The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	28 October 2022 (Friday)
Time	***:***	9:00 am (Hong Kong time)
Zoom Link	***:***	https://cuhk.zoom.us/j/93229138228?pwd=NFlROU0xYStXR2FodGh4c3NGcUwvZz09
Meeting ID	***:***	932 2913 8228
Password	***:***	369610

Title: Development of Deep Neural Networks for Quantitative Phase Reconstruction, Cell Classification and All-optical Computing

Quantitative phase imaging (QPI) has become an important label-free imaging technique with emerging applications in single cell analysis, material metrology, etc. To make QPI more accessible and ease-of-use to users, two main obstacles exist: (i) phase retrieval and image post-processing speed is too slow; and (ii) interpretation of the phase images is difficult, especially in cell analysis. In this talk, I will present my PhD research on developing deep neural network-based solutions to tackle these problems. In the first topic, I will introduce Neural Architecture Search generated Phase Retrieval Network (NAS-PRNet), which is proposed by us for retrieving phase from fringe patterns with high accuracy and low computation latency. Using NAS-PRNet, we do not need to capture a calibration image as normally required, while a highest Peak Signal-to-Noise Ratio (PSNR) of 36.1 dB is realized, outperforming the widely used U-Net by 1.4 dB. The computation latency of NAS-PRNet is as low as 31 ms, which is 12 times less than U-Net. Finally, NAS-PRNet can be easily adapted into other off-axis QPI systems with different fringe patterns. In the second topic, I will present our work on label-free classification of leukocytes based on QPI and deep learning. Leukocyte differential count is widely used in clinics for screening diseases. While classifying granulocytes, monocytes, and lymphocytes are relatively easy, detection of B and T lymphocytes usually requires chemical staining or fluorescence labeling. By designing a two-step residual neural network for mining the rich information embedded in cell phase images, we achieved classification of human granulocytes, monocytes, and B and T lymphocytes with an average accuracy of 90.5%. The method also shows a promising potential in differentiating CD4 and CD8 T cells. We cross-validated the performance of the model on all blood donors. In the third topic, I will propose the use of optical neural networks (ONNs) for cell classification. Imaging flow cytometry has the benefit of detecting cell morphology for subsequent identification of cells. However, capturing and analyzing tens of thousands of cell images in real time is challenging. To address this issue, we propose to construct an ONN to directly analyze the light wave scattered from the cells and output task-related information only, such as cell types. With a model-free on-site network optimization method, we have achieved classifying B and T lymphocytes, displayed on a spatial light modulator, with an accuracy of 77.2%. Finally, I will conclude my talk and discuss the limitations of our methods and potential solutions .

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

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