



Omni usability Soft Robotic Exoskeleton Phase II (OSRE)

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Introduction

- OSRE Phase II is meant to meet similar goals as the original, as it continues the goal of using soft robotics to mimic human motion while broadening our goals to include increase adaptability of the platform.
- OSRE phase II maintains its broad range of usability in biomedical, industrial, and space operations.
- OSRE phase II uses fluid-driven origami artificial muscles (FOAMs) with a similar cost, a higher compression ratio, but a lower power output when compared to McKibben's muscles.

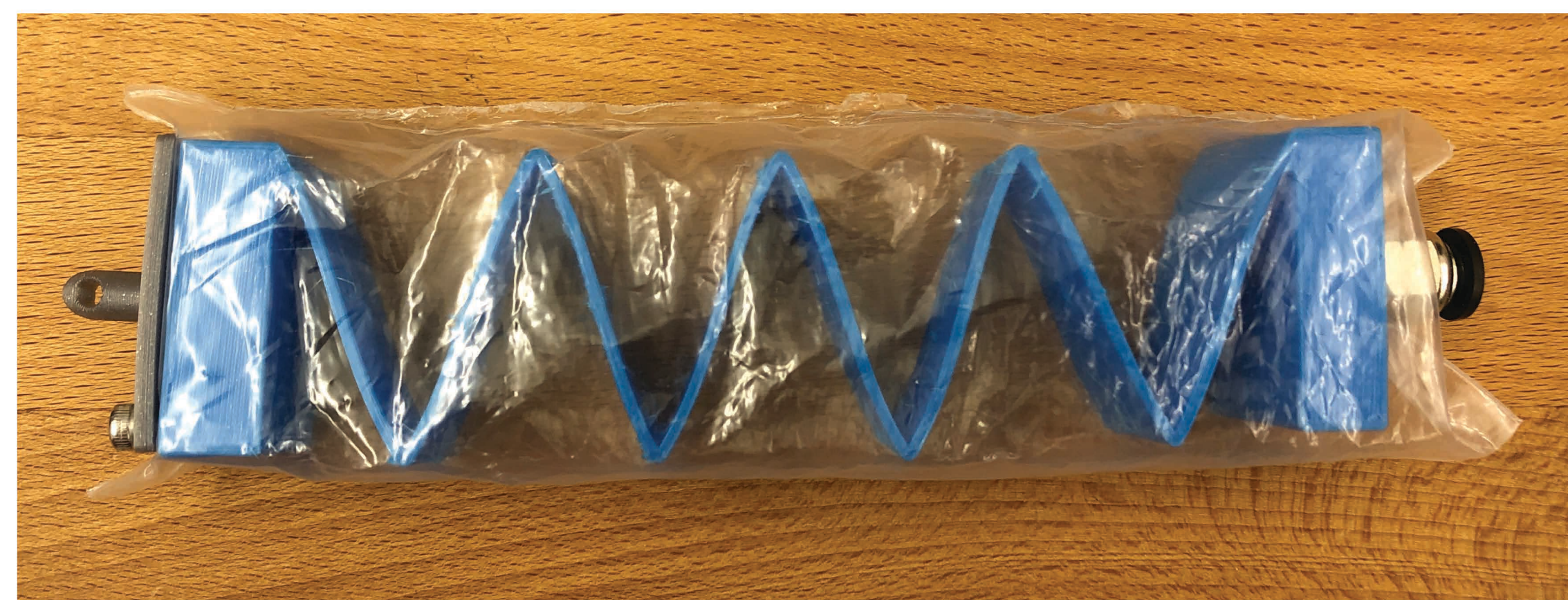


Figure 1: A fluid-driven origami artificial muscle (FOAM)

Objectives

- Implement on the full-body soft robotic exoskeleton platform Fluid driven Origami Soft Muscles.
- Implement sliding mode control for the McKibben soft muscles to create more fluid and precise motion.
- Utilize electromyography data and live positional data to allow the OSRE platform to act in either an assistive or resistive role.

Methods

- Inertial Measurement Units (IMUs) are used to measure the angle between different mounts on the exoskeleton. This is done from the acceleration and gyroscopic data collected.
- Electromyography will be used to read the current status of each of the wearer's muscles to determine how OSRE needs to react to assist the wearer. Baseline electromyography data will be collected for the wearer so the data can be turned into a target angle for the exoskeleton.
- Then the exoskeleton will then react to help the wearer achieve that angle. To control the system currently, we have applied two control loops one using a Basic Negative Feedback Loop and the other a simple PID.

