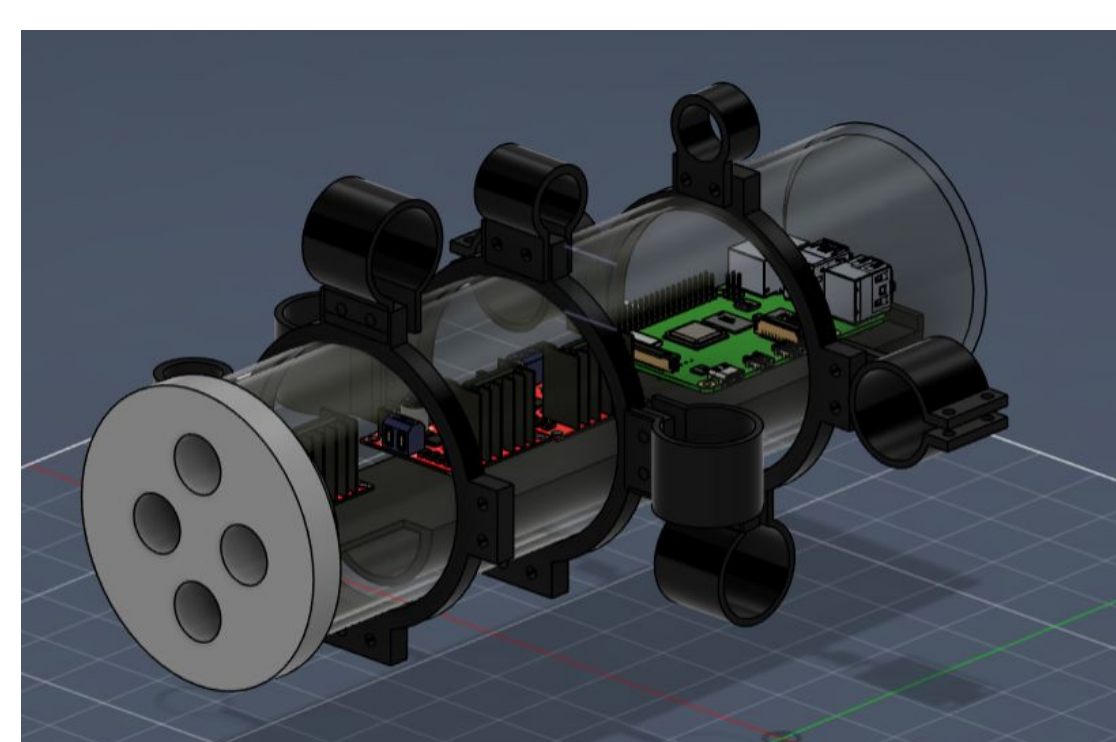
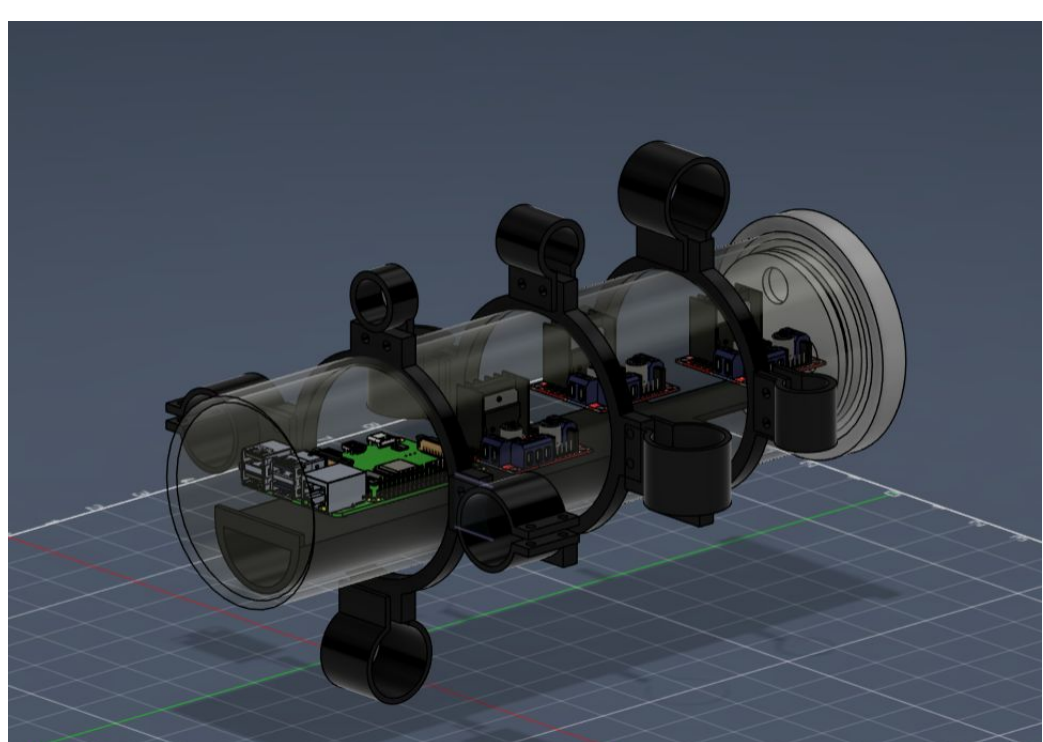


