Compliant Robotic Sensing Skin

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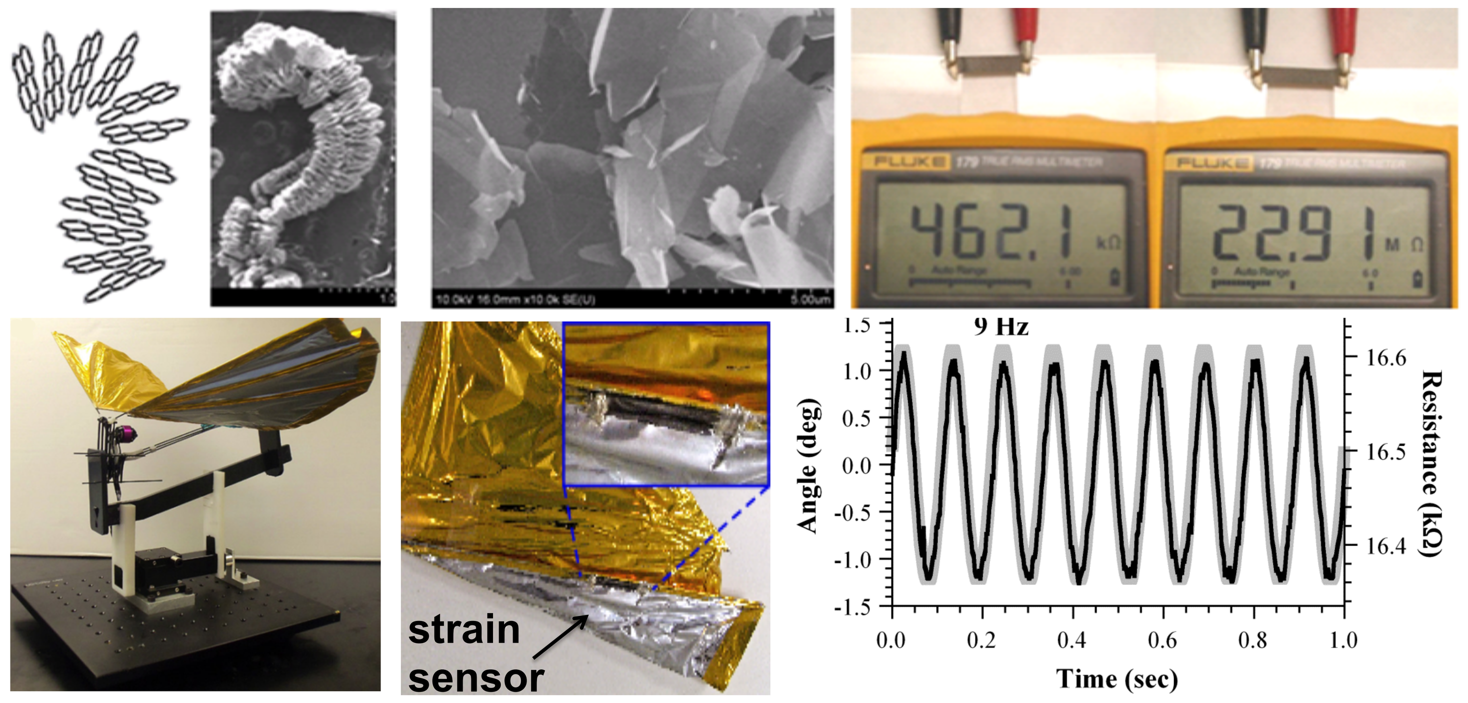
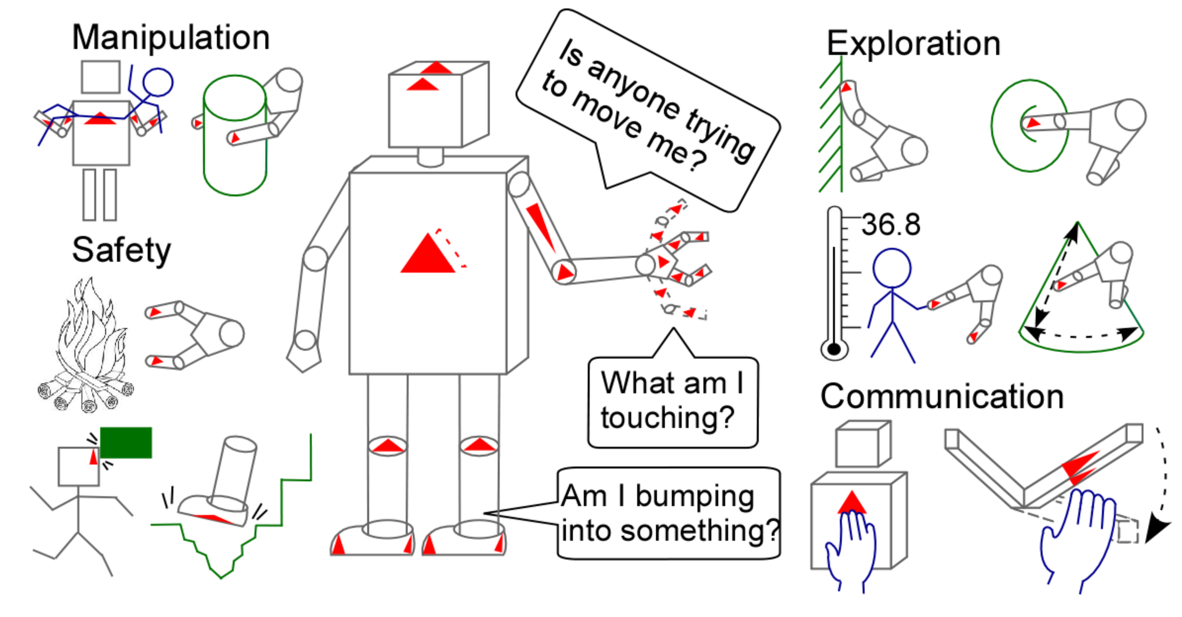
Compliant Strain Sensors

