The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	11 July 2024
Time	***:***	9:30 am
Venue	***:***	Room 405, William M W Mong Engineering Building, CUHK

Title: Minimally-invasive High-resolution Optical Coherence Tomography Endoscopy for Preclinical and Clinical Applications

Endoscopic optical coherence tomography (OCT) offers real-time, three-dimensional imaging of luminal organs in vivo with an imaging depth of 1-3 mm. This label-free technique provides near-histologic quality visualization of tissue microstructures. Unlike traditional biopsy, endoscopic OCT allows volumetric sampling across a large area without tissue removal. Current systems operating at 1,300 nm have limited resolution (~10 μm). To address this, researchers have developed endoscopic OCT systems at shorter wavelengths (800 nm and visible-light range), achieving higher resolution (1-4 μm) and enhanced image contrast, albeit with shallower imaging depth. Additionally, the bulky size of traditional OCT endoscopes restricts their use in clinical scenarios requiring minimally-invasive imaging.

This presentation highlights the development of minimally-invasive, high-resolution endoscopic OCT systems and their translational potential. We designed two spectral-domain OCT systems operating at 800 nm and visible-light range, achieving axial resolutions of 2.4 μm and 1.4 μm. To address material dispersion, we introduced a phase-based digital dispersion compensation method, enhancing axial resolution from 3.3 μm to 1.4 μm. Additionally, we developed a liquid shaping technique for submillimeter liquid-shaped microendoscopes, demonstrating high resolution, flexibility, and minimal invasiveness in imaging the esophagus of rats and the aorta and deep brain of mice. Using two-photon polymerization-based 3D glass printing technique, we created aberration-corrected high-resolution OCT microendoscopes with high transmission efficiency and thermal stability. We also integrated robotic position control into an 800-nm OCT neuroendoscopy system, enabling precise deployment and minimally-invasive imaging within the deep brain of mice. Finally, we showcased the clinical potential by imaging the cervical canal of patients in vivo, revealing detailed microstructures. Our system offers minimal invasiveness, high spatial resolution, stereotactic imaging capability, and strong translational potential. These results suggest that minimally-invasive high-resolution endoscopic OCT can significantly impact preclinical and clinical studies.

***** ALL ARE WELCOME *****

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