Positive Operative Buoyancy Submersible (POBS)

TEXAS A&M UNIVERSITY Engineering

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TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Methodology

By developing a positively buoyant submersible which is versatile in many applications within aquatic environments, we can enhance the safety, sustainability, and ease of task in these domains.

Surfacing

- Rapid Emergency Surfacing: In the event of an emergency, the submarine can quickly rise to the surface without the need for complex ballast adjustment.

Efficiency

- The positive buoyancy can help the submarine maintain a higher position in shallow waters, reducing drag and making navigation easier.
- It can reduce the energy required to counteract the weight of the submarine.
- The need for elaborate ballast system does not exist, allowing for greater energy conservation.

Sustainability

- Vessels are less likely to sink, meaning less waste on our ocean floors while saving valuable data and equipment.
- The simple submersion technique means that short explorations consume less energy than traditional submarines.
- Positive buoyancy ensures that the submarine remains afloat even if there is a loss of propulsion.

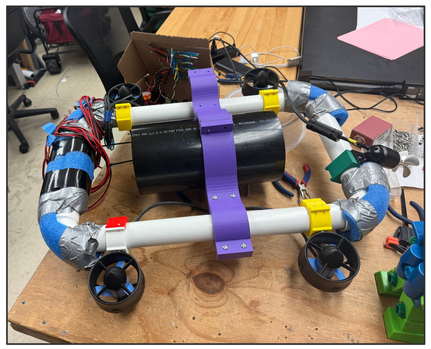

Figure 1: *Photo of test bed before its first run*

Chassis

To produce a submersible chassis capable of resisting the pressure forces of water while housing the equipment for propulsion and navigation, we spent the semester implementing the following improvements:

- Introduced new thrust + lift motor configuration
- Improved hull geometry
- Developed tethered and untethered testbed

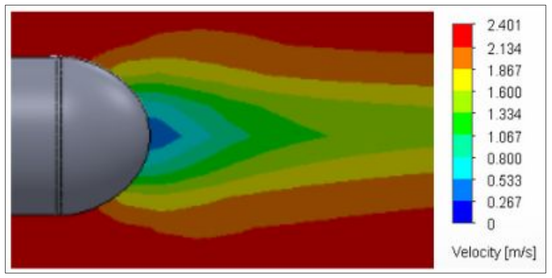

Figure 2: *Velocity Profile of Improved POBS End*

Electrical

This semester, we focused on preforming tests on the reliability and performance of our components. We use

- Blue Robotics T200 Thrusters
- Raspberry Pi 4B
- Blue Robotics Ping Sonar Altimeter and Echosounder
- Zeee 6S Lipo Battery 22.2V 100C 6000mAh

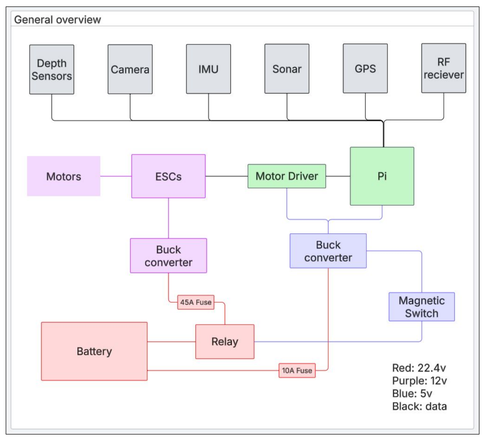

Figure 4:
POBS' electrical diagram

Controls

The robot keeps an estimation of it's current state (Position, Velocity, and Orientation) using a unscented kalman filter. Given just the IMU, we are unable to maintain a close enough position to accurately map a space. We fix this using pressure sensors to determine the current rotation and velocity. These are the sensors used

- IMU
- Adafruit Ultimate GPS
- 4x Teyleten High Precision Pressure Sensor
- Adafruit High Accuracy Temperature Sensor

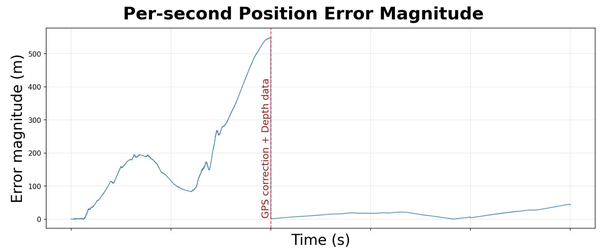

Figure 5: *Graph showing error accumulation at a given time*

Because multiple processes are constantly handling data and interrupts, we need to isolate them and leverage the Raspberry Pi's four cores. To make the separation of the processes easier we use ROS for interprocess communication. Splitting the code between running the sonar, planning the path, and stabilizing the submarine. We send the current estimated state, goal state, estimated errors and the new absolute state estimate using the GPS.

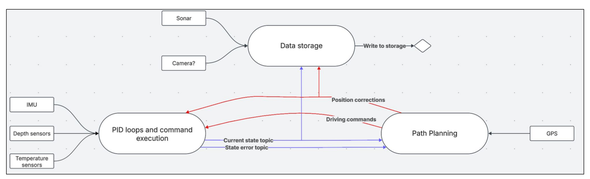

Figure 6: *Stylized version of the POBS' ROS node graph*

Controls Cont.

Even with those optimizations it is impossible to stay within the necessary error range over a long period of time. With an extra $20,000 we could probably run for an entire dive. Limited to $500 we need to implement a software solution to correct the estimate. We do this by returning to the surface and utilizing the otherwise unavailable GPS to get absolute position and velocity.

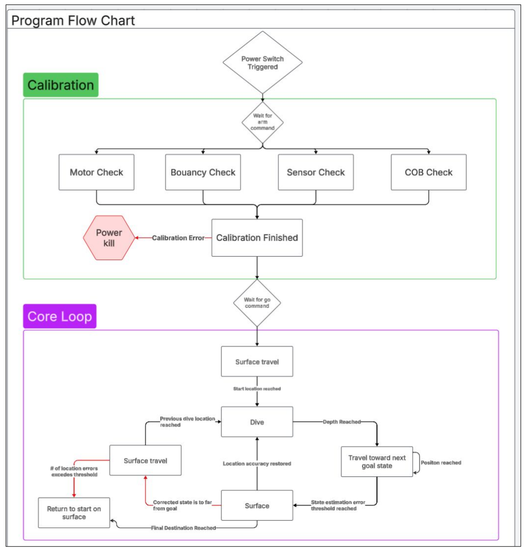

Figure 7: *POBS' core control loop*

Next Steps

In the coming semester, our team plans to transition into completing the final state of our testing systems and begin autonomous test runs. We also plan to construct the proper diving rig with a metal frame and better balanced components.

POBS

- Get the V2 CAD finished and begin constructing the core chassis.
- Implement new electrical components, including the camera.
- Port the controls system.