LARGE AREA WAVEFRONT CORRECTION BASED ON CONJUGATE ADAPTIVE OPTICS WITH MULTIPLE GUIDE STARS

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ABSTRACT

Adaptive optics (AO) has been widely used in the optical microscopy to correct the wavefront aberration. However, the corrected field of view (FOV) with a single correction is generally limited, which seriously restricts the imaging speed of an AO system. Thomas G. Bifanoa. *et. al.* theoretically proved that the conjugate AO has the effect of increasing the corrected FOV compared with the pupil AO in microscopy[1], which was successfully used in retinal imaging[2] and simulated astronomical imaging system[3]. Cui M. *et. al.* applied the coherent adaptive optical technique (COAT) in the conjugate AO and studied the influence of the number of phase correction devices[4]. However, the enhancement corrected FOV is limited. Here, we demonstrate a high-speed method of large area wavefront aberration correction by the conjugate AO with multiple guide stars (CAOMG) based on the COAT. Figure 1(c) test the Conjugate AO with five uniformly distributed guide stars. By comparing the image resolution of the beads (Fig. 1), the corrected FOV of CAOMG is 131 times larger than that of the pupil AO and 14 times larger than that of the conjugate AO with a single guide star (CAOSG).

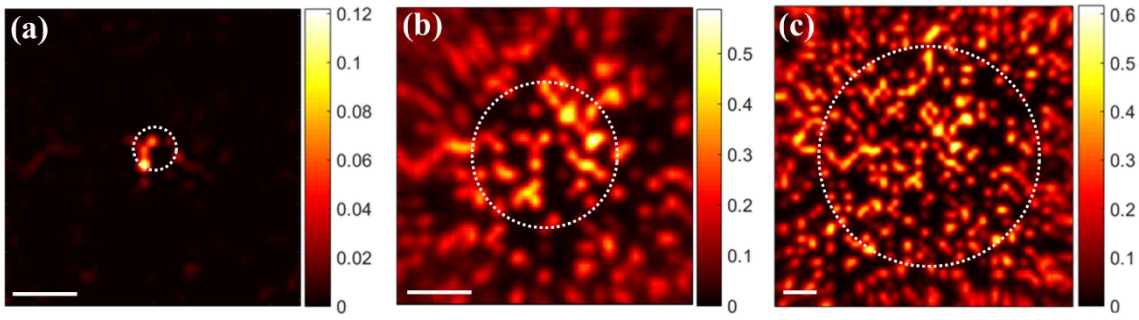

Figure 1: Comparison of imaging of fluorescent beads (7.8 μm diameter) through random phase mask ($\mu_s L$=3.98) (a) with pupil AO, (b) with CAOSG and (c) with CAOMG. The dotted circles are intended to determine the corrected FOV. Scale bar 25 μm.

[1] J. Mertz, H. Paudel, T. G. Bifano, "Field of view advantage of conjugate adaptive optics in microscopy applications," *Applied Optics*, 54, 3498 (2015).

[2] R. D. Simmonds, M. J. Booth, "Modelling of multi-conjugate adaptive optics for spatially variant aberrations in microscopy," *Journal of Optics*, 15, 4010 (2013).

[3] A. Puglisi, A. V. Goncharov, J. C. Dainty, S. Esposito, "Laboratory MCAO test-bed for developing wavefront sensing concepts," *Optics Express*, 13, 5580 (2005).

[4] T. W. Wu, M. Cui, "Numerical study of multi-conjugate large area wavefront correction for deep tissue microscopy," *Optics Express*, 23, 7463 (2015).