ABSTRACT

Over the years, virtual reality (VR) applications combining somatosensory operations have gained popularity, moving beyond entertainment and into medical and educational realms. Wearable sensing devices, robot interaction, and VR devices have evolved, and the user's physical activity can now provide instructions, creating a new type of human-computer interaction. Intuitive operation can make users feel the same sense of operation in the virtual world as in the real world, and the sound, tactile, and visual stimuli directly fed back to the user after the operation can increase the user's sense of presence in the virtual world. However, there are issues with existing hardware devices such as wand controllers and depth cameras, which cannot provide users with intuitive operations (passive interaction). Moreover, current interactive robots can only provide feedback in the physical world. Therefore, the main research problem to be solved through the proposed hardware and software in this research is to provide an intuitive and immersive interaction procedure to increase the immersive experience in VR. This research can be divided into four aspects.

First, the existing VR device controller mimics the user's hands in the virtual world. However, the actual operation method is through the equipped touchpad, trigger, and buttons, using touch, press, or slide to interact and operate with the objects in the game. Therefore, the research proposes a wearable motion tracking device and a VR glove. The researchers aim to combine feedback from gesture operations with VR and somatosensory control to achieve a more intuitive and humanized human-computer interaction (HCI) for head-mounted VR devices.

Second, interactive gestures between users and animals or friends in the real world are usually continuous gestures, such as waving, clapping, and touching. However, existing gesture recognition usually only recognizes static gestures (fist or OK sign). Therefore, this research proposes an algorithm to recognize continuous gesture interactions so that users can interact with characters in the virtual world through gestures, just like in the real world.

Third, in the virtual world, interactive objects between the user and the game are usually classified as objects or virtual characters. However, when the user grabs or pulls the objects in the game through the controller, they cannot feel real feedback. To reproduce the interactive feeling of holding objects of various shapes and behaviors with both hands, this research proposes the use of intuitive manipulation of VR gloves to allow users to stretch, bend or twist flexible materials and display the corresponding

physical deformation on the virtual object. The realization allows users to perceive the difference between virtual and real tactile sensations only with their hands.

Finally, it is not enough to provide only visual feedback in the virtual world but also tactile and auditory feedback in the real world. To achieve an easy-to-read human-computer interaction target interface, the research proposes an interactive doll that can also show how the user's daily behavior is integrated into the virtual world. When interacting with characters, the feedback that virtual characters can bring to users is a very important factor. Therefore, this research will develop an interactive doll that integrates visual, auditory, and physical tactile feedback to simulate the sense of presence brought by the interaction of virtualization and realization. By integrating data gloves, persistent gesture interaction, and interactive dolls, this research aims to provide intuitive and immersive interactions between virtual and physical realities to increase the presence experience in VR.

Keywords: Human-Computer Interaction, Free-hand Interactions, Intuitive Manipulation, Virtual Reality, Embodied Operation.