



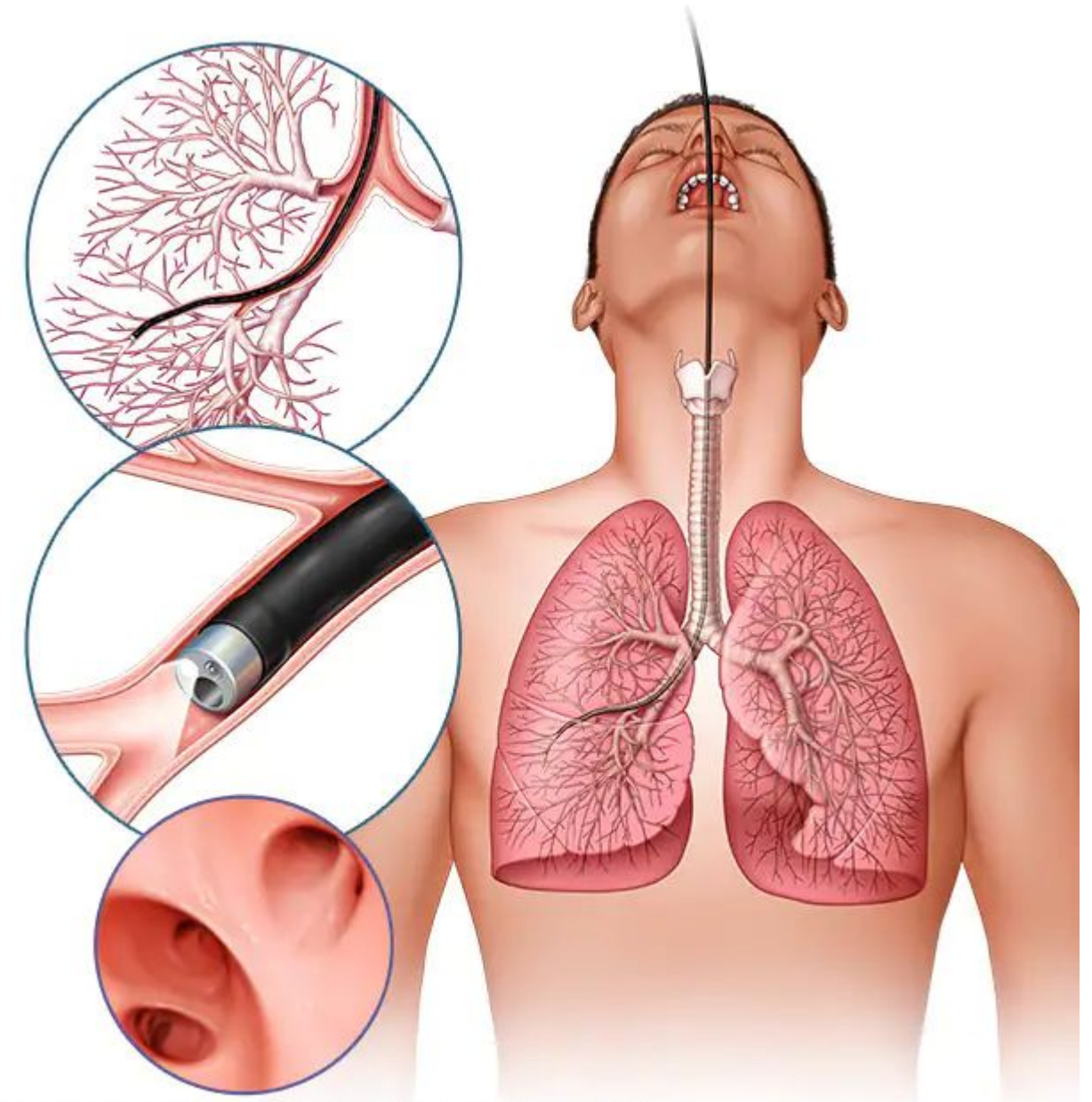
A Soft Robot for Surgical Interventions

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1 Project Motivation



- Lung cancer is the leading cause of cancer-related deaths worldwide
- 13% of all new cancers begin in the lung
- Existing bronchoscopes have limitations in clinical settings

