

# PROJECT PORTFOLIO

2021-2025

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# RESEARCH WORK

- I am working as a Research Intern at the Transactional Healthcare Research Innovation and Value Engineering (THRIVE) Laboratory, IIITDM, under the guidance of Dr. Karthik C.

# Open-Loop Control of Soft Robot

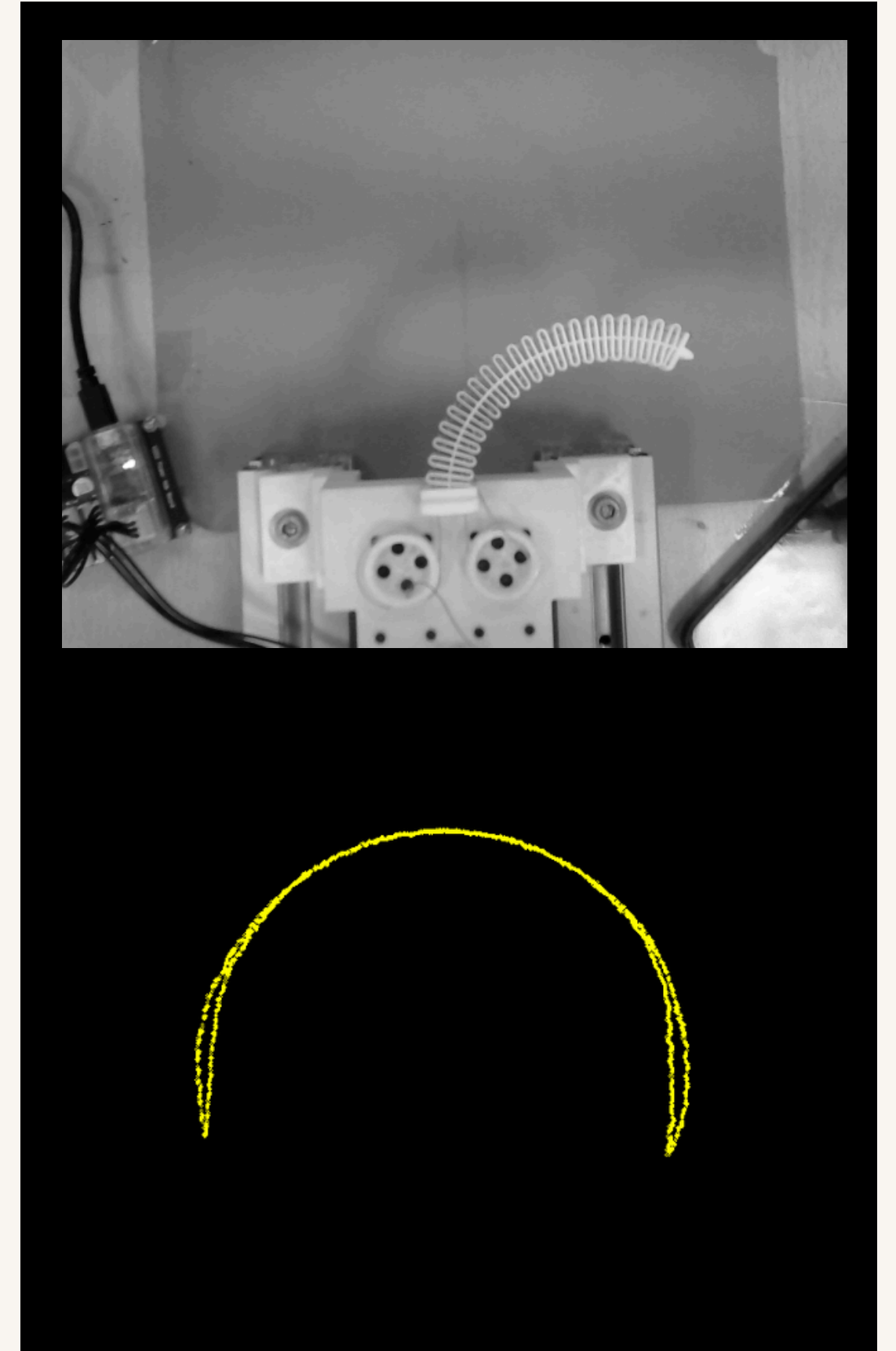
## What is it

Aims to control a soft robot using a kinematics model [REF] and a machine learning model for error correction

