ReverseCAVE: Providing Reverse Perspectives for Sharing VR Experience

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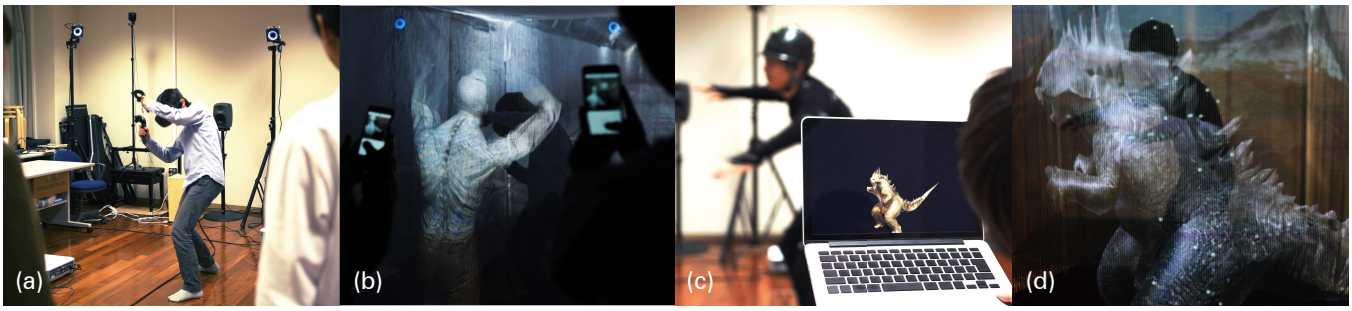

Figure 1: Conventional situation (a, c) and result of our method applied (b, d). a, b) One is playing the VR game and being attacked by a zombie. c, d) One is an actor acting as a creature using a motion capture system. In (a) and (c), it is difficult to understand what one is doing, however, in (b) and (d), we can understand what one is doing in the physical space.

ABSTRACT

Virtual reality (VR) with HMD is closed experience among those who are experiencing the VR, and can only be individually experienced by the specific person. We call this "*perspective gap*." These perspective gaps exist in many situations. To address these problems, we present "*ReverseCAVE*", a system for sharing the experiences of people in VR with others (observer). As another application, it is possible to visually recognize the actual appearance of the person performing the act at the motion capture studio and the superimposed character at the same time. ReverseCAVE has four translucent screens surrounding the player. VR environment that the player is experiencing is projected onto the screens. By this, the observer can see both the physical player and the VR environment experienced by the player simultaneously. Also, in the motion capture system, when viewing the actor from the observer outside of ReverseCAVE, the character is superimposed to the actor. This makes it look as if the actor is the actual character from the observer. ReverseCAVE enhances the observers' experience.

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CCS CONCEPTS

•Human-centered computing →Mixed / augmented reality;

KEYWORDS

Environmental VR, mixed reality (MR), sharing experience

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1 INTRODUCTION

Head mounted display (HMD) is rapidly spreading as a device for experiencing virtual reality (VR). It is important to be able to share VR experience with others [Biocca and Levy 1995]. However, VR with HMD is closed experience among those who are experiencing the VR, and can only be individually experienced by the specific person. In many cases, VR player cannot share the experiences with people not wearing HMD. We call this problem "*perspective gap*." To solve this problem, for example, SAVE [Zhu et al. 2016] superimposes the image of the person who is experiencing VR onto the VR environment, and displays this to the LCD monitor.

* Ishii and Tsuruta contributed equally to the work.