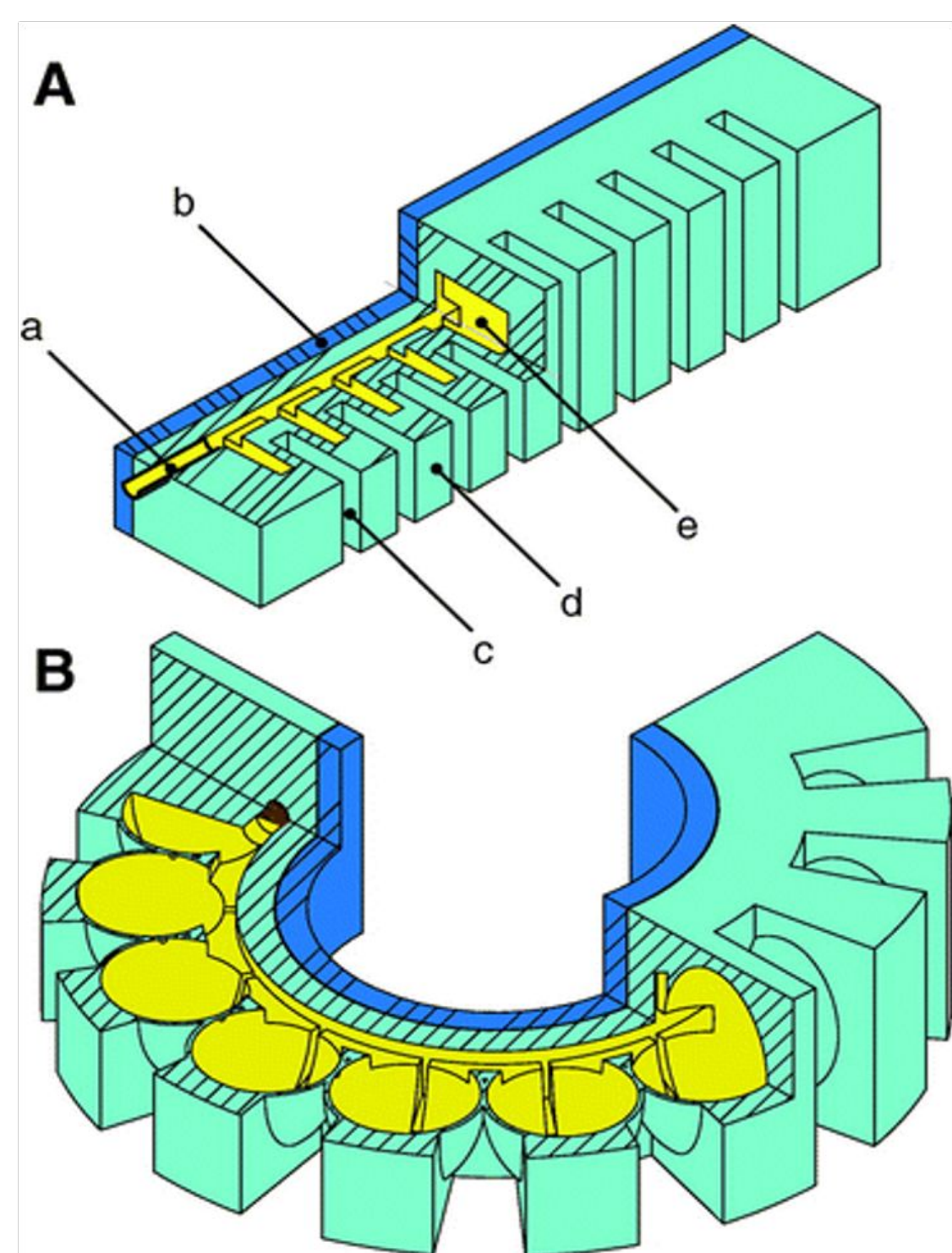
Features to Maximize

Controls — Patient safety — Depth of Biopsy

2 Proposed Solution

Soft Robotics

- Uses Compliant Materials
- Adaptable in unpredictable environments
- Lots of promise in Biomedical applications
- Safer in Robot-Human Interactions
- Sensing and control with these robots are an intriguing and continued point of research



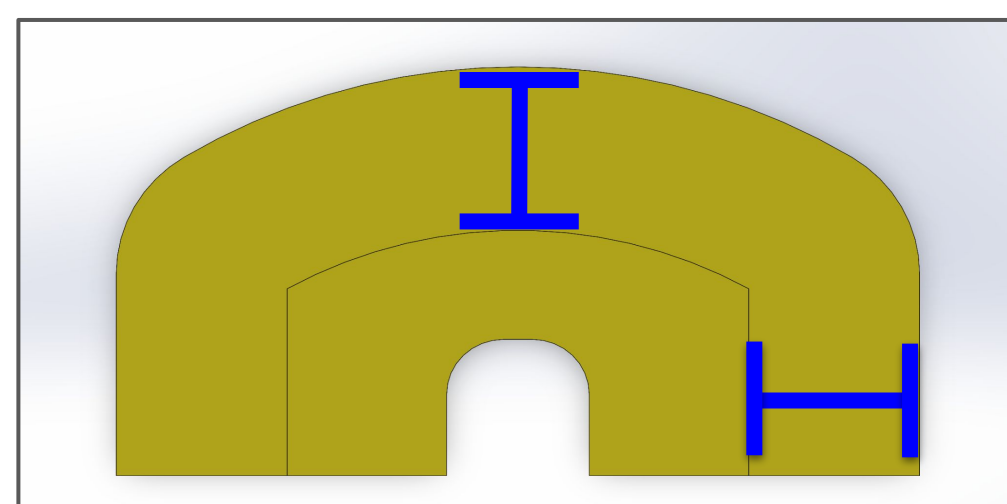
<https://www.liebertpub.com/doi/10.1089/soro.2014.0022>

