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Reconstruction & Imaging of Living Nerve Cells

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Peter Saggau
Dept. of Neuroscience, Baylor College of Medicine

Costa M. Colbert
Dept. of Biology and Biochemistry, University of Houston

Ioannis A. Kakadiaris
Dept. of Computer Science, University of Houston

We are investigating various aspects of neuronal computation including nonlinear summation of synaptic potentials and signaling of dendritic action potentials. To understand these dendritic functions, it is essential to analyze the interplay of structure and function. Such analysis requires computational models that incorporate neuronal morphology and ion channel distributions. However, conventional methods of neuron reconstruction are labor-intensive and not highly reproducible. The long-term goal is to be able to choose optimal dendritic sites for functional imaging on-line, based on predictions of a compartmental model built from the reconstructed morphology of the neuron being imaged. Towards this goal we have developed optical imaging techniques to support structural and multi-site functional data acquisition from living neurons during a single experiment. We have also developed techniques for robust, accurate, and rapid morphological reconstruction of fluorescently labeled neurons from optical sections obtained by confocal and two-photon optical imaging. We have implemented a computational pipeline consisting of data acquisition, registration of multiple image stacks, denoising (using wavelets and frames), deconvolution, segmentation, cylinder extraction, and output to modeling and visualization software. The success of the reconstruction process has been demonstrated with neurons in brain tissue and validated with computational phantoms. Our computational and experimental framework will guide the efficient design of experiments and the generation of hypotheses to reveal functional mechanisms underlying both normal and diseased states of the nervous system.

Project (or PI) Website

http://www.vcl.uh.edu/ORION/research/overview.html

Publications

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6. V.Iyer, T.Hoogland, B.Losavio, R.Fink, R.Gaddi, S.Patel, A.,Larson, and P.Saggau. Acousto-optic multiphoton laser scanning microscopy (AO-MPLSM) for structural and functional imaging in living brain slices. *Prog.Biomed.Opt.Imag*. 6 (15): 90-101, 2005.

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1. V.Bansal, S.Patel, and P.Saggau. High-speed addressable confocal microscopy forfunctional imaging of cellular activity. *J.Biomed.Optics*.

In preparation

1. Deister, C.A., and Colbert, C.M., Subthreshold Na^+ and and K_A^+ channel inactivation properties in CA1 pyramidal neurons: Implications for dendritic integration.

2. Colbert C.M., Shah. S, Kelleher, K., and Deister, C.A., Dendritic action potential boosting by subthreshold inactivation of Na^+ and K_A^+channels: A computational study.