MBL
Morphable Biorobotics Lab

# Control for multi-functional soft robot for cardiac intervention

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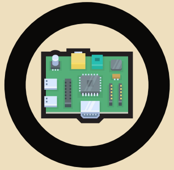
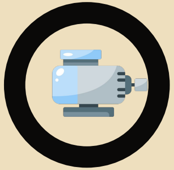
# Internship objectives

Fabrication



Raspberry pi



Linear Actuators Control

Constant Curvature Modelling


GUI

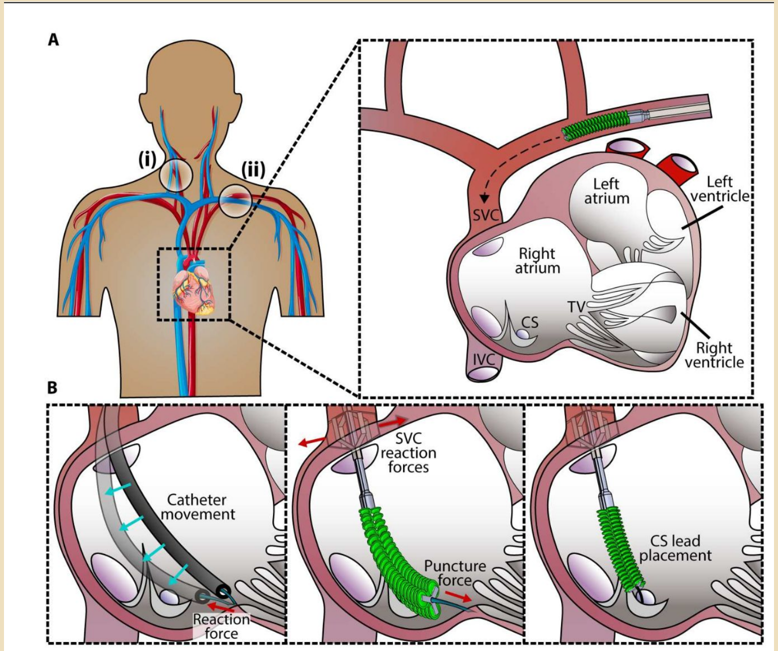
Controller Integration

# Introduction

- **Problem Statement:** Minimally invasive endovascular procedures require high-dexterity catheters to navigate the challenging environment inside the beating heart, which is difficult with current tools.

- **Solution:** A millimeter-scaled soft robotic platform is introduced designed to self-stabilize at the heart's entrance and guide interventional tools to target sites.

- The robotic platform offers sufficient dexterity to reach multiple anatomical targets within the right atrium, and maintains stable contact on moving targets.



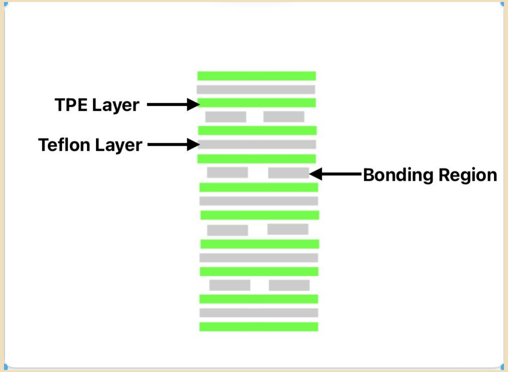


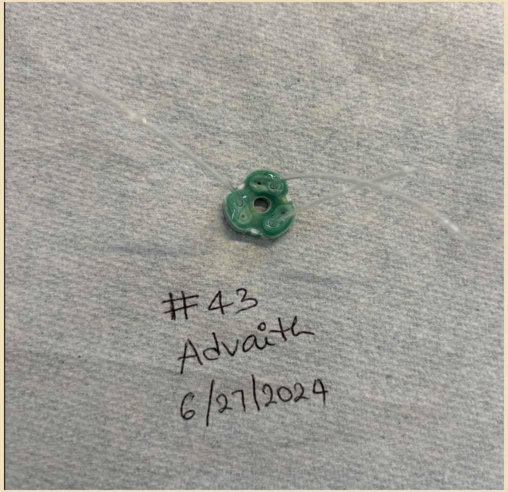
- Rogatinsky, J., Recco, D., Feichtmeier, J., Kang, Y., Kneier, N., Hammer, P., O’Leary, E., Mah, D., Hoganson, D., Vasilyev, N.V. and Ranzani, T., 2023. A multifunctional soft robot for cardiac interventions. Science Advances, 9(43), p.eadi5559.

