Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 228 (2023) 1054–1058

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd International Conference on Machine Learning and Big Data Analytics for IoT Security and Privacy

Research on multi-mode human-computer interaction design evaluation system based on virtual reality technology

Xue Han

Research Institute For Water Transport Engineering,M.O.T.,300456,China

*

Abstract

The research of multi-mode human-computer interaction design evaluation system based on virtual reality technology is the application of virtual reality technology in the field of human-computer interaction. The main purpose of this study is to provide a new method to evaluate and improve user interface design, which can be used by designers to evaluate their own works. It also provides users with a new way to explore different interfaces through interactive experience.. The purpose of this study is to study the impact of various factors on user performance, as well as the impact of different modes on user performance. Therefore, we designed two experiments: (1) single mode experiment and (2) multi-mode experiment. In these experiments, each factor is vertical to find out its impact on user performance. The results of these experiments are presented in this paper. It also discusses how to apply our findings to future research in HCI.

Keyword: Virtual reality technology; Human computer interaction; evaluation system

1 Introduction

Multimodal human-computer interaction aims to use multimodal information such as voice, image, text, eye movement and touch to exchange information between people and computers. It has a very broad application prospect in physiological and psychological evaluation, office education, military simulation, medical rehabilitation and other fields. In this paper, the latest progress of multimodal human-computer interaction is reviewed to help beginners quickly understand and become familiar with the field of multimodal human-computer interaction; Classify multimodal human-computer interaction methods to help researchers in this field better understand various

*Corresponding author.Xue Han

E-mail address: hanxue@tiwte.ac.cn

10.1016/j.procs.2023.11.138

technologies in multimodal human-computer interaction; The opportunities and challenges in the field of multimodal human-computer interaction are sorted out to inspire relevant researchers to make more valuable multimodal human-computer interaction work[1]. This paper systematically summarizes the development status and emerging directions of multimodal human-computer interaction, and thoroughly combs the research progress of big data visual interaction, interaction based on sound field perception, mixed reality physical interaction, wearable interaction and human-computer interaction, as well as the comparison of research progress at home and abroad. In this paper, the future research trend of multimodal human-computer interaction is to develop new interaction methods, design efficient interaction combinations of various modes, build small interactive devices, cross device distributed interaction, and improve the robustness of interaction algorithms in open environments[2].

2.Related work

2.1.Virtual Reality Technology

We may usually notice in shopping malls and other places that some people wear thick equipment on their heads, and even though they can't see the outside world, they still seem to make some actions in the real world. Obviously, the black box must give the wearer a feeling of being in a certain environment, and it must be full of strong three-dimensional sense[3]. With the development of electronic information technology, this technology, which brings special feelings to people through human observation, is called Virtual Reality, which is called VR for short in English. Research and development of VR, the core of technical support for image processing means related to image generation, rendering and recognition, etc. In addition, building virtual reality space also requires synchronous follow-up of other light and shadow technologies, including stereo manufacturing. VR is a computer technology that integrates display and interaction of virtual objects in the real world. Some scholars believe that VR is augmented reality. Milgram's definition of VR is adopted in this paper. According to Milgram's theory, VR, AR and AV can be regarded as a real virtual continuum in one-dimensional coordinate space (see Figure 1 below).

Fig. 1. Real Virtual continuum

The name source of virtual reality includes two meanings. The first is virtual, that is, the environment recognized by the human eye and felt by the human brain is divorced from reality. The second meaning is "reality", that is to say, it emphasizes that the feeling brought to people through image rendering and other technologies will make the experiencer seem to be in a three-dimensional "reality" space. The main feature is the artificial three-dimensional space environment created by computer graphics technology[4]. In this virtual environment, a new sense of experience (such as simulated driving, simulated medical appliances, simulated flight, etc.) is simulated. The virtual reality system has interactivity, interactivity, and sense of existence, imagination and artistry.

2.2.Multimodal human-computer interaction

The appearance of new interactive technologies and devices of multi-mode user interface makes human-computer interaction interface develop towards a natural and efficient direction. Human computer interaction interface is to study the coordination relationship between human, machine and environment by using the principles of ergonomics. Here, "human" refers to a variety of human sensory organs, "machine" refers to VR interactive equipment, and "environment" refers to an interactive environment that combines virtual and real. Through the comprehensive utilization of human multi sensory channels and effect channels, the computer is trying to listen, speak and understand the user's interaction intention. Figure 2 below shows the multi-modal user interface model in the

environment.

