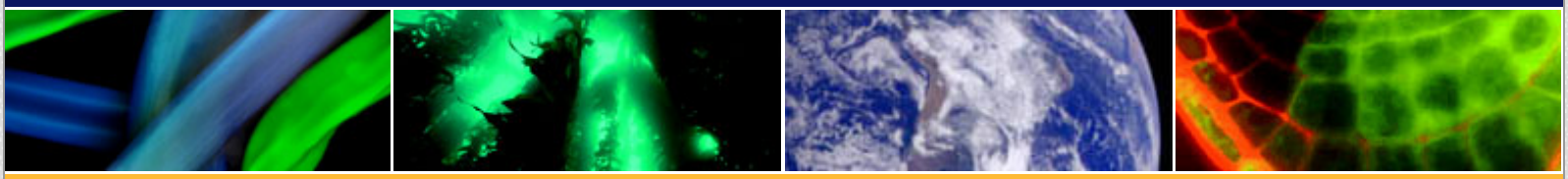

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U.S. Kavli Frontiers of Science

19th Annual
Kavli Frontiers of Science Symposium

U.S. National Academy of Sciences
Arnold and Mabel Beckman Center
November 8-10, 2007
Irvine, CA

"Dynamic Generation and Control of Spinal Locomotion Signals and Its Application to Neural Prosthetic Devices" -Presentation

Ralph Etienne-Cummings, The Johns Hopkins University

Please click on the above link to watch the presentation - both slides and audio. This presentation file is in Adobe Flash player format, available free online.

For normal locomotion, the brain initiates and modulates the activity of spinal cord circuits that generate the basic motor pattern, loosely called the central pattern generator (CPG). After severe spinal cord injury (SCI), patients are unable to walk because they cannot activate or control the CPG, although the circuits may still be intact. To restore locomotion, one could use phase-dependent electrical stimulations of the spinal cord or muscles, relative to either the underlining activity in the cord or sensory feedback. Consequently, research on understanding how to generate signals required for locomotion and/or control the existing locomotion circuits is required.

We have approached this problem from an instrumentation and neural signal processing perspective. We develop /neuromorphic/ integrated circuits (IC) models of spinal circuits. These ICs may become implantable neural prosthetic devices. Ultimately, such a neuroprosthesis, which could be used in combination with other SCI therapies, could initiate activity and dynamically modulate the rhythm of the CPG according to parameters or commands supplied by the user.

I will show how CPGs circuits are modeled mathematically and in silicon. I will then show these silicon CPGs being used to adaptively control walking/ running in robotic biped. The robotics experiments direct us to neuroscience experiments, using lamprey spinal cords, to investigate how to interact with

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biological locomotion controllers. Finally, we use these neuroscience results and neuromorphic chips to “replace” the spinal cord and brain signals while making an anesthetized cat walk. This work has applications in treating SCI and the control of artificial limb.

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