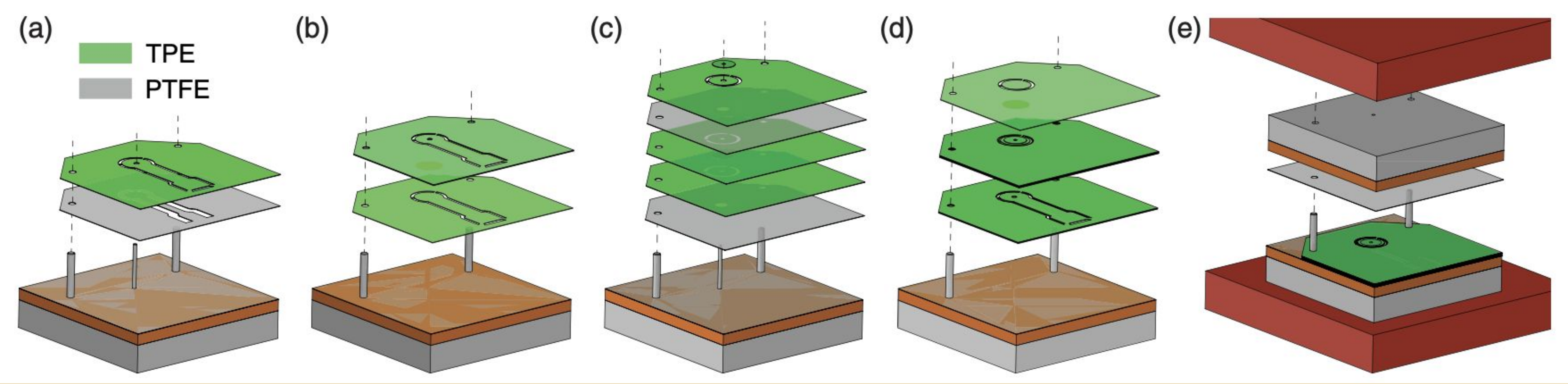
# Fabrication(Stacked Balloon Actuators(SBA))

- Materials used: Thermoplastic Elastomers(TPE), Teflon.

- Process:
    - Laser Cutting the TPE and Teflon sheets.
    - Stack the middle layers of the balloons.
    - Heat bond the middle layers using the heat press at 285 F, 100 lbs for 10 mins.
    - Stack the top and the bottom layers and heat bond again for 20 mins at 285F, 100 lbs.



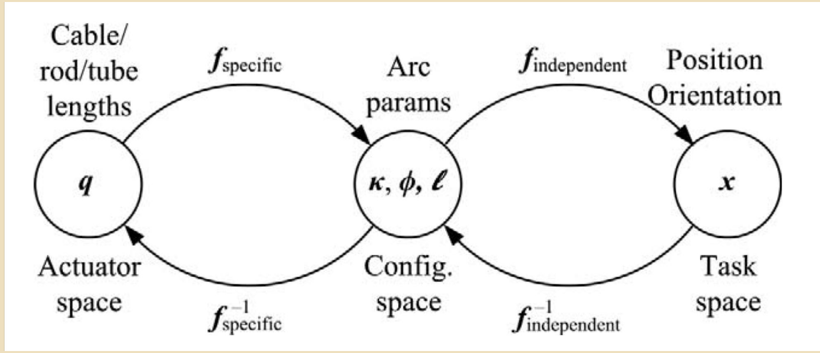







- Rogatinsky, J., Recco, D., Feichtmeier, J., Kang, Y., Kneier, N., Hammer, P., O'Leary, E., Mah, D., Hoganson, D., Vasilyev, N.V. and Ranzani, T., 2023. A multifunctional soft robot for cardiac interventions. Science Advances, 9(43), p.eadi5559.
- Rogatinsky, J., Gomatam, K., Lim, Z.H., Lee, M., Kinnicutt, L., Duriez, C., Thomson, P., McDonald, K. and Ranzani, T., 2022. A collapsible soft actuator facilitates performance in constrained environments. Advanced Intelligent Systems, 4(10), p.2200085.