Fluidic Elastomer Actuators

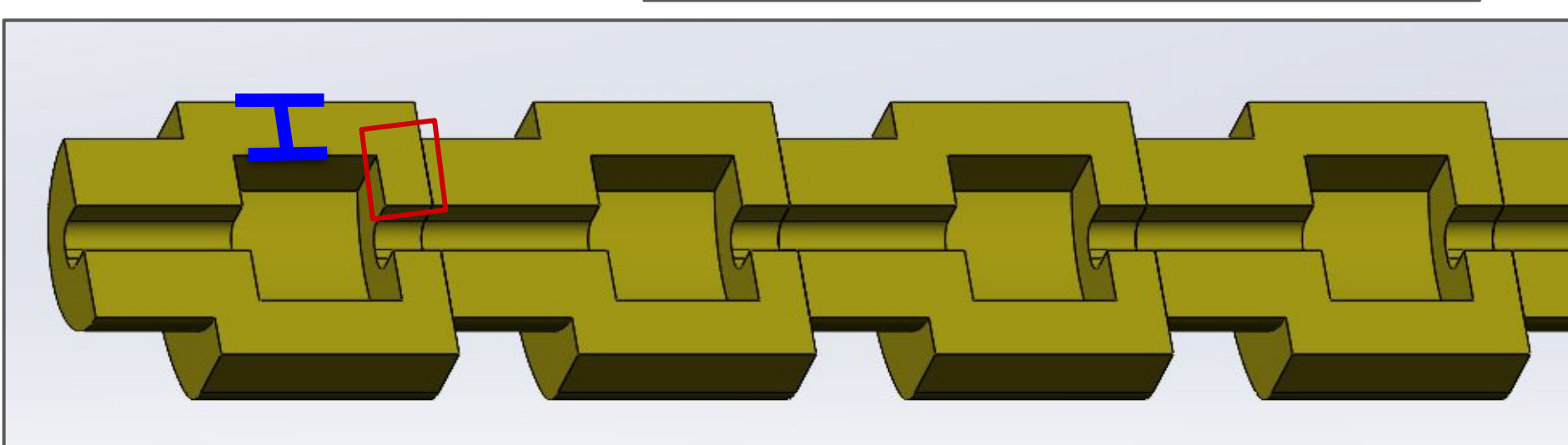
- Class of Soft Robotic Actuators that utilize positive pressure from a fluid to induce bending

