Viewing-window extension of holographic display using high-order diffraction

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Abstract: Viewing-window extension is one of the solutions to both binocular and narrow window of viewing problems. In this study, we show the possibility of the viewing-window extension using high order diffraction.
OCIS codes: (090.0090) Holography; (090.2870) Holographic display; (070.0070) Fourier optics and signal processing

1. Introduction

Recently, the research and development of three-dimensional (3D) holographic display is very active. One of the big problems with 3D holographic display is the narrow viewing window. Various research has become issues to extension of viewing window. The viewing window means a space in which an observable image is formed [1, 2]. The viewing window is related to the static structural factor such as the resolution of the panel, the pixel pitch, the observation point, and the focal length of the field lens. In this study, the viewing-window extension method is proposed using higher order diffraction are used to expand the narrow viewing window.

2. High order diffraction and viewing-window extension

High order diffraction occurs by black matrix of the panel [3]. The black matrix is the region outside of active region in a unit pixel of spatial light modulator. This structure has a lot of type. Also, the shape of the high order diffraction pattern is changed by the shape of the pixel structure. The pixel structure of the spatial light modulator (SLM) usually have rectangular structure and Fourier transform result of rectangular represent sinc function. In the higher order region, signal has lower energy. But we can observe the signal in 1-st order diffraction with enough energy.

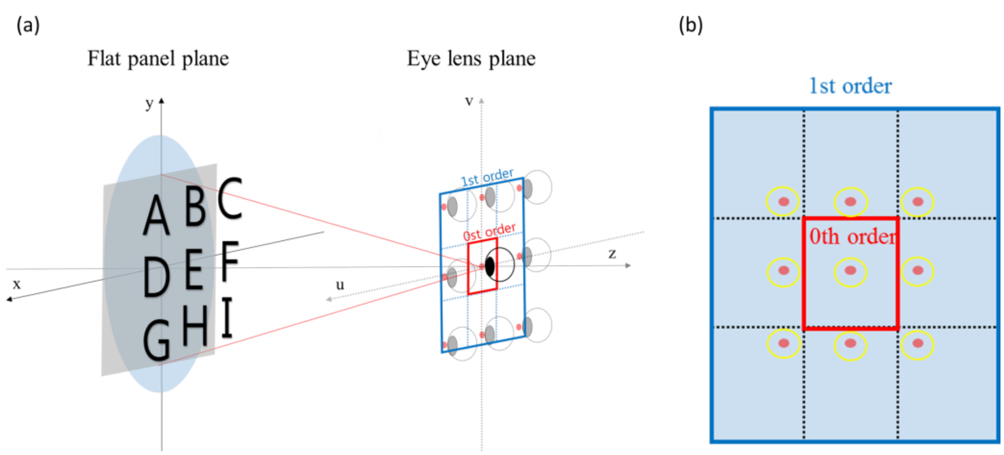

Fig. 1. (a) Schematic diagram, (b) viewing-window

Figure 1. (a) means eye lens plane schematic diagram through the filed lens and flat panel. Computer generated hologram (CGH) is float to SLM panel. The signals of 0-th diffraction field and 1-st diffraction field generated on the eye lens plane. Each diffraction field has all signals shown in fig 1. (b). We use a method of sending signals to wherever we wanted using phase shifting. And, all CGH are multiplexed with combined the CGH in all cases. We can observe same object in spot of 0-th order and each 1-st order field. Because each field has same CGH. In other words, you can observe the same object everywhere in the viewing window. If we only use up to 1-st diffraction field, the viewing window will be three times. If we use up to 2-nd diffraction field, the viewing window will be five times, but the quality will lower.

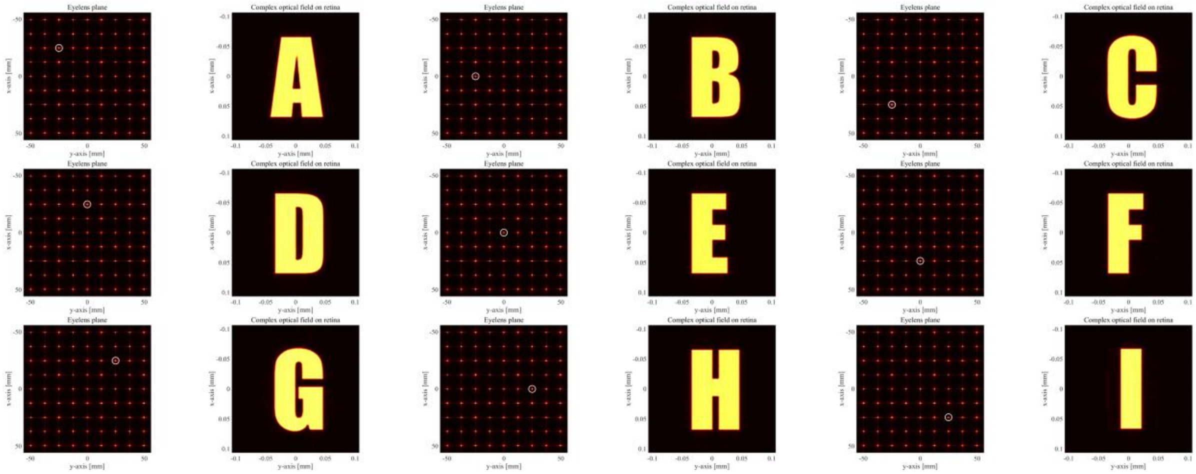

Fig. 2. Results of simulation

We simulate the extension of viewing window shown as figure 2. Alphabet ‘E’ has center signal. The signals of another alphabet are in the remaining positions except for the center signal for ‘E’. The simulations used different objects to identify observations in the 0-th diffraction field and 1-st diffraction field. If all objects were equal, we can observe the equivalent object at any spot in the viewing window. This simulation has condition that pixel pitch is 8.5um (SLM) , resolution is 1000×1000, focal length of field lens is 0.5m, locations of object are different in z-axis, and red laser is 633 nm.

3. Conclusion

We demonstrate extension of viewing window using high order diffraction through simulation. As we expected, the viewing window is three times, and if the higher the black matrix ratio, then we can use more high order diffraction. The ultimate goal of this study is the extension of the viewing window using color simulations and uniform intensity.

Acknowledgement

This work was supported by Samsung Future Technology Fund of Samsung Electronics Inc. under Grant Number SRFC-IT1301-07.

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