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Computational and Optical Studies of Neural Input/Output Relationship

(NIA R01-AG027577 FY 05)

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At the single-neuron level, information from thousands of synaptic inputs is received at dendritic spines, where it is processed by the dendrite's specific morphology and distribution of voltage-gated ion channels ultimately to produce a single output in the form of trains of action potentials. For most neurons in the central nervous system, the details of this transformation of information remain poorly understood. In large part this is because of the massively parallel nature of the connectivity between neurons, i.e., it has not been possible to experimentally stimulate neuronal synapses in large numbers with well-defined spatial and temporal patterns that mimic the physiological input to the neuron. The goal of this project is to determine the input/output function of pyramidal neurons in the hippocampal area CA1. To this end, we are developing an imaging workstation allowing hundreds of individual synapses to be activated nearly simultaneously across the spatial extent of the dendrite by multi-site photolysis of caged neurotransmitter. We will use online morphological reconstruction developed in our previous CRCNS project -- *Reconstruction & Imaging of Living Nerve Cells* -- to identify dendritic sites for stimulation and recording. Specific stimulation protocols will be used to assess the whether synaptic input is added linearly, how clustering of input affects output, and how many synapses must be coactivated to produce action potential output. Compartmental computer simulations of the neuron will be used to aid understanding the underlying ionic mechanisms of nonlinearities in the neuron's response to stimulation.

Project (or PI) Website

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

Publications

Published

1. G.D.Reddy, and P.Saggau. Fast three-dimensional scanning scheme using acousto-optic deflectors. *J.Biomed.Optics*, 10:064038, 2005.

2. V.Iyer, T.M.Hoogland, and P.Saggau. Fast functional imaging of single neurons using random-access multiphoton (RAMP) microscopy. *J.Neurophysiol.*, 95(1):345-355, 2006.

In press

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