Levitar: Real Space Interaction through Mid-Air CG Avatar

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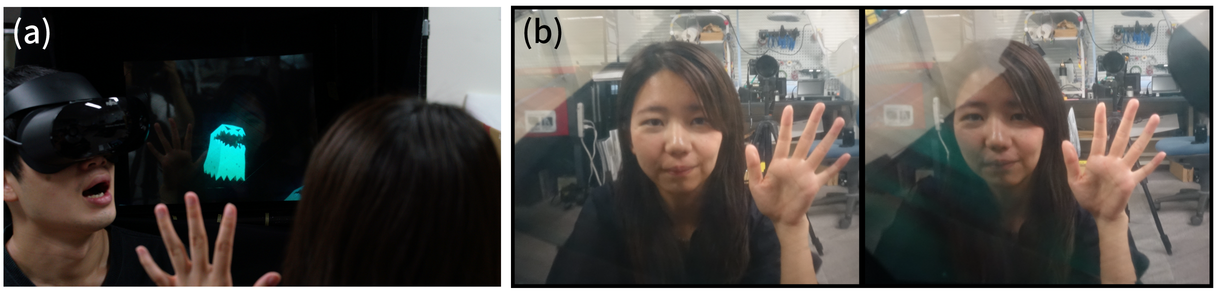

Figure 1: (a) User controls a motion of the mid-air CG avatars using an HMD tracking system and our proposed system, (b) he can see the video from the viewpoint of a mid-air image via the HMD.

ABSTRACT

In this paper, we propose a system for using computer graphic (CG) avatars to re-design human-to-human interactions in real space. Virtual reality (VR) social networks enable users to interact with each other through CG avatars and to choose their appearances freely. However, this is only possible in VR space. We propose a system that takes the avatar from VR space to real space with the help of mid-air imaging technology. The video captured from the mid-air image position is presented to the user via a head-mounted display. Our technical contribution is the design of a mid-air stereo camera in which the gaze direction is synchronized with the user's head movements. A simple mechanism that rotates the mirror and the camera independently enables a complex horizontal and vertical gaze control of the mid-air stereo camera.

CCS CONCEPTS

• **Human-centered computing → Displays and imagers**.

KEYWORDS

mid-air image, telepresence, virtual avatar

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1 INTRODUCTION

If you ever wanted to change your appearance, virtual reality (VR) might be one of the ways to fulfill this aspiration. Using a head-mounted display (HMD), we can transform ourselves into a computer graphic (CG) avatar in VR space. The appearances of the CG avatars can easily be changed, so we can choose different characters without any physical restrictions. However, at the moment, this possibility is limited to VR space. The next step is to extend it to real space. Although an existing system can connect VR users and AR users [Piumsomboon et al. 2018], the VR users remain in the VR space.

In this paper, we propose the Levitar, which takes the avatar from VR space to real space with the help of mid-air imaging technology (Figure 1 (a)). A video captured from the mid-air image position is presented to the user via the HMD (Figure 1 (b)). We control the camera gaze direction according to the user's head movements. In other words, this system provides the user with an experience of becoming a mid-air CG avatar and interacting with other users in real space.

2 SYSTEM DESIGN

The optical design and system flow are shown in Figure 2. The optical system consists of a camera, two concave lenses, a display, a beam splitter, and the micro-mirror array plates (MMAPs). This design is based on the design of previous research [Tsuchiya et al. 2018]. We also referred to the design of the previous research [Jones et al. 2009] to place the camera and the display in conjugate positions.

Light from the display passes through the beam splitter and is reflected by the MMAPs to form a mid-air image. By reflecting the camera with the beam splitter, the virtual image of the camera (virtual camera) is superimposed on the display. The MMAPs form the mid-air image with the light from the display and transfer the

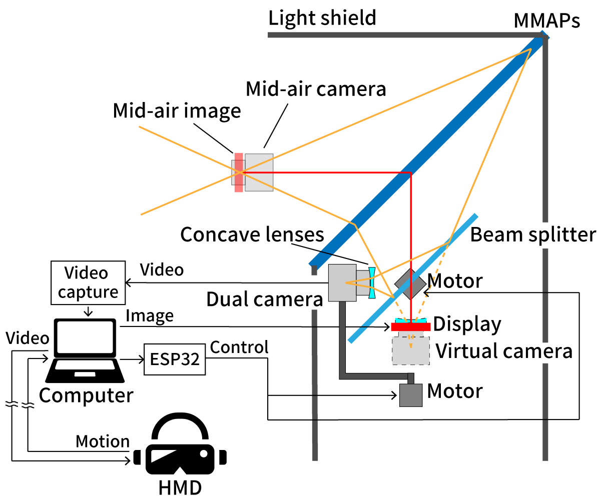

Figure 2: Optical design & System flow

virtual camera to form the mid-air camera. Thus, we can display the mid-air image and capture a user who observes the mid-air image from that viewpoint. The camera is a dual camera, and the captured video is displayed on the HMD. Furthermore, we control the camera gaze direction with two motors synchronized with the head movements of the HMD wearer. At the same time, we can change the facing direction of the CG avatar on the display.

An overview of the camera gaze control is shown in Figure 3. The gaze is controlled horizontally and vertically by two motors. The camera is moved to control the gaze in the horizontal direction.We control the gaze direction of the mid-air camera by moving it in an arc. The beam splitter is rotated to control the gaze in the vertical direction. We control the gaze direction of the mid-air camera by rotating the beam splitter around the intersection of the camera gaze and the beam splitter. The radius of gyration control is 90 mm, which is close to the radius of the human head.

3 IMPLEMENTATION

The implementation of the system is shown in Figure 4. We used two Sony RX0 cameras for the dual camera. The focal length of the concave lens was -250 mm, and the reflectivity of the beam splitter was 70%. The MMAPs were ASUKANET ASKA3D-Plate (size: 488 mm × 488 mm, pitch: 0.5 mm), and the display was Feelworld FW279S (IPS, 7 inch, 323 ppi). We covered this equipment with black clothes to avoid the effects of ambient light.

4 EXPERIENCE

The system enables users to transform themselves into CG avatars and interact with other users in real space. The users can communicate with other users through various CG avatars without revealing their own appearances. From the perspective of a user who observes the mid-air image, it makes human-to-human interaction in a real space such as an amusement park more enjoyable. The appearance of a customer service agent at the park, for example, can be changed according to the visitor's preferences.

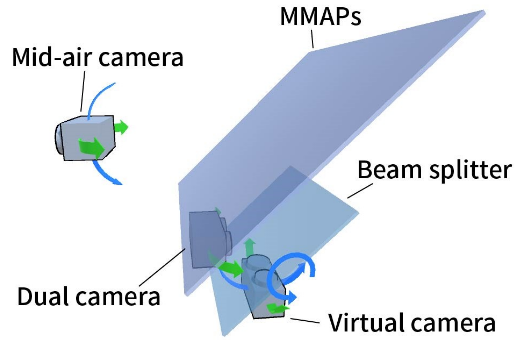

Figure 3: Overview of camera gaze control

Figure 4: Implementation

5 CONCLUSION

In this paper, we proposed the Levitar for levitating CG avatars in real space. In this system, the video captured from the mid-air image position is presented to the user via the HMD. Furthermore, we added a function to control the camera gaze direction synchronized with the user's head movements. The system provides the users with an augmented experience of transforming themselves into a mid-air CG avatars.

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