DYNAMIC WAVEFRONT CODING USING A DEFORMABLE LENS

Tommaso Alterini[1], Francesco Mazzocco[1], Stefano Bonora[2]
[1]Dynamic optics s.r.l, Piazza Giacomo Zanellato, Padova, Italy
[2]CNR-Institute of Photonics and Nanotechnology via Trasea 7, Padova, Italy
E-mail : t.a@dyamic-optics.it

KEY WORDS: wavefront coding, microscopy, adaptive optics, depth of focus, phase mask.

1. INTRODUCTION

Wavefront coding is a relatively new optical technique studied since 1995 [1]. It is used to make an optical imaging system less sensitive to defocus shifts, thus extending the depth of focus, and some aberrations such as spherical or chromatic. This technique was already implemented in fields such as optical microscopy and astronomy using passive phase mask, SLM or deformable mirror. Its usage is still limited by factors such as system integrability or speed. Using a deformable optical element, different phase functions can be generated dynamically correcting for different aberration depending on the case. Deformable lenses permit a robust and easy integration of wavefront coding in industrial or custom optical system [2]. In this study we present preliminary results of the generation of a cubic phase mask to correct for defocus with a deformable lens proving its potential as a wavefront coding corrector.

2. Methods and preliminary results

To generate the phase mask, we use a deformable lens (AOL1810, Dynamic Optics srl), with an optical aperture of 10 mm. This lens has a response time of less than 2 ms and can generate wavefronts up to the 4th order of Zernike polynomials. To measure the wavefront we use a Shack-Hartman wavefront sensor connected with Photon Loop software [3]. The PSF was acquired using a CMOS camera in the focal plane of the system. In Fig. 1 the PSF with and without the cubic phase mask is presented for the in-focus position and for a focus shift of 5 mm. From this result it is clear that the stability of the PSF is increased using the modulation in respect to no coded wavefront. Future works efforts will be spent in the application of this technology to microscopy, spherical aberration control and imaging system with field of view of cm scale.

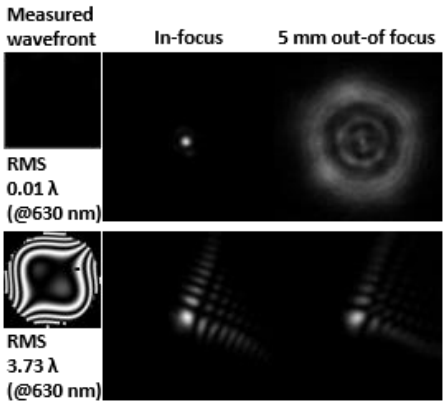

Figure 1: PSF images with and without wavefront coding (rows) and at two axial positions.

[1] R. E.W. Dowski; W. T. Cathey, "Extended depth of field through wave-front coding," *Applied Optics*, **34**, 1859-1866 (1995).
[2] O. E. Olarte et al., "Decoupled illumination detection in light sheet microscopy for fast volumetric imaging," *Optica*, **2**, 702-705 (2015).
[3] J.Mocci et al., "A Multiplatform CPU-Based Architecture for Cost-Effective Adaptive Optics Systems", *Transaction on Industrial Informatics*, **14**, 4431-4439 (2018).