Bubble Design

- Different wall thicknesses to direct robot's actuation

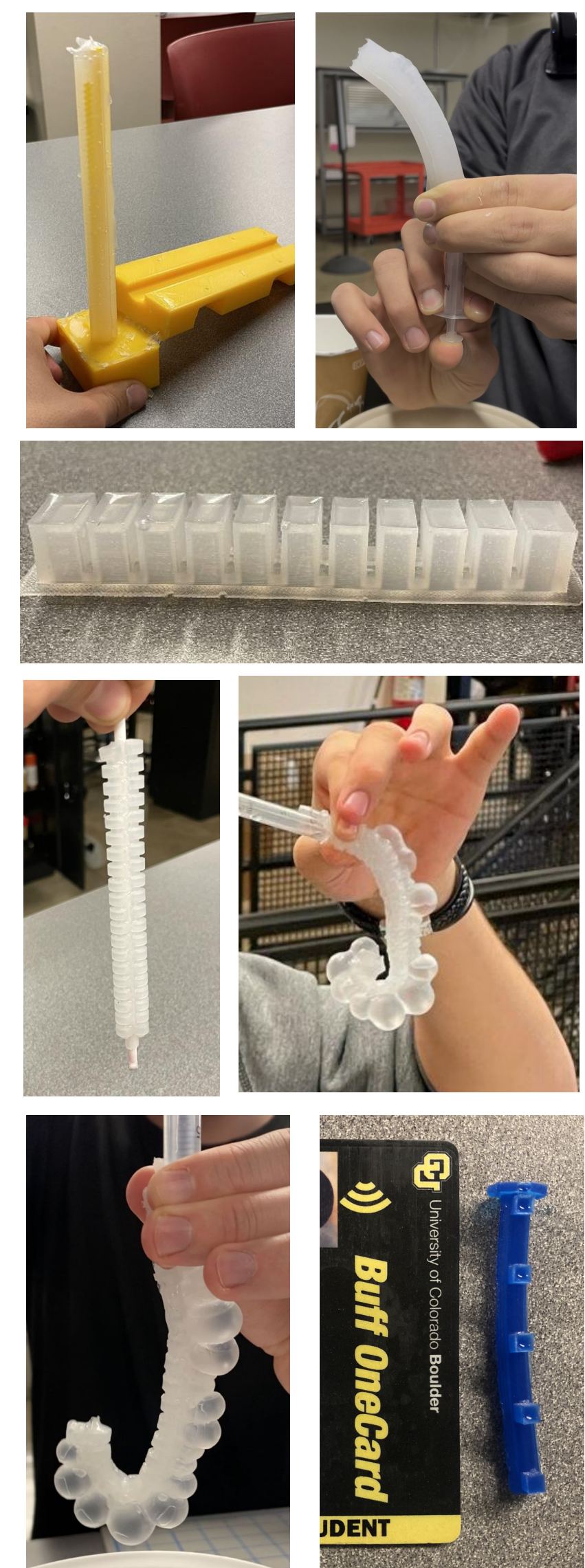


- Cavities for air movement



3 Mechanical Design

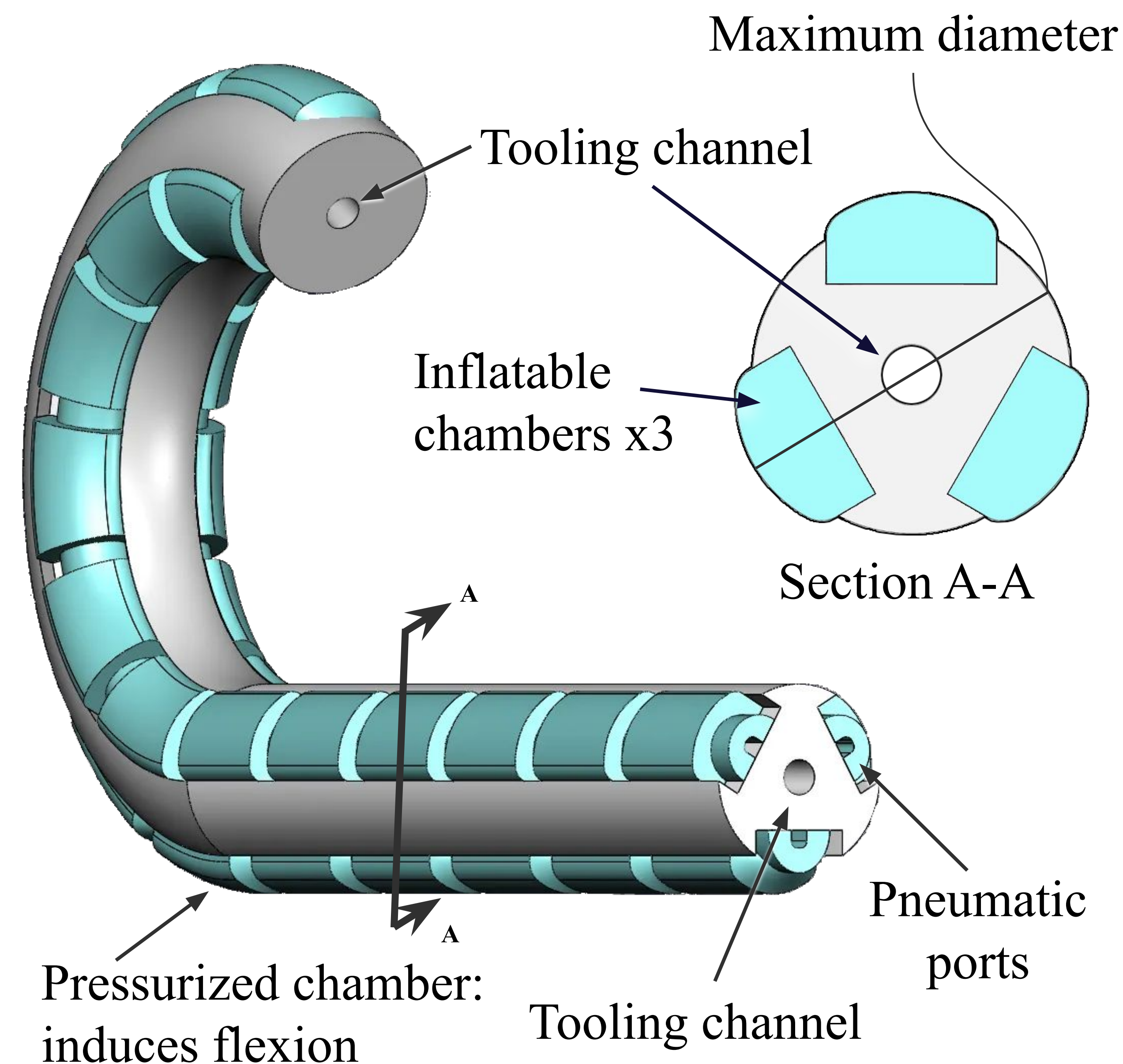
Iterations



Full length
6 cm

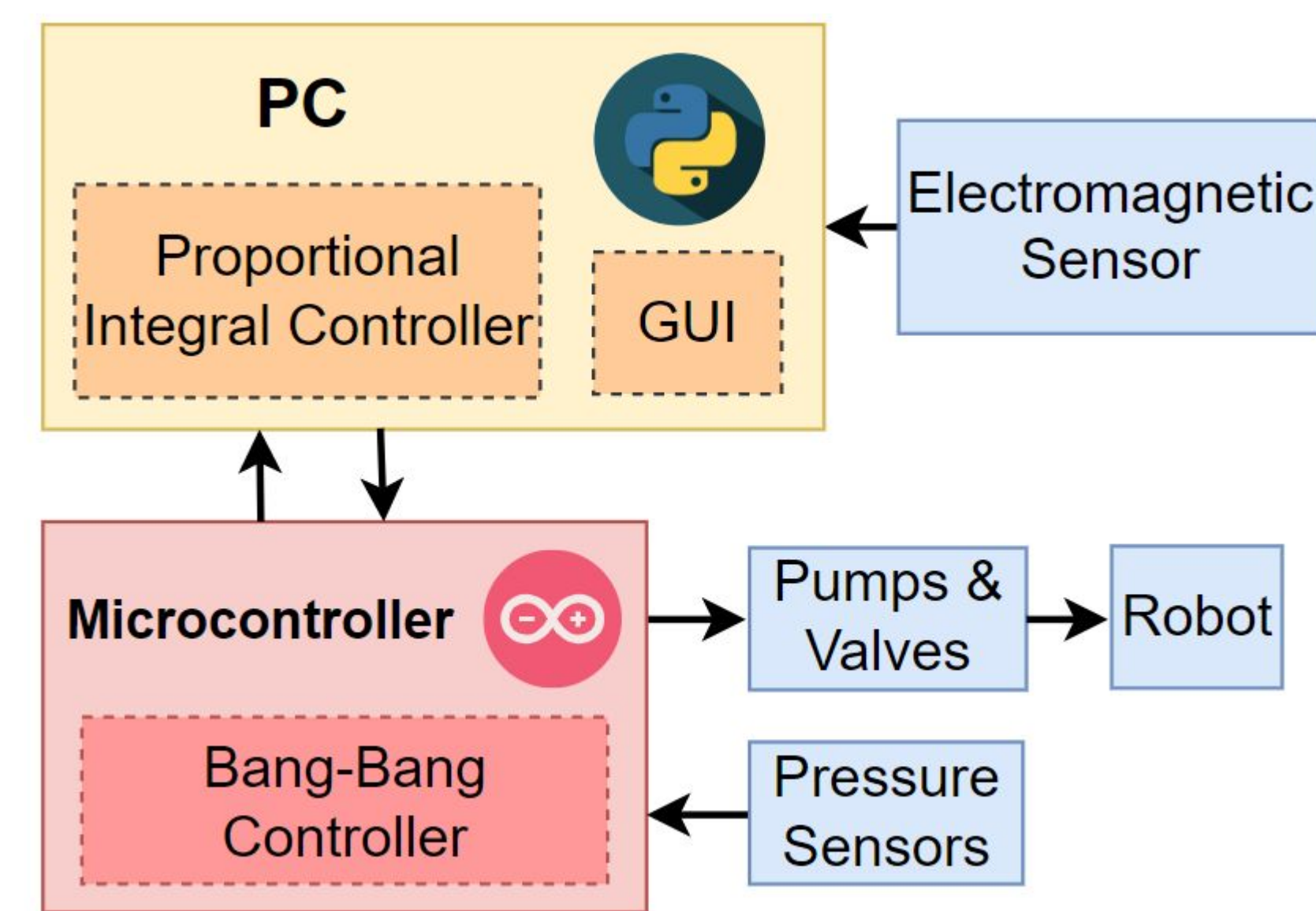