## What I did

- Designed a test setup with end-to-end automation as the primary goal.
- I used Dynamixel SDK, OpenCV and DeepLabCut for automated extraction of end-effector locations at various joint-space coordinates.
- Used a kinematics model followed by a machine learning model for error correction.
- Implemented a kinematics model and enhanced it with an ML-based error correction, reducing the average error from 10% to 4%.
- Developed a GUI application to control the soft robot.
- Automation and test scripts used in this project were reused/repurposed in future projects

**Outcome** Reduced the average end-effector error from 10% to 4% by implementing an ML-based error correction mode



# Novel Low-Cost Embedded Sensor for Soft Robot Control

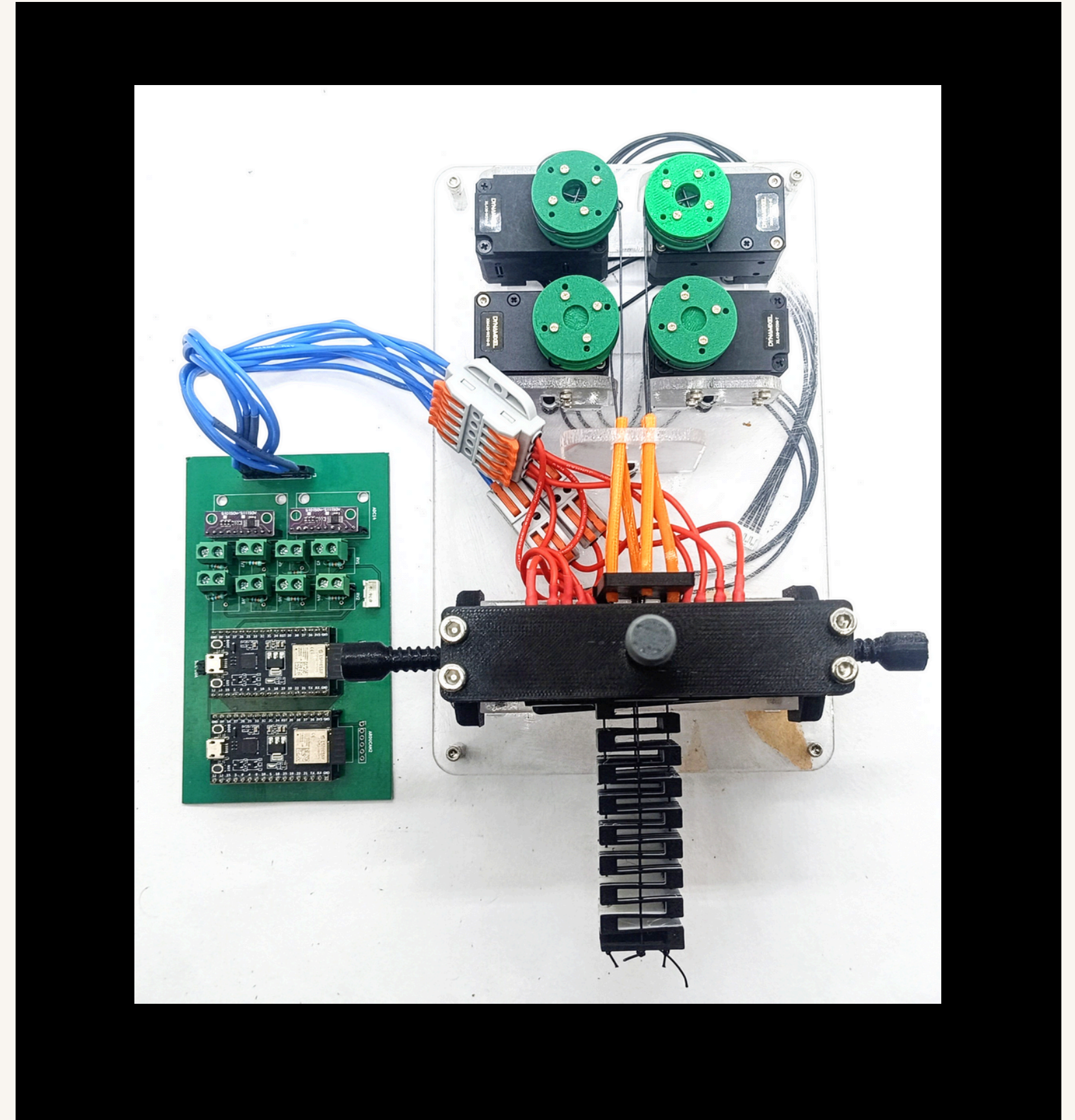
## What is it

- This is an extension of the previous project. It aims to further reduce the error in the system by adding a feedback element.
- This novel feedback element is minimally invasive for the robot and embedded directly into its structure.

## What I did

- The principle of its operation was described by my guide Dr.Karthik C, but a practical design to implement it as feedback for the soft robot was yet to be realized.
- I designed a structure that utilizes the principle, enabling feedback from the robot while allowing localization of the feedback to specific points along the soft robot.
- Completed proof-of-concept development and created an initial prototype.
- Designed the test bench using OpenCascade and a PCB to house the electronics with KiCad.
- Using the above modality, the error rate of pose estimation was reduced from 4% (open loop) to 1.5%.

**Outcome** Successfully demonstrated a embedded strain sensor for soft robots and reduced pose estimation error from 4% (open-loop) to 1.5% with sensor feedback.



