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Soft robots: where robotics meets mechanics

Katia Bertoldi
1 Harvard University

John A. Paulson School of Engineering and Applied Sciences
E-mail: bertoldi@seas.harvard.edu

Soft robots comprising several inflatable actuators made of compliant materials have drawn significant attention over the past few years because of their ability to produce complex motions through nonlinear deformation. Their design simplicity, ease of fabrication and low cost sparked the emergence of soft robots capable of performing many tasks, including walking, crawling, camouflaging and assisting humans in grasping, suggesting new paths for space exploration, biomimimetics, medical surgery and rehabilitation. However, to achieve a particular function existing fluidic soft robots typically require multiple input lines, since each actuator must be inflated and deflated independently according to a specific preprogrammed sequence.

An interesting avenue to reduce the number of required input signals is the direct exploitation of the highly nonlinear behavior of the system without the introduction of additional stiff elements. In this talk I will present three different strategies that we have recently explored to achieve this. First, I will show that a segmented soft actuator reinforced locally with optimally oriented fibers can achieve complex configurations upon inflation with a single input source. Then, I will demonstrate that the non-linear properties of flexible two-dimensional metamaterials are also effective in reducing the complexity of the required input signal. Finally, using a combination of evolutionary optimization and experiments I will show that fluid viscosity in the tubes can be harnessed to design fluidic soft robots capable of achieving a wide variety of target responses through a single input.