MANTA RAY - Marine and Naval Technological Advancements for Robotic AutonomY

Autonomous Surface Vehicle 2 (ASV2)

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Team MANTA RAY Mission

Team MANTA RAY is an interdisciplinary project dedicated to creating, maintaining, and expanding a network of marine robots for seafloor mapping and underwater perception. The network began as just the Autonomous Surface Vehicle (ASV) and Unpiloted Underwater Vehicle (UUV) but expanded to include a prototype of the ASV, known as TUPPS, A fully operational ASV launch vessel, and two kinds of remotely operated vehicles, known as GUPPS and KRILL. With these systems, students work to improve communication between vehicles, develop autonomous behaviors and algorithms, and upgrade existing mechanical systems to improve precision and performance.

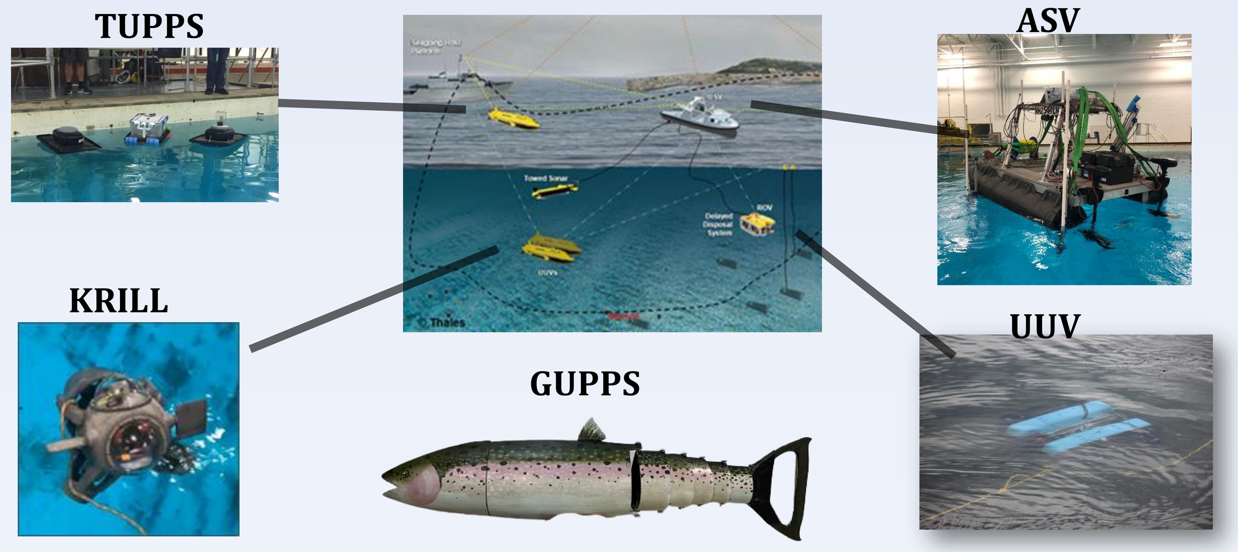

Figure 1: MANTARAY Mission

ASV2 Mission

The ASV2 mission for the 23'-24' academic year is to design and manufacture an autonomous surface vehicle that is capable of autonomous travel at 3 knots in sea state 0, and will support the necessary subsystems to deploy, localize, and recover an Uncrewed Underwater Vehicle (UUV) developed by White River Technologies (WRT) for the purpose of detecting unexploded ordinances underwater.

Resistance Testing

Tow Tank Experiment

- Built 1/6 scale model of pontoon floats using 3D printed PLA and extruded aluminum
- Attached a 25-lb load cell to collect force measurements
- Operated the tow tank in Chase at various constant velocities and accelerations

