NRI: INT: COLLAB: Mesh Of Robots on a Pneumatic Highway (MORPH): An Untethered, Human-Safe, Shape-Morphing Robotic Platform

Award #: CMMI 1925373, Poster #45

PI: Elliot W. Hawkes (UC, Santa Barbara); PI: Sean Follmer, co-PI: Mac Schwager (Stanford University)

Challenge

- How can we create un-tethered soft robots capable of dramatic shape change?

Solution

- Iso-PERI-metric soft robots with an effective constant volume

Scientific Impact

- New Robotic Architectures
- Distributed Control Methods
- Soft Inflated Tube Mechanics

Broader Impact

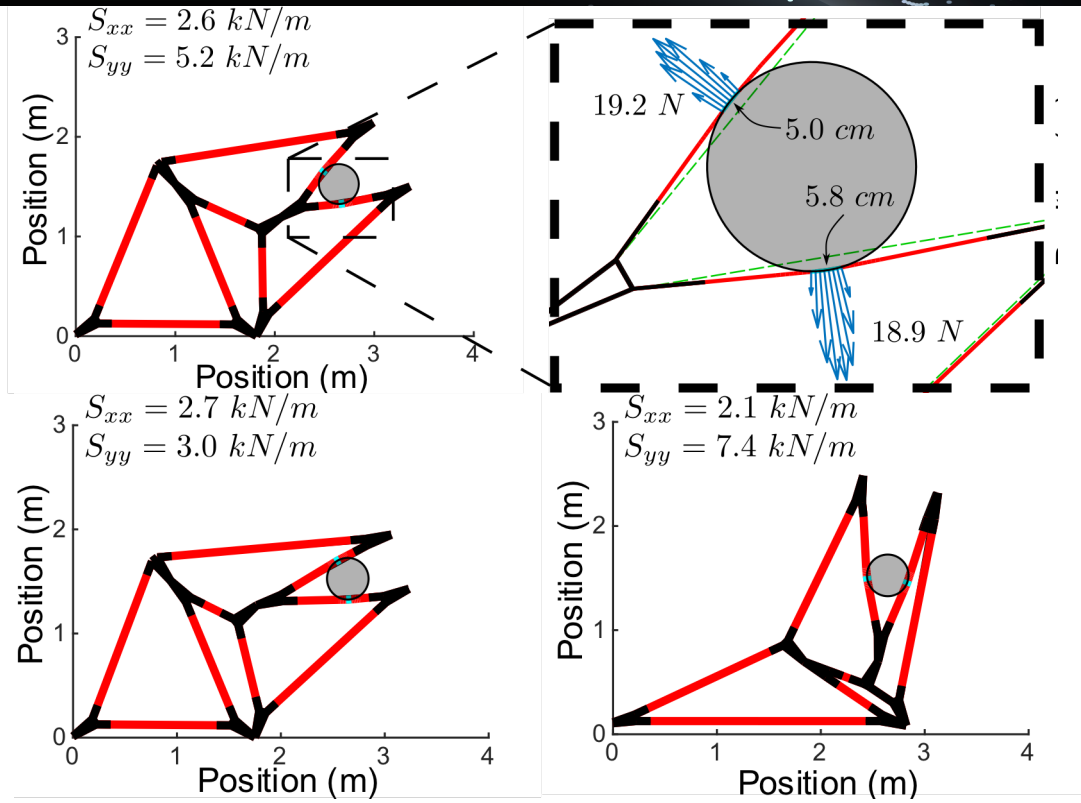
- Search and Rescue
- Human Safe Interaction
- Robotic Platform for exploring Kinematics

Modeling: Grasp Analysis with Isoperimetric Truss Robots

Compliant truss robots can grasp objects with large contact areas and even force distribution

