The Effect of Shot Noise on the Accuracy of Particle Positions in Hologram Reconstruction Using Inverse Method

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ABSTRACT

The holography techniques have gained much popularity in recent years due to their ability to record the light field information in a three-dimensional volume. This makes it possible to perform time-resolved volumetric PIV/PTV. The experimental setup is relatively simple, but the digital reconstruction of holograms needs to be done with some care and understanding of the underlying optical physics. This paper introduces a holography reconstruction method that overcomes some of the problems of digital in-line holography. The method introduced in this paper uses deconvolution, 3D clustering, and inverse approach and particle deletion steps following the direct reconstruction in an overall iterative approach. This paper also discusses the effect of shot noise in the hologram on the percentage of particles detected and their positioning accuracy. The study finds that the percentage of particle detected can be maintained at 90% if the signal to noise ratio of the hologram is above 10, which is a 60% increase in the particle detection relative to the direct method. The standard uncertainty increases as more noise are present in the hologram but stay below 11 wavelengths for all directions even for a signal to noise ratio as low as 5.