- Formed from exfoliated graphite (EG) and elastomers (e.g., latex).
- Strain sensitive (piezoresistive).
- Applied to surfaces using spray processes.
- Can be integrated into existing structures (e.g., flapping wing) .



Tactile Sensing for Co-Robotics

- Compliant multi-functional skins for robotics can “sense” contact with other structures and temperature.
- Large-area compliant skins over padded robots.
- Enables bio-inspired robotic control principles for manipulation, safety, exploration, and communication.
- Enables humans to work alongside with robots.

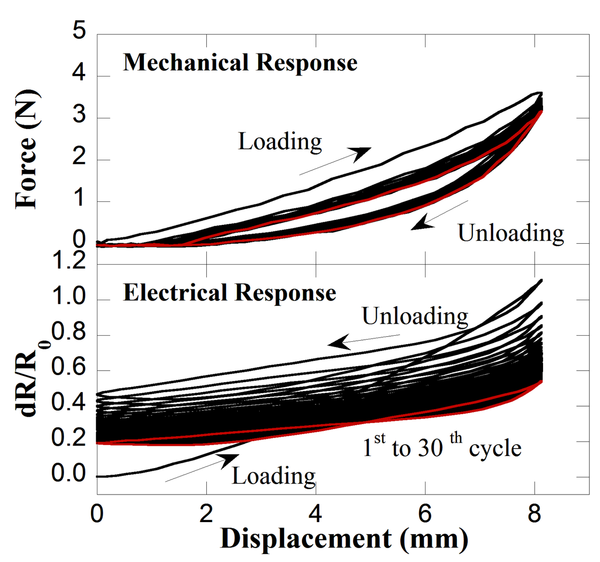


Red rectangle stands for tactile sensor, grey stands for robot, green stands for object, blue stands for human.

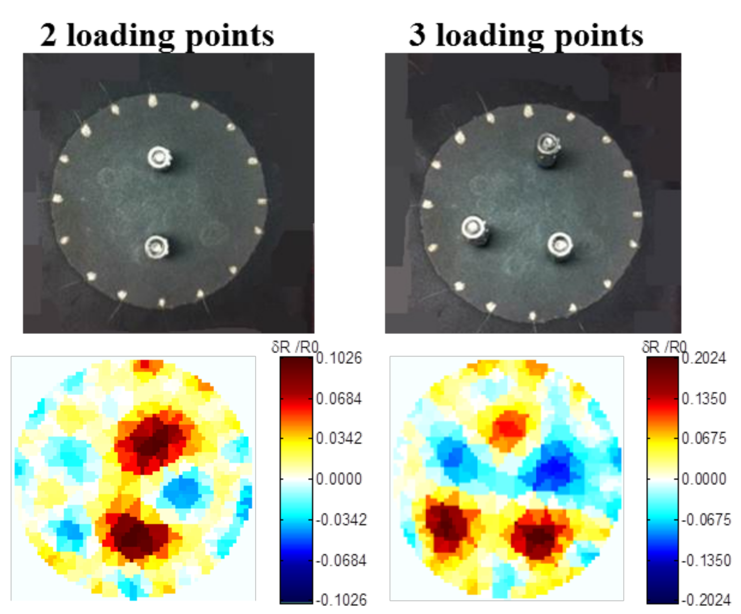
Multifunctional Sensing

- Calibrate for both static and dynamic response under a combination of compression and tension.
- Investigate the performance of the skin with padding materials .
- Characterize cross-sensitivities of sensing materials for compensation of environmental conditions.