# Disposable Compliant Surgical Tool-tip for Robotic Assisted Minimally Invasive Surgery.

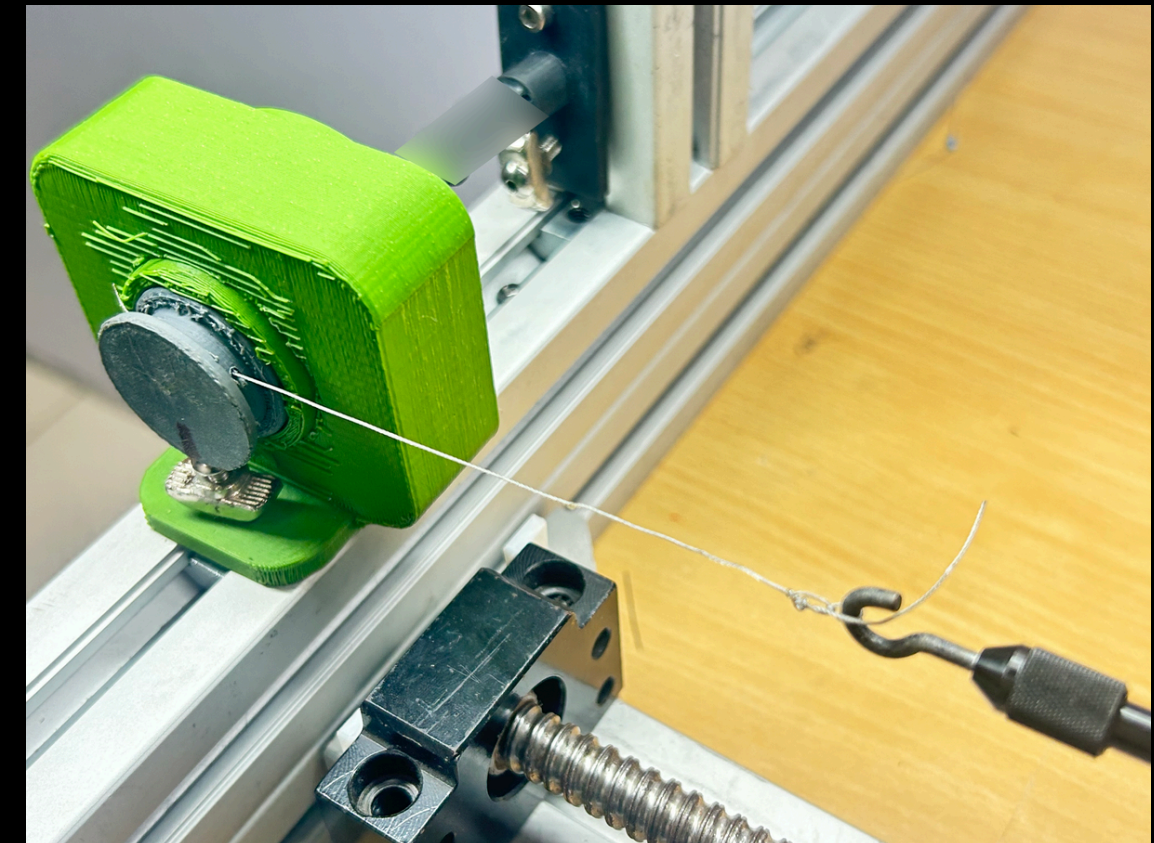
## What is it

- This project, funded by Intuitive surgical, looks into the feasibility of a novel power delivery system for Compliant surgical tooltips

## What I did

- Assisted in setting up the electronics required for testing the tool-tip.
- Developed scripts to automate testing and benchmarking of the tool-tip, enabling the collection of multiple readings that would otherwise be impractical.
- The scripts automated the tracking of the end effector's location, eliminating the need for manual tracking.
- Created thorough documentation to ensure future reproducibility of the experiments.

**Outcome** The results are being prepared for submission to the International Journal of Computer Assisted Radiology and Surgery, where I will be listed as a co-author.



# SIDE PROJECTS



# Side work

## Freelance projects

- Worked with a client on Upwork, for two projects
- The client has issues with integration and distribution of PyTorch with Rust.
- Provided a solution without adding additional deps/ complexities to the existing system. Parts of the code are available in this open-source repository.
- Following that, I worked on a PDF to image conversion library .

## Software

- Created a PAM module to allow a different password for elevated permissions (e.g., sudo) on Linux, avoiding the need to type a long login password repeatedly.
- I made an app which dynamically changes display brightness based on screen content.

## OSS contribution

- I always wanted to contribute to open source software.
- I tried getting into Linux kernel development and was also curious about compiler development. As a practice created following project where I implemented Lox language interpreter in kernel space.
- I added a feature , and a bug-fix on these projects.
- I look forward to contributing more significantly.

## Robotics Club

- Served as the Lead and Electronics lead of Robotics club IIITDM during AY 2023-2024
- Oversaw a team of 16 for building a combat bot, also conducted robotics events for Techfest conducted at IIITDM during 2024.
- Created an autonomous Pick and Place robot for Flipkart Grid Hackathon 2023. Our team ranked 64th in India.

