20a-C4-2

Three-dimensional see-through display using resolution enhanced lens-array holographic optical element

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Recently, there were some efforts to realize a see-through 3D display using an integral imaging method [1]. By adopting a lens-array holographic optical element (HOE) in the display devices for the augmented reality, it is able to display 3D images with the see-through property. Since the HOE reacts as an optical element only to the Bragg-matched light, it can have optical see-through property for Bragg-mismatched light. In this paper, we present the see-through 3D display system using resolution enhanced lens-array HOE by the recording plane control method.

We propose the recording plane control method for the lens-array HOE to reduce the lens pitch of recorded lens-array HOE. Since the wavefront after passing through the reference lens-array is a spherical wave, size of recording area for the wavefront is varying according to changing the distance of its propagation from the reference lens-array. If we record the wavefront of the reference lens-array on the photopolymer which is located at the distance of half of the reference lens-array's focal length, it is possible to make a lens-array HOE which has a half lens size. In this case, four times of recording process is needed to fill the whole recording plane on the photopolymer because the size of the recorded area in single recording process is one fourth of the recording plane area. We performed these sequential recordings by shifting the photopolymer parallel to the reference lens-array. Since the lens pitch of the lens-array HOE becomes half of the conventional one, resolution of reconstructed 3D image is enhanced by four times, maintaining the viewing angle since there is no change of the numerical aperture on the recorded lens-array HOE compared to the reference lens-array.

The results of reconstructed 3D images by using the proposed lens-array HOE are shown in Fig. 1. The resolution of reconstructed 3D images is enhanced by four times when we use the lens-array HOE with the proposed recording plane control method. Each perspective view image shows the correct disparity according to the observer positions.

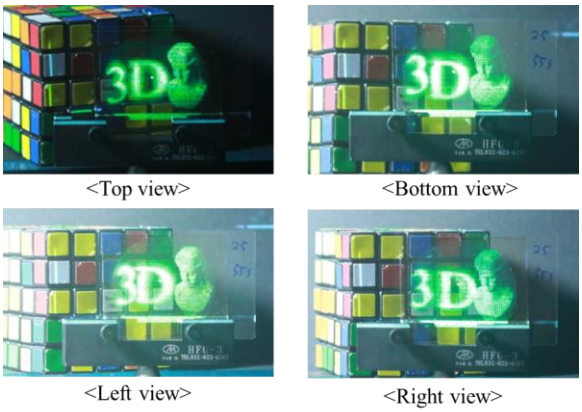

Figure 1. Reconstructed 3D images using the proposed lens-array HOE captured at different view positions.

Acknowledgement

This work was supported by the IT R&D program of MSIP/KEIT (Fundamental technology development for digital holographic contents).

Reference

[1] K. Hong, J. Yeom, C. Jang, J. Hong, and B. Lee, "Full-color lens-array holographic optical element for three-dimensional optical see-through augmented reality," Opt. Lett, **39**(1), 127-130 (2014).