Micro Robotics Lab

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ISR @25 — The Institute for Systems Research — A. James Clark School of Engineering

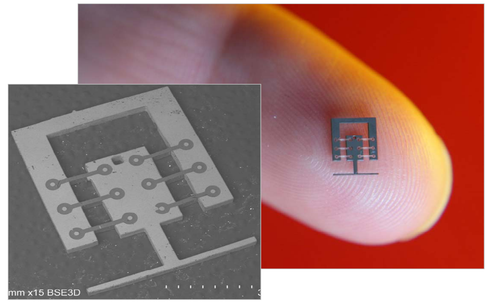
Goal

Engineer efficient and capable robotic systems at small size scales

Technical Areas

- **Robot Locomotion**
  - Insect biomechanics
  - Improving efficiency and efficacy
  - Scaling of locomotion principles
- **Microrobot Mechanisms**
  - Multi-material micromechanisms
  - Rapid prototyping processes
  - Microfabrication
- **Microrobot Actuation**
  - High power actuation from stored energy
  - High force density microactuators
  - Polymer-based thermal actuators
  - Energetic materials
- **Power Sources**
  - Energy harvesting
- **Systems Integration**
  - Low mass, low power control and sensing
  - Robust integration
- **Mobile Sensor Networks**
  - Sensors for localization
  - Low power communication

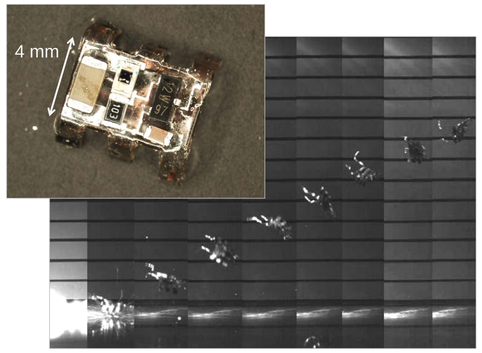
Project Highlights



Silicon/PDMS Micromechanisms for Jumping Microrobots

Technical Highlights
- First monolithic , high aspect ratio PDMS/Si mechanisms
- 100s of μJ stored for energy release in jumping microrobots

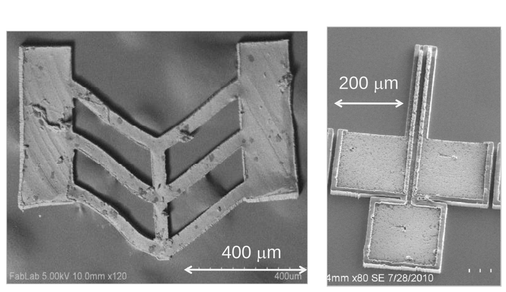
Broader Impacts
- Soft springs, grippy sidewalls, mechanical energy storage for various MEMS applications
- First truly mobile μrobots



Autonomous Jumping Microrobots using Energetic Materials (**w/ ARL**)

Technical Highlights
- First fully integrated sub-cm³ robot (sensing, actuation, control, power)
- An 8-cm high jump was demonstrated in response to a light stimulus

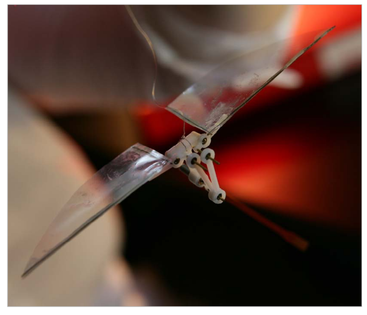
Broader Impacts
- New integration method for COTS electronics components and polymer/metal robots



Soft Polymer Microactuators

Technical Highlights
- First all-polymer microfabricated actuators (both thermal and electrostatic)
- High aspect ratio conductive and non-conductive PDMS features

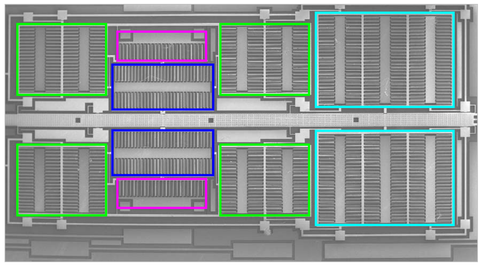
Broader Impacts
- Robust actuators for use in miniature robotics, medical devices, prosthetics, etc.



A 1.5g Micro Air Vehicle (w/ Prof. S. K. Gupta)

Technical Highlights
- New compliant frame architecture to reduce weight

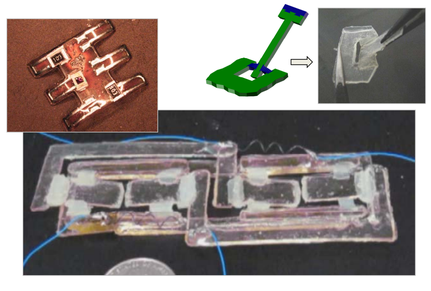
Broader Impacts
- Reduced mass of frame, wings, and electronics can increase payload carrying capacity resulting in useful MAVs at this scale



High Force Density Silicon Actuators for Microrobots

Technical Highlights
- New design for electrostatic inchworm actuators to improve force density, power density, and efficiency

Broader Impacts
- Efficient and scalable actuators for use in miniature robotics, prosthetics, etc.



Rapid Multi-Polymer Prototyping for Microrobots (w/ Profs. Abshire, Martins and Smela)

Technical Highlights
- Low-cost, low-overhead fabrication of sub-cm robot systems
- Inclusion of thermal actuators and wiring on polymer platform

Broader Impacts
- Reduce design cycle time for sub-cm robots
- Experimentally investigate questions on scaling locomotion

Selection of References (since 2009)

Gerratt, A. P., Penskiy, I., and Bergbreiter, S., "SOI/elastomer process for energy storage and rapid release," *Journal of Micromechanics and Microengineering*, vol. 20, no. 10, p. 104011, 2010.
Penskiy, I., Gerratt, A. P., and Bergbreiter, S., "Friction, Adhesion, and Wear Properties of PDMS Coatings in MEMS Devices," in *IEEE MEMS*, 2011 (*accepted*).
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Rajkowski, J.E., Gerratt, A.P., Schaler, E.W., and Bergbreiter, S. "A Multi-Material Milli-Robot Prototyping Process," IROS 2009, St. Louis, October 11-15, 2009.