To best explain the control and frame you research you can us the scheme below:




The actuator space are the volumes that you control with the linear actuators to move the syringes filled with fluid. Jacob developed already a way to map those into the configuration space so you did not need to do that.

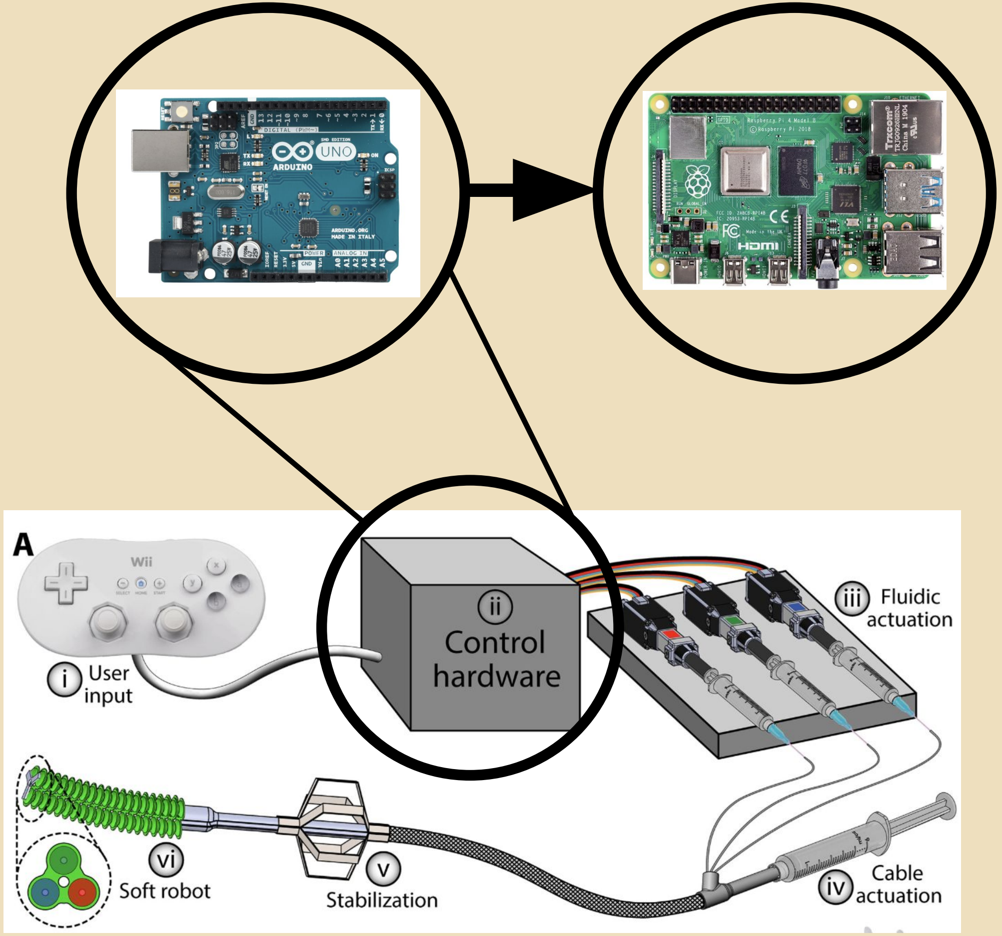
To go from the configuration space to the task space we used the constant curvature model.

# Raspberry Pi

- Earlier the control hardware uses Arduino.

- My objective was to change the control hardware from Arduino to Raspberry pi 4.

