Application Research of Human-Machine Interface Design Based on Virtual Reality (VR) Technology

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Abstract. With the development of human-machine interface design, VR technology has been widely used in game, education, medical and other fields. In human-machine interface design, VR technology also has a broad application prospects. This paper will analyze the concept, development and application of VR technology, and discuss the application of human-machine interface design based on VR technology, in order to provide useful reference for the related research fields.

Keywords: Virtual reality; interactive interface; user experience; interaction mode.

1 Introduction

Virtual Reality (VR) is changing the way we interact with computers, especially in games and entertainment. In the human-computer interaction interface, VR technology provides a new, immersive experience, so that users can really feel personally. Hamacher [1]proposes an expert tool for automatically evaluating the usability of graphical user interface, phrasing, and dialogue structures, which greatly reduces the development burden on designers. Anuar[2] and so on use the project sequence diagram tool proposed the automation system man-machine interface design requirement method, thus reduces the operator's workload.

In recent years, with the popularity of head-mounted display devices, VR technology has become an important form of human-computer interface. In human-machine interface design, virtual environment is one of the important applications of VR technology. Through VR technology, designers can build a more realistic virtual environment, thus providing a more immersive user experience. In games, for example, VR can simulate real-world or fictional environments, giving users an immersive experience. According to user surveys, more than 70% of users said they had experienced a VR game or application in the past year. In addition, more than 80% of users said they would continue to use VR devices for gaming or entertainment in the future; the Global VR market grew at a CAGR of 35% from 2016 to 2019 and is expected to grow by 2025, the Global VR market will be worth $20.9 bn. Games and entertainment are the main application areas of VR technology, accounting for nearly 60% of the total market.

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2 Overview of VR technology

VR technology, or virtual reality technology, is a technology that simulates a real scene. It takes people to a virtual three-dimensional space through a head-mounted device, allowing people to interact with the virtual scene. VR technology has been widely used in games, education, healthcare and other fields with its unique interaction mode, visual effects and immersion.

VR technology originated in the 1950s, when American scientists founded the field of virtual reality research. With the development of computer graphics and human-computer interaction technology, VR technology has also been rapidly developed and widely used. At present, VR technology has become an important technical means in human-machine interface design.

Virtual reality technology (VR) mainly includes simulated environment, perception, natural skills and sensing equipment. The simulated environment is a computer-generated, real-time and dynamic three-dimensional stereo-realistic image. Perception means that the ideal VR should have the perception that all people have. In addition to the visual perception generated by computer graphics technology, there are hearing, touch, force perception, motion and other perception, and even including smell and taste, also known as multi-perception. Natural skills refer to a person's head rotation, eyes, gestures or other human behavior actions. The computer processes the data corresponding to the movements of the participant, and responds to the user's input in real time, and feeds back to the user's facial features respectively. A sensing device refers to a three-dimensional interactive device. Commonly used are three-dimensional helmet, data gloves, three-dimensional mouse, data clothing and other devices worn on the user's body and sensing devices set in the real environment, such as camera, floor pressure sensor, etc[3].

3 Application of VR technology in human-machine interface design

3.1 Build the virtual environment

Specifically, designers can use 3D modeling technology to build various elements in the virtual environment, such as buildings, people, props, and so on. At the same time, through the texture mapping, light and shadow rendering and other technical means, can make the virtual environment more realistic, natural. In the process of building a virtual environment, designers need to take into account users' visual experience and interactive experience to provide a better user experience.

With the development of science and technology, mobile VR interaction mode is favored by more consumers. This interaction mode is more natural and intuitive than the traditional interaction mode, and is more and more extensive in the application of interactive interface design. In recent years, mobile VR has achieved rapid development. It has shown better mobility and light experience in games, video and other applications. It is the most popular and popular VR product type in the market today. In the article "Virtual Reality Systems and Their Applications" published at the Electro93 International Conference, American scientists Burdea G. and Philippe Coiffet proposed the "3I" characteristics of VR (as shown in Figure 1), namely interaction (Interactivity), immersion (Immersion) and conception (Imagination).

Mobile VR not only has the above characteristics, but also has the unique advantages of mobile devices[4]

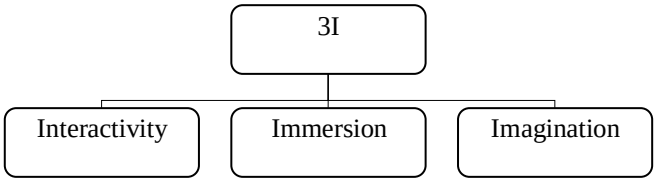


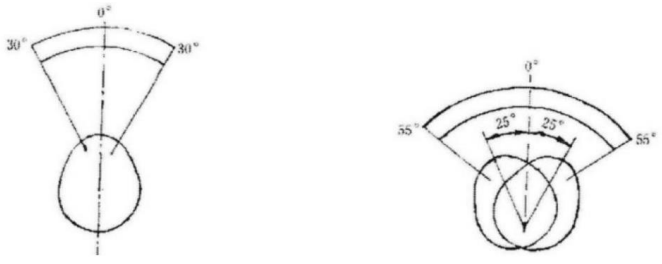
Fig. 1. Three features of VR technology

3.2 Interactive interface design

Interactions are an important part of the user-interface design. Users of the traditional interaction mode are always in the third-party perspective and rely on the interaction of input and output devices. Virtual reality devices allow the user to switch to a first-person perspective. Instead of inputting the device, the device transmits the information to the computer, which then transmits the feedback to the user in a first-person way[5].