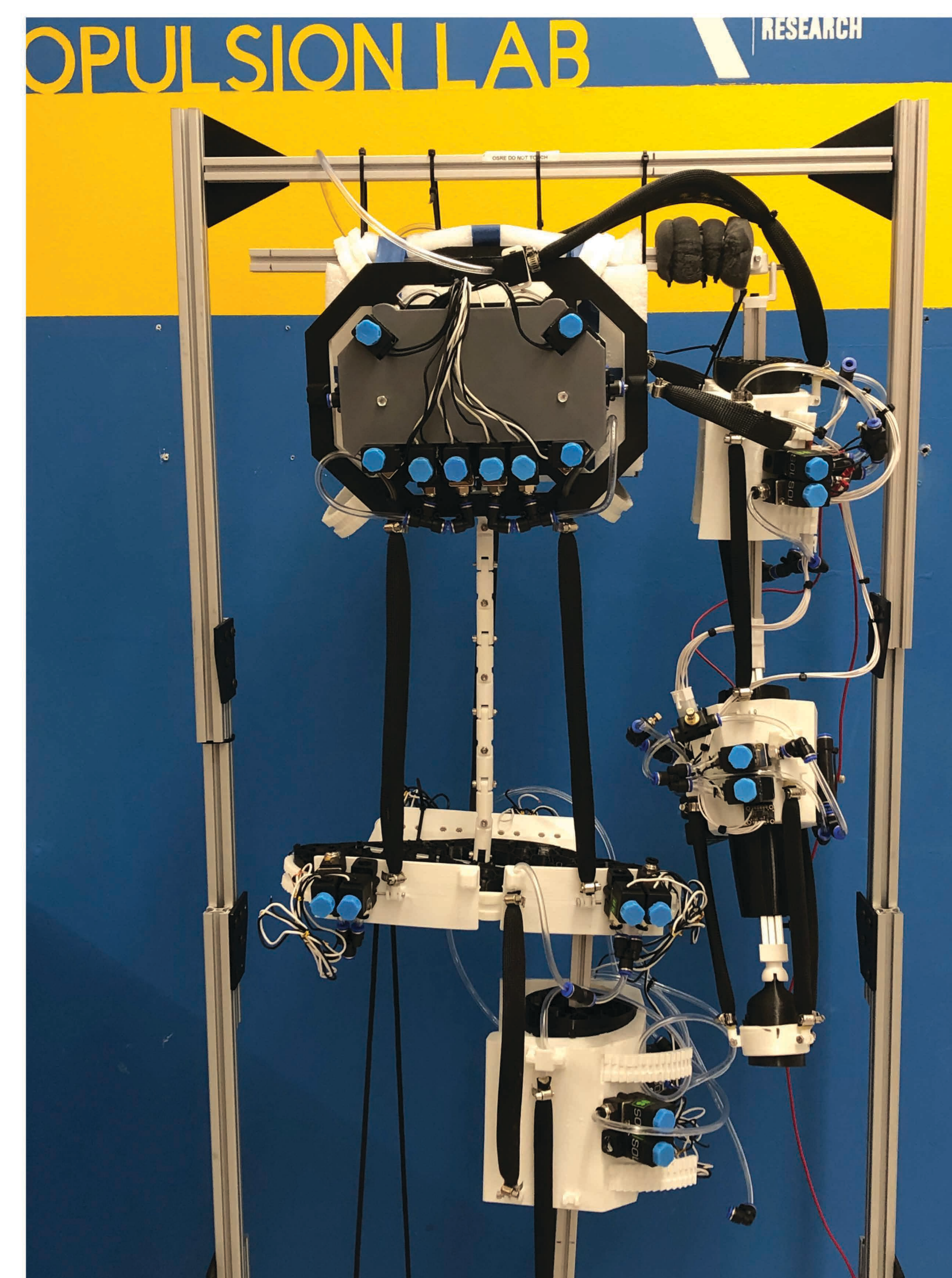


Figure 2: OSRE Exoskeleton

Progress

- In our hardware, we have constructed half of the overall exoskeleton reserving the second half to add the FOAMs too. We have constructed multiple FOAMs for testing their motion, force output, and flexibility.
- We have tested multiple types of control systems on OSRE, including a basic negative feedback loop and a Proportional-Integral-Derivative controller (PID).
- The negative feedback loop involves detecting when OSRE is not at the desired location and taking the required action to move OSRE towards the desired location and has an accuracy of approximately .5 degrees.

Conclusion & Future Work

- We have seen success with the usage of the McKibben muscle and linear control algorithms and desire to expand upon this. Our next step would be to move to the usage of a nonlinear controller such as the Sliding mode controller as we believe this would be able to overcome limitations in the control of the muscles with generic solenoids.
- Our implementation of the FOAMs is slow due to the redesign of the control of them in the software. The general motion we desire for their usage is to generate rotations around the body. This motion has difficulties being read by our MPU 6050 IMUs on a certain axis.