Northeastern UNIVERSITY

Biomimetic Underwater Robot Program

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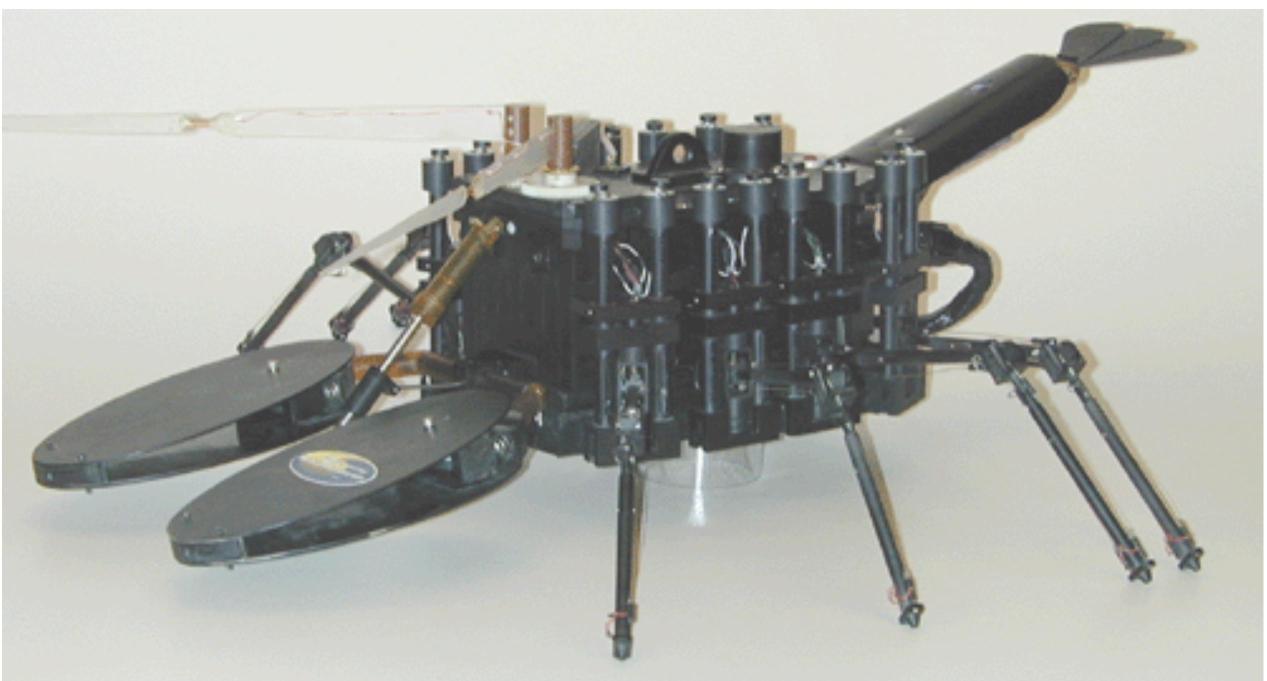
What we do:
We employ biomimetic approaches to confer the adaptive capabilities of marine animal models to engineered devices. These devices include sensors, actuators, adaptive logic systems, electronic nervous systems, biomimetic underwater robots and neurorehabilitative devices.

Our Robots: RoboLobster and RoboLamprey



Our Technologies

Biomimetic Robots: We have built four classes of biomimetic robots based on the American Lobster. These robots capture the biomechanical advantages of lobsters and employ a sensorimotor system consisting of neuromorphic sensors, a controller based on the command neuron, coordinating neuron, central pattern generator architecture of animals and myomorphic actuators and a behavioral library reversed engineered from studies of the lobsters. We have also created two generations of a biomimetic robot based on the lamprey that swims by lateral axial undulations. We are developing a ultrashort baseline sonar navigation system to allow this robot to home on a sonar beacon.

Electronic Nervous Systems: We construct controllers based on three types of electronic nervous systems: (1) Finite state machines that emulate the logic and dynamics of animal central pattern generators. (2). UCSD Electronic Neurons and Synapses and (3). Discrete Time Map-based electronic neurons and Synapses.

Myomorphic Actuators: We actuate our devices with artificial muscle constructed from the shape memory alloy nitinol. These actuators are actuated by current pulse trains generated by the electronic nervous systems and grade force by pulse width duty cycle modulation.

Neuromorphic Sensors: We monitor the environment with sensor systems that employ a labeled line code. We have developed neuromorphic sensors for heading, pitch and roll, hydrodynamic flow and surge, collision and impediment.

Behavioral Libraries: We have developed technologies for reverse engineering the command sequences that underly adaptive behavior and network technologies for embedding these sequences in electronic nervous systems. These behavioral acts are capable of both adaptive modulation and perturbation.

Neurorehabilitative Devices: We are developing electronic nervous systems for the adaptive augmentation of constraint induced movement therapy for stroke and traumatic brain injury.

Current Projects

Special-Purpose Computing for Neurobiologically Inspired Networks. DARPA/IPTO Phase II SBIR, With Information Systems Laboratories, San Diego.

Biomimetics of Passive and Active Tactile Sensing in Tentacles and Antennae, Schlumberger, Cambridge.

Market Assessment of Biomimetic Robots. Massachusetts Technology Transfer Council.

Adaptive Control of Underwater Robots with Electronic Nervous Systems, With Tufts and Harvard Universities

Augmented Constraint Induced Therapy, with The University of Alabama, Birmingham

Collaborators

Department of Electrical and Computer Engineering, *Northeastern University.* David Brady (Sonar), Yong-Bin Kim (Electronic Neurons), Gilead Tadmor (Nonlinear Dynamics)

Information Systems Laboratories (San Diego), Nikolai Rulkov, (Electronic Nervous Systems)

Schlumberger*, Cambridge, MA*. Martin Poitzsch (Sensor Physics)

Institute for Nonlinear Science*, University of California, San Diego,* Allen Selverston (Neuroscience), Henry Abarbanel, Alexander Volkovski (Nonlinear Dynamics)

Center for Engineering Education Outreach*, Tufts University,* Chris Rogers (Biomimetic Robots, Electronic Neurons)

School of Engineering and Applied Sciences*, Harvard University,* Robert Wood, (Biomimetic Robots)

Department of Psychology, *University of Alabama,* Birmingham, Edward Taub, Gittendra Uswatte (Constraint Induced Movement Therapy).

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