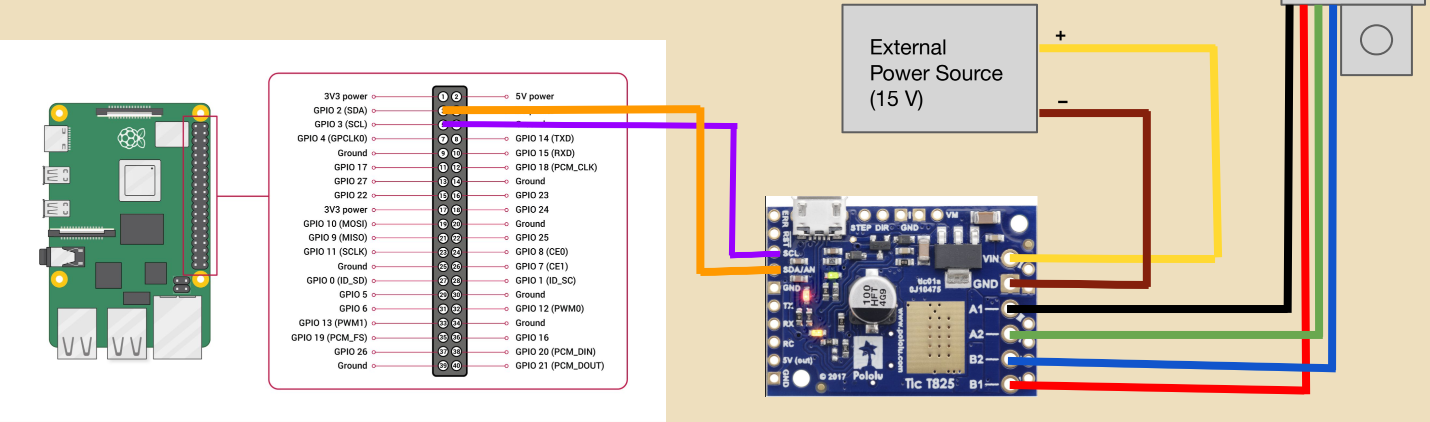
- Reasons for transition:
    - Can handle complex computation.
    - Has wifi and Bluetooth
    - Can integrate it with other sensors.

