FULL ABERRATION COMPENSATION IN DIGITAL HOLOGRAPHIC MICROSCOPY

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Digital Holographic Microscopy (DHM) is a powerful method that allows from the numerical acquisition of a single amplitude image (the hologram), to recover at a high reconstruction rate (15 Hz) the amplitude and the phase delay introduced by a microscopic object with a nanometric precision along optical axis [1].

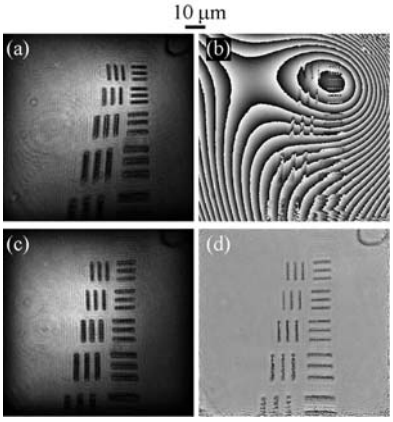

Figure 1: (a) amplitude and (b) phase reconstructions without application of calibration method. (c) amplitude and (d) phase reconstructions with compensation for phase aberration and distortion

Furthermore, the digital approach allows the application of numerical procedures to improve the quality of the reconstructed images by compensating for different kind of aberrations such as spherical aberration [2] or astigmatism [3] among others. We present here a calibration method inspired by the work of Ward *et al.* [4], allowing a full aberration compensation in terms of phase aberrations and image distortion in DHM. The principle consists to record a calibration hologram containing only the aberrations terms (hologram recorded without presence of specimen). The multiplication of the specimen hologram with the conjugated calibration hologram (containing the conjugated phase aberrations terms), allows the suppression of phase aberrations. The reconstructed amplitude and phase are also corrected in terms of distortion and phase aberration as presented in Fig.1, where a lens ball is used as a microscope objective to image a USAF test target.

[1] E. Cuche, P. Marquet and C. Depeursinge, "Simultaneous amplitude-contrast and quantitative phase-contrast microscopy by numerical reconstruction of Fresnel off-axis holograms", Appl. Opt. **38**, 6994-7001 (1999).
[2] A. Stadelmaier and J. H. Massig, "Compensation of lens aberrations in digital holography," Opt. Lett. 25(22),1630–1632 (2000).
[3] S. de Nicola, P. Ferraro, A. Finizio, and G. Pierattini, "Wave front reconstruction of Fresnel off-axis holograms with compensation of aberrations by means of phase-shifting digital holography," Optics and Lasers in Engineering, 37(4), 331–340 (2002).
[4] J.Ward, D. Auth, and F. P. Carlson, "Lens Aberration Correction by Holography," Appl. Opt. pp. 896–900 (1971).