# Optimization of ROV simulation

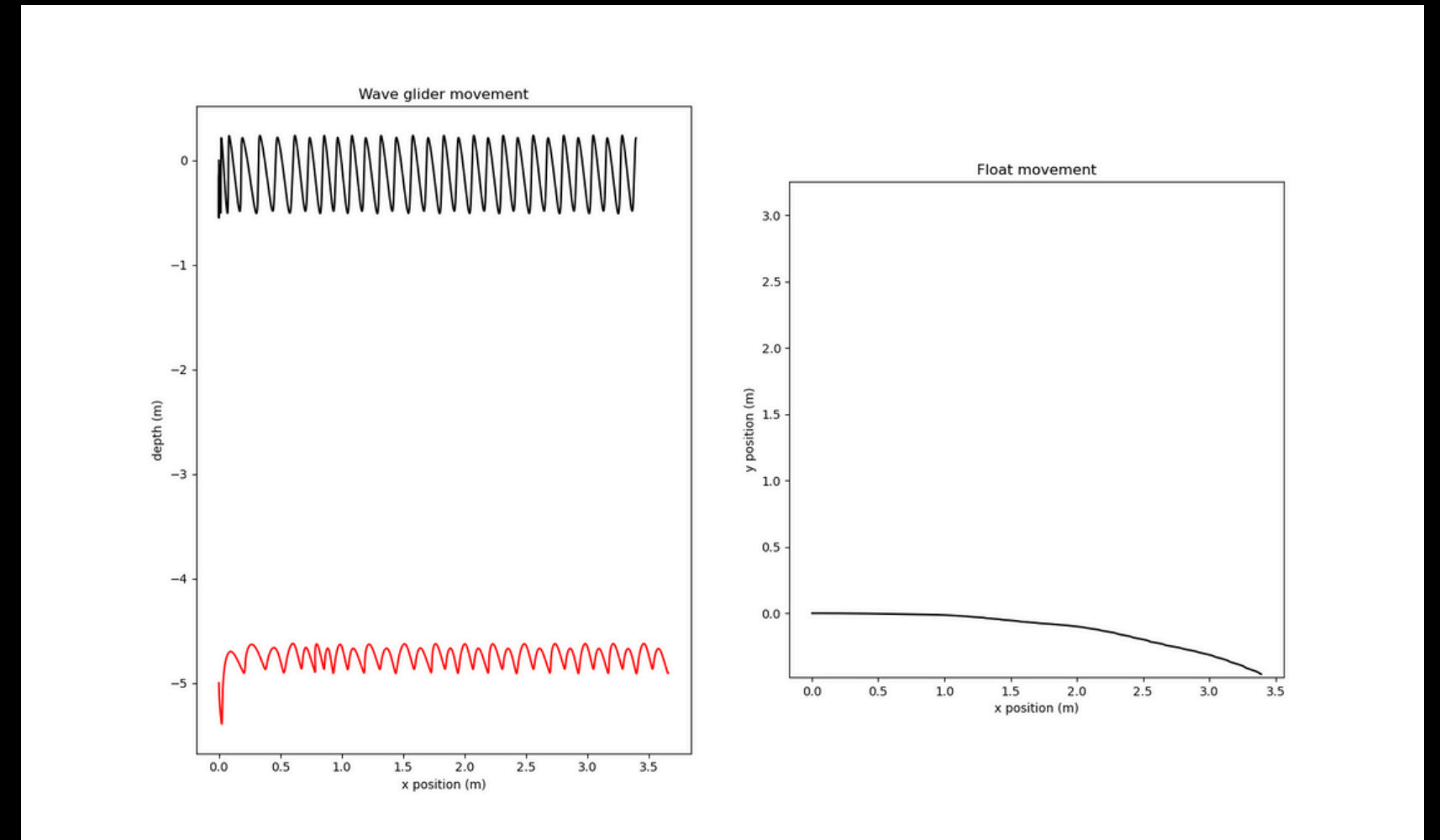
## What is it

- Planys Technologies is an underwater ROV manufacturer
- During my internship at Planys, I worked on firmware/ embedded software required in the ROV.
- Due to my personal interests, I began working on the in-house simulation software developed and used at Planys.

## What I did

- I extended the simulation to 6 DoF, previously accounted for only the X, Z and pitch axes (3 DoF).
- Reduced memory usage by implementing disk-based result caching, enabling users to resume simulations that were interrupted mid-run.
- Improved performance by optimizing the codebase and then using Numba to further boost critical functions. Also removed a significant bottleneck caused by the front-end.
- Thoroughly documented this work, organized meetings and explained the changes to fellow employees before end of internship.

**Outcome** Sped up the execution speed by 200%.



A representative plots for a wave glider motion.

