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Control of light wavefront using spatial optical modulator and correction of its distortion phase

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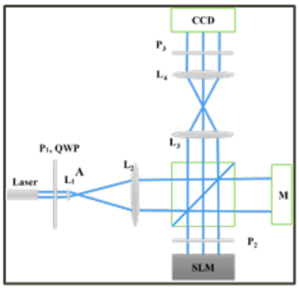
[Introduction] A spatial optical modulator (SLM) is an object that imposes some form of spatially varying modulation on a beam of light. SLM can modulate the physical parameters such as the phase, polarization plane, amplitude, intensity and transmission direction of the light beam according to the input information. Only by changing the input information, the parameters of the SLM can be controlled by the computer. In this paper, two kinds of vortex beams, LG beams and HyG (hypergeometric) beams are generated by reflective SLM. The interference method was used to verify their vorticity and topological charge. The HyG beam is theoretically simulated by numerical calculation, and the simulated value is compared with the experimental value, and the error is analyzed. Due to the manufacturing process, the SLM surface will have minor defects, so the use of SLM will cause the modulation phase distortion. In this paper we proposed a method to measure and correct the distortion phase of SLM

[Theoretical description and experimental] The setup of SLM distortion phase experiment is shown on the right. A Michelson interferometer is used to obtain the interference pattern of the reference beam and the sample beam. Then use the phase shift method to find the distortion phase based on the interference pattern. On the other hand, the obtained main value phase needs to be restored to the absolute phase, that is, phase unwrapping is required. The least square method can be used to unwrap the phase.



In cylindrical coordinates, the field distributions of HyG beams and LG beams on the incident plane (z=0) can be expressed by equations $E(r,\varphi,z=0)=\frac{E_0}{2\pi}(\frac{r}{\omega})^m \exp\left(-\frac{r^2}{2\sigma^2}+i\gamma\ln\frac{r}{\omega}+in\varphi\right)$ and $G_p^l(r,\phi,0)=L_p^{|l|}\left(\frac{2r^2}{\omega^2}\right)\exp\left(\frac{-r^2}{\omega^2}\right)\times\exp(-in\phi)$, respectively. The CGH obtained by the above is shown in Fig.1(a). Figures 1(b,c) and (d,e) show the diffracted HyG beams and LG beams patterns and their interference patterns, respectively. In the theoretical calculation of the diffracted HyG beams, considering that the aperture of the CGH diaphragm is limited, the diffraction aperture function is calculated using the expansion $A_p(r)=\sum_{h=1}^{N}A_h\exp\left(-\frac{B_h}{a^2}r^2\right)$ of the complex Gaussian function, and the diffraction integral is obtained. The results are shown in Fig.1(f) and (g). Figures 1(f) is a comparison between the calculation result of the diffracted HyG beams and the theoretical value (ideal value), and (g) is a comparison between the calculation result of the diffracted LG beams and the theoretical value.

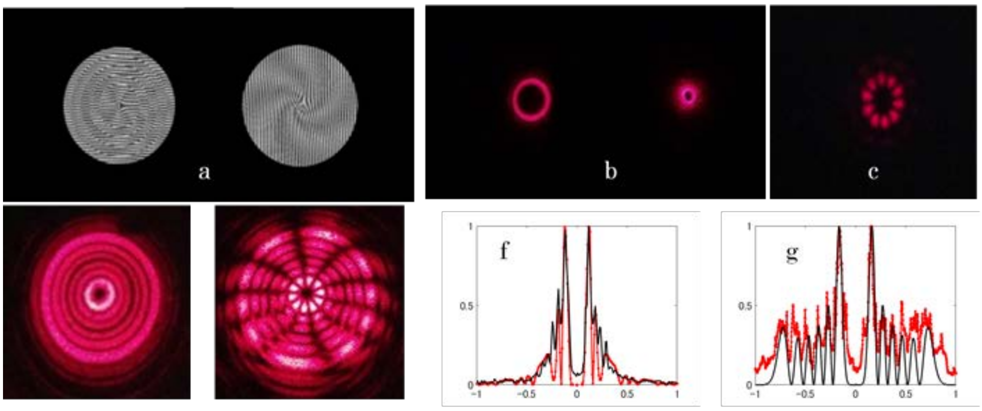


Fig.1 Experimental result

[Conclusions] In summary, in this study, we have developed a system that can process the distortion phase of SLM quickly and accurately. Furthermore, the correction effect could be confirmed by the generation of two types of vortex beams. Due to the finite spatial bandwidth of the LG beams, it was confirmed that the optimum CGH aperture size exists. On the other hand, in the case of a HyG beams, the spatial band tends to be infinite, so an ideal HyG beams cannot be obtained, but it was found that the larger the aperture size of the CGH, the closer to the theoretical value.