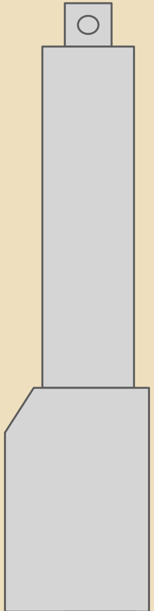


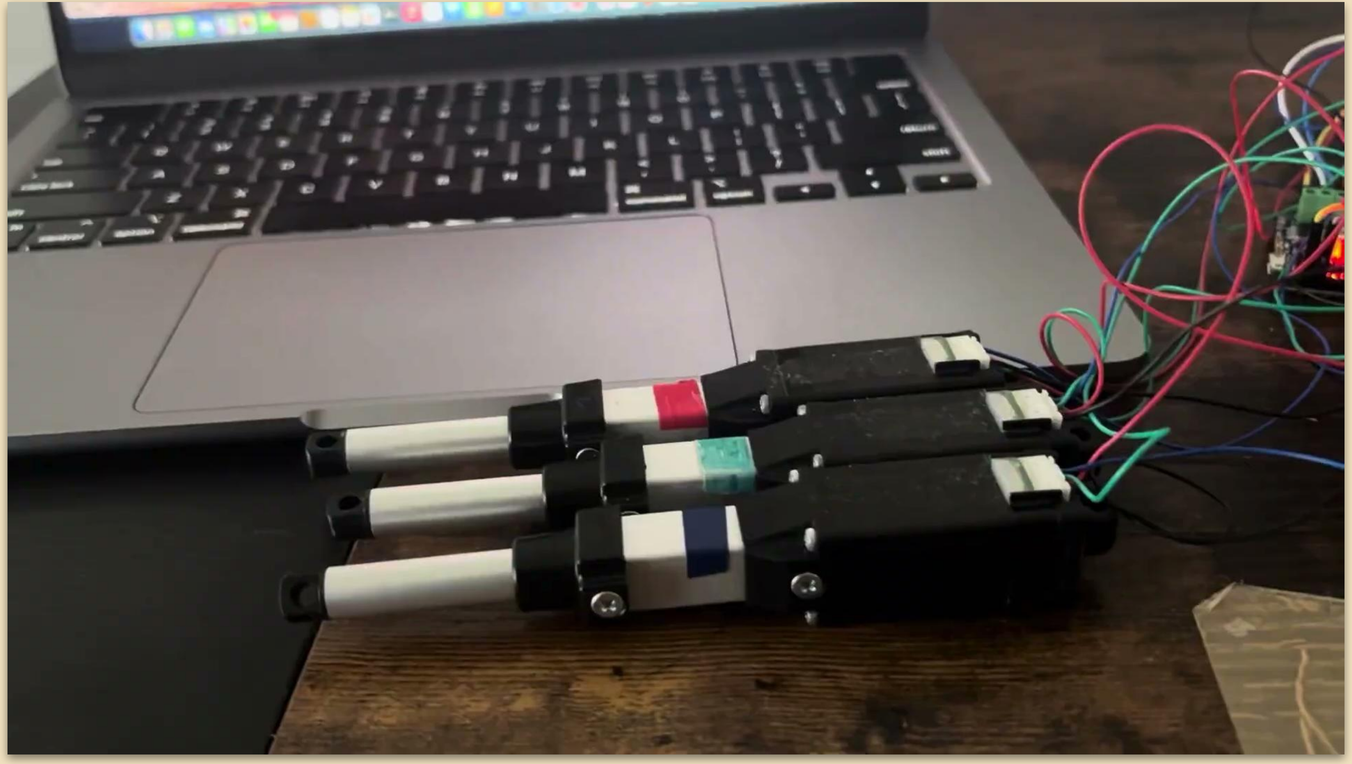
# Linear Actuators Control

- Components: Raspberry pi 4 B+, Pololu Tic T 825, Actuonix S20 Linear Actuator.

- Initial task: Controlling the linear Actuator through keyboard.

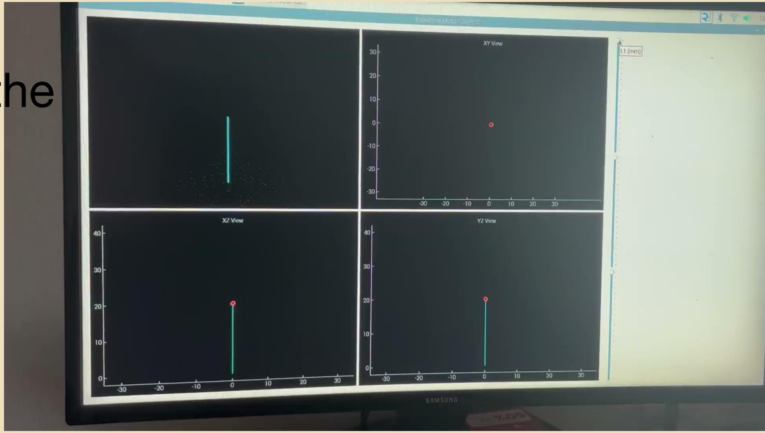




# Constant Curvature Modeling

- What does the constant curvature modeling do?
  - Approximates continuum robots as arcs with constant curvature.
  - This simplifies the assumptions and makes the kinematics easier.
  - Because continuum robots make makes traditional kinematics computationally intensive or difficult.
  - Cannot apply discrete methods.