We use a direct stiffness model to predict

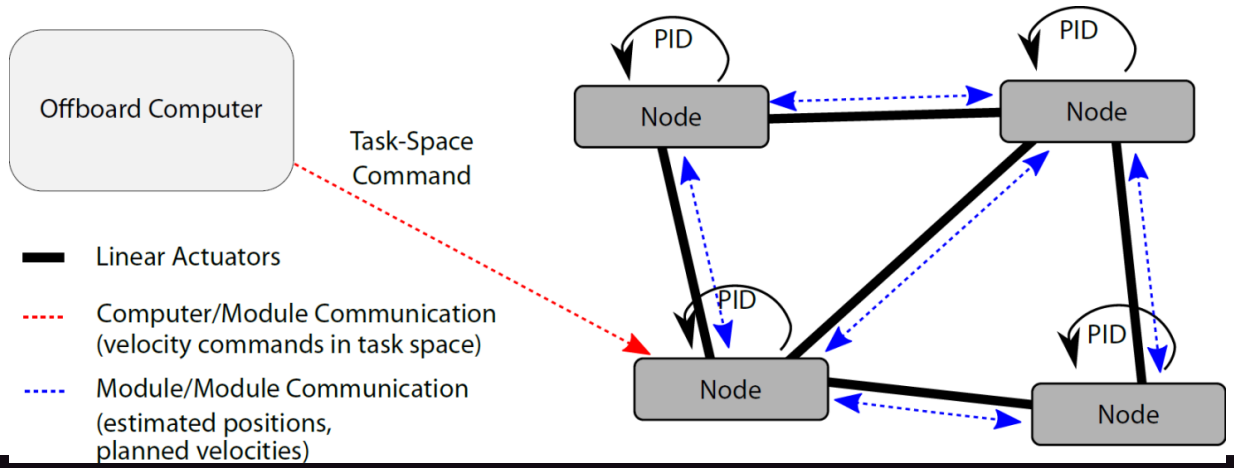
- Grasp forces
- Contact region
- Structure deformation
- Grasp stiffness

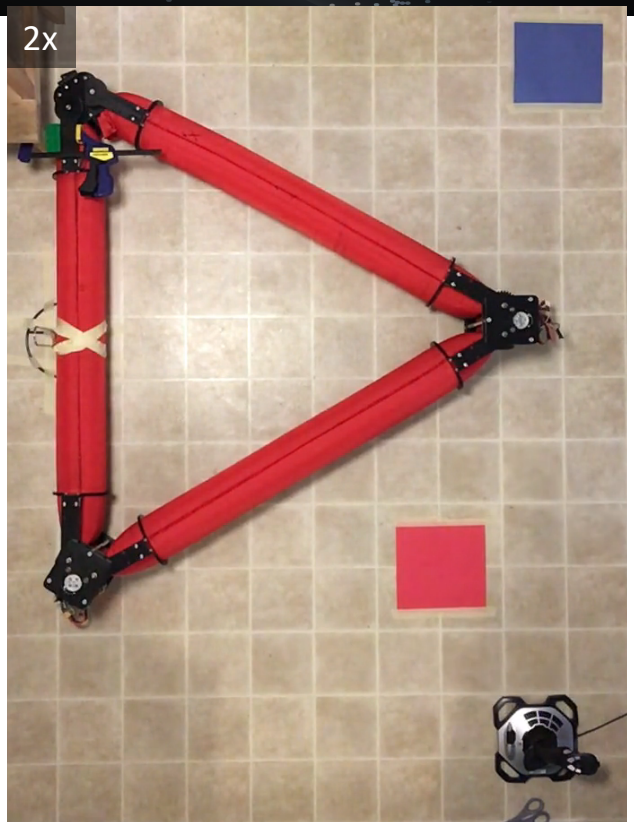


Hammond, Z. M. & Follmer, S. "Grasp analysis and manipulation kinematics for isoperimetric truss robots." *ICRA 2021, (Under Review)*

