A Study of Autostereoscopic Transparent Display with Directional Display

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***Abstract*— In this study, we propose a stereoscopic transparent display that can be viewed with the naked eye. The purpose of this study is to blend realistic images more naturally into the surrounding environment. Presented images can be observed with naked eye and from all sides in midair using a directional display and Pepper's ghost technique. The prototype confirmed that high-resolution images merge with the environment.**

I. Introduction

Various methods have been proposed to create realistic images. An example of autostereoscopic technology, which is one of these methods, includes head-mounted displays and fly-eye lenses. However, these approaches can cause discomfort due to the fatigue of wearing the device or the strong visibility of the stereoscopic display itself, as well as low resolution.

Therefore, we propose a transparent curved display that seamlessly blends into the environment without degrading the image resolution. This is achieved by creating directionality that presents images in a specific direction.

II. Proposed Method

In this research, we propose a transparent display that presents stereoscopic images visible to the naked eye. The proposed system is composed of a time-multiplexed directional display and a transparent reflector. The autostereoscopic images are generated by a directional display, which presents separate images to the left and right eyes. Additionally, these images are presented inside the reflector using Pepper's Ghost technique, an illusion technique for presenting virtual images.

In the proposed directional display, the light source and liquid crystal elements of a typical liquid crystal display are separated and placed at a distance from each other. Figure 1 shows the principle of the directional display. Directional parallax images are presented by adjusting the display position of the parallax images for the right and left eyes and the position of the light source according to the observer's position. Stereoscopic images are generated by rapidly switching between the parallax images for the right eye and the left eye.

A transparent reflector is placed at an appropriate angle on the directional display. Consequently, virtual images of stereoscopic images displayed by the directional display are presented in the reflector.

Furthermore, the reflector is formed into a conical trapezoidal shape so that stereoscopic images can be observed from all sides [1]. By changing the display position of the image according to the position of the observer and applying a geometric correction to the image, distortion-free parallax images are presented inside the reflector, allowing the observer to perceive a stereoscopic image.

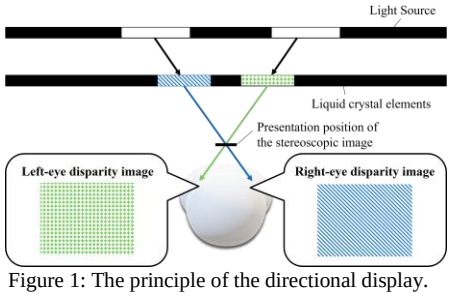

Figure 1: The principle of the directional display.

III. Results

Figure 2(a) illustrates a prototype device of the proposed method. When stereoscopic images were represented as white ellipses, the results of capturing parallax images are shown in Figure 2(b). At this point, stereoscopic images were presented at four different depth positions within a range from 35mm in front to 10mm behind the virtual image presentation position, which was set at 0mm, and the observation position was in front of the stereoscopic images.

The results indicate that the directionality of parallax images was maintained at all depth positions. Furthermore, in a separate experiment using a different 3D model as a stereoscopic image, stereoscopic images were observable at all of these depth positions.

In the future, we plan to enhance directionality to reduce crosstalk and enable observation from all angles.

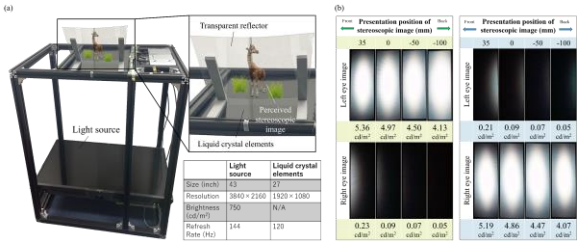

Figure 2: (a)Front view of prototype display, (b) Obtained parallax images.

References

[1] Luo, Xuan and Lawrence, Jason and Seitz, Steven M.:Pepper's Cone: An Inexpensive Do-It-Yourself 3D Display", Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology (2017)

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