INTERACTIVE THREE-DIMENSIONAL HOLOGRAPHIC OPTICAL TRAPPING AND IMAGING

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Holographic optical tweezers is a useful tool to trap and manipulate dielectric particles in three dimensions (3D). Multiple laser foci can be produced interactively at arbitrary 3D positions by a computer-generated hologram displayed on a spatial light modulator (SLM) [1]. 3D volume imaging of trapped particles becomes a concern as axial displacement results in a defocused image. Conventional 3D imaging techniques such as confocal microscopy have limited imaging speed. Other techniques combining 3D optical trapping and imaging usually require computational reconstruction, image analysis, or require spatial coherence and thus are not compatible with fluorescence imaging.

Here, we present a 3D holographic optical tweezers system integrated in a volume holographic microscope (VHM) imaging system. VHM is a non-scanning 3D imaging system incorporating a thick holographic grating [2,3]. It captures 3D spatial and spectral information in a single measurement. The holographic grating performs as a Bragg filter highly sensitive to spatial-spectral information. Each holographic grating is tuned to a certain imaging depth. Multiplexing many gratings allows obtaining different depth information in one capture. The advantages of integrating volume holographic microscope imaging system with holographic optical tweezers system is to enable real-time interactive biological study of a large volume with optical trapping, manipulating and imaging abilities. No numerical computation or image analysis is needed, and this method can work in transmission, reflection and even fluorescence imaging mode.