Multi-Purpose Artificial Muscle and Sensor Array for Untethered Soft Robots

Early Career Faculty Award (ECF): *Topic 1 – Soft Machines*

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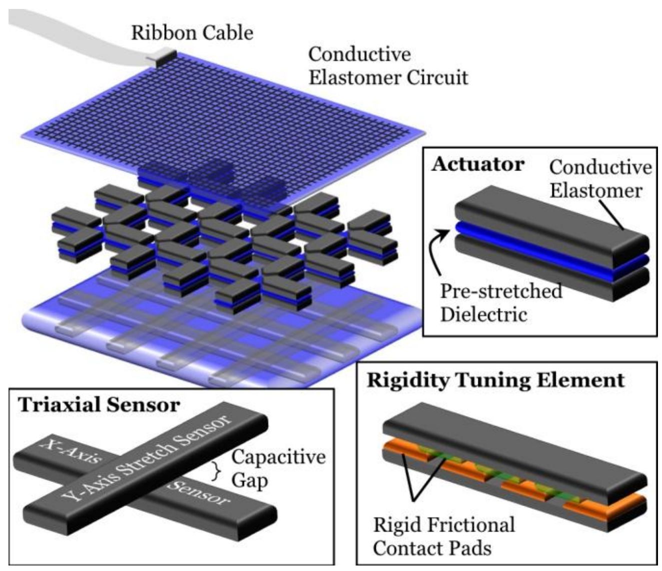
Objectives

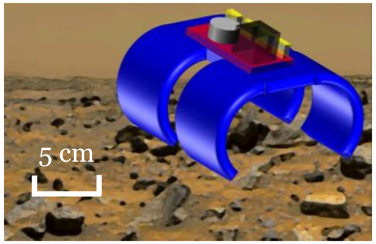
"Soft Robotic Tissue" Multifunctional Composite

- General-purpose 1-5 mm elastic film
- "Artificial" skin, nervous tissue, and muscle
- Laser-patternable; "plug-and-play" operation
- *All-Soft-Matter* – no rigid materials
- Functional under *extreme* elastic deformation (up to 200% strain)

Soft Robot Implementation

- Compliant Gripper
- Untethered Quadruped
- Wearable Sensing Skin
- Predictive Modeling w/ Modified Composite Plate Theory





Approach

Laser-patterned conductive & insulating elastomer

- Rapid prototyping (< 1 hour fab. time)
- Solid-state – no phase-change over a large (±150 ^oC) temperature range

Resistive & Capacitive Sensing

- Pressure, stretch, and bending curvature
- Theory & design principles based on nonlinear elasticity

Electrostatic Activation

- Low-power dielectric elastomer actuator (DEA) array
- Reversible tensile/stretch rigidity tuning

Modeling – Hyperelasticit; Electrical Enthalphy; Rayleigh-Ritz; Calculus of Variations; multi-physics FEA (commercial)

Impact

Soft robotics for planetary exploration

- Untethered
- Elastically conform to delicate objects, uneven terrain, tight spaces

Inflatable/collapsible space structures

- Elastic wiring for supporting electronics/antennae
- Rigidity-tuning for controlled/selective inflation

Humanoid & Wearable Robotics

- Compliance matching with natural human tissue
- Artificial skin for tactile and pose/shape sensing
- Artifical muscle for grasping, manipulation, robot locomotion, human motor assistance, and injury prevention