Light sheet microscopy revisited: improving illumination with opaque lenses

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ABSTRACT

For centuries optical microscopy constitutes one of the most fundamental paradigms in biological and medical imaging, even though significantly challenged by light diffusion in tissue, limiting its applicability to superficial depths. Recent advances though have paved the way for exploiting multiple scattering and the increased optical paths to predetermine light propagation, addressing the depth to resolution limits and significantly improve optical imaging capabilities. Radical approaches based on wavefront shaping can proactively and efficiently compensate for the refractive index variations in tissue using active elements, such as Spatial Light Modulators (SLMs) to manipulate light and compensate for the diffusive light transport [1]. This is achieved by properly adjusting the incident wavefront properties through scattering photonic structures, to create opaque lenses to accurately manipulate and control light propagation.

In this work, we exploit wavefront shaping techniques to produce and manipulate custom made illumination patterns and significant challenge the detection depth limitation in biological samples. Using, Light Sheet Fluorescence Microscopy (LSFM), as a test bed we present an experimental setup that utilizes a 594nm CW laser, an SLM and exploits the light propagation through a scattering structure that presents anisotropy along one dimension. In addition we have devised a robust iterative optimization algorithm in order to control the phase in the SLM, using optical feedback, and create a near to the diffraction limit light-sheet focused on a user-defined position.

We present preliminary results and we demonstrate the creation of a light-sheet at larger distance behind scattering medium than previous works[2]. Our results could be used in a LSFM setup with the aim is to image small biological samples (10-100um).

REFERENCES

[1] Mosk, A. P. & Vellekoop. 2007. *Opt.Lett.,* **32**: 2309-11.
[2] Battista, D. Di *et al, 2016, Optica, 3, 1237-1240*