Final diameter
6 mm

Mechanical Design



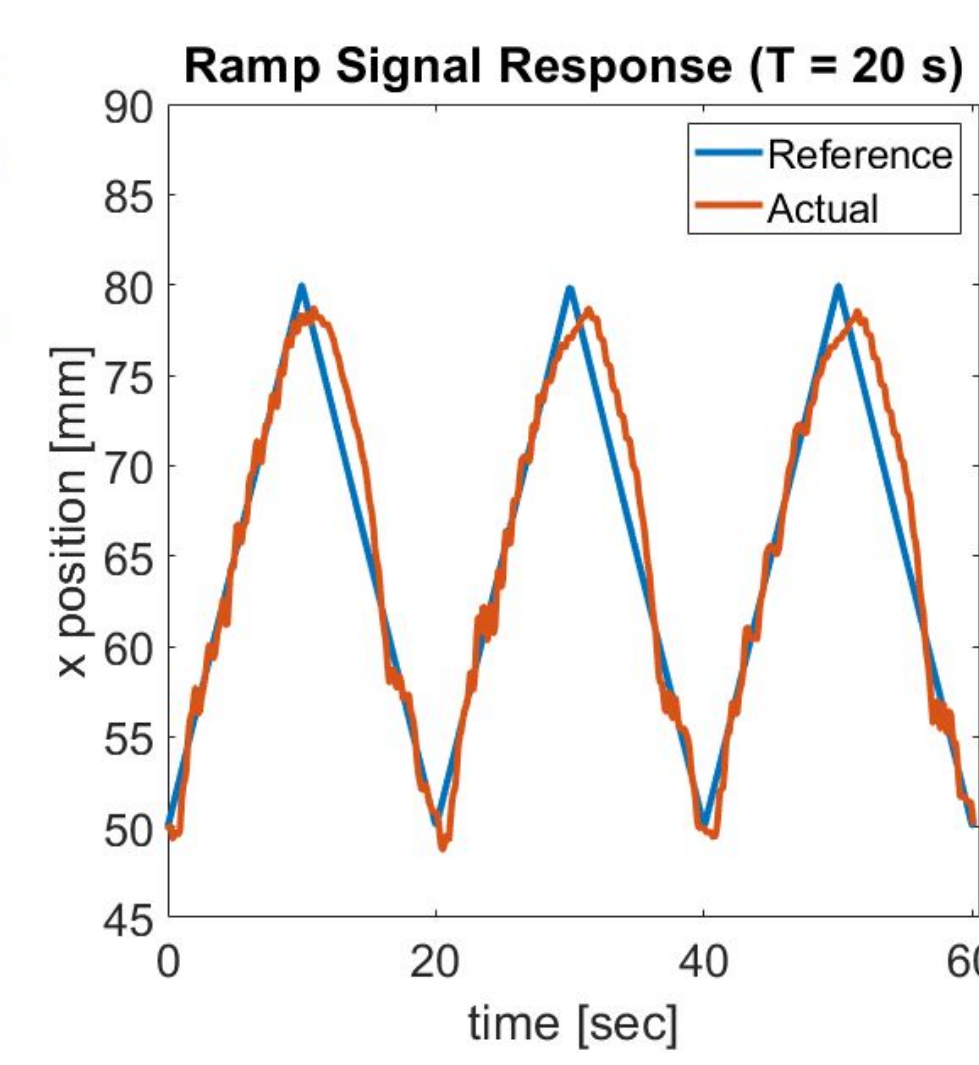
Due to the complexity of computational models for soft robotics, we underwent an iterative design process with **55 iterations** of separate designs and prototypes.

