Advanced ultrahigh-speed digital holography for ophthalmology

Master's internship and PhD research proposal | Institut Langevin, CNRS–ESPCI Paris–PSL contact: micatlan@gmail.com

Research vision

Ultrahigh-speed digital holography records the eye's complex optical field at tens of thousands of frames per second. Its amplitude, phase, temporal, angular, and depth information supports complementary research directions: high-resolution retinal imaging; paired dynamic ocular wavefront and lateral aberration measurements; and multidimensional processing of ocular structure and dynamics.

Scientific objectives

1. High-resolution retinal imaging. Computational adaptive optics using a virtual Shack–Hartmann.
2. Dynamic wavefront and lateral aberrations.
3. Multidimensional holographic processing. Analyze recordings across complex-field amplitude and phase, temporal frequency, detection-aperture angle, and reconstruction depth.

Master's project (5–6 months)

Implement and benchmark one focused module from the three directions: graph-based computational adaptive optics; paired dynamic wavefront/lateral-aberration tracking; or multidimensional phase/aperture analysis.

PhD project (three years)

Year 1: develop high-resolution reconstruction, graph-based adaptive optics, and motion-robust local filtering. Year 2: establish paired dynamic wavefront and lateral aberration measurements during accommodation, and investigate amplitude–phase, angular, frequency, and depth-resolved observables. Year 3: integrate the three approaches across retinal and anterior-segment datasets.

Fig. 1. Retinal arteries and veins : annotated section and Doppler velocity-proxy spectrum.

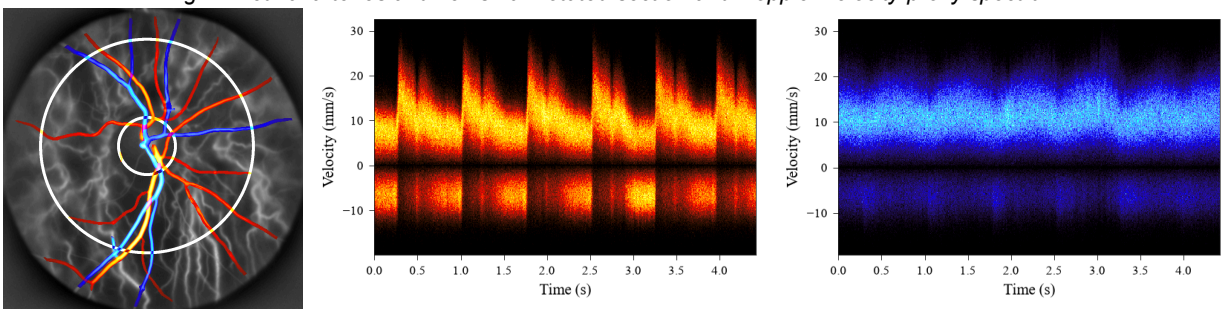


Fig. 2. Periocular holography: closed-eye and open-eye photos with flow renderings.

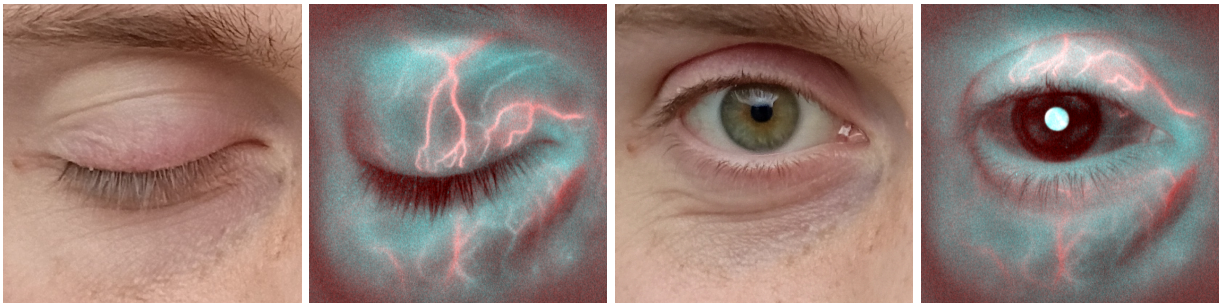


Fig. 3. Computational adaptive optics. Virtual Shack–Hartmann: central and peripheral subaperture images.