In a VR environment, users can interact with a head-mounted device, for example through a handle, or through head movement and voice. Specifically, designers can design different interaction modes according to different application scenarios and needs. For example, in the game field, you can attack and move through the handle button or joystick; in the education field, you can choose and answer through the head movement or voice. These interactive methods allow users to participate more naturally in the virtual environment, improving user experience and engagement.

Virtual reality interface design is different from that of flat surfaces, Generally, users are in a relatively closed environment, So how to deal with the relationship between people, machines and environment to the user's experience, Relatively reasonable interface and environment design must meet the needs of ergonomics, Ensure that the information is accurately communicated to the users, Ensure eye comfort, According to the diagram given in the appendix of GB / T 12984-1991 Human onomics-Basic Terms of Visual Information Operation (as shown in Figure 2), In the horizontal direction, The best eye movement field (both eyes) is between-30 and 30, The best field of view (both eyes) is between-55 and 55; Vertical direction, The best eye movement field (both eyes) is between-55 and-5, The best field of view (in both eyes) is between-65 and 50.



(a) Best horizontal eye movement field of vision (b) Best level of visual field

(c) Best vertical eye movement field of vision (d) Best vertical viewing field

Fig. 2. Human visual scope

3.3 Immersive learning experience

VR technology can be used to create a realistic learning environment, such as simulated chemistry experiments, physics experiments, etc., so that users can conduct practical operations in the virtual environment and improve the learning effect.

Specifically, designers can design different virtual experiment scenarios according to different disciplines and knowledge points. Users can conduct practical operations through handles or other interactive devices, such as chemical experiments, physical experiments, etc. This learning method can enable users to further understand and master the knowledge, and improve the learning effect.

Back in 2015, Google hoped to use virtual reality technology to help children improve their classroom experience, working with California's top public schools to promote the virtual reality classroom system for free and improve the research and application of virtual reality in education. Zhang Dongling et al. pointed out in the teaching study of general Chemistry based on numerical simulation that in order to meet the needs of students for experimental courses under the COVID-19 epidemic, improve the experimental efficiency. It is proposed to use Solid works software to model the sedimentation tank, import the built model into the computational fluid mechanics software Fluent for numerical simulation experiment, and construct a virtual simulation experiment system. The results show that the numerical simulation model based on Fluent software can be efficient and accurate sedimentation performance test of the simulation, virtual simulation experiment system broke through the limitation of time and space, greatly meet the students under the outbreak of COVID pneumonia demand for experimental teaching course learning, for other experimental course teaching has important reference significance[6].

Using virtual reality (VR) technology, through the virtual theory of applied numerical simulation, and build numerical simulation experiment virtual simulation experiment system, analysis theory research, break through the limitation of time and space, greatly meet the demand of people for individual course learning, at the same time for other course teaching and learning has important significance.

3.4 Immersive entertainment experience

Using VR technology can create more realistic game environments, such as simulated war, adventure and other scenarios, allowing users to be more deeply involved in the game

Specifically, designers can use VR technology to build more realistic game scenes, such as forests, cities, space, etc. At the same time, through different interaction methods, users can participate more naturally in the game, such as through the controller to attack, movement and other operations, or through the head movement and voice interaction. This game allows users to be more deeply involved in the game, improving the immersion and experience of the game. At present, the heat of virtual reality technology in all kinds of audio and video entertainment products is continuing to heat up, major brands have launched VR glasses, VR helmets and other entertainment devices, among which there is no lack of full-body virtual reality devices with limb touch sensing, in order to more real immersive experience[7].

In the increasingly serious aging situation, the entertainment problem of the elderly has become the focus of social attention. Can use virtual reality (VR) technology and equipment to replace the traditional elderly entertainment products, through the control module and application module design system process (as shown in figure 3), from the system function construction, system operation mode, system content, auxiliary equipment and product use environment in-depth study, improve the practicability of the elderly entertainment products, adjust the mood, create a positive pension mental state.

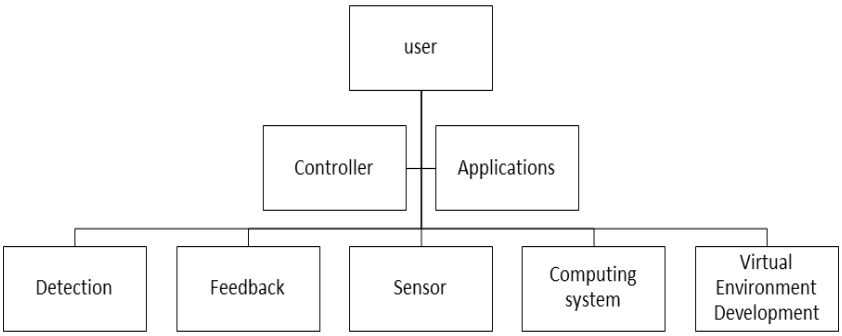


Fig. 3. System process

4 Conclusion

In this paper, the application of VR-based technology in HMI design is analyzed. According to the analysis, VR technology has a wide range of application prospects in human-computer interface design, which can provide a more real, natural and immersive user experience, and can also improve the communication efficiency and interactive experience between designers and users. However, there are also some challenges and problems. Due to the high technical cost, virtual reality technology requires a lot of capital investment, including hardware equipment, software development, maintenance and upgrade. Although virtual reality technology can provide immersive experience, limited user experience and long use may lead

to dizziness and headache. In short, although virtual reality technology has some disadvantages, its advantages also make it have a wide application prospect in many fields. With the continuous development and progress of technology, I believe that the shortcomings of virtual reality technology will be gradually improved and optimized.

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