Distributed estimation and control of isoperimetric truss robots

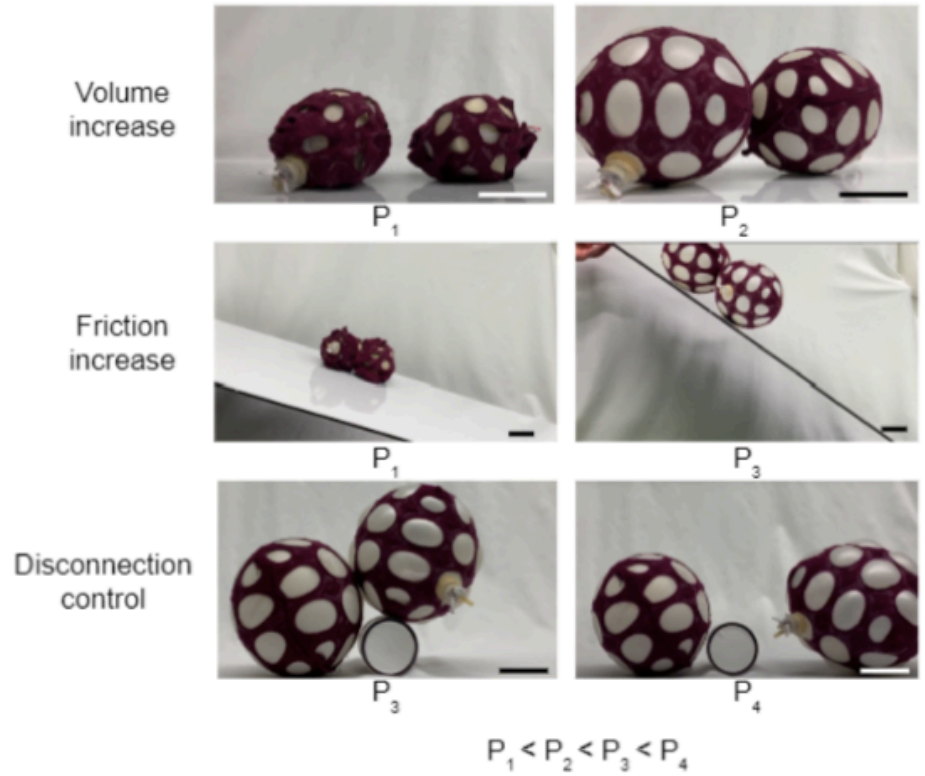
- Consensus ADMM enables scalable distributed state estimation and control.
- The nodes converge to jointly optimal velocities while enforcing local constraints.





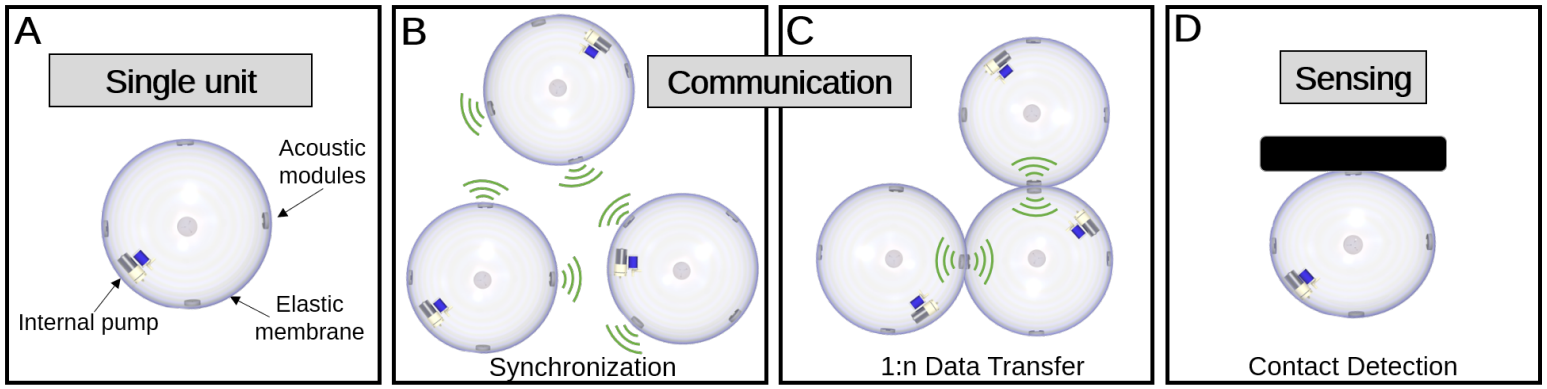
Hardware Exploration: Soft Cellular Robots

