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Adaptive Locomotion by Soft Animals and Machines

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Abstract. Most animals can successfully travel across cluttered uneven surfaces and cope with enormous changes in surface friction, deformability, and stability. In contrast most mobile machines are confined to predictable environments (e.g. roads) or they interact destructively with their surroundings.

This talk will present research showing how the adaptive movements of soft animals such as caterpillars are controlled and how this can be related to the design and control of soft robots. The guiding framework is that morphological computation (embodied intelligence) is essential for soft animals to move in the natural world, and that soft machines need to incorporate the same strategies.

Unlike most animals and soft robots, caterpillars do not control their movements through pressure control or pneumatics. Instead they use a tension-based crawling mechanism that allows them to conform to the substrate and remain fully soft. A critical element in this strategy is the ability to control grip release using both mechanical and neural mechanisms to synchronize movements.

Some of these concepts have been implemented in a family of simple elastomeric robots (*Softworms*) and we have succeeded in generating caterpillar-like gaits based on model-free approaches using motion primitives and through distributed mechanical feedback. The next challenge is to make these robots climb in complex branched structures and to apply the control approaches to more diverse body shapes.