Increasing imaging area for diffused object in digital holography

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1. Introduction

In digital holography technique [1], holograms are recorded using electronic sensor (CCD/CMOS) and reconstructed numerically using wavefront reconstruction methods [2,3]. The imaging area in digital holography is restricted due to finite size of active region of the electronic sensor. Some methods used to extend the imaging area with grating in digital holography for transparent objects are reported in literature [4-6]. Information of transparent objects is much easier to filter out in Fourier domain and further propagate to reconstruct with increased imaging area. In case of diffused object, the spectrum in Fourier domain is scattered and difficult to filter out object's information. So, this article explores the field of increasing the imaging area using grating for diffused object in digital holography.

In presented work, the imaging area of reconstructed wavefront of a diffused object is extended by using grating in the object beam in off-axis digital holographic setup.

2. Experimental set-up

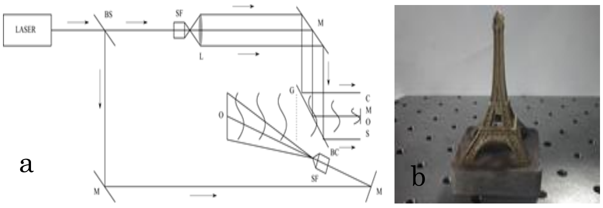

Fig: 1. (a) Scheme of off-axis digital holographic experimental set-up. BS-Beam splitter, SF- Spatial filter, M-Mirror, BC- Beam combiner, G-grating, L-Lens, CMOS-Complementary metal oxide semiconductor and (b) sample image of the diffuse object.

In the experimental set-up shown in Fig. 1, a coherent laser source (wavelength - 532nm) is split by beam splitter into two parts. One beam diverged by spatial filter illuminates the object and gets scattered from its surface. This beam is called as the object beam. Other beam diverged by spatial filter and collimated by convex lens (focal length-200mm) is called as reference beam. A grating (70 lines per mm) is placed at 150 mm in front of the object between object and sensor. The grating creates multiple object beams due to diffraction. The object and reference beams combine at the beam combiner and create an interference pattern. This interference pattern is called as digital hologram. Digital hologram is recorded by a CMOS sensor which is placed at 150 mm from the grating. Recorded digital holograms are stored into a computer for further processing.

3. Results

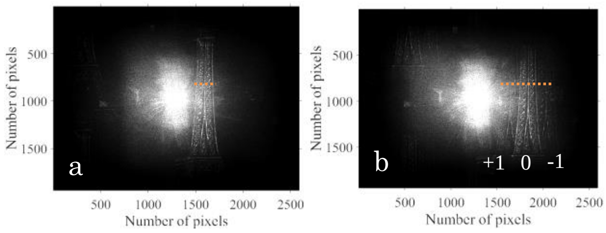

Fig: 2. Images of reconstructed wavefronts (a) without grating and (b) with grating in the object beam.

Numerical reconstruction of the recorded digital holograms (with and without grating) is performed using Fresnel diffraction method. Fig. 2(a) shows reconstructed wavefront of object without grating. In this experiment, limited width of the object's is recorded due to the definite numerical aperture of the sensor. But, with grating, the imaging area is three times more as compare to without grating due to the diffraction order of the grating as can be noticed in Fig. 2(b). The reconstructed wavefront covers 208 pixels when recorded without grating along the scanned region shown in Fig. 2 by dotted line while with grating they covered 620 pixels scanned along same dotted line. The increase in imaging area occurred because grating generates multiple diffraction orders of the object beam which are multiplexed onto the CMOS sensor (hologram plane). The three diffraction orders of the object contain low (0 order) and high frequency (±1 orders) spatial frequencies which can be multiplex to reconstruct complete object information.

4. Conclusions

The imaging area of the reconstructed wavefront of a diffused object is extended three times as compared to conventional digital holography by using a grating in the path of object beam.

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