Afterglow Projection: Virtual Information Projection Method to Real Environment Using Pico Projector in Mixed Reality

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Figure 1: Remaining of projection in the real environment (left), and application images (center, right)

ABSTRACT

Projection-based mixed reality (MR) is a method of superimposition that projects virtual information on real environment using a projector. In previous studies, a method using a pico projector as an operation device has been proposed. However, the projection range and the continuity of information presentation are limited. In this research, we replace the projection of the pico projector with a ceiling projector installed in the environment and leave it in place. In this manner, a plurality of virtual information is realized simultaneous with the continuous presentation to the real environment.

CCS CONCEPTS

• **Human-centered computing** → **Mixed Reality**;

KEYWORDS

Multi-Projector, Projection-Based MR, Mixed Reality

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1 INTRODUCTION

Projection-based mixed reality (MR) directly combines virtual information into the real world using a projector [Jones et al. 2014; Mine et al. 2012]. In this method, because the user can visually recognize the virtual information without using a head-mounted display or tablet, multiple people can easily view this information. In addition, virtual information can be overlaid along the shape of a real environment. In the projection-based MR, an operating method has been proposed in which users themselves project arbitral virtual information on a real environment using a pico projector [Schmidt et al. 2012; Willis et al. 2013; Yoshida et al. 2010]. However, the pico projector suffers from the limitation in which the projection range is narrow and the amount of virtual information that can be presented is small. In addition, the luminance is also low; thus, the environment application is limited. In this research, in addition to the pico projector, ceiling projector (the hanged projector from the ceiling) to install in the real environment. Using this ceiling projector, the virtual information projected from the pico projector is replaced depending on the arbitrary timing of the user. As a result, because the virtual information remains in the real environment, the presentation can be sustained.

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2 PROPOSED SYSTEM

This system consists of a tracking system, a pico projector, a ceiling projector, and a tangible object. The system concept is shown in the figure.2. First, the user holds the pico projector as an operating device so that virtual information can be freely projected to a real space. Depending on the projector characteristics, the angle of view of projection increases in accordance with the distance between the projection surface and pico projector. Therefore, quickly changing the size of the virtual information is possible. In addition, because the image is projected along the shape of the real environment to be projected, the user can possibly superimpose the virtual information in a form that he can easily see. A ceiling projector is used to leave the virtual information projected from the pico projector in the real environment(see Fig.1 left). This process is realized by replacing the projected image of the pico projector with the same image projected from the ceiling projector. To project the

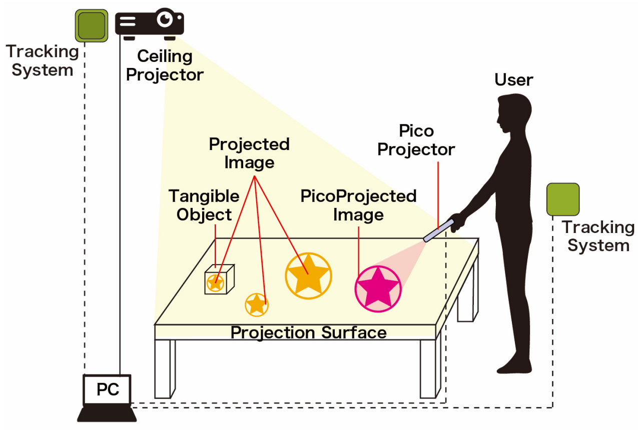

Figure 2: System Concept

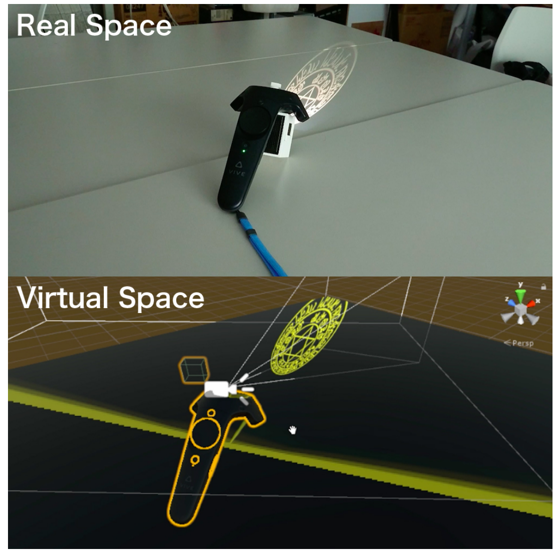

Figure 3: Real Space and Virtual Space

same image from the ceiling projector, the real space is reproduced in the virtual space using Unity. The shape of the real space is reproduced, the projection angle of view of the pico projector is used, and the virtual information is projected (see Fig.3). The virtual pico projector reflects the position and angle of the actual pico projector on the real environment, which is recognized using the HTC Vive Lighthouse. Therefore, the virtual information with the same position and shape as the virtual information projected on the real environment can be generated in real time. By projecting this generated image from the ceiling projector, the virtual information projected from the pico projector by the user can be duplicated and left on the spot at an arbitrary time. In addition, a smartphone is attached to the pico projector. The user can freely select the virtual information using the interface displayed on the attached smartphone. Further, an object called tangible object is prepared using Vive Tracker attached to the real object. When virtual information is projected on the tangible object, the virtual information is associated with the tangible object. Because the position and angle of the tangible object are always tracked, the superimposed virtual information can be possibly made to follow the real object. As a result, the user can directly manipulate the virtual information by directly picking up the real object.

3 APPLICATION

We implemented a application that can project images and movies. As an example, users could take notes similar to a bulletin board by projecting screenshots of smartphones, and paste textures on objects to change their appearance. In addition, by projecting a movie, arranging multiple videos at desired positions and sizes and viewing them at the same time could be made possible. Effects and annotations could be applied to real objects using tangible object(see Fig.1 center). Further, In addition, the user can move and rotate them by using tangible object (see Fig.1 right). Moreover, in this study, the same object projected as a picture in the pico projector is reproduced in virtual space. We will consider not only duplicating the same object but also creating new virtual information using the ceiling projector by adding images to the projected image from the pico projector. A new application method can be realized by expanding the coordination of such multiple projectors.

4 CONCLUSIONS AND FUTURE WORK

In this research, we extended the projection range and sustainability of projection-based MR that uses a pico projector as an operating device. In the future, by organizing multiple high-precision projectors, we will reduce the discomfort during projection transition and perform user experiments on them. In addition, we will also consider a method of projecting information to an entire space. By then, with reference to Jonesś work [Jones et al. 2014], the placement of many projectors and measurement of the shape of a real environment using a depth sensor such as Kinect will be realized. Thus, using a real environment with a complicated shape as the projection plane can be possibly realized.

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