Department of Biomedical Engineering
The Chinese University of Hong Kong

High-throughput miniaturized microscopes to image neuronal activity in freely-moving mice

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Date : 20 August 2026 (Thursday)
Time : 2:00 pm
Venue : Room 1122, William M W Mong Engineering Building, CUHK

Abstract

Miniaturized microscopes (miniscopes) are powerful optical tools that enable functional recording of neural activity at cellular resolution in freely moving animals. However, conventional miniscopes suffer from limited optical throughput, thus restricting the scale of the neuronal circuits that can be studied. In this talk, I will present our recent work to increase imaging throughput for both two-photon and one-photon miniscopes. First, I will introduce two-photon miniscopes that incorporate innovative sampling techniques, such as beam multiplexing and point-spread-function engineering, to significantly boost imaging speed. Using these systems, we demonstrated in vivo volumetric calcium and voltage imaging in the mouse cortex during open-field behaviors. Second, I will describe a computational one-photon miniscope capable of capturing volumetric neuronal activity in a single exposure. By leveraging a randomly positioned microlens array as a multi-channel light encoder alongside an efficient 3D reconstruction algorithm, we achieved high-resolution imaging across a large 3D volume within a compact footprint. These high-throughput miniscopes provide valuable toolsets for investigating large-scale neural circuits during natural behaviors.

Biography

Weijian Yang is an associate professor at the Department of Electrical and Computer Engineering at the University of California, Davis. He received his undergraduate degree from Peking University and a PhD from the University of California, Berkeley, all in Electrical Engineering. After postdoctoral training in neuroscience at Columbia University, Dr. Yang started his own laboratory at UC Davis in late 2017. His current research aims to develop advanced optical methods and neurotechnologies to interrogate and modulate brain activity, with a goal to understand how neural circuits organize and function and how behaviors emerge from neuronal activity. He is a recipient of the Career Awards at the Scientific Interface from Burroughs Wellcome Fund in 2016, the Early Career Award from National Science Foundation in 2019, and the Science and PINS Prize for Neuromodulation (second prize) from American Association for the Advancement of Science in 2021.

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