- Employ electrical impedance tomography (EIT) for distributed sensing.
- Reduce wiring complexity through reconstruction of the internal resistance change from periphery measurements.
- Improve the algorithm for the inverse problem to enhance image quality of the reconstruction.

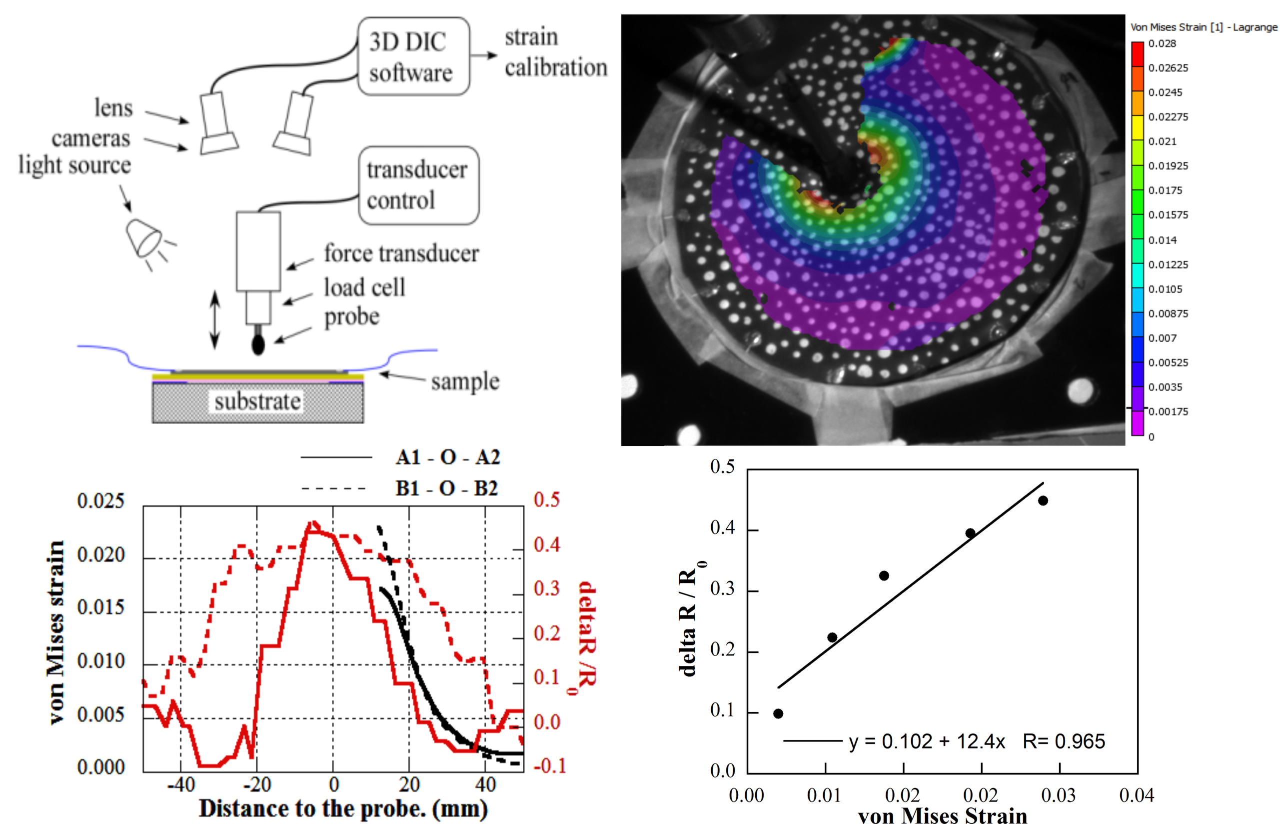


Stabilization of the Sensing Skin



Distributed Sensing Skin

Characterization



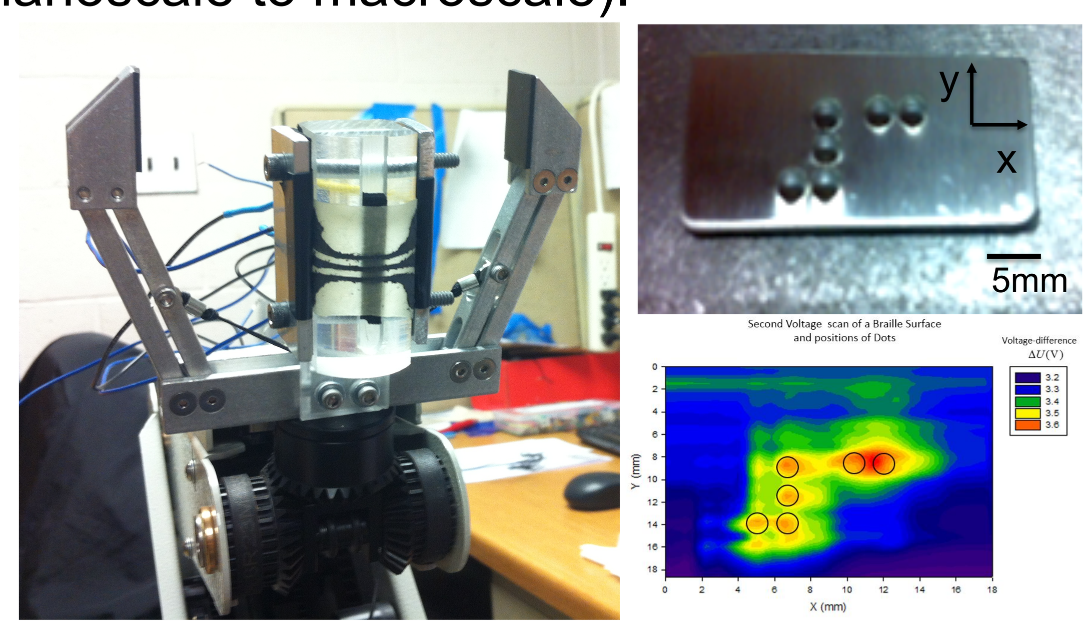
DIC Strain Characterization of Sensing Skins for Robotics

- Use digital image correlation (DIC) to characterize deformations of compliant robotic structures.
- Provide high resolution full-field deformation measurements.
- Enable direct quantification of interactions.
- Develop fundamental relationship between sensor configuration and distributed pressures and geometries from human contact .

