Untethered and Modular Inflatable Robot for Lunar Applications

BYU CMR

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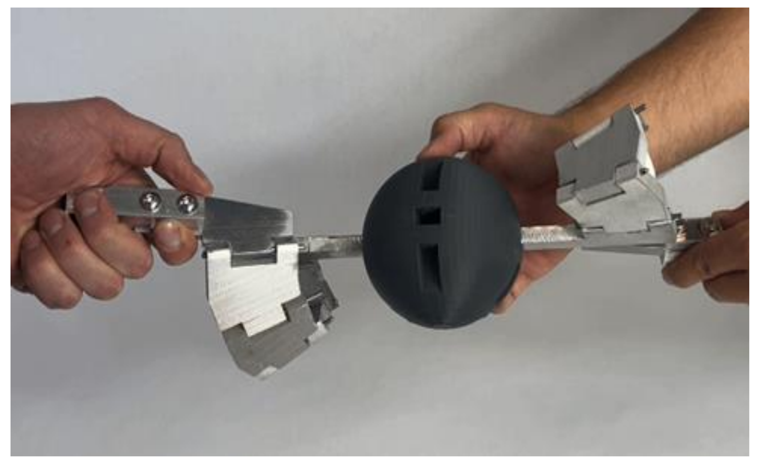
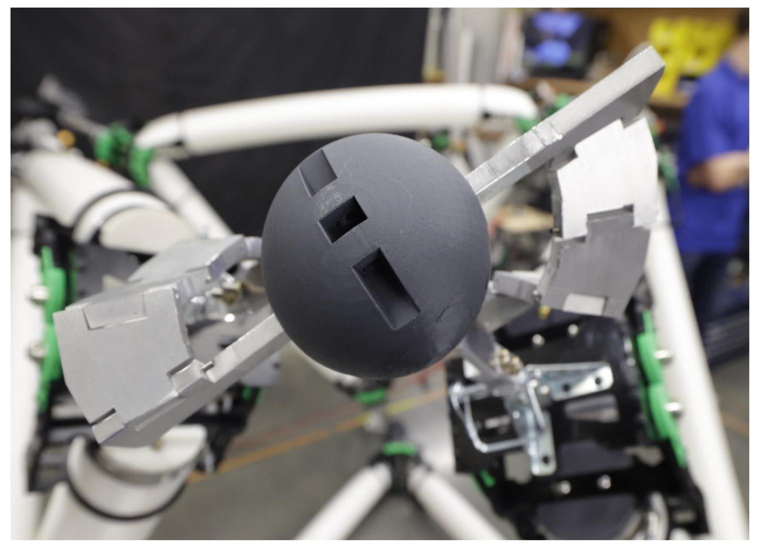
Background & Motivation/Introduction

Sustained operations on the moon will require **robotic structures** that can perform tasks like building solar arrays and habitats, servicing equipment, exploring, or rescuing astronauts.

As an alternative to traditional rigid robots, **inflatable soft robotics** could be used to fill these needs while keeping weight low and taking up less payload volume for a mission.

Spherical Joints





Our spherical joints allow for up to four interconnected roller modules with independent movement around a central point.

The joints are made of **aluminum panels** connected with **steel pins** to form hinges. When linked together, multiple panels create a fin that bends. Bending the fins allows the connected joints to move around the central sphere.

A future compliant version could reduce part count and prevent friction welding.

Inflatable Tubes

The inflatable tubes of our robot are made from industrial firehose tubing with a **polyurethane inner liner** and a **polyester external weave**.

Each tube is capped with two "pucks" or "plugs" that is clamped into place and mounted to one of the stationary rollers on our robot. One of the pucks contains a two-way valve stem for inflation.

