INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Digital holography is a three-dimensional imaging technique, which involves digital recording of a hologram as the intensity of interference pattern of an object scattered light and a reference light. The complex light field at the object plane is retrieved by numerical reconstruction of the hologram. As a result, digital holography provides both amplitude and quantitative phase imaging which is one of its unique features. Especially, digital in-line holographic microscopy (DIHM) has found its way in microscopic imaging applications and microfluidic studies due to its unique features and cost effectiveness. DIHM has found numerous applications in particle imaging due to its three-dimensional particle localization capability, compact and cost-effective experimental setup. The particle objects placed at any given distance between source to camera can be detected in reconstructed images numerically. In general, the reconstructed images in digital in-line holography suffers from twin image effect and background noise. This affect the particle detection and its size estimation accuracy. The improvement of reconstructed image quality can result in improved particle detection accuracy. Conventional reconstruction method takes high computation time for the accurate particle localization as the hologram reconstruction is required to be performed at different planes within the measurement. This problem can be overcome with a computationally efficient reconstruction algorithm. Accurate detection of object focal plane is of crucial importance in digital holography as it offers numerical autofocusing capability. In that context, establishing an appropriate autofocusing criteria is essential. Thus, taking these observations into consideration, a number of digital hologram processing algorithms are reported in the thesis. Novel hologram reconstruction algorithms are developed which provide computational efficiency without compromising the reconstruction quality. In the case of quantitative phase imaging, an important problem of phase unwrapping is addressed by developing an quality-guided, computationally efficient phase unwrapping algorithm. The thesis proposes different autofocusing algorithm for accurate detection of focal plane of amplitude, phase and mixed type objects. The performance of all these algorithms were evaluated and compared with state-of-art method with different simulation examples. Furthermore, practical validation of the algorithms were performed with experimental data. A comprehensive study on the particle size distribution of fly ash samples is also reported. We believe that the proposed hologram processing methods can be important additions in the field of digital holography.