IMPROVED MULTIPHOTON MICROSCOPY WITH A MULTI-ACTUATOR ADAPTIVE LENS

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Multiphoton microscopy provides high resolution imaging of tissues without the need of fixation and labelling procedures. However, the quality of the recorded images is limited (especially at deeper locations) by the presence of specimen-induced aberrations. Adaptive optics (AO) has been shown as a powerful technique to overcome this limitation. Both deformable mirrors and liquid crystal spatial light modulators have been used to increase image resolution and multiphoton efficiency [1-4]. Since direct wavefront sensing is not straightforward, sensor-less AO schemes through iterative algorithms are often used [2,4].

Here we incorporated a multi-actuator adaptive lens (AL) [5] in the illumination pathway of a research multiphoton microscope to modify the wavefront of the incident laser beam in a controlled manner. A deterministic hill-climbing technique based on a modal algorithm was used. Individual Zernike modes (from the 2nd to the 4th order) were sequentially induced by the AL in order to optimize the corresponding multiphoton image according to pre-defined metrics. The performance of the AL in terms of image enhancement was compared with that of a liquid-crystal spatial light modulator. The results show that the AL can successfully be used to improve the quality of multiphoton images (see Figure 1). Moreover, an AL can easily be implemented into a multiphoton microscope, what facilitates alignment and calibration operations (compared to existing AO elements).

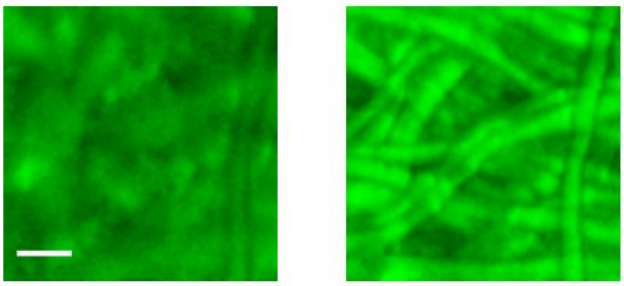

Figure 1: Multiphoton images (silk mesh, 25-μm depth) images before (left) and after aberration correction using a multi-actuator AL. Bar length: 25 μm.

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