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Optimization of Spatial Light Modulator to Generate Aberration Free Optical Traps

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Abstract : Holographic Optical Tweezers (HOTs) in general use iterative algorithms such as weighted Gerchberg-Saxton (WGS) to generate multiple traps, which produce traps with 99% uniformity theoretically. But in experiments, it is the phase response of the spatial light modulator (SLM) which ultimately determines the efficiency, uniformity, and quality of the trap spots. In general, SLMs show a nonlinear phase response behavior, and they may even have asymmetric phase modulation depth before and after π. This affects the resolution with which the gray levels are addressed before and after π, leading to a degraded trap performance. We present a method to optimize the SLM for a linear phase response behavior along with a symmetric phase modulation depth around π. Further, we optimize the SLM for its varying phase response over different spatial regions by optimizing the brightness/contrast and gamma of the hologram in different subsections. We show the effect of the optimization on an array of trap spots resulting in improved efficiency and uniformity. We also calculate the spot sharpness metric and trap performance metric and show a tightly focused spot with reduced aberration. The trap performance is compared by calculating the trap stiffness of a trapped particle in a given trap spot before and after aberration correction. The trap stiffness is found to improve by 200% after the optimization.

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