Autonomous Surface Vehicle (ASV)

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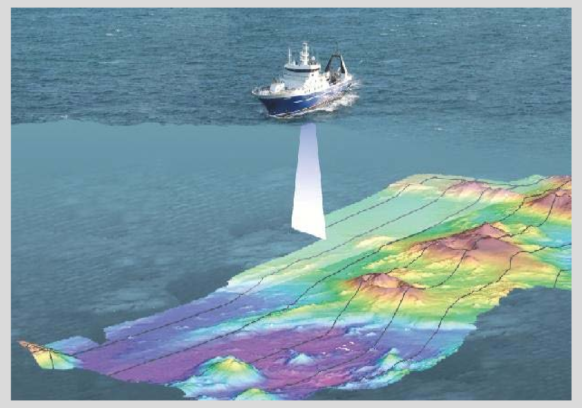
Background



The Autonomous Surface Vehicle (ASV), is a self-driving self-aware boat, it requires integration of multiple fields of engineering (e.g., mechanical, electrical, and software). The team uses Mission Orientated Operating Suite-Interval Programming (MOOS-IvP) software platform (incorporating ROS) to integrate multiple vehicle sensors and actuators, along with user-defined command inputs. Advanced modeling and control techniques are also implemented to ensure high performance, and reliability for autonomous obstacle avoidance and path planning.

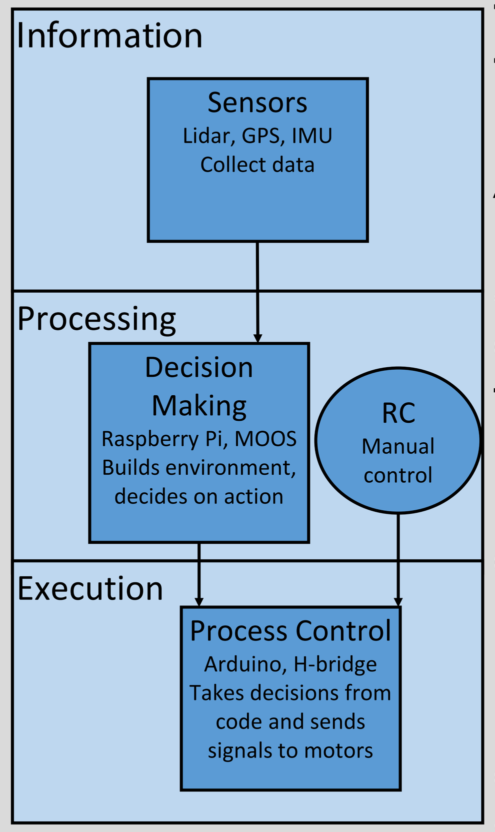
Potential uses for ASVs include national defense, research like ocean floor mapping, commercial shipping, and fishing opportunities.

Platforms

ASV 2:
- 58" length
- Brushless electric motor for propulsion
- Achieved First Stage Autonomy
- Second Stage Autonomy in progress
- Cross Platform Communication and multivehicle operations in progress

ASV 3:
- 7' Bass fishing boat
- Outboard Electric trolling motor
- Achieved First and Second Stage Autonomy
- Third Stage Autonomy in progress
- Cross Platform Communication and multivehicle operations in progress

Modularity



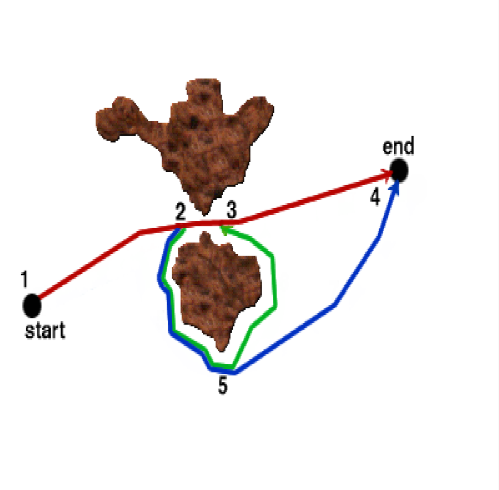
The autonomy of the ASV consists of three major systems. The first includes, GPS, IMU, and LIDAR, or the sensors. It must be able to accurately gather information about the ASV and the environment. The second includes the processor (Raspberry Pi) and the code that runs the autonomous protocols (MOOS-IvP). This system takes data from the sensors and makes decisions based on them. The last system required for autonomy is the process control, which includes an Arduino microcontroller and H-bridges. This system receives the decisions made by the autonomy code and converts them into signals for motor orientation and direction control. For any vehicle using our design, these three systems remain relatively unchanged aside from power and size constraints. Together they form the modular autonomous system we intend to employ on multiple vehicles.

Project Goals

Focus:
Low Cost, Modular, Robust Design allowing any existing vehicle autonomous capabilities.

Autonomy:
First Stage: Basic point to point navigation using GPS positioning with IMU for heading

Second Stage: Second stage autonomy involves pairing point to point navigation with obstacle avoidance, thereby creating a self sufficient navigation algorithm to serve as a platform for more complex tasks.

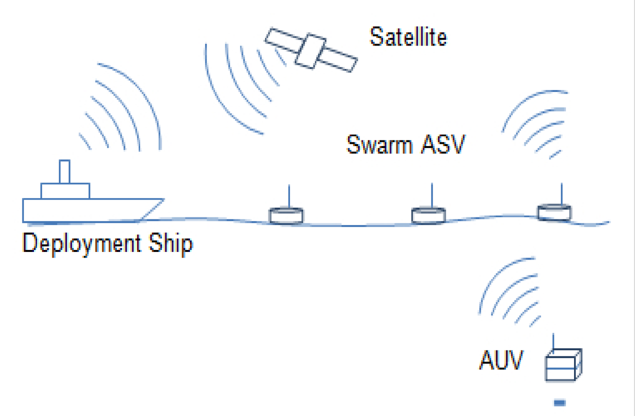


Third Stage: Target recognition, tracking, and trailing. This allows for more advanced behaviors and aids in multi-platform coordination and swarm optimization.