4 Robotic Controls



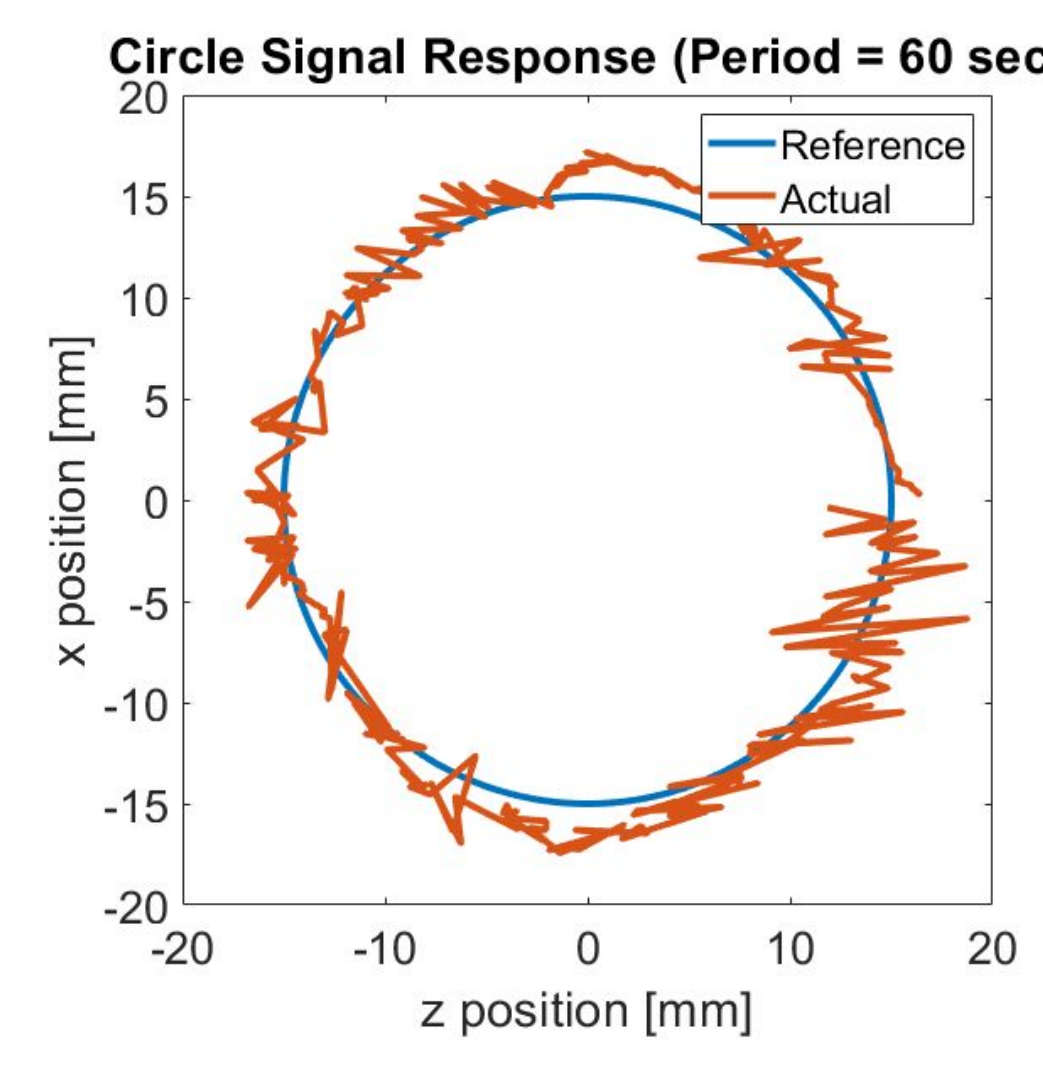
Control System

- Low-level pressure control integrated with our high-level algorithms

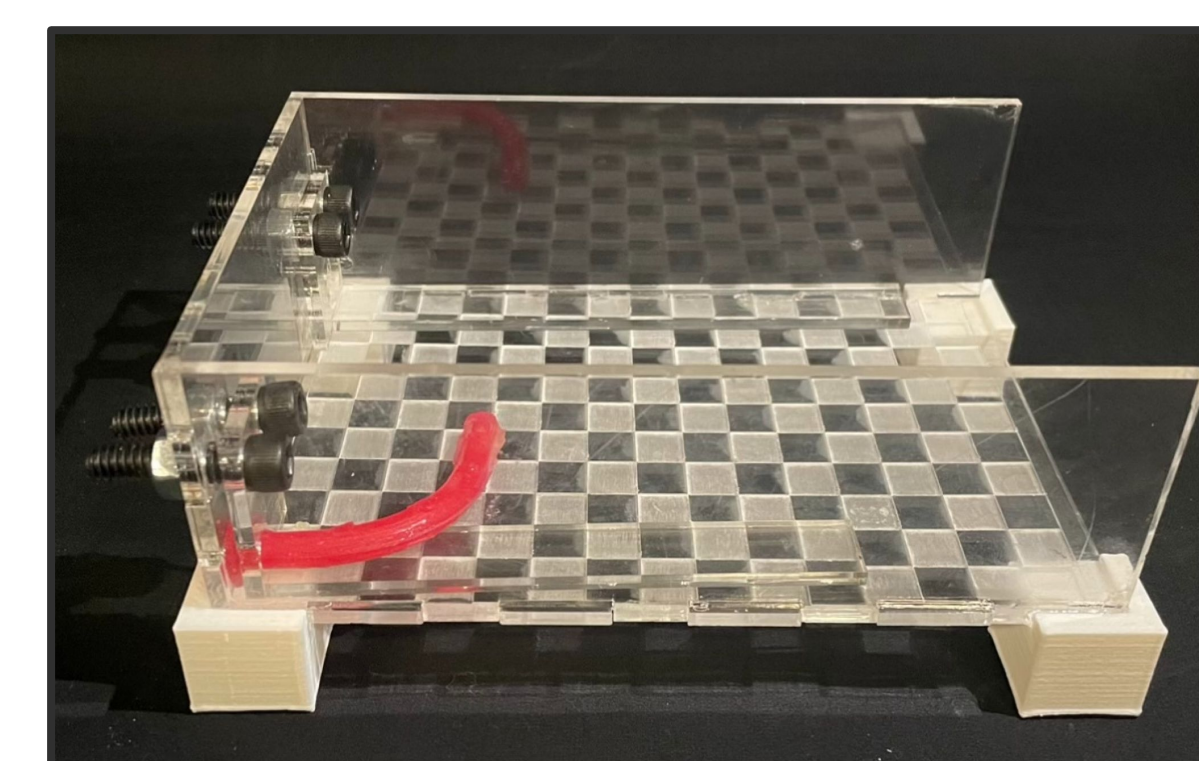