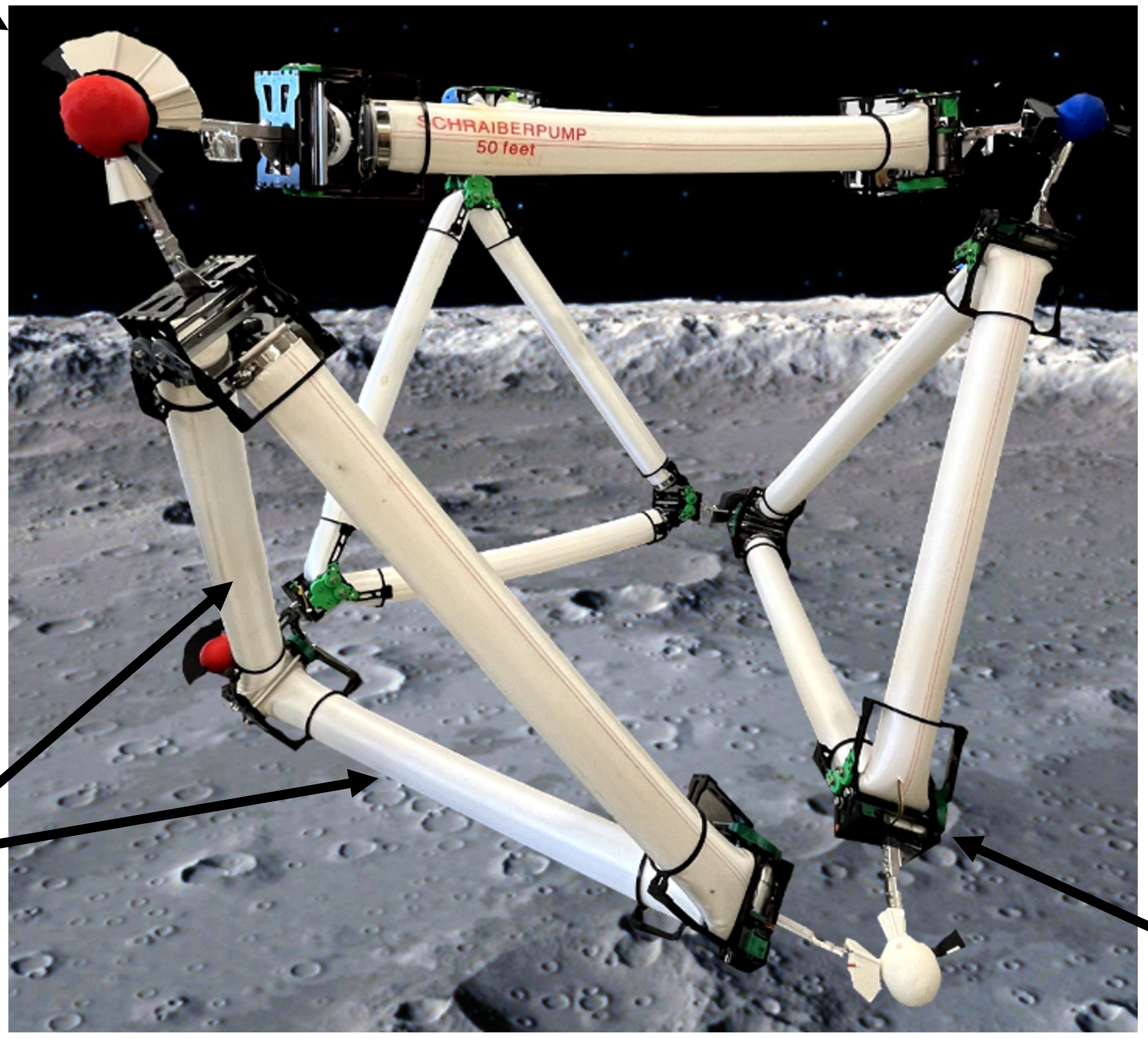
The **tubes** act as the **structural members** of our robot, supporting the robot's weight and any external loads.

Once inflated, the tubes are kept at a stable pressure (around 5 psi in our testing) minimizing the need for air tethers that are common in other inflatable robots.

Our Robot Overview

Our robotic design consists of **inflatable beams** that are bent into **triangles**, with **motor-driven nodes** at the corners, pinching the tubing.

These triangles can be combined into an **octahedron** (shown below) or larger structures. Each motor node uses 4 rotating steel rods to move tubing from one side of the node to the other, changing the side lengths of that triangle. Coordinating this motion across triangles results in large motion as a structure.



Robot Advantages

- **Untethered Operation** – Once inflated, no air compressor is required, allowing free locomotion.
- **Modular Assembly** – When assembling, triangles can be combined in any number of desirable configurations.
- **Morphable Structure** – Once assembled, the shape of the robot can adapt for the load conditions required.
- **Deployable** – When stored, the robot shrinks down to 1/6th of its original size and is easily deployable.
- **High Strength** – The tubes can withstand ≥50 psi gauge, contributing to a high strength-to-mass ratio.
- **Safe** – Due to the compliance in the tubes, the robot provides little to no danger when interacting with it.

Acknowledgements/References

We recognize the BIG Idea challenge for supporting this project.

