High throughput, high content neurobiological imaging

Peter So, MIT

Wednesday, May 16, 11 am

Room E-220, Engineering Building 2

LECTURE ABSTRACT

As an outgrowth of our work on studying neuronal plasticity, we seek to understand a single neuron integrate its inputs from over 104 synapses. This target requires optical imaging technology with high resolution and high speed for both structural or functional imaging. Parallel multifoci imaging is a significant method to improve the imaging speed while preserving high image signal-to-noise-ratio (SNR). Here we demonstrate a scanless method, selective access multifoci multiphoton microscopy (saMMM), for volumetric structure imaging and function imaging. The system is able to excite multifoci modulated by spatial light modulator, and more importantly, detect fluorescence from these multiple spots simultaneously using a Gaussian-Laguerre (GL) phase plate for phase modulation. The phase plate modulates a Gaussian point spread function to double-helix point spread function, which both extends the depth of focus and encodes axial position by rotation angle. We showed the multifoci advantage of the system by simultaneous recording calcium dynamics of cultured neuron from 149 locations across the whole field of view, and we showed the volumetric imaging advantage by simultaneously exciting and detecting multiple locations in three-dimension of a neuron and reconstruct the exact axial positions from a single plane image. Calcium dynamics recorded with and without modulation with a GL phase plate recorded and compared in terms of SNR. This “3D image by one shot” strategy largely improved the signal to noise ratio of fluorescence images, therefore it is possible to accelerate the imaging speed. The selective access illumination further elevates the imaging speed by only recording labeled area, also avoid unnecessary photodamage to the specimen. The scanless design breakthrough the limit of mechanical scanning speed, ensured dynamic records from all the foci are strictly synchronized, and no perturbation to cell physiology during imaging. This saMMM system potentially can be applied for in vivo high throughput imaging and dynamic monitoring.

SPEAKER BIOSKETCH

Peter So is a professor in the Department of Mechanical and Biological Engineering in the Massachusetts Institute of Technology. Prior to joining MIT, Peter So obtained his Ph.D. from Princeton University in 1992 and subsequently worked as a postdoctoral associate in the Laboratory for Fluorescence Dynamics in the University of Illinois in Urban-Champaign. His research focuses on developing high resolution and high information content microscopic imaging instruments. These instruments are applied in biomedical studies such as the non-invasive optical biopsy of cancer, the mechanotransduction processes in cardiovascular diseases, and the effects of neuronal remodeling on memory plasticity. Peter So is currently the Director of the MIT Laser Biomedical Research Center, a NIH NIBIB P41 research resource.