Combined swept-source and diffraction grating optical coherence tomography for deep imaging in scattering tissue

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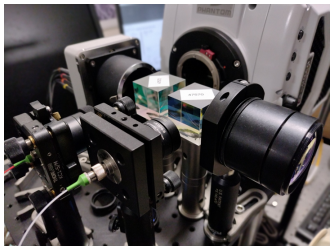
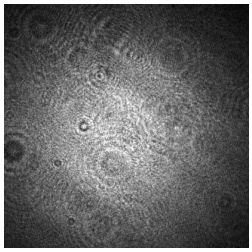
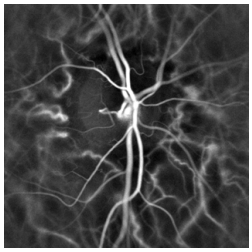
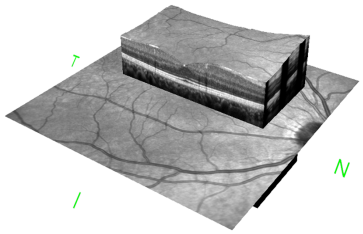

Context : The clinical investigation centers of the Quinze-Vingts Eye hospital, the Foundation Adolphe de Rothschild Hospital, the University of Pittsburgh, and the Langevin Institute, have developed unique innovative expertise in digital holography, laser Doppler imaging and optical coherence tomography, and the evaluation of their medical use in a variety of ocular pathologies, which demonstrates clinical relevance.

Goal : A line pattern illumination from a swept-source laser, in the 820 nm to 870 nm wavelength range, will be formed to illuminate a tissue sample. The backscattered light will be filtered spatially and diffracted by a diffraction grating, in order to create a diffraction pattern that will be swept spatially according to the wavelength variation of the laser. That pattern will be recorded by an ultrahigh-speed camera. The recording process will be done with an optical interferometer, by digital holography, in order to enable high sensitivity phase-resolved measurement in low light. Digital signal processing of the recorded optical field diffraction patterns may allow selection of deep backscattered photons, Doppler-shifted photons and filtering of coherent crosstalk that emerges from randomized optical path length distribution in the scattering sample.

Mission : A team of interns will build and develop a prototype imaging device that will be used to provide Doppler and tomographic images of the eye. They will also conduct the experiments and perform data processing in Matlab and ImageJ. They will learn and improve coherent image formation by wave propagation, fluctuation analysis, statistical filtering. Support for software development is provided by the Digital Holography Foundation, and through the Discord server Digital Holography.

References :

Diffuse laser illumination for Maxwellian view Doppler holography of the retina

https://arxiv.org/abs/2212.13347

Full-field swept-source optical coherence tomography and laser Doppler holography:

http://arxiv.org/abs/2112.08494

Anterior segment, blood flow imaging, eye tracking, and transparency assessment:

https://arxiv.org/abs/2107.10799

Blood flow reversal in out-of-plane vessels:

https://arxiv.org/abs/2008.09813

Reverse contrast laser Doppler holography:

https://arxiv.org/abs/2004.00007

Real-time principal component analysis:

https://arxiv.org/abs/2004.00923

Spatio-temporal filtering:

https://arxiv.org/abs/2003.10259

Waveform analysis of human retinal and choroidal blood flow with laser Doppler holography:

https://arxiv.org/abs/2106.00634

Choroidal vasculature imaging with laser Doppler holography:

https://arxiv.org/abs/2106.00608

Swept-source optical coherence tomography by digital holography in real-time:

https://arxiv.org/abs/2003.08960

Doppler holography of the human retina:

https://arxiv.org/abs/1804.10066

High speed optical holography of retinal blood flow:

https://arxiv.org/abs/1607.07800

Doppler imaging of microvascular blood flow:

https://arxiv.org/abs/1412.0580

Holographic laser Doppler ophthalmoscopy:

https://arxiv.org/abs/1006.2604