Metamaterial based active complex modulation for ultimate holographic 3D display

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1. Introduction

Recently, the hologram display has been spotlighting attention as the next generation display technology and research and development are proceeding [1]. Generally, spatial light modulator (SLM) is mainly used for amplitude or phase modulation to generate holograms and it must need additional optical systems, which is applied to eliminate DC or conjugate noise. Therefore, the technique of the SLM for complex modulation has been continuously studied to reduce the volume of the optical system and efficiently generate the hologram. In this paper, we propose a spatial optical modulator source technology with complex modulated single pixel that can modulate amplitude and phase simultaneously using photonic crystal structure with double zero index (DZI) characteristics and effective medium phase delay structure of subwavelength scale [2-3].

2. General Instructions

A single pixel structure is shown in Fig. 1 that can simultaneous control of amplitude and phase. The complex modulation single pixel can be realized with a multilayer integrated structure in which two optical layers having unique functions, is stacked on a transmission type amplitude LCD (SLM). The incident light toward the LCD is modulated with each amplitude passing through three amplitude-modulated subpixels, and the light wave passing through each pixel has a phase difference of $0(rad)$, $2\pi/3(rad)$, $4\pi/3(rad)$ through three phase delay layers (TPRL). The three light waves with relatively phase delay are then combined by a three-pixel combiner layer (TPCL) as shown in Fig. 1.

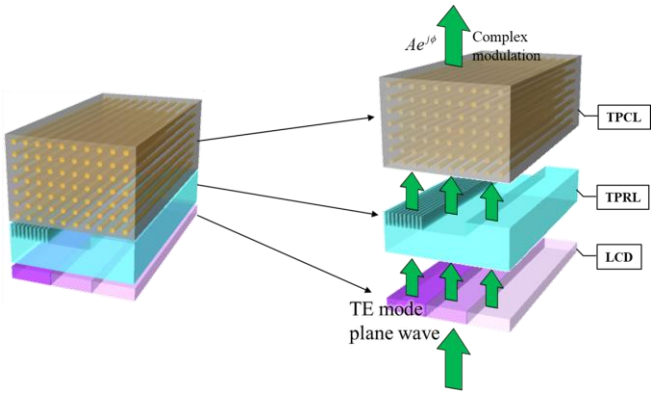

Fig. 1. The proposed 3-layer complex modulation single pixel architecture

The TPCL in Fig. 2(a) is a layer that combines three pixels having the relative phase delay into one optical wave. We can find a two-dimensional photonic crystal structure that excites a plane wave eigenmode with effective low refractive characteristic at a particular wavelength, and that is called a DZI characteristic. The eigenmode with the DZI characteristic can make the effective permittivity and the permeability near zero, and the approximate DZI characteristic can be realized through the two-dimensional photonic crystal structure. The TPCL converts three amplitude pixels with a 120-degree phase difference into complex modulation single pixel by operating as an expander that extremely extends a light wave of each pixels.

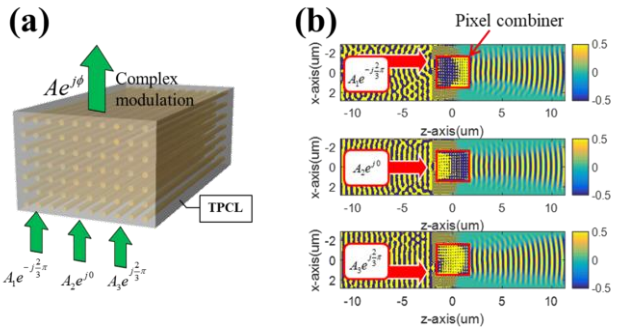

Fig. 2. (a) The proposed 3-layer complex modulation single pixel architecture, (b) Electric field distribution by pixel combiner

3. Conclusions

In this study, it is necessary to design TPCL based on materials such as Amorphous and Polycrystalline silicon, which is suitable for display low-temperature process, and the simulation results of the TPCL operation characteristic are confirmed through Amorphous-silicon based photonic crystal structure as shown in Fig. 2(b).

Consequently, we analyze the active complex modulation technique using the photonic crystal structure of Amorphous-silicon and the phase delay structure of the effective medium.

References

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