Position Signal Tracking

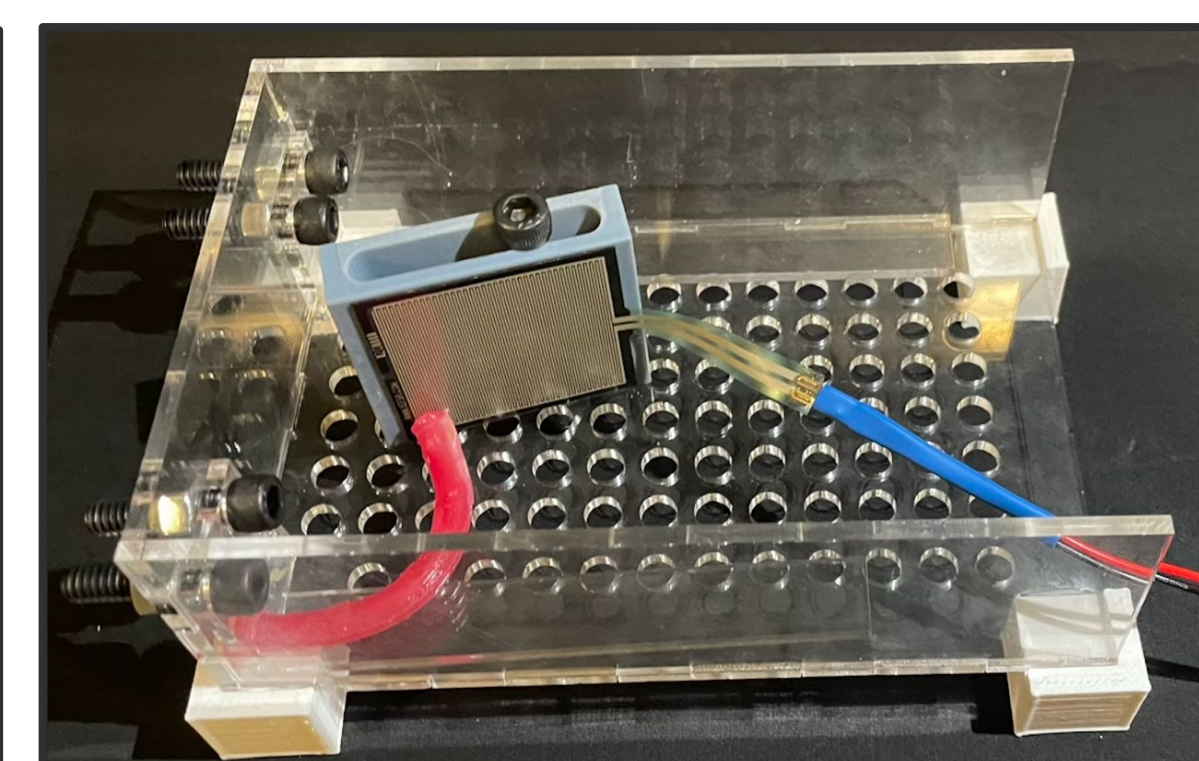
- One channel robot tracking linear trajectory
- Three channel robot tracking circular trajectory