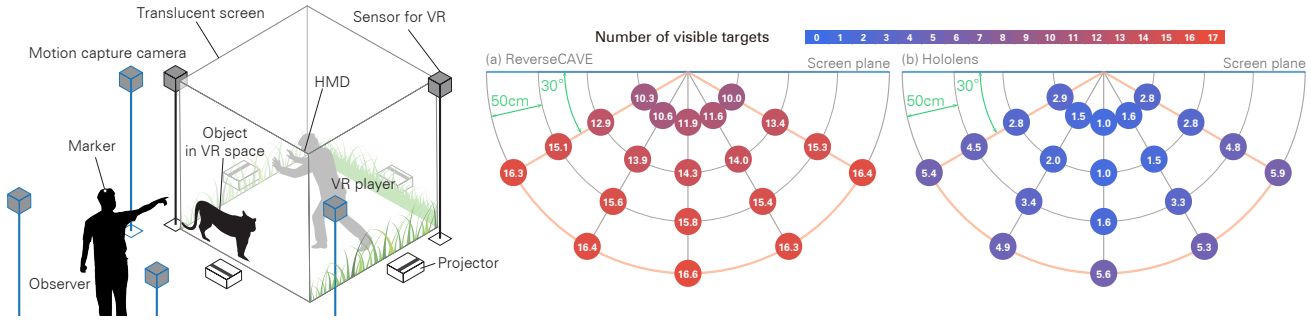

Figure 2: Left: Overview of ReverseCAVE for sharing VR Experience. Right: Result of the experiment. Red color is better.

We focus on these perspective gaps in VR and computer graphics applications. These perspective gaps exist in many situations (e.g., VR games in game shows, actors and observers in the motion capture studios, telepresence situation in conferences). To address such problems, we present "ReverseCAVE", a system for sharing the experiences of people in VR environment (player) with others (observer), as shown in Figure 1 (a, b). Observer can also visually recognize the actual appearance of the person performing the act at the motion capture studio and the superimposed character at the same time, as shown in Figure 1 (c, d). As similar to CAVE, ReverseCAVE has four screens surrounding the player. The VR environment that the player is experiencing is projected onto the screens. By this, the observer can see both the physical player and the VR environment experienced by the player.

2 IMPLEMENTATION OVERVIEW

ReverseCAVE consists of a motion capture system, a cubic translucent screen, and projectors, as shown in Figure 2 (Left). The motion capture system is used to acquire the position of the observer to calculate the projection position. The VR environment that the player is experiencing is projected onto the screen. Also, in the motion capture studio, when viewing the actor from the observer's side, the character is superimposed to the actor. This makes it look as if the actor is the character from the observer. The character's position changes corresponding to the position of the actor and observer. In other words, the character is superimposed on the intersection point of the eye-line (between the observer and actor) and the projecting plane of ReverseCAVE.

3 EVALUATION

We conducted an experiment to explore the viewing angle of contents. Eight participants (all males) aged between 19 and 23 years (mean: 21.6) participated in the experiments. Three participants had normal vision and five participants had corrected vision.

Sharing VR experience can also be achieved using Hololens. However, ReverseCAVE and Hololens have different viewing angles. Therefore, we examined the influence of the viewing angle on the visibility of content. We conducted an experiment using two conditions, with ReverseCAVE and with Hololens. We used the same content in both conditions. As part of the VR content, 17 spherical objects radially arranged from the center of the front translucent screen were used. We set several standing positions placed in front of the screen (Figure 2 (Right)). At each point, the participant described the number of objects viewed, while facing the direction to the central object. In addition, the participants were instructed to gaze at the central point of the object, and not to move their gaze and neck.

System	Payload	Viewing angle	Free viewpoint
ReverseCAVE	None/Marker	V 135° / H 114°	Yes
Hololens	Headset	V 50° / H 35°	Yes
SAVE	None	Depends on setup	No

Table 1: Comparison of systems to share VR experiences.

The results of the experiment (Figure 2 (Right)) show that using ReverseCAVE, observers can visually recognize a larger range of content at each standing position compared to Hololens. The visible range of the content is limited to the viewing angle of Hololens. However, since ReverseCAVE is not affected by other than the humans' viewing angle, it is possible for the user to visually recognize the contents in a broader range.

4 DISCUSSION

Table 1 indicates the comparison of three systems to share VR experiences. ReverseCAVE has a wide viewing angle compared to other systems and users can see from free viewpoints. In addition, ReverseCAVE is suited for public usages (e.g., game shows) because the payload is light. However, with multiple observers, some observers see misaligned VR environment. In other words, there are trade-offs between visual consistency and the number of observers. We assume that the visual consistency does not relate to the understanding of the VR situation. Therefore, we plan to conduct another experiment to explore this hypothesis.

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