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# Hybrid neuronal architectures for biomimetic robot controllers

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We are developing robots controllers based on biomimetic design principles. The goal is to realize the adaptive capabilities of the animal models in natural environments. These controllers are based on central pattern generators that control artificial muscle to mediate behavior and are modulated by coordinating systems and pre-motor interneuonal networks that mediate exteroceptive reflexes and provide simple decision making capabilities.
We report feasibility studies of a hybrid architecture that instantiates the command and coordinating level with computed discrete time map-based (DTM) neuronal networks and the central pattern generators with analog VLSI electronic neuron (AV) networks. DTM networks are realized using neurons based on a 2-D Map with two parameters that define silent, spiking and bursting regimes and realize post-inhibitory rebound. Chemical synapses have both variable reversal potentials and time constant. Both neurons and synapses have been realized as LabView objects for rapid prototyping and as C++ objects for applications on small embedded processors.
AV networks have been simulated using Spice in a subthreshold 2V 0.25 process. Electronic neurons based on USCD electronic neurons can be instantiated in analog VLSI and exhibit similar behavior to discrete components. We have constructed locomotor CPGs with AV networks that can be modulated to select different behaviors on the basis of selective command input. The two technologies can be fused by interfacing the signals from the DTM circuits directly to the AV CPGs.
Using DTMs we have been able to simulate complex sensory fusion for rheotaxic behavior based on both hydrodynamic and optical flow senses. We will demonstrate controllers for both ambulatory and undulatory biomimetic robots. These studies indicate that it is feasible to fabricate DTM controller to operate a distributed network of AV CPGs.

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