HidEye: Proposal of HMD Interaction Method by Hiding One Eye

ABSTRACT

Immersive head-mounted display (HMD) provide a highly immersive experience by blocking the view of the real space, but using them for an extended period in daily life is challenging due to difficulties in switching tasks between virtual and real spaces and communicating with neighbors. We propose HidEye, an interaction method that enables users to easily switch contents by covering one eye. The goal is to seamlessly integrate tasks in virtual and real space through natural movements, without the need for special sensors or other devices on the HMD.

CCS CONCEPTS

• **Human-centered computing** → **Gestural input**.

KEYWORDS

Head Mount Display, Virtual Reality, Mixed Reality

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1 INTRODUCTION

In recent years, immersive HMDs have been used not only for entertainment (e.g., VR games,) but also for office work (e.g., taking notes)[1]. When using an immersive HMD in a public space (e.g., office), it is necessary to pay attention to the surrounding environment. However, since immersive HMDs cut off the user's view, the user often has difficulty to operate objects in the real world or to communicate surrouding people during work. Therefore, the immersive HMDs are not suited for the casual use in daily life. To solve these problems, Endo et al [2] proposed a novel HMD using a modular mechanism that can be reconfigured manually. The HMD is composed of two side and one bottom detachable display modules to enable interaction with the outside world as needed while ensuring a highly immersive VR experience. By removing the bottom module, the HMD can be used as an input device, and by removing the side modules, the HMD provides a means of communicating with the person in the vicinity while continuing the VR experience. To check the situation in the real world while watching VR contents using the HMD, it is necessary (1) to physically deform or remove the HMD, or (2) to use a video pass-through function. However, it is bothering to remove the HMD each time. The pass-through function allows the user to check the situation in the real space while wearing the HMD, but the VR contents become invisible, reducing the sense of immersion. Here, we propose a method of superimposing the virtual space and the pass-through function by triggering a natural motion, which allows the user to check the situation in the real space while maintaining a certain degree of immersion in the virtual space. We focused on the act of covering one eye with one hand as a triggering behavior. We may focus on a specific task by covering/closing one eye when performing a vision test or looking through a camera viewfinder or a telescope, for example. In addition, Joe Navarro reported that the act of "covering the eyes with a hand" is considered to be a psychological intercept what a person does not want to see [3]. Therefore, we considered that the act of "covering an eye" is a clear way to block out the current content (e.g., VR space) and move on to another one(e.g., real space). In this study, we propose HidEye, an interaction method that enables users to easily switch between virtual-space and real-space contents by superimposing VR contents and a pass-through function with the movement of covering one eye (Fig. 1). The goal is to seamlessly link tasks in virtual and real spaces with natural movements, without the need for special sensors or other devices on the HMD.

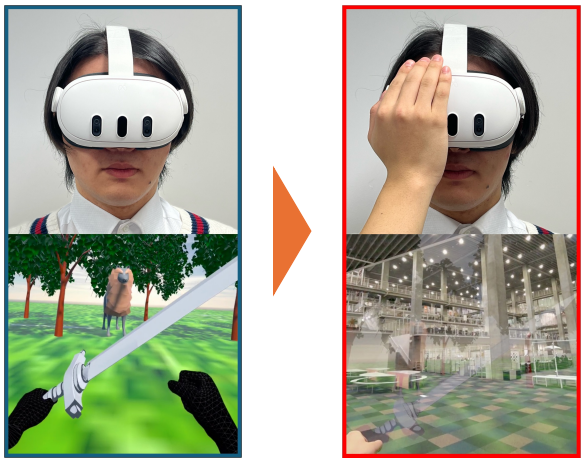

Figure 1: Switching the content displayed on the HMD by performing the act of covering one eye.

2 IMPLEMENTATION

In this study, we introduce an interaction method called HidEye, designed for seamless switching between virtual-space and real-space content by covering one eye while using an immersive HMD (Fig. 1). This method involves superimposing a pass-through function on the VR contents, allowing users to assess the real-space situation while maintaining a certain level of immersion in the virtual space, all without removing the HMD. Its distinct feature lies in its activation through the natural movement of covering one eye, making it achievable using only the HMD, without the reliance on external sensors or a microcomputer. The HMD chosen for this

