The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – MPhil Oral Defence

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Date	**:**	22 December 2025 (Monday)
Time	**:**	10:00 am
Venue	**:**	Room 1122, William M W Mong Engineering Building, CUHK

Title: Interpretable Adaptive Deblurring and Denoising for Optical Coherence Tomography Images

Optical Coherence Tomography (OCT) is a powerful "optical biopsy" tool, yet its diagnostic clarity is limited by inherent imaging artifacts: spatially-varying blur and speckle noise. Traditional hardware solutions are costly and complex, while conventional artificial intelligence (AI) enhancement methods often operate as "black boxes" that lack interpretability and can neglect the underlying physics of OCT. This not only limits clinical trust but can also generate enhancements that are inconsistent with the true tissue properties, potentially leading to misinterpretation of microstructure.

Here, we introduce a physics-guided deconvolution and denoising framework that combines the reliability of physics with the adaptability of deep learning. We first establish a robust phantom calibration protocol to precisely characterize our OCT system's spatially-variant blur and noise fingerprint. These real, measured physical parameters then guide a customized unfolded Richardson-Lucy Deconvolution network, a hybrid model that incorporates the well-established deconvolution algorithm within a lightweight neural network. The model learns to adaptively enhance OCT images, preserving structural detail and minimizing artifacts through physics-guided deconvolution. This results in a method that is both highly interpretable, because it is grounded in OCT image formation physics, and adaptable to any OCT system.

Validated on simulations, phantoms, and in vivo data across two OCT systems, our physics-guided framework produces sharper and higher-contrast images. We demonstrate that this adaptive, physics-guided approach outperforms conventional methods, which often do not account for spatial variance and true system physics. By ensuring the enhancement process is transparent and aligns with imaging physics, we provide a trustworthy tool that can integrate into clinical workflows, aiming to support more precise analysis and diagnosis.

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

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