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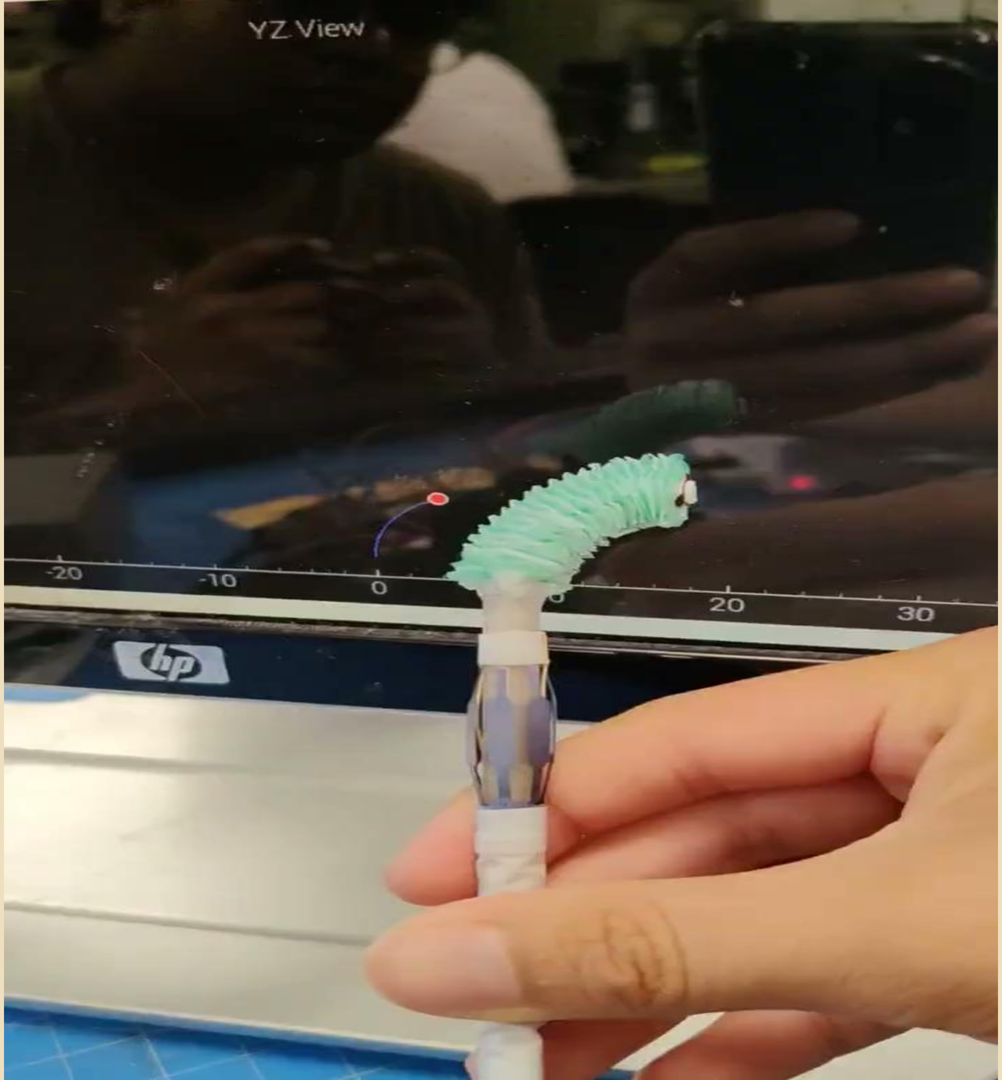