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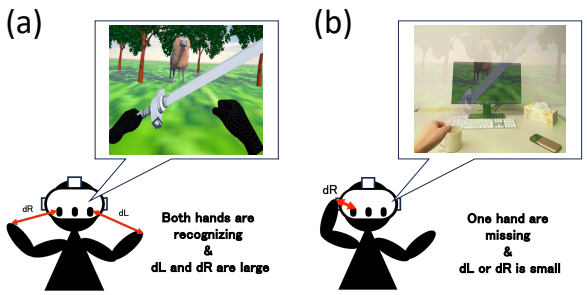

Figure 2: Basic Mechanism. (a)The system calculates the distance between the left hand and the left eye (dL) and the distance between the right hand and the right eye (dR) respectively. (b)When the hand-tracking of one hand disappears and the value of dL or dR is enough small, the system judges that one eye is hidden.

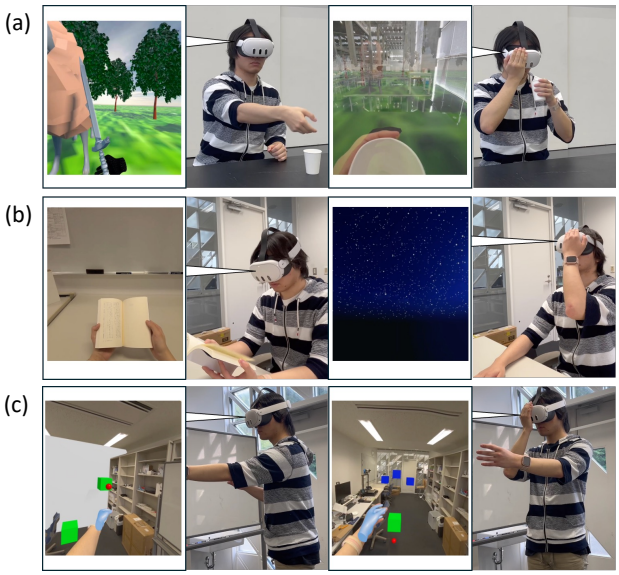

Figure 3: Application examples using HidEye. (a)Pausing the VR game for drinking water, (b)Taking a break in MR task and watching the starry sky in VR, (c)Removing the virtual wall and shooting the hidden targets.

study was MetaQuest3.The main unit is equipped with RGB color cameras (18 PPD, 4 megapixels) on the left and right sides, and a depth sensor and microphone in the center. Additionally, tracking sensors are positioned under the left and right RGB cameras and on both sides of the main unit, enabling full-color pass-through and high-resolution hand tracking. The development environment involved the use of Unity, with the editor version being 2022.2.8f1.The Meta XR Core SDK asset was used to develop VR content compatible the MetaQuest3. In this proposed study, we implemented a detection function for tracking the movement of covering one eye using hand tracking in MetaQuest3. Hand tracking recognizes the 3D shape, position, and posture of the fingers through an infrared camera mounted on the HMD. Using this information, an interaction method is introduced that superimposes a 3D model of the hand in the VR space. However, it is important to note that in hand tracking, if the hand goes beyond the camera's angle of view, it becomes unrecognizable (disappears). In our study, we considered that the coordinates of the hand before its disappearance could be used to estimate its status. In other words, when one hand disappears from a position very close to the camera, it is recognized as an action to cover one eye. Fig.2 shows the flow of motion detection. This proposal aims to improve the everyday usability of HMD by implementing a pass-through superimposed display triggered when covering one eye. To demonstrate the practical application for this concept, we have created a simple example. In Fig. 3.a, a user engaged in a VR game temporarily interrupts the experience by covering one eye to pick up a cup of water from a desk in the real space and take a drink. Once the hand is removed from the eye, hand tracking is restored, allowing the user to immediately returns to the VR game. Conversely, in Fig. 3.b shows an example of displaying VR content that hides one eye, providing a brief respite for the eye while engaging in MR-like tasks using the pass-through function. The scenario of unintentionally covering one's eyes with hands when fatigued was implemented as a metaphor. Figure 3.c shows an example of a MR target shooting game. The user can shoot targets by fliping fingers. Each shot usually reflects on surfaces of both real/virtual walls. When the user hide one eye, the virtual wall become disappeared and enable to shoot hidden targets.

3 DISCUSSION AND FUTURE WORK

In this study, we propose an interaction method, HidEye, to easily switch between virtual and real-space content by covering one eye while using an immersive HMD. In the future, we would like to demonstrate the effectiveness of this method through the construction of various application examples. The proposed method's effectiveness and key aspects will be further explored and verified.

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