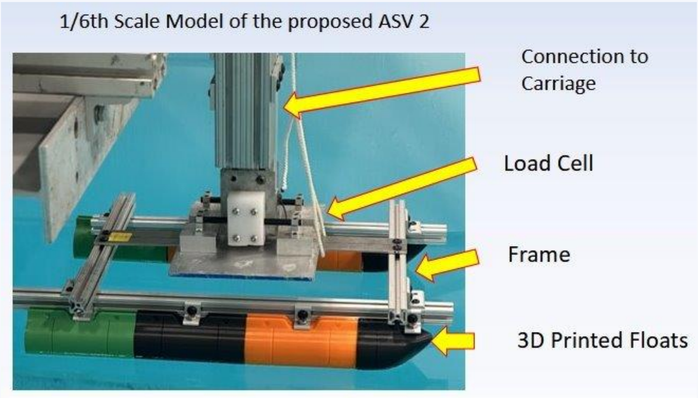

Figure 2: Description of 1/6th scale model

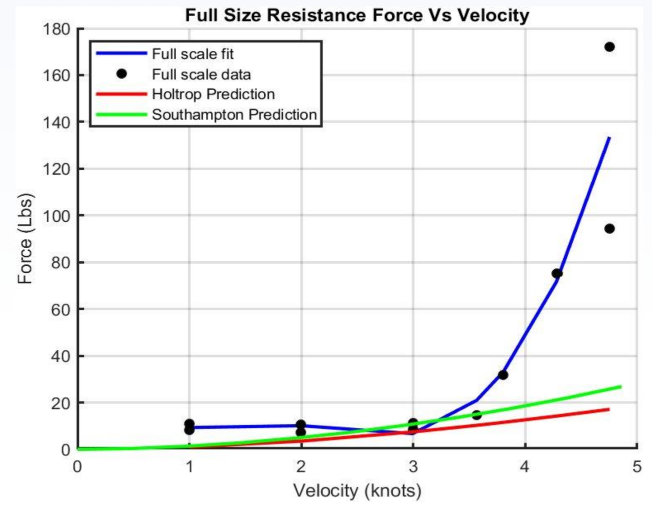

Figure 3: MatLab plot of the modeled resistance force

Propulsion Analysis

- Concluded that the collected data is accurate when compared to our Holtrop and Southampton prediction models around our ideal speed of 3 knots, but differentiates as the model approaches dynamic pitch
- With this force data, we were able to estimate the desired thrust for the propulsion system to be 140 lbs.

ASV2 Design & Construction

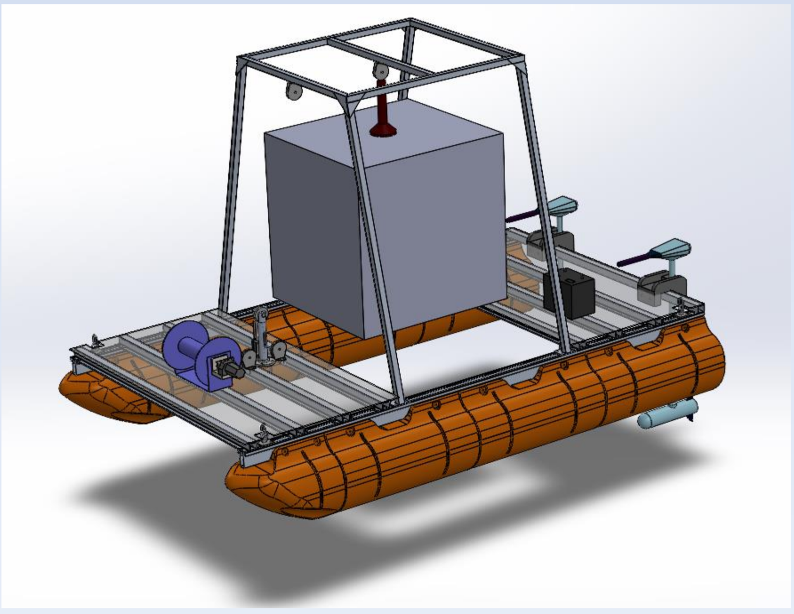

Figure 4: SolidWorks assembly of ASV2

Design Requirements:

- Comfortably house a large UUV with the dimensions of 40" x 36" x 42"
- Support the estimated maximum weight of the UUV at 150 lbs.
- Maintain a center of buoyancy that will prevent a tipping or rocking effect
- Propulsion must be capable of a speed of 3 knots
- Modularly support future subsystems

Mechanical Specs:

- Twin pontoon catamaran style body
- Two 24-Volt deep cycle batteries
- Dual 80lb thrust electric trolling motors
- "Penthouse" welded aluminum framing to support UUV and keep electronics box above the waterline
- Center moon pool for UUV clearance