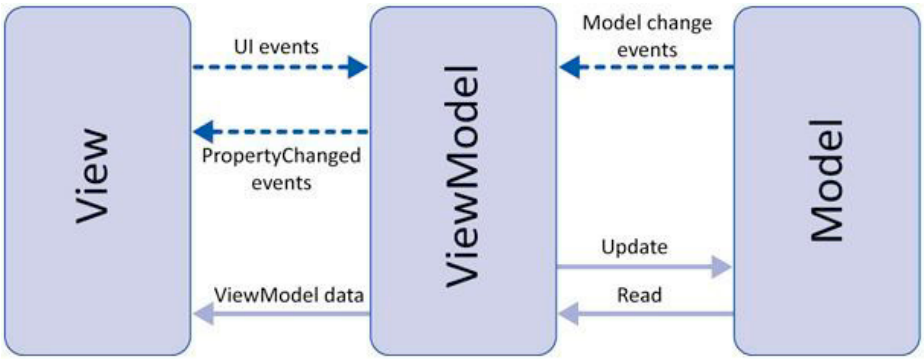

Fig. 2. Multimodal user interface model

Common VR user interface forms include TUI, touch UI, 3DUI and multi-mode UI. Among them, multimodal user interface, also known as multi-channel user interface, supports users to interact with computers through gesture, voice, vision, touch and other channels, and realizes more natural human-computer interaction through the gain effect between channels[5]. VR multimodal natural interaction seeks to make users focus on the activities they want to engage in, while ignoring the existence of the interface itself.

3.Research on multi-mode human-computer interaction design evaluation system based on virtual reality technology

In this paper, multimodal information input and multimodal information output are reviewed. Among them, the multimodal information input process involves wearable interaction technology and input interaction technology based on sound field perception. The multimodal information presentation process involves big data visualization interaction technology, mixed reality interaction technology and human-computer interaction technology. Aiming at the differences of interaction devices, interaction modes and interfaces among interaction channels, this paper proposes a multi-mode human-computer interaction framework based on a three-tier structure. Among them, a complete information processing process includes three development stages: the physical device layer, the interaction definition layer and the application interface layer. The physical layer is related to the physical device, and it is used to obtain the original data transmitted by the human body. The interaction definition layer can be divided into lexical layer, grammatical layer and semantic layer[6]; The application interface layer integrates the defined interaction information into various application interfaces, and is the final link to realize the user's intention. The VR platform focuses on differentiated experience and provides three calibration methods for user interface. The first is screen locking (see Figure 3a), which is like pasting a layer of information on the VR device lens. When the human body rotates, the information on the lens is always in front of the field of vision[7]. The second is user locking (see Figure 3b). This method is to place the tool menu in a three-dimensional space. When people move, the tool menu will rotate with them. The third kind of environment locking (see Figure 3c) refers to that a Hologram or 2D interface is locked at a fixed spatial position. When a person moves, Hologram will not change with the person's movement. The main calibration method used in this project is environment locking.

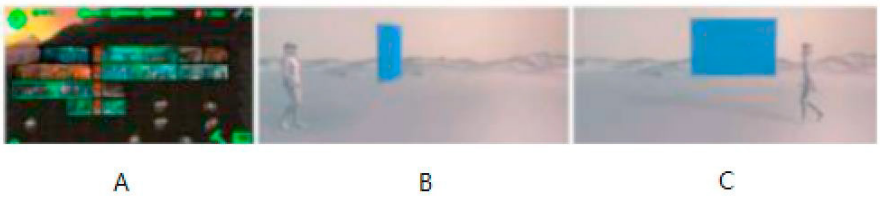

Fig. 3. Three calibration methods provided in VR devices

When using the VR platform, the enhanced virtual interface needs to be calibrated. The calibration process uses the coordinate system shown in Figure 4 below. Wherein, W represents the world coordinate system, C represents the tracking camera coordinate system used to establish the connection between the system and the external environment, S represents the 2D image plane coordinate system of the VR device display, and V represents the virtual camera coordinate system of a pinhole model composed of the human eye and the image plane of the VR device display[8]. The calibration process is mainly to determine the mapping relationship between the tracking camera coordinate system and the VR display screen coordinate system.

