3D CONOSCOPIC HOLOGRAPHY IN VIEW OF RETINAL IMAGING

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In vivo high-resolution eye fundus imaging is a much-needed tool for early diagnosis of retinal diseases such as AMD and for the follow-up of such pathologies. One way to obtain high-resolution 3D images of the retina is to use an Adaptive Optics (AO) corrected conventional microscope (with no optical sectioning capacity) and to perform the optical sectioning \textit{a posteriori}, digitally, via 3D deconvolution [1].

3D deconvolution on retinal data is difficult because the point spread function (PSF) of the system (eye+imager) is not well known and because of the poor 2D spatial frequency information coming from each out-of-focus planes of the retina. To improve the 3D deconvolution results, we propose to slightly modify the imaging setup by placing an incoherent holography device in the optical path. The method is called conoscopic holography and is based on optical propagation through birefringent crystals.

A birefringent crystal, having its optical axis parallel to the optical axis of the microscope, mounted between a circular polarizer and a circular analyzer, is placed in front of the recording camera [2]. A stack of 2D images is recorded and deconvolved with conventional 3D deconvolution methods except for the new, modified 2D PSFs (Fig 1). The conoscopic PSFs are interference patterns, their fringe spacing coding the depth position of the emitting point, and have much higher spatial frequency information than the conventional ones, especially for out-of-focus planes, which improves the 3D deconvolution algorithms results.

The simulations performed (Fig 2) show a notable improvement in sectioning capacity and therefore axial resolution. The three planes of the simulated data, all within the depth of focus of the simulated instrument, are clearly resolved after 3D conoscopic deconvolution whereas it was not the case with conventional 3D deconvolution.

Preliminary experimental results on non biological samples will also be presented.