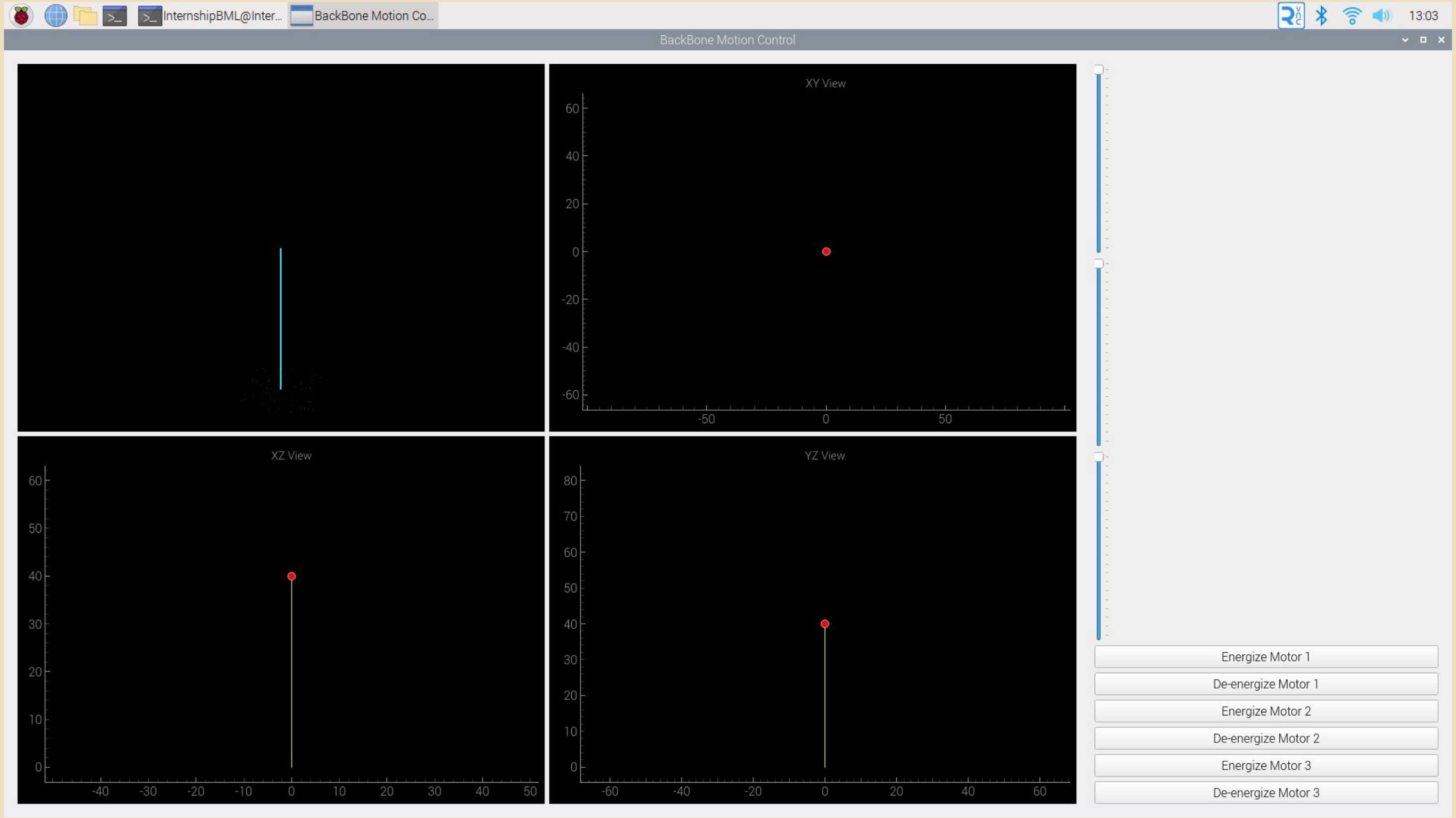
- Constant Curvature Modeling Approach, JACOB ROGATINSKY, PHD @ MORPHABLE BIOROBOTICS LAB

