HUMAN EYE MICROSCOPY WITH FULL FIELD OPTICAL COHERENCE TOMOGRAPHY

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Optical Coherence Tomography (OCT) has become a standard of care for diagnosing and monitoring eye diseases. However, OCT is limited by the presence of coherent noise arising from the use of spatially coherent lasers that are necessary to implement scanning and confocal detection. The noise, which manifest itself as speckle or crosstalk, effectively limits the achievable imaging depth and spatial resolution, which in turn reduce its diagnostic capabilities.

To speed up OCT imaging, Fourier-domain Full-Field OCT (FF-FD-OCT) has been introduced that uses a multipixel (2D) detector (camera) to parallelize signal acquisition [1] and enables computational aberration correction.

We have recently shown that destroying spatial coherence of a laser not only allows removing crosstalk noise, but also reduces speckle size when imaging retina [2]. We have optimized the system by employing a multimode fiber for crosstalk reduction [3] and by implementing a fast preview mode [4] that enabled acquisition of high-resolution, high-contrast OCT images deep in retina [5].

Fig. 1(a) shows the FD-FF-OCT system that consists of a fast-tunable laser source, a Linnik interferometer and an ultrahigh-speed 2-D camera. The laser light is delivered to the interferometer by the help of 300 meters multimode fiber (with 50 μm core). Interference between photons backscattered from the retina and reflected from the reference mirror is detected by the camera after recombination with the beamsplitter. A stack of multispectral interferometric images is acquired within just 10 ms by tuning (in the range of ~80 nm) the wavelength of the laser while the camera acquires 60000 images per second. To derive retinal volumes, Fourier transform is performed on each pixel. The illumination path features a rod mirror that separated illumination path from that of the backscattered light to implement a fast preview mode with an additional (line) camera.

OCT images shown in Fig. 1 were acquired in vivo from a human volunteer. Multiple 3D volumes were generated (each acquired in <10 ms) and averaged to increase signal-to-noise ratio. Axial (XZ) and enface (XY) projections in Fig. 1(b) clearly demonstrate that high-contrast high-resolution images can be acquired all the way to the choroid.

In conclusion, FD-FF-OCT, unlike other OCT techniques, is less sensitive to coherent noise and therefore allows imaging various retinal layers with higher quality and contrast promising to become a viable clinical tool in ophthalmology.

References

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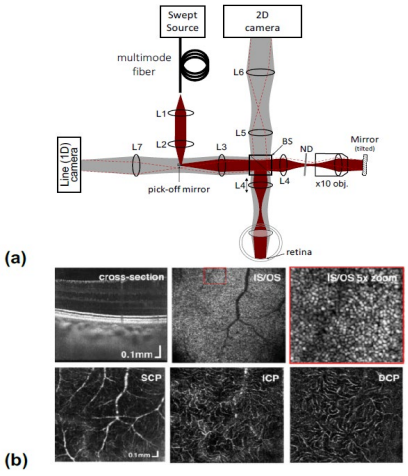

Fig. 1. (a) FD-FF-OCT setup. (b) FD-FF-OCT images ofthe human retina acquired in vivo. SCP, ICP, DCP: superficial, intermediate, and deep capillary plexus, respectively; IS/OS: inner/outer segment junction.