## Background

Autonomous underwater vehicles (AUVs) are used in applications ranging from ocean exploration to infrastructure inspection [1]. This project develops a miniature AUV capable of visually identifying a known target and autonomously navigating toward it using onboard computer vision and closed-loop control.



Front CAD Render    Rear CAD Render

## Problem Definition

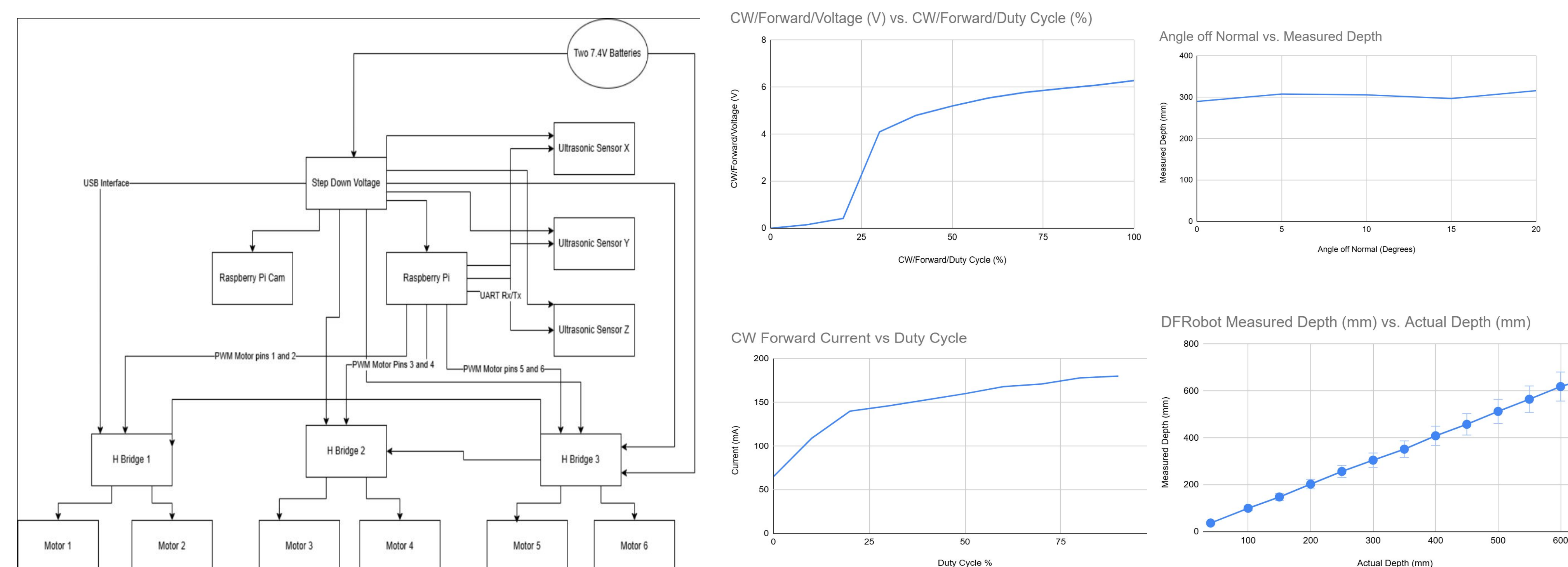
- Detect a known underwater target (a 3D-printed model of Testudo) using an onboard camera and computer vision pipeline
- Approach that object, and report back the coordinate location of the object in the tank
- Deploy the pipeline on resource-constrained embedded hardware (Raspberry Pi 4)