Figure 5: Constructed pontoons with base framing

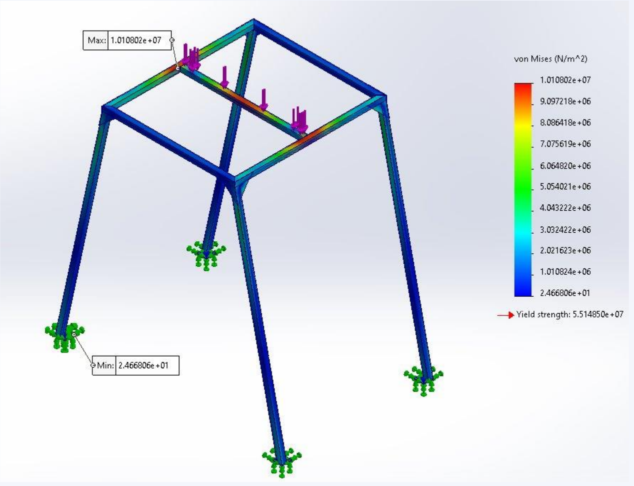

Figure 6: SolidWorks FEA analysis of penthouse

FEA Analysis:

- Completed a stress analysis of the Penthouse frame when the UUV is suspended out of the water
- Found a minimum factor of safety of 5.546 and a maximum deflection of 1.43mm at the top of the aluminum cross frame

Future Subsystems

The Tether System (TTS)

The tether system maintains a 5-20lb constant tension in the line between the UUV and the ASV. The Arduino microcontroller reads in the values from the linear encoder and communicates with the rotary encoder. The winch reels in or out depending on the changes in tension from UUV movements.

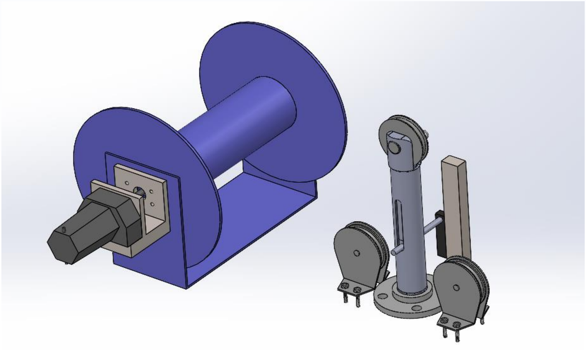

Figure 7: SolidWorks assembly of TTS components

Underwater GPS (UGPS)

The UGPS incorporates acoustic nodes that triangulate a precise location of the UUV and allows for real time location tracking of UUV with respect to shore station.

Moon Pool Bay Door

A moon pool style retractable door will be added to provide support for the UUV while it is suspended out of the water and prevent rocking due to the pendulum affect from a swinging suspended weight. It will use a linear actuator for powerful and controlled movement, and limit switches denote the open/closed position of the door.

Autonomous Control

- All data (GPS position, operating mode, active commands, etc.) published through ROS topic.
- Raspberry Pi (onboard computer) sends commands over ROS to the Arduino.
- Topics published over ASV's onboard Wi-Fi network.
- Missions started through GUI that publishes these topics.
- Arduino controls subsystems based on ROS command from the Pi.
- Can navigate to a GPS location from a given .plan file
- UUV deployed once location is reached

