Abstract

Human-built machines are usually efficient, fast and powerful, and are largely constructed from stiff materials. In order to cope with complex environments, the most recent robotic devices have begun to incorporate compliant joints and control systems based on impedance rather than force and position monitoring. However, even these advanced machines cannot perform with the robustness and adaptability found in living animals. A major challenge is that the design, fabrication and control of highly deformable structures is still poorly understood. Our research is directed at understanding how the movements of soft animals are controlled and then applying these findings to the development of soft robots. The guiding framework is that morphological computation (embodied intelligence) is essential for soft animals to move and manipulate in the natural world, and that soft machines need to incorporate the same strategies.

We have used the caterpillar as a tractable model system to understand how neural commands and nonlinear material properties interact to create useful movements. Some of these concepts have been implemented in a family of simple elastomeric robots (Softworms) that can move with a variety of caterpillar-like gaits. The next challenge is to make these robots climb in complex branched structures.

Biographical sketch

Barry Trimmer (Professor, Department of Biology) – Barry Trimmer is the Henry Bromfield Pearson Professor of Natural Science and holds secondary appointments in Biomedical Engineering and in Neuroscience at the Tufts Medical School. He received both his undergraduate and PhD degrees from the University of Cambridge in England and carried out post doctoral training in Neuroscience at Harvard Medical School with Professor Edward Kravitz and at the University of California, Berkeley and the University of Oregon, Eugene with Professor Janis Weeks. His research focus is on the Neuromechanics of Locomotion. In addition to his work on living systems, Professor Trimmer is Director of the Tufts Neuromechanics and Biomimetic Devices Laboratory which specializes in the application of found biological principles to the design and fabrication of soft robots. Dr. Trimmer is also Director of the NSF-funded Integrative Graduate Education and Research Training (IGERT) program in Soft Material Robotics and Editor in Chief of the journal Soft Robotics. These interests converge in his recent research that seeks to "grow" robotic devices using a combination of biosynthetic materials, cellular modulation, and tissue engineering. These Biosynthetic Robots will be versatile, safe, biocompatible, and biodegradable.