- Nodes and links of truss can be represented as size-changing spheres
- Groups of these “cellular robots” could form a collective to perform locomotion, shape change, and apply forces

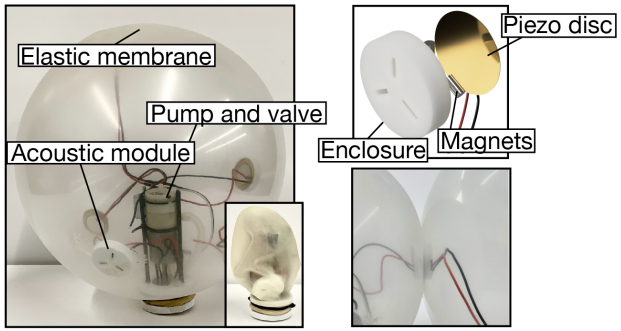


Devlin, M.R., Young, B.T., Naclerio, N.D., Haggerty, D.A. and Hawkes, E.W., An untethered soft cellular robot with variable volume, friction, and unit-to-unit cohesion. *IROS2020.*

Acoustic Sensing and Communication for Inflated Soft Robots



Multifunctional, low-cost components that take advantage of the robot's structure



D. S. Drew, M. Devlin, E. Hawkes, and S. Follmer, "Acoustic Communication and Sensing for Inflatable Modular Soft Robots," *ICRA2021, Under Review*

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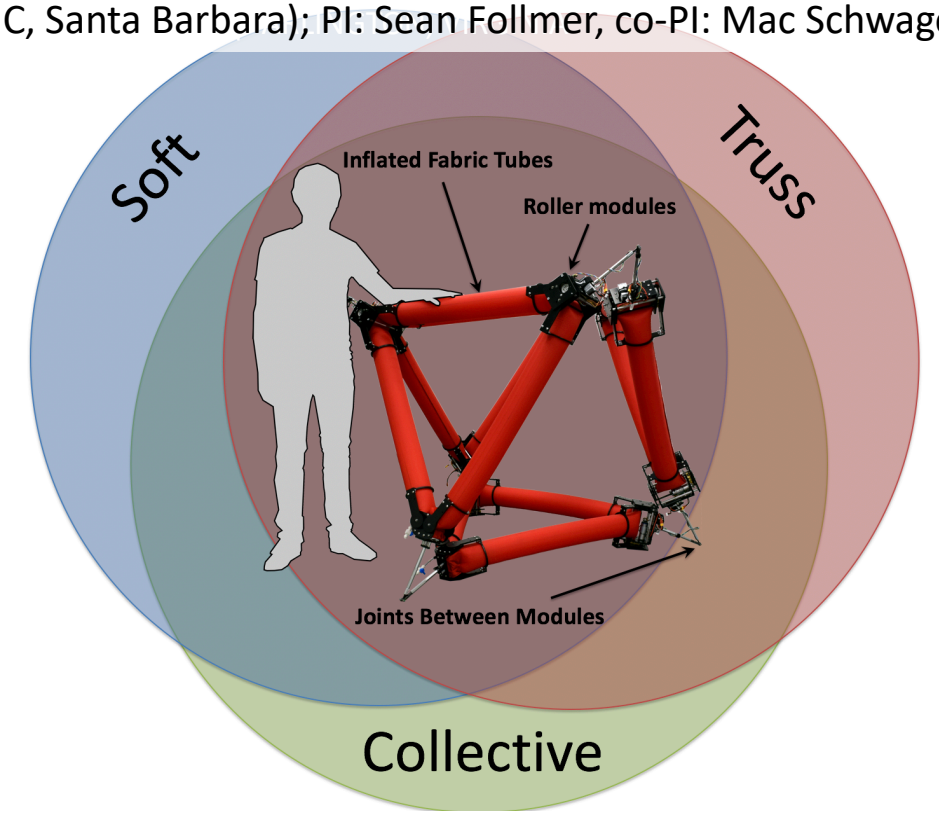

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