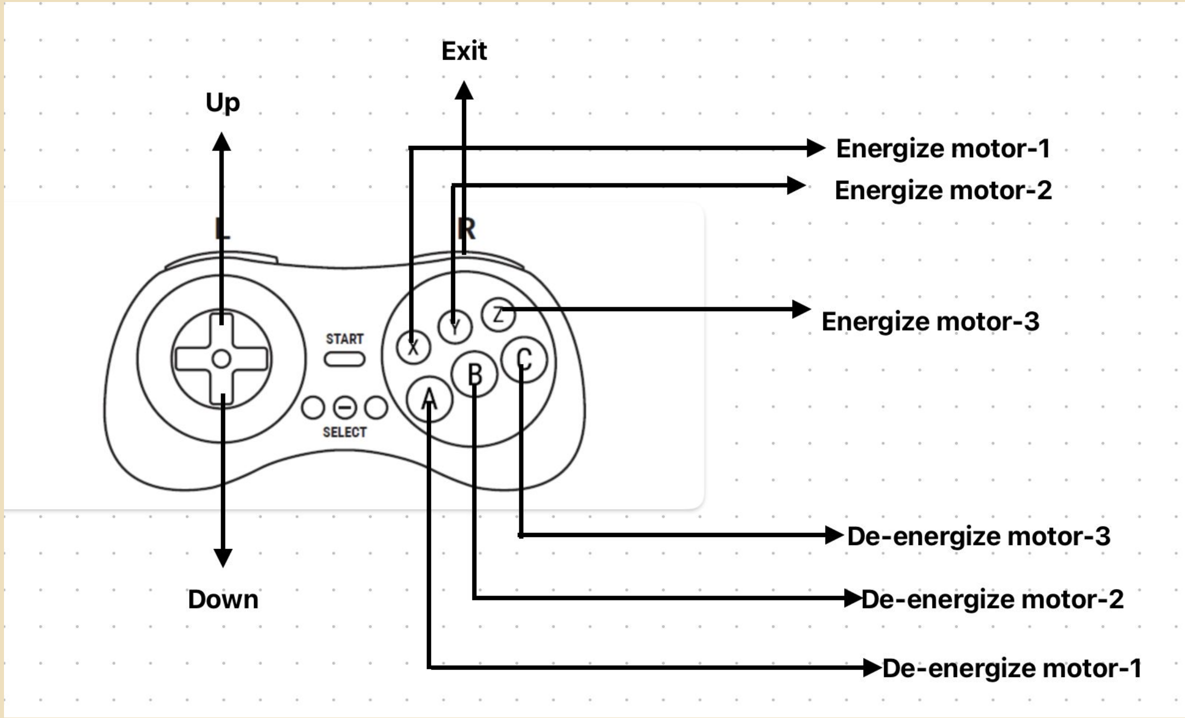

YZ View
-20
-10
0
20
30
hp

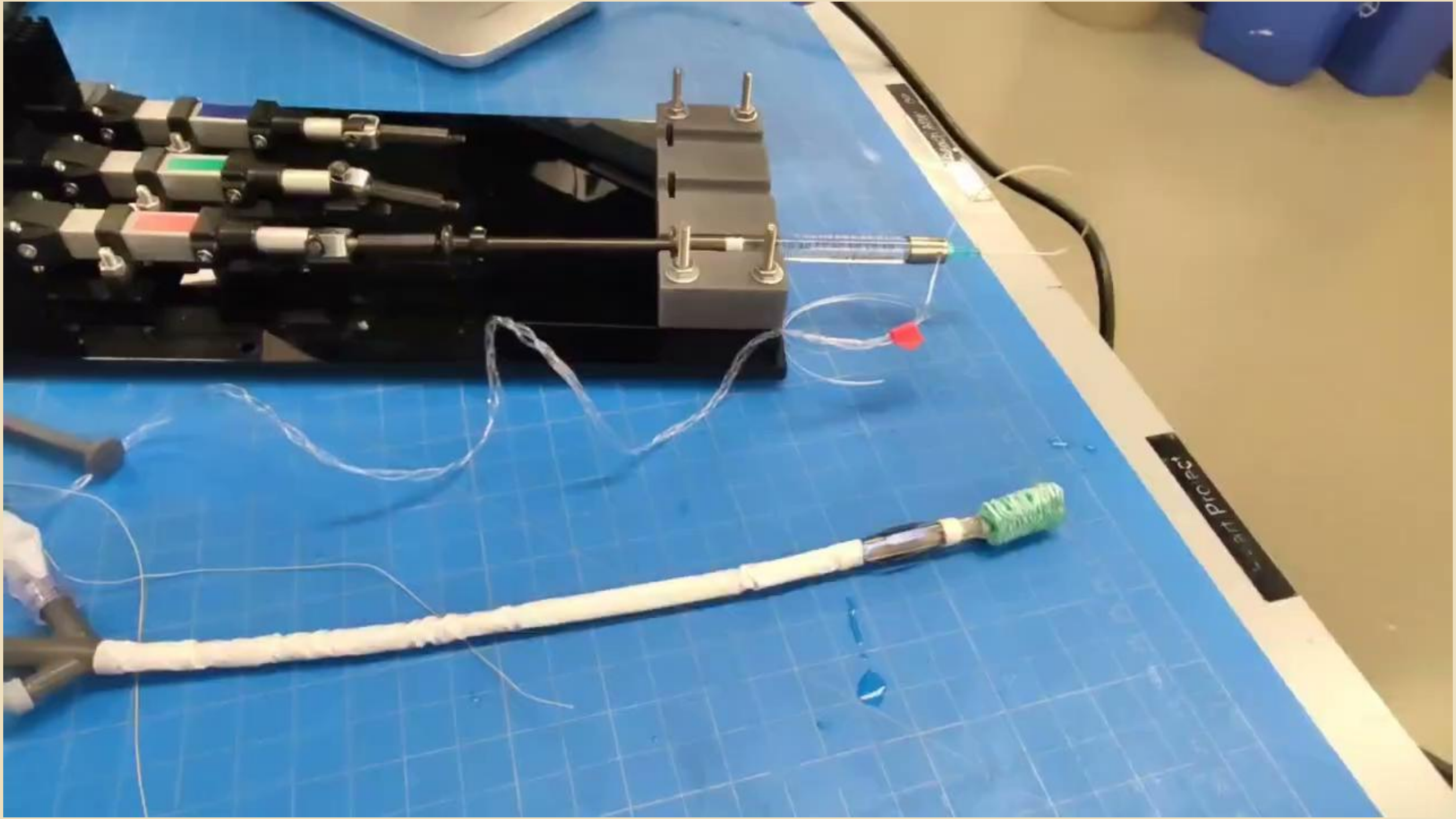
# Graphical User Interface(GUI)



# Controller Integration

Controller Model: 8BitDo M30 Bluetooth Gamepad




Project

Thank You!!