Constraints:

- Inside 3' x 3' x 7' aquarium
- Low power thrusters
- Battery Capacity Size (7.4 V)

## Mechanical & Electrical Hardware Design

- 13 in Long, 3.5 in Diameter Plastic Tube with silicone bond adhesive applied to one end to prevent water ingress. 14 ounces hanging weight to match Neutral Buoyancy
- Subtractive Manufacturing Methods utilized to create cap with o-ring and gland holes for sealing opposite end of sub.
- 6 Motors, 3 Depth Sensors, 1 RPi Camera Module 3

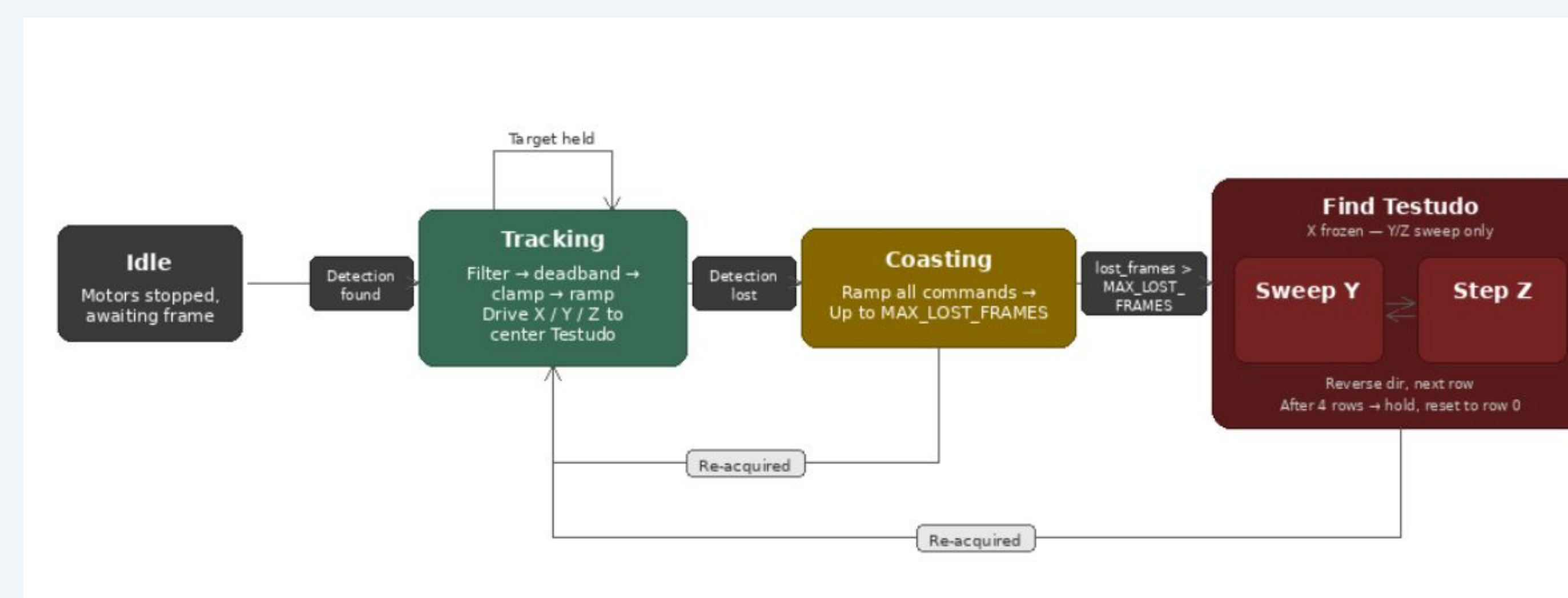


Hardware Architecture [3]

Motor and Sensor Characteristics

## Software Architecture

- YOLO26 model was trained on the Testudo target, exported to ONNX for inference on the RPi4.
- Depth was controlled via thrusters using a custom PID controller with measured error from camera feed.
- Navigation was implemented according to the below state machine.