# Sparring robot Project

## What is it

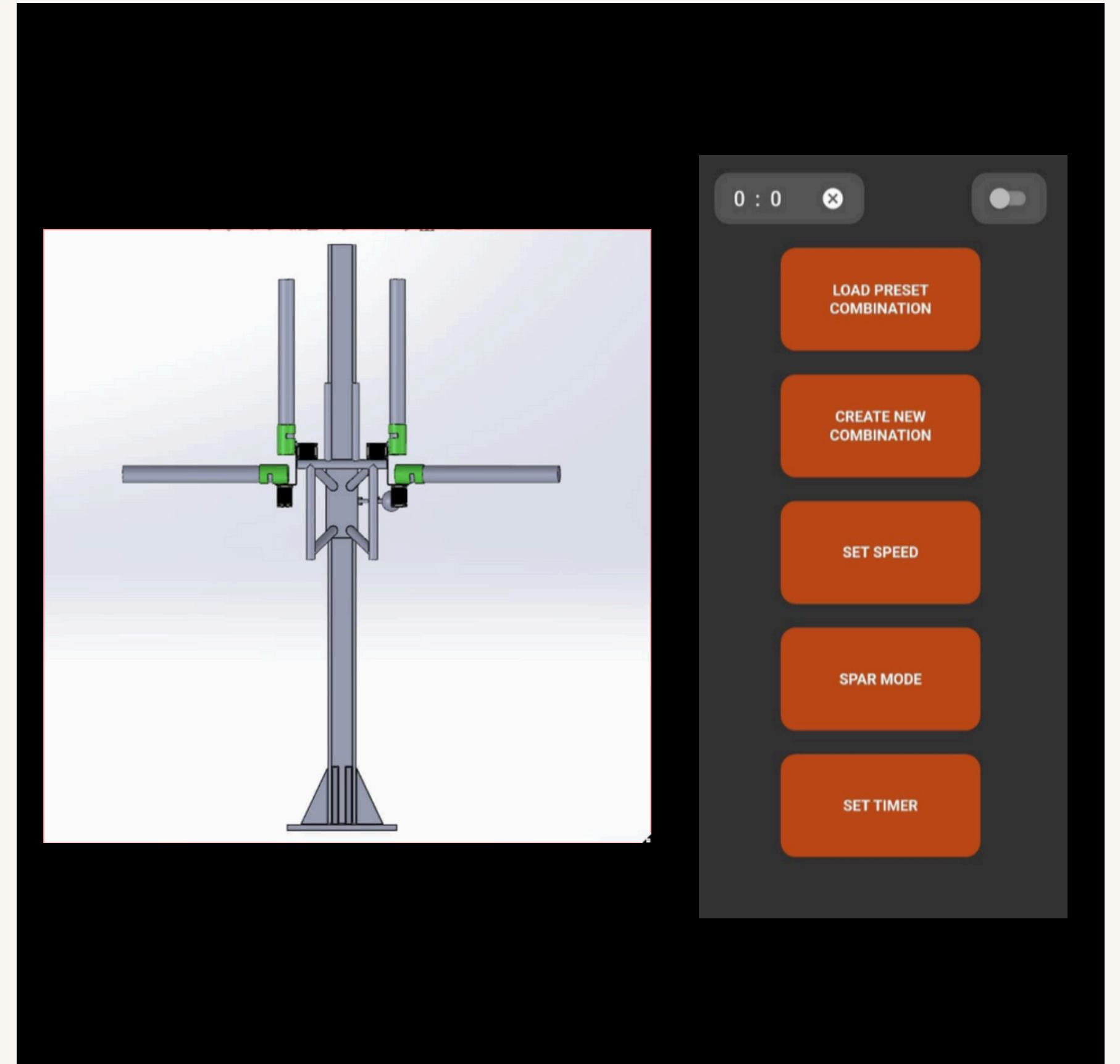
- GS Boxing Club operates near slum areas of Broadway, Chennai, India, training underprivileged kids in boxing. Many of these kids have achieved national-level success in competitions.
- The organization approached me to develop a sparring robot to help coaches dedicate more time to teaching boxing techniques to the kids.

## What I did

- Formed a multidisciplinary team of 6 for the project
- Coordinated funds and timeline with Veyyil Robotics, who was the primary sponsor of the project.
- Designed the electronics and control systems for the robot.
- Assisted in development of an Android companion app for controlling the robot

## GS Boxing Club: LINK

**Outcome** Successfully built a proof-of-concept prototype featuring a single arm.



# THANK YOU

## Contact and socials



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