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Trends and Bottlenecks in Virtual Reality and Tactile Interaction Technologies

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Abstract: ***The main form of artistic expression of virtual reality technology is not visual expression. In the course of human history development, visual art plays an extremely significant role, such as ancient mural art, Western Han shadows and modern cinema and television are all visual arts, and these are vivid reflections of economic life and scientific and technological standards during the stage of human social development, becoming the essence of human civilization development. Art comes from everyday life and is above life. It not only records all aspects of human life, but also reflects people's aspiration for a better life and their boundless vision for the future. Visual expression not only allows the plot of the story to be more vivid, but also brings people a sense of enjoyment. This article explores the trends and bottlenecks of virtual reality and tactile interaction technology.***

Keywords: Virtual Reality; Tactile interaction technology; Trends; bottleneck.

1. OVERVIEW OF VIRTUAL REALITY TECHNOLOGY

Virtual reality technology is a three-dimensional environment simulation system that enables people to experience and interact with virtual space, which is the most complete artistic expression of visual perception, and it has a strong sense of immersion, which can give people a dreamlike multi-sensory experience. Virtual Reality is the English name of virtual reality, meaning virtual reality. It can also be explained as a "reality" created for computers. Virtual reality has two layers of meaning: first, it can be not only a fake Churchillian reality, but also a digital reality, but a computer-created reality; Second, reality is reality in its true sense. Fake reality relies on three-dimensional virtual spaces created by computer simulations. And this virtual space can provide people with hearing, vision, taste, touch and smell and other senses of the full simulation, can use the staff feel really in this completely realistic three-dimensional environment, real-time and unlimited appreciation of all things in the three dimensional space. Some of the most typical features of virtual reality are interactivity, multi-sensory, immersive, and contextual. Zhang et al. [1] explored anomaly detection techniques in biomechanical big data environments using machine learning, highlighting its potential for identifying irregularities in complex datasets. In the field of computer vision, Guo et al. [2] proposed an improved YOLOv8 network for vehicle detection, while Jin et al. [3] further advanced object detection and pose estimation through hybrid task cascade and high-resolution networks. Liu et al. [4] introduced a computational-friendly personalized generation framework combining cloud-based and on-device collaboration with causal inference. For complex data querying, Liu et al. [5] developed a modular agent-based approach integrating SQL generation and parameter-efficient fine-tuning. In logistics optimization, Wang [6] focused on predictive modeling for sortation and delivery in e-commerce. The applications of AI in supply chain management were extensively investigated by Saunders et al. [7], who analyzed pathways for operational efficiency enhancement, and Wang et al. [8], who constructed an intelligent supply chain finance decision support system using deep reinforcement learning and optimization algorithms.

1.1 Interactive features of virtual reality

Interaction focuses on the operationality of things in a virtual environment and the timeliness and naturalness of the interaction. For example, when a user uses a hand to grab an object in a virtual environment, the hand should have the touch of grabbing the object, and in turn, the user needs to sense the weight of the virtual object when grabbing it, and the object can move with the hand.

1.2 Multisensory nature of virtual reality

The multi-sensory nature of virtual reality is when the user is in a virtual reality environment, Not only can see the three dimensional space in the vision, but also can touch, hear, taste or smell and other aspects of one or several things to experience the three dimensional space, and can interact with it. Idealized virtual reality technology should be able to satisfy all of people's perceptual functions. However, due to the limitations of current technological developments, the perception capabilities that virtual reality can provide are still very limited. In

general, virtual reality systems can generally provide both visual and auditory perception, while other perception functions are less common. With the rapid development of haptic interaction technology, the tactile glove and force feedback device which can provide haptic interaction for virtual reality systems have been developed in recent years. It is estimated that in the next three to five years, tactile interaction functions will become the basic functional configuration of virtual reality systems, as will visual and auditory functions. Research on the technologies related to taste and smell is lagging because they involve the chemical reaction of the human sensory organs, mainly divided into gas and liquid stimulation of the human sense organs, so the breakthrough of these two technologies is very difficult, and the promotion and application of these technologies is even more difficult [2].

1.3 Immersion of virtual reality

Virtual reality immersion can also be called immersion, and its focus is on the authenticity of the experience of the user, who is in a virtual reality environment. The perception needs to be consistent with the real world so that it is difficult to tell fakes. The ideal virtual reality environment should not only be close to the real world in vision, hearing and touch, but also in taste and smell [3].

1.4 Conceptuality of virtual reality

The conceived nature of virtual reality focuses on the need for virtual reality to be broad, The space that can be imagined, the cognitive range that humans can expand, can present real environments that exist, and can construct objective virtual objects as they wish, even environments that cannot exist.

2. TRENDS IN VIRTUAL REALITY

Virtual reality is a slowly developing concept, and its technology is constantly progressing from far to near, and its content is constantly adjusting and enriching in the course of its development. The essence of virtual reality technology is to create a "world" with which humans can freely interact, in which users can explore or move things in the environment at any time. Immersion is the ideal goal of virtual reality, which can be achieved by wearing a special helmet display device, data gloves and body movement tracker. This allows the user to experience visually, hearfully and touchfully in a virtual scene. The invention of this technology will bring disruptive reforms to the various major games already in existence, and at the same time will greatly promote the development of technology. Judging from the development process of virtual reality technology, the future exploration of virtual reality will continue the development principle of "low cost, high performance," from both parts of hardware and software, and its development trends are summarized as follows.