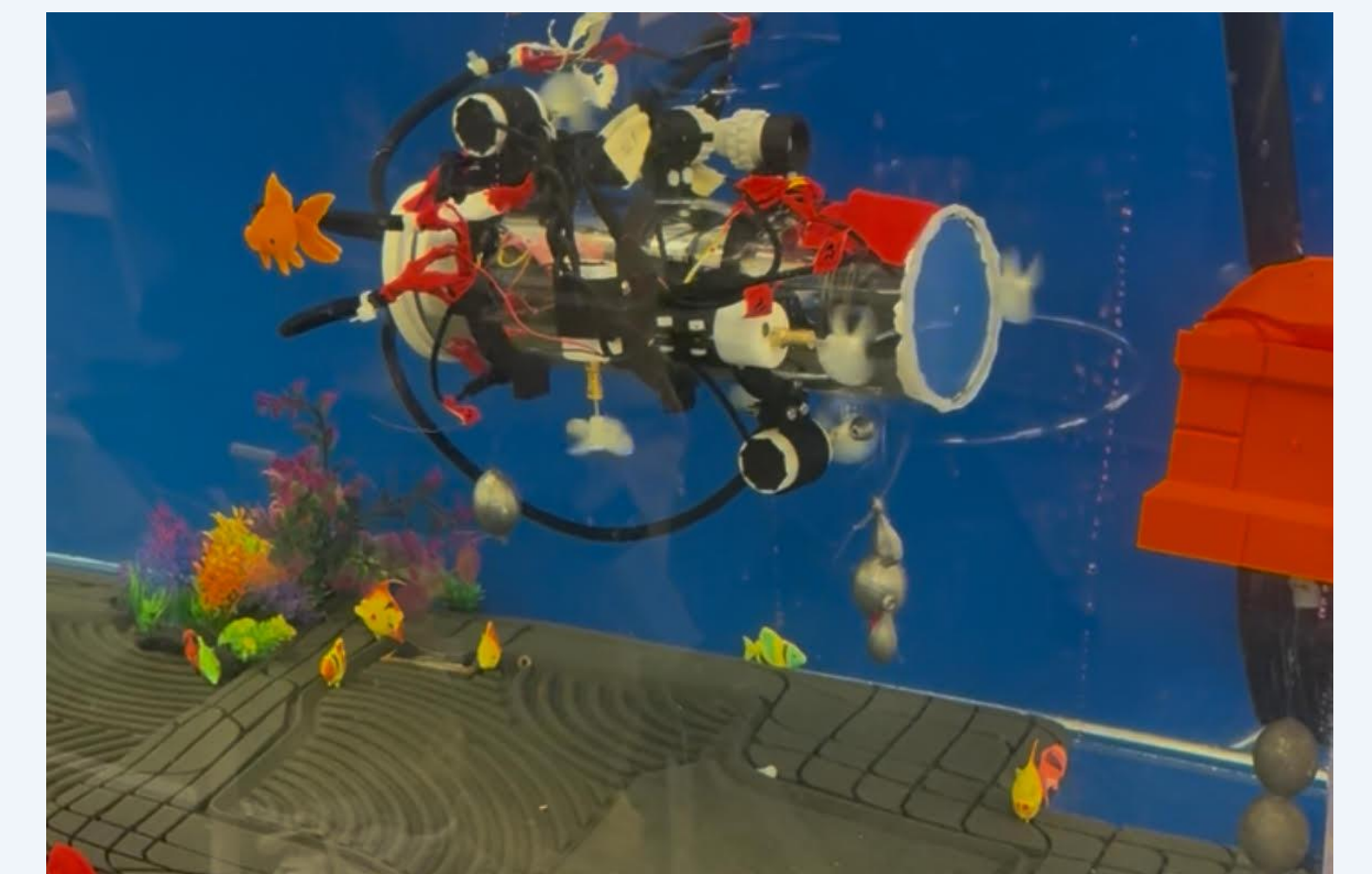
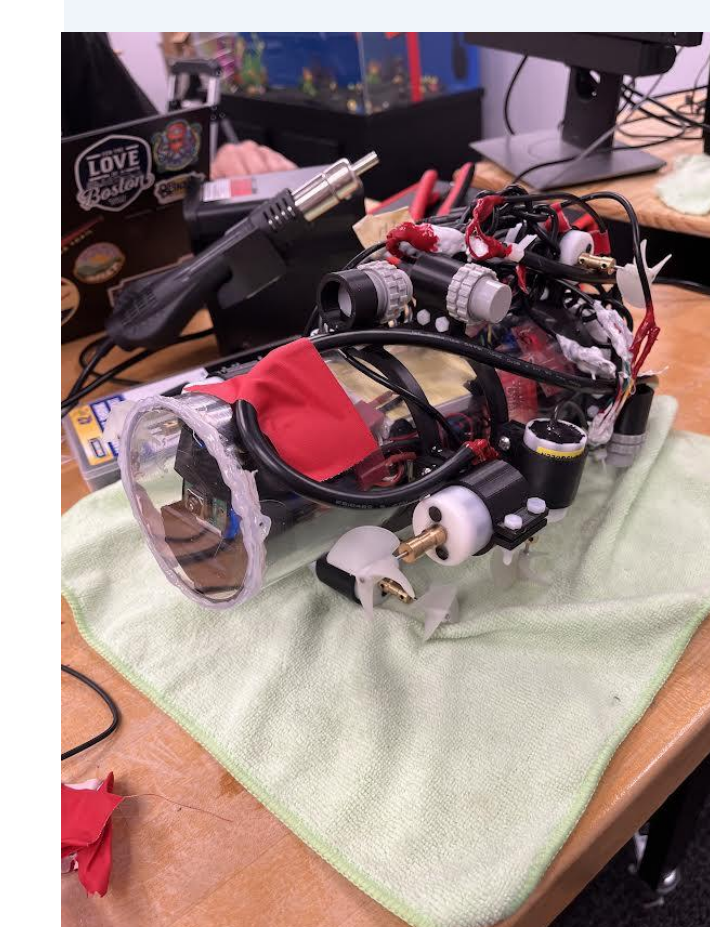
Navigation State Machine [3]



End Cap

## Testing and Results

1. Controlled Neutral Buoyancy & minimal oscillation during depth Control achieved.
2. Depth-matching with an object and autonomous navigation were successfully demonstrated in later testing.
3. Localization and the ability to relocate a lost target were achieved.



Final Design

Sub Navigation

## Conclusion

The project targeted vision-based autonomous underwater navigation on constrained embedded hardware. Primary objectives including target detection, depth control, and localization were achieved. Future work should focus on improving sensor control and minimizing mechanical complexity.

## References

- [1] "Autonomous Underwater Vehicles - NOAA Ocean Exploration," NOAA Ocean Exploration, 2020. <https://oceanexplorer.noaa.gov/technology/subs-auvs/>
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