**Introduction**

We are developing robots that are composed of a large number of high elongation linear actuators connected at universal joints into a truss structure. Changing the lengths of the actuator enable the robot to dramatically change its shape, enabling new flexibility for a variety of tasks and missions. We are exploring the following topics:

- Novel High Elongation Actuators using inspiration from soft robotics
- Optimization-based control schemes that allow the robot to locomote and change shape

**Related Work**

- Tensegrity and tetrahedral robots use a similar architecture, and have been considered for planetary exploration in unstructured environments.
- Methods in changing shape draw from computer graphics
- Formation Control Literature also provides key insights on how to coordinate motions of large numbers of agents to reach target configurations

**Hardware**

We are developing two separate hardware implementations:

- High elongation pneumatic reel actuators
- A constant volume architecture where movable nodes drive along static pneumatic tubes

Key Advantages:

- Pneumatic components allow inherent compliance
- High elongation enables dramatic shape change

**Future Work**

- Developing a distributed control architecture (the current optimization controller is centralized)
- Building Physical Robots on which to execute the algorithms
- Evaluate the robot in experimental conditions
- Examine Dynamic Motions of the Robot

**Optimization Design**

- If the graph describing the robot configuration is infinitesimally rigid, node positions are controllable
- Perform nonlinear optimization to find a kinematic pathway that satisfies physical constraints to help the robot achieve an objective (locomotion or shape change)
- Optimization solved through sequential quadratic programming

**Shape Change**

- We have developed control algorithms that enable the robot to compute a path between two different shapes
- Shape Changing algorithms inspired by work on shape morphing in computer

**Gait Design**

- For locomotion, the optimization can determine motion primitives offline that start and end in symmetric configurations
- A high level planner can use the precomputed motion primitives while performing real time planning

**Acknowledgments and References**

This work was supported in part by National Science Foundation Award 1637446, ONR grant N00014-16-1-2787, and US Army Medical Research and Materiel Command grant W81XWH-15-C-0091.

**References**
