Metalens for structured light

Mu Ku Chen[1], Cheng Hung Chu[2], Hsin Yu Kuo[1], Yu Han Chen[1], Ren Jie Lin[1], Tsung Lin Chung[1], Yi-Teng Huang[1], Jia-Wern Chen[1] and Din Ping Tsai[1,2]
[1]Department of Physics, National Taiwan University, Taipei 10617, Taiwan
[2]Research Center for Applied Sciences, Academia Sinica, Taipei 11529, Taiwan
E-mail: d04245001@ntu.edu.tw

1. Introduction

Metasurfaces have very wide application such as beam deflection, holographic images, polarization generation, tunable meta-devices, sensing, achromatic metalens [1] and pixel-level full-color routing [2][3]. Metalens have great ability in light focusing and can be tailored to exhibit varied functionalities in ultrathin optical applications. A metalens is realized by using integrated-resonant unit elements whose geometric phase are combined with phase compensation from integrated-resonant unit elements. In this work, we use metalens array to project a focused light spots array which has potential in the structure light application.

2. Experiment results

A metalens array is formed by GaN metalens with diameter is 10 μm and 20 μm, respectively. The numbers of the metalens array is 20 × 20 which single metalens with the diameter is 10 μm. And the numbers of the metalens array is 10 × 10 which single metalens with the diameter is 20μm. For the measurement, as shown in Fig. 1, the incident light wavelength is selected by the acoustic optic tunable filter. The circular polarization light incidents to the metalens array sample which is generated by a linear polarizer and a quarter-wave plate. A 20× magnification objective which N.A. is 0.4 is used to focus the incident circularly polarized light onto the metalens array. Another objective (50× magnification, NA = 0.42) is used to collected the focused spot from the metalens array in transmission. A screen is placed 150 cm far away the metalens array to display the focused light spots array. A focused light spots array can be observed in the screen which is 150 cm far away the metalens array under the incident light wavelength is 532 nm. Fig. 2 shows the photograph of the focused spot array in the screen with the diameter of single metalens is 10 μm and 20 μm, respectively. For sensing distance, we can measure the distance between two focusing spots (Δs) to detect the distance between the metalens array and object (Δd). This work opens a great progress for robotic vision, drone vision, automobile driving and geo profiling

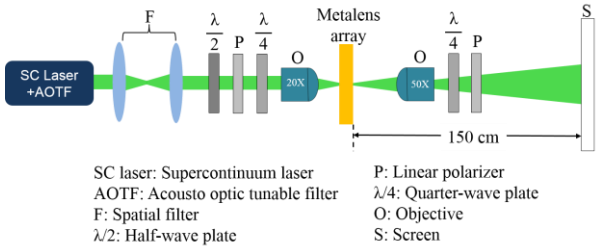

Figure 1. Experiment setup of the metalens array.

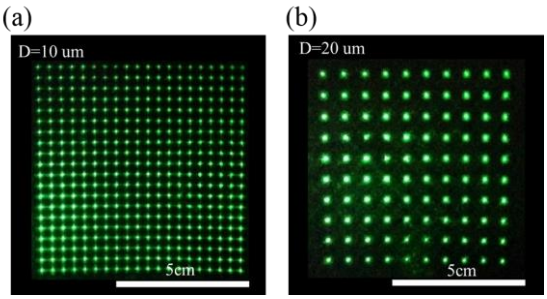

Figure 2. The photograph of the focused spot array in the screen. (a) The diameter of single metalens is 10 um. (b) The diameter of single metalens is 20 um.

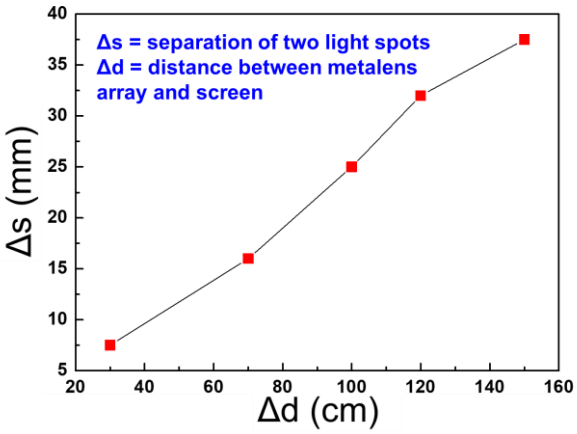

Figure 3. Distance measurement.

References

[1] S. M. Wang, P. C. Wu, V.-C. Su, Y.-C. Lai, C. H. Chu, J.-W. Chen, S.-H. Lu, J. Chen, B. B. Xu, C.-H. Kuan, T. Li, S. N. Zhu, and D. P. Tsai "Broadband achromatic optical metasurface devices," Nature Comm. 8, 187 (2017).
[2] B. H. Chen, P. C. Wu, V.-C. Su, Y.-C. Lai, C. H. Chu, I. C. Lee, J.-W. Chen, Y. H. Chen, Y.-C. Lan, C.-H. Kuan and D. P. Tsai "GaN Metalens for Pixel-Level Full-Color Routing at Visible Light," Nano Lett. 17 (10), 6345–6352 (2017).
[3] B. H. Chen, P. C. Wu, V.-C. Su, Y.-C. Lai, C. H. Chu, I. C. Lee, J.-W. Chen, Y. H. Chen, Y.-C. Lan, C.-H. Kuan and D. P. Tsai "GaN Metalens for Pixel-Level Full-Color Routing at Visible Light," Nano Lett. 17 (10), 6345–6352 (2017).