Single-shot phase and polarimetric microscopy

Baptiste Blochet[1], Grégoire Lelu*[1], Miguel A. Alonso[2], and Marc Guillon[1,3]

[1]Saints-Pères Paris Institute for Neurosciences – Université Paris Cité – France
[2]Centrale Med, Institut Fresnel, CNRS - UMR 7249 – Aix Marseille Univ – France
[3]Institut Langevin - Ondes et Images (UMR7587) – ESPCI Paris, PSL Research University – France

Abstract

Abstract: We introduce a polarimetric wavefront imager that provides both the phase and the full-Stokes polarimetric images at high resolution in a single acquisition of a multiplexed image.
1. Principle

Phase and polarimetric imaging are separately used in many application fields in microscopy. Polarized resolved imaging can provide information about structural anisotropy at the molecular scale and is typically used for gems characterization in geology, healthy tissues identification in cancerology or fluorophore orientation determination in super-resolution microscopy (1). Phase imaging gives access to the height profile of reflecting surface samples and the optical path difference through samples. In cell biology, the optical path difference has been shown to be proportional to the dry mass and thus allows monitoring the metabolism of cells (2).

Here, we introduce a polarimetric wavefront imager that provides both the phase and the full-Stokes polarimetric images in a single acquisition of a multiplexed image. The device, composed of a depolarizing Hartmann mask placed in the close vicinity of a camera, is first calibrated by recording images obtained when illuminating with beams of known polarization state. Then a single intensity image of a sample is recorded and demultiplexed thanks to a numerical inversion step to retrieve the full-Stokes polarization information and the optical path difference.

2. Results

The device is shown to reach the diffraction limit and to perform quantitative measurement of both the phase and the polarization (3). We also demonstrate molecular orientation sensing of fluorescent marker in a polarized fluorescence microscope configuration.

3. References

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*Speaker

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