrated into various aspects of our lives and continuously penetrate various professional fields, including medical, military, education, entertainment, etc. It is expected to continue to deepen development in the future. At present, the paper mainly draws conclusions based on existing literature and data, and future research will explore areas where VR technology can be improved through specific experiments and data models.

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