Design of Diffractive Optical Elements based on Iterative Fourier Transform Algorithm to reduce DC and Conjugation noise

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1. Introduction

Diffractive Optical Element (DOE) is a device forming a specific diffraction image on the image plane. Generally, it is calculated by iterative Fourier Transform Algorithm (IFTA) in the inverse direction from the three-dimensional information of the target image and incident beam. However, there is a problem that DC noise occurs due to various factors in conventional design method of DOE, and a lot of researches have focused on them [1, 2]. In this paper, we analyze the cause of DC noise from DOE and propose the noise reducing method when the designing the DOE. Moreover, we can recognize the conjugation noise in the binary DOE can be reduced using this method.

2. Method and Results

Generally, the binary DOE has a problem that DC noise and conjugation noise are occurred as shown in Fig. 1 (a). If there are errors in the thickness of the actual process, or in the wavelength of incident beam from designed wavelength, a phase modulation is wrong and DC noise becomes larger as shown in Fig.1 (b) and (c).

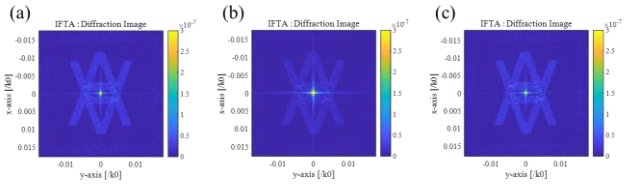

Fig. 1. Simulation results for observed diffraction image of (a) noise for the binary DOE, (b) noise by process step for thickness of DOE, (b) noise by wavelength error of incident beam

To solve this noise problem, we suggest a system that is applying appropriate phase profile of convex lens and entering by a point light source to DOE. The proposed method shows that the signal is located in the correct position, while the DC and conjugation noise are dispersed as shown in Fig. 2.

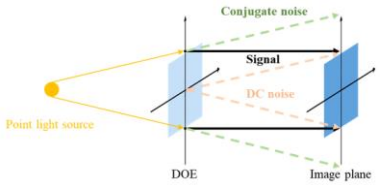

Fig. 2. Design scheme of Diffractive Optical Elements with convex lens profile

In the simulation results of the proposed design method can be seen in Fig. 3, the DC noise and conjugation noise are reduced considerably and hardly appear.

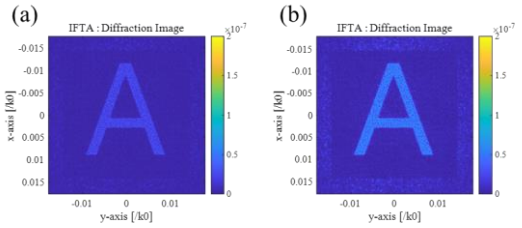

Fig. 3. Simulation results for observed diffraction image with the proposed method. (a) Noise by process step for thickness of DOE, (b) Noise by wavelength error of incident beam

3. Conclusions

In this paper, we analyze the DC noise, which is limits of the binary DOE, and suggest the method of reducing DC and conjugation noise using phase profile of convex lens to the DOE phase profile.

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References

[1] H. Kim, B. Yang, and B. Lee, "Iterative Fourier transform algorithm with regularization for the optimal design of diffractive optical elements," Journal of the Optical Society of America A, vol. 21, no. 12, pp. 2353-2365, 2004.

[2] H. Kim and B. Lee, "Iterative Fourier transform algorithm with adaptive regularization parameter distribution for the optimal design of diffractive optical elements," Japanese Journal of Applied Physics, vol. 43, no. 6A, pp. L702-L705, 2004.