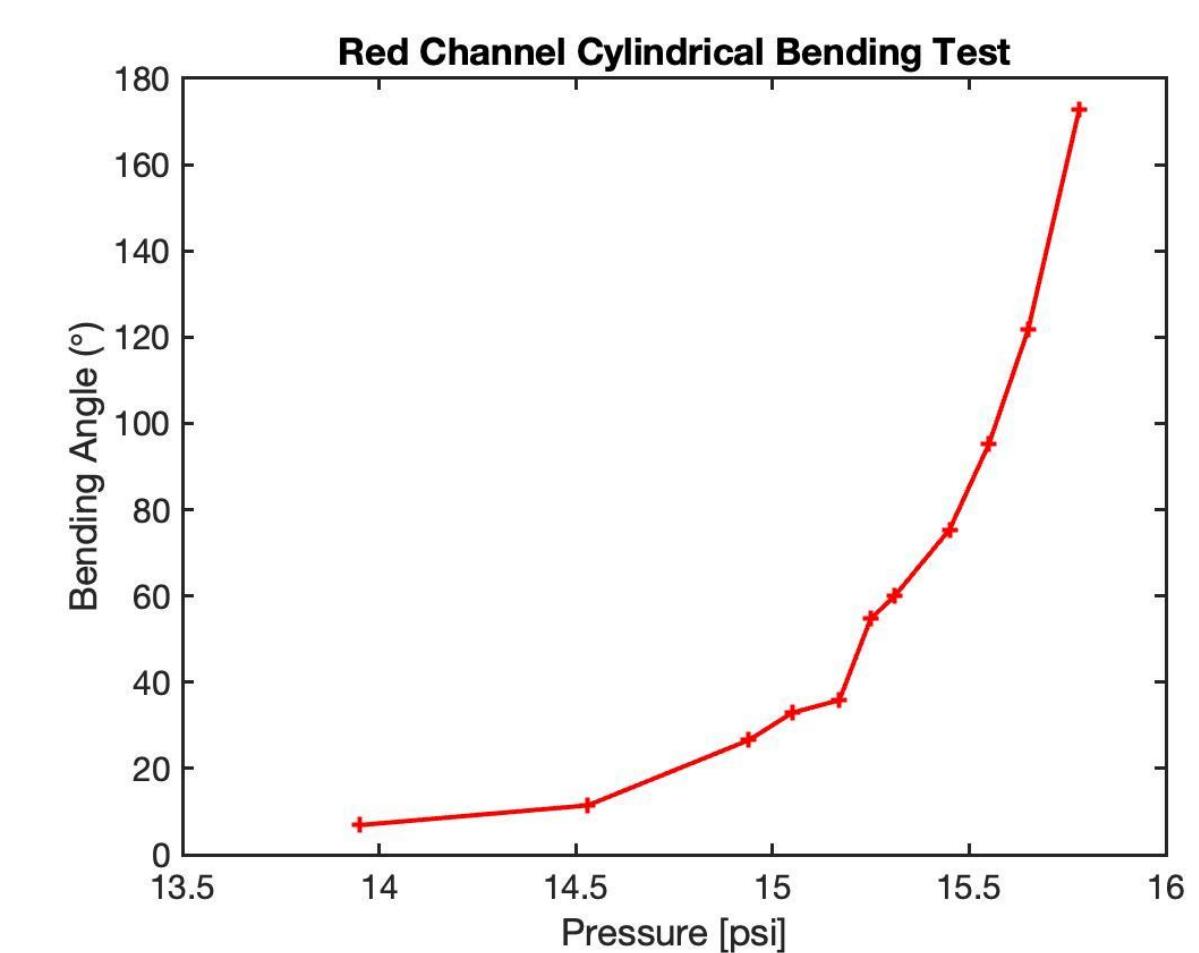
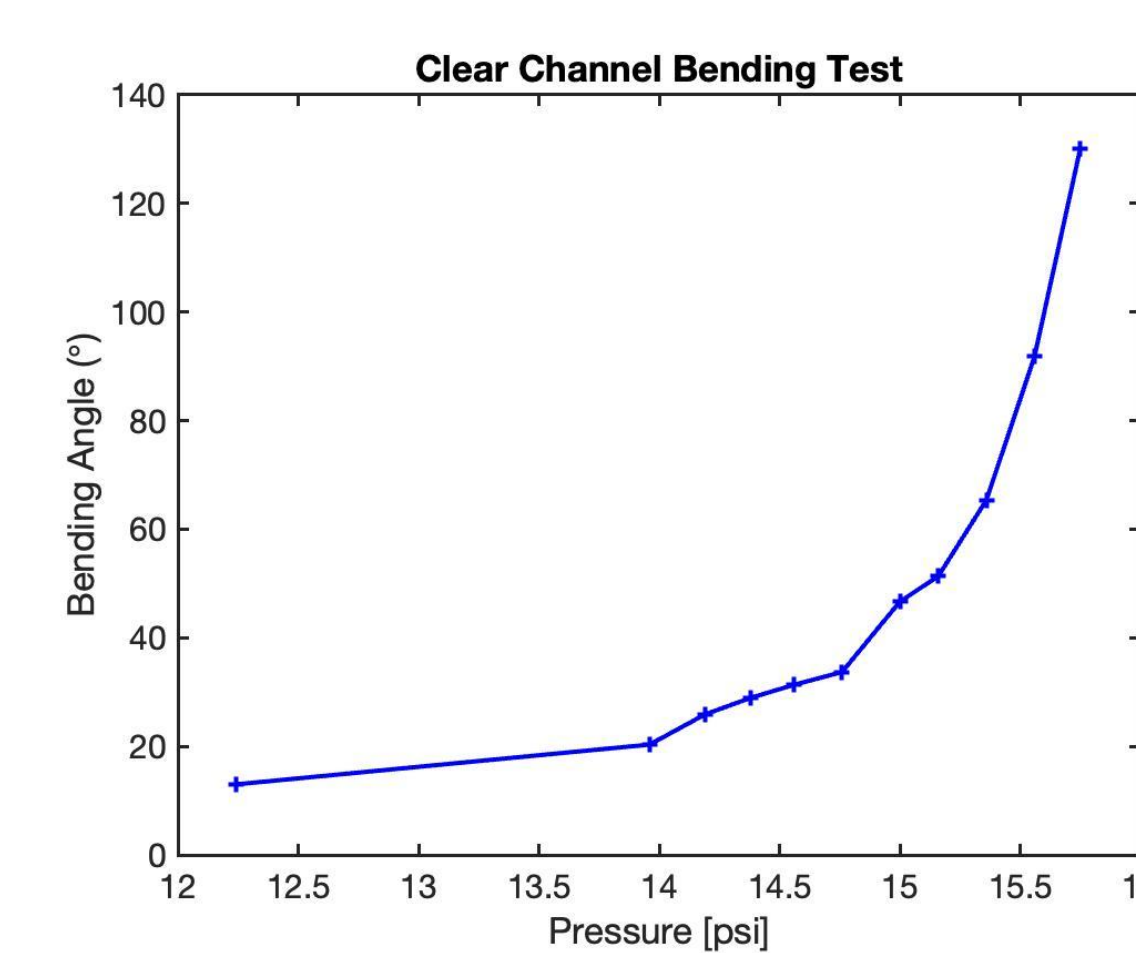
5 Testing



Bending Test Fixture



Force Test Fixture



Bending Test Results

- Pressure commands were manually sent to induce actuation at designated increments
- Snapshots of bending was collected and angles processed in MATLAB's imaging software

6 Future Work

- Reducing outer diameter from 6mm to ~2mm
- Manufacturing of mold for use in injection molding processes
- Analysis of materials and impacts of material properties
- Refining of design and eliminating discrepancies in manufacturing process
- Implement more sophisticated feedback algorithm on three channel robot to reject disturbances

Acknowledgements

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