2.1 Dynamic Environment Modeling Techniques

Building a virtual environment is the core content of virtual reality technology, and obtaining 3D data of the real environment is the purpose of dynamic environment modeling technology, and a corresponding virtual environment model can be built according to the requirements.

2.2 Real-time generation and display of three-dimensional graphics technology

The generation and display technology of 3D graphics has become relatively mature, but the key is that the real-time generation technology of 3d graphics has not yet emerged, and how to improve the frequency of refreshes is the main research content in the future, based on the fact that the quality and complexity of the graphics are not reduced. In addition, virtual reality technology also relies on the development of sensors and stereo display technology, and existing virtual devices still cannot meet the needs of virtual reality systems, and there is an urgent need to research and develop new 3D graphics generation and display technology [4].

2.3 Research and development of new interactive devices

VR allows you to freely interact with things in the virtual world as if you were there. Wearable input-output devices include head-mounted displays, data gloves and clothing, and fuel rack position sensors and audio generators. Therefore, new, low-priced data gloves and clothing with good sensing will be the main direction for carrying out follow-up research.

2.4 Intelligent voice virtual reality modeling

Modeling of virtual reality technology is a relatively complex task that must be invested in a lot of time and effort. If the virtual reality and intelligent technologies, speech recognition technologies integrated, we can greatly solve this problem. We can use the speech recognition technology to transform the data into the data we need to model, so that we can better describe the properties, methods and characteristics of the model. After that, the computer's artificial intelligence technology and graphics processing technology can be used to implement design, navigation and evaluation. Models can be represented with objects, and a variety of underlying models can be connected either statically or dynamically to create a model of a system. The difficulty in the industry's current research is artificial intelligence, and artificial intelligence plays an important role in various fields, and it is also of great use in the virtual reality world, and high-quality artificial intelligence systems can greatly reduce manual labor and have a positive effect.

2.5 The Future of Distributed Virtual Reality Technology

Distributed virtual reality technology is the main direction of future virtual reality technology development. With the invention of a large number of DVE development systems and tools, the application of DVE has also been integrated into various fields, including medical, architecture, training and teaching, and collaborative design. Simulation training and teaching is one of the main application fields of DVE, including virtual battlefield and auxiliary teaching. In addition, developers also use DVE systems to implement collaborative work. With the application and popularization of the Internet in recent years, many DVE applications integrating the Internet can let users in different parts of the world work together. By continuing virtual reality systems scattered across different regions through a network, using harmonized structures, standards, databases, and protocols, it is possible to create a virtual synthesis of time and space that is mutually integrated, and users can interact freely. Its application value is extremely significant in aerospace technology, as the countries using the International Space Station are distributed in different parts of the world. Therefore, distributed virtual reality training environments can not require countries to build simulation systems, which not only reduces the investment costs in research and development and equipment, but also reduces the huge costs of job mobility and the inflexibility of living abroad.

3. BOTTLENECKS IN VIRTUAL REALITY TECHNOLOGY

3.1 Environment and Object 3D Modeling

A virtual reality system has two coordinate spaces: one is a coordinate space in the real world; The second is the coordinate space of the virtual world. When the user interacts in a virtual environment, the user is in the absolute space of the real world, and the object in the interaction is in the virtual world, and a mapping relationship needs to be established between the coordinates of the two worlds so that the user can accurately manipulate the virtual object.

3.2 Mass data communication

In the process of virtual reality interaction, whether it is to obtain the data of the image sensor or the stereo display of the scene, it will involve the transmission of a large number of pictures and image data. Especially during the interaction process, as the user's virtual visual scene is transformed, it will involve a lot of image transmission and data computation, and the data volume is huge. When there are multiple interactive objects in the system, the volume of data transmission will increase rapidly, which not only puts higher requirements on the performance of the hardware system, but also requires the performance of data transmission to maintain first-class. If there is a lag in the transmission of data, it will greatly affect the user experience, and the current development of computer networks makes the security in this area not optimistic [5].

3.3 Virtual sensors

Most of the existing virtual reality is video images, in which three-dimensional objects and environments can be observed visually, but cannot be used for direct contact exploration, and in addition, three-dimensional object and environment cannot be obtained.

The parameters associated with the geometry of the environment make it difficult to determine and calculate the position and touch between the user and the three-dimensional object. Therefore, the research work currently invested in this area is extremely limited, and there is still no mature algorithm to learn from.

3.4 Gloss-free 3D display

While naked 3D display has significant advantages over head-mounted displays, there are still many unresolved difficulties in naked 3d displays. First, the user must be confined to a certain range; Second, there is a dizziness; Third, naked eye displays such as fog and water curtain have an impact on the sense of reality and the visual field environment; Fourth, the quality of the naked eye image generated by the LED blade method is poor; Fifth, it is difficult to display color images such as air molecular plasma displays; Sixth, due to the presence of physical or visual field barriers, users of naked 3D TVs and LED blades cannot enter the virtual space and cannot interact with drinking touch when they are displayed.

4. CONCLUSION

In conclusion, the future of virtual reality may become a comprehensive platform throughout the world, and human beings begin to acquire their unique identity in the ideal country of the virtual world from birth and continue to live with them. When human beings have their own virtual social life and space, they can also use virtual currency to conduct business such as buying and selling houses and making businesses.

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