**Concurrent Computational Modeling, Morphological Reconstruction and Guided Imaging of Living Nerve Cells**

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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 neuron morphology and ion channel distribution. However, conventional methods of neuron reconstruction are labor-intensive and not highly reproducible. Our advances in optical imaging techniques support structural and multi-site functional data acquisition from living neurons during a single experiment.

Our short-term goal is to develop a computational and experimental framework for real-time mapping of functional imaging data (e.g., spatio-temporal patterns of dendritic voltages or ion concentrations) to neuronal structure. Therefore, our research objectives center on developing techniques for robust, accurate, and rapid morphological reconstruction of fluorescently labeled neurons from optical sections obtained by non-invasive structural imaging. We will use these automated reconstructions to optimize computational models of the neurons by minimizing error between the model predictions and the actual functional imaging data.

The long-term goal is to choose functional imaging sites on-line based on predictions of the compartmental model built from the reconstructed morphology. Our approach will significantly improve the data acquisition, particularly by optimizing the value of multi-site optical recordings, as well as the focused and directed incorporation of data into quantitative computational models of nerve cells. Our computational and experimental framework will guide the efficient design of experiments and the generations of hypotheses to reveal functional mechanisms underlying both normal and diseased states of the nervous system.

## Project (or PI) Website

www.vcl.uh.edu/ORION/

## Publications

*Published*

V.Iyer, B.E.Losavio and P.Saggau. Compensation of temporal and spatial dispersion for acousto-optic multiphoton laser-scanning microscopy. *J.Biomed.Optics*, 8:460-471, 2003.

A.Larson, V.Iyer, T.M.Hoogland, R.Gaddi, and P.Saggau. Efficient fiber-coupled detection for multiphoton microscopy: characterization and comparison with air-coupled detection. *Prog.Biomed.Opt.Imag.* 5(12):415-424, 2004.

C.Uehara, C.M.Colbert, P.Saggau, and I.A.Kakadiaris. Towards automatic reconstruction of dendrite morphology from live neurons. *Proc. 26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, San Francisco, CA, 2004.

S.Urban, S.O'Malley, B.Walsh, B.Losavio, T.Hoogland, P.Saggau, C.Colbert, and I.A.Kakadiaris. Automatic reconstruction of dendrite morphologies from confocal images. *Proc. Texas Systems Day*, pp.25, Houston, TX, 2004.

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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*In preparation*

S.O'Malley, S.Urban, B.Walsh, B.Losavio, T.Hoogland, P.Saggau, C.Colbert, and I.A.Kakadiaris. Automatic reconstruction of dendrite morphologies from optical section stacks. *Proc. 8th International Conference on Medical Image Computing and Computer Assisted Intervention*, Palm Springs, CA, 2005.

V.Iyer, T.Hoogland, B.Losavio, R.Fink, R.Gaddi., S.Patel, A.Larson, and P.Saggau. Structural and functional imaging of single neurons in living brain slices with acousto-optic multiphoton laser scanning microscopy. *Nature Neuroscience.*

S.O'Malley, S.Urban, B.Walsh, B.Losavio, T.Hoogland, P.Saggau, C.Colbert, and I.A.Kakadiaris. Automatic reconstruction of dendrite morphologies from optical sections of living fluorescently labeled neurons. *Journal of Neuroengineering.*