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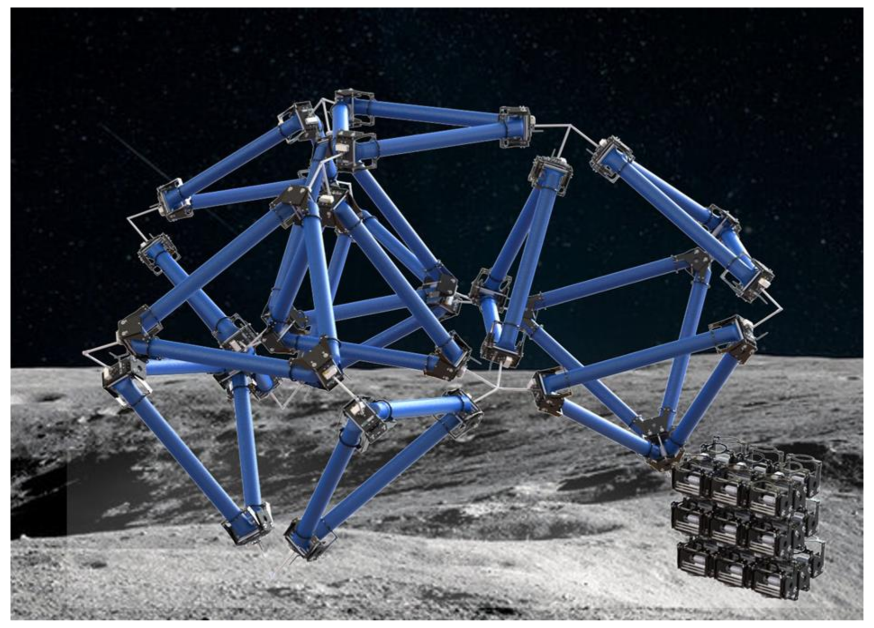
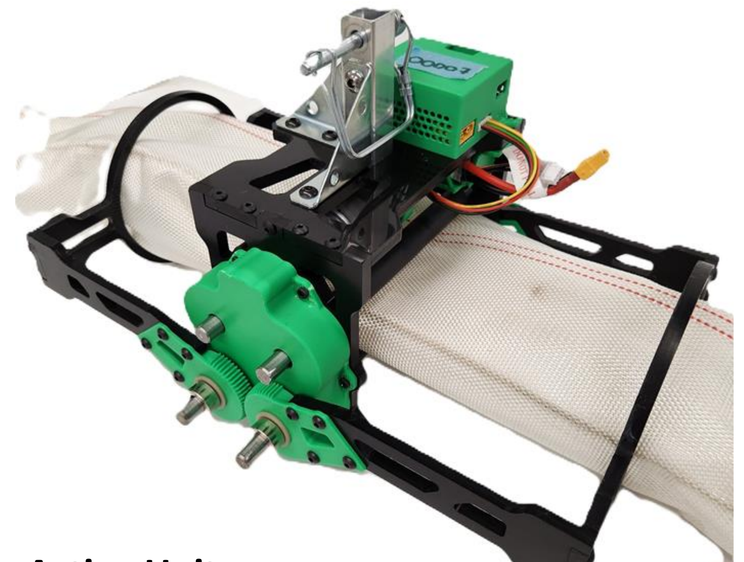
Larger Structures

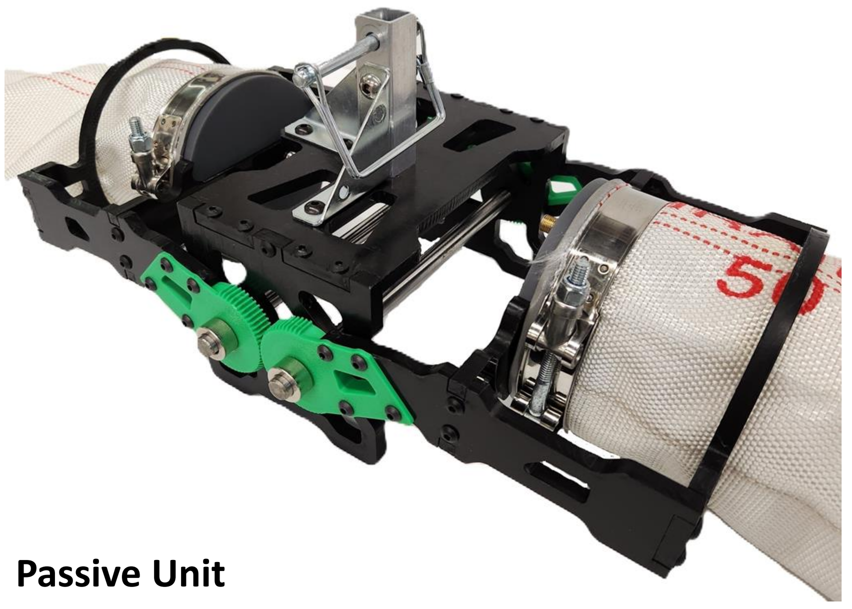
By connecting multiple octahedra together, we can create many useful structures for lunar applications. On the right is a **solar panel mount** with a mock blue solar panel mounted to the top. Below is a concept for **a lunar crane**.



Mechanical Rollers



Active Unit



Passive Unit

Each triangular face has **three roller modules**: two active (left) and one passive (right). These rollers provide the actuation to morph our truss robot into any number of desired configurations. The active roller modules use a **65rpm motor** to rotate **four metals rods** which roll along the tube. Guide arms ensure a bisecting angle is formed. Position is controlled via radio through a PCB-mounted Arduino board.