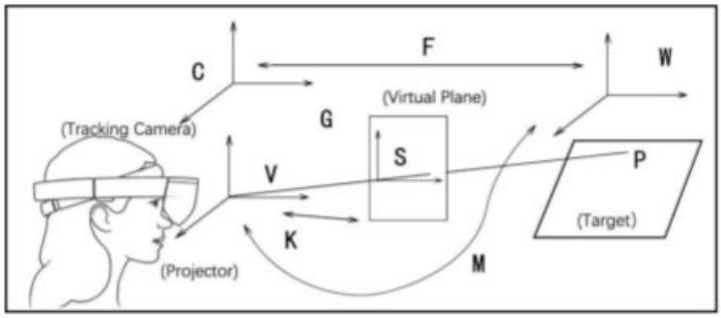

Fig. 4. Holographic application

4.System development

The multi-mode human-computer interaction system under VR platform includes data processing, 3D registration, mixed display, human-computer interaction and other technical links. First, VR devices use cameras to obtain real environment information; Then, the virtual scene is generated and superimposed on the real scene[9]; Then, the user sends an interactive command through judgment, and the system combines sensors to locate, track and interact, and then changes the display state of the holographic object when performing the task, thereby generating a new virtual reality combination scene, which is repeated until the user completes the task. Figure 5 below shows the system structure of the VR platform.

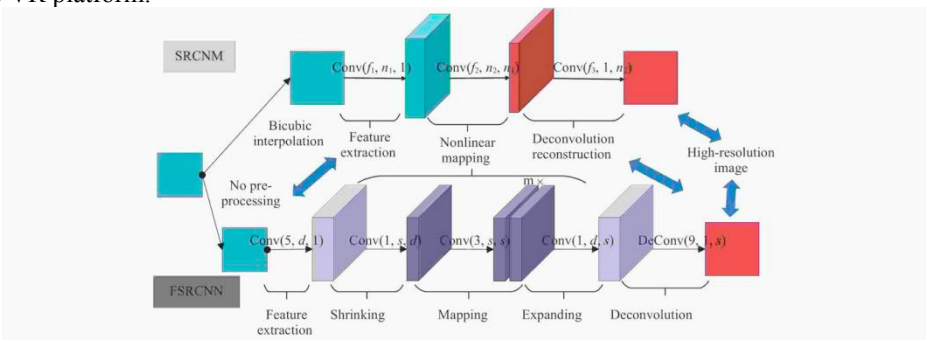

Fig. 5. System Structure Diagram of VR Platform

The VR platform provides developers with a highly integrated virtual reality development platform, integrates various tools for user development, solves many problems related to low-level development, and allows users to focus more on the realization of the evaluation function of the product evaluation system and the optimization of user experience. This system focuses on the design and implementation of interaction definition layer and data interface.

Through the demand analysis and problem domain analysis of design evaluation system, the principles and methods of structural design and functional design of industrial design evaluation system with multi-mode human-computer interaction under VR environment are proposed, which provides a new evaluation tool for industrial design products[10]. In addition, considering the large amount of complex data in industrial design model modeling, a

method of optimization processing using PBR technology is proposed.

5.Conclusion

The research content is about the evaluation of multi-mode human-computer interaction design system based on virtual reality technology. The research also involves the development of multi-mode human-computer interaction design system based on virtual reality technology. Moreover, it is about evaluating the performance of such a system. The system can evaluate the user's performance in various modes, including navigation mode and operation mode, in the interactive experience between the user and the computer system. For example, it can evaluate how long it takes a user to find the required information or perform the required operation using different input methods (e.g., keyboard, mouse). The study also aims to develop a methodology for assessing this performance. In addition, we are interested in exploring new ways to improve usability in many ways.

References

1. Chen B , Cao J , Liang J , et al. Design of Multi-Mode UAV Human-Computer Interaction System[J]. Aircraft Design, 2018.
2. Zhang M , Huang H . Research on product design evaluation system based on virtual reality interaction technology[J]. Modern Electronics Technique, 2019.
3. Sun Y B , Dong Y C , Gao R L , et al. Construction and Application of Virtual Evaluation System for Vehicle Human-Machine Interaction Design[J]. Packaging Engineering, 2019.
4. Feng Z , Wu J , Ni T . Research and Application of Multifeature Gesture Recognition in Human-Computer Interaction Based on Virtual Reality Technology[J]. Hindawi Limited, 2021.
5. Xiaoyu L I . Research on Fashion Design System Based on Virtual Reality Technology[J]. Video Engineering, 2018.
6. Ding J . Application of Virtual Reality Technology in Landscape Design[J]. China Computer & Communication, 2019.
7. Qi X , Zhang Y , Cao S , et al. Intelligent Retrieval Method of Power System Service User Satisfaction Based on Human-Computer Interaction[J]. Journal of Interconnection Networks, 2022, 22(Supp05).
8. Wan X Y , Song M , Zhao K X , et al. Human-Computer Interactive Blind Reader Based on Virtual Reality Technology[J]. Modern Computer, 2018.
9. Jin, Xing. Design of Electronic Information Interaction System Based on Cloud Computing[C]// 2018.
10. Jiang S , Wang L , Dong Y . Application of Virtual Reality Human-Computer Interaction Technology Based on the Sensor in English Teaching[J]. Hindawi Limited,