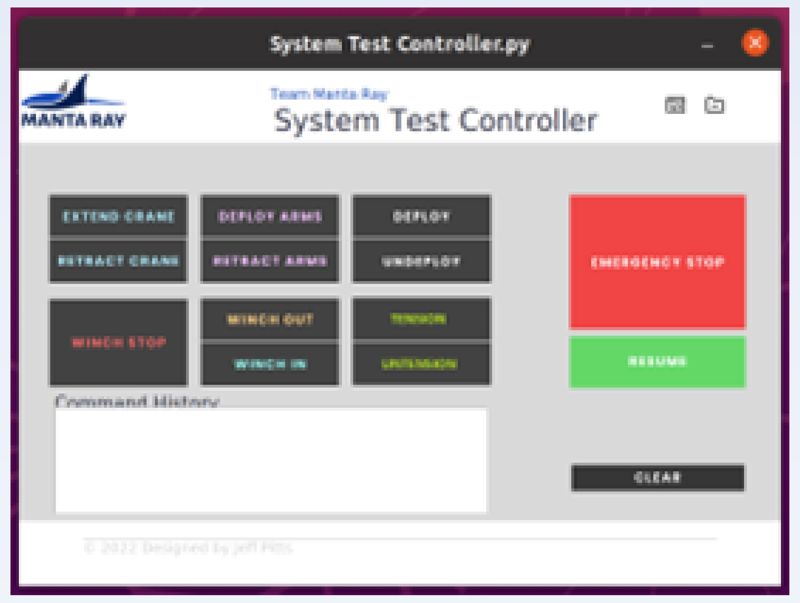

Figure 8: Ground Station GUI

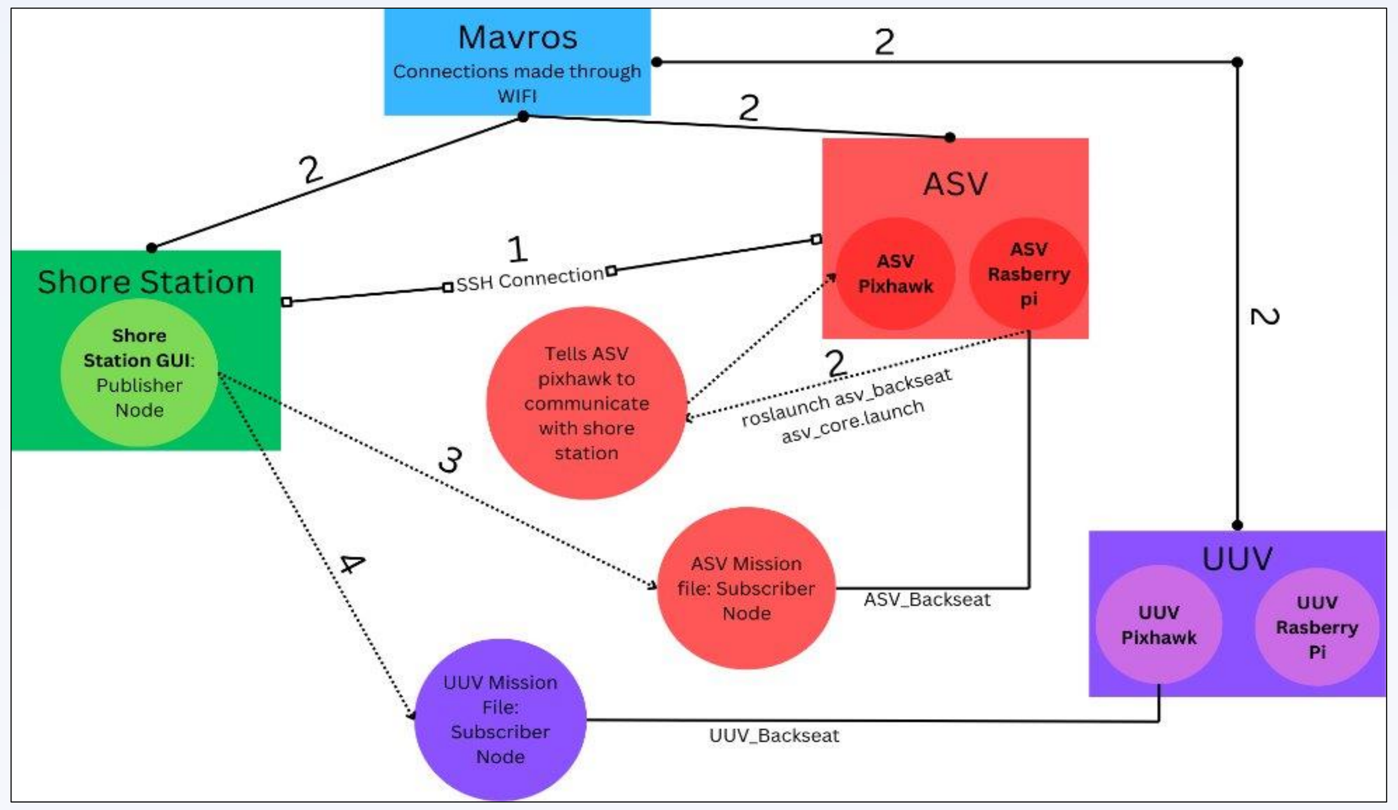

Figure 9: Software Architecture

References

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