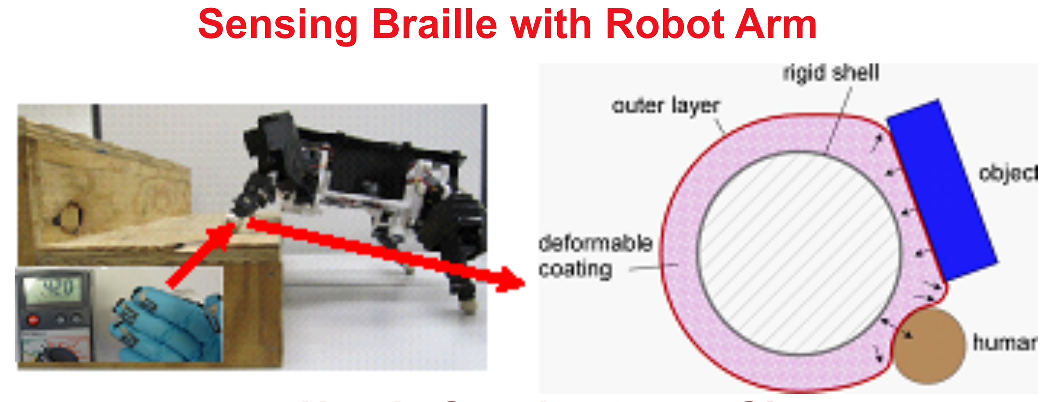
References:
[1] J. Wissman, et al., Smart Materials and Structures, vol. 22, p. 085031, 2013.
[2] M. Kujawski, et al., Carbon, vol. 48, pp. 2409-2417, 2010.
[3] M. Kujawski, Thesis: Polymer Composites for Sensing and Actuation, 2011.

Integration

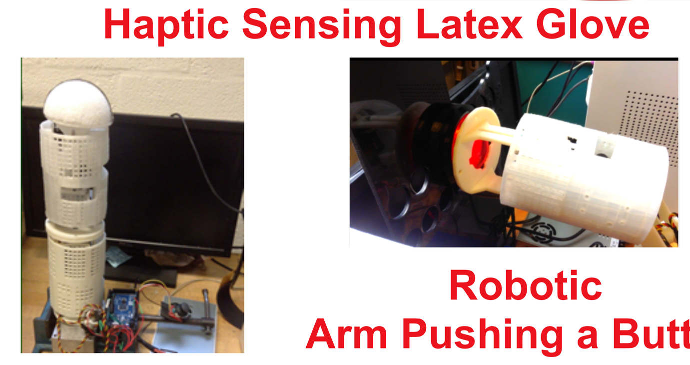
- Readily integrate sensing materials or retrofit onto any robotic platform.
- Create multifunctional robotic structures with integrated sensing materials at many length scales (nanoscale to macroscale).



Sensing Braille with Robot Arm



Haptic Sensing Latex Glove



Robotic Arm Pushing a Button

National Science Foundation (NSF) award number 1317913

Multiscale Measurements Laboratory
Laboratory for μ Technologies
Sensors and Actuators Laboratory