WAVEFRONT SENSING WITH A THIN DIFFUSER: APPLICATION TO SUPER-LOCALIZATION

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We recently proposed and implemented a broadband, compact, and low-cost WaveFront Sensing (WFS) scheme by simply placing a thin diffuser in the close vicinity of a camera [1]. The local wavefront gradient is determined from local translations of the speckle pattern. The translation vector map is computed using a fast-diffeomorphic image registration algorithm and integrated to reconstruct the wavefront profile. The simple translation of speckle grains under local wavefront tip/tilt is ensured by the so-called "memory effect" of the diffuser [2]. We also demonstrated that the method allows quantitative phase-imaging, since the unique signature of the speckle pattern avoids reconstruction artifacts encountered in periodic mask-based WFS. After a detailed description of the WFS principle, we will demonstrate the potential of the technique for 3D nanoparticle localization. In the context of super-localization-based microscopies, we will show that the high localization precision of the method (0.3x0.3x3nm) makes this device a valuable add-on for estimating sample drifts and enhance the performances of super-resolution microscopy techniques [3].

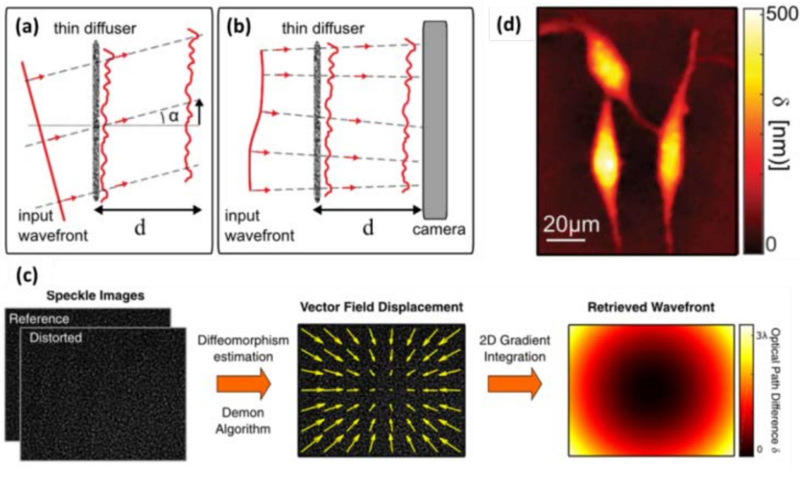

Figure 1: Principle of the thin-diffuser-based wavefront sensor. (a) For a thin diffuser, a tip or tilt angle α in the impinging wavefront results in a global shift of the speckle pattern by an amount α.d at a distance d. (b) For a distorted wavefront, speckle grains are locally shifted. (c) Wavefront reconstruction procedure. (d) Quantitative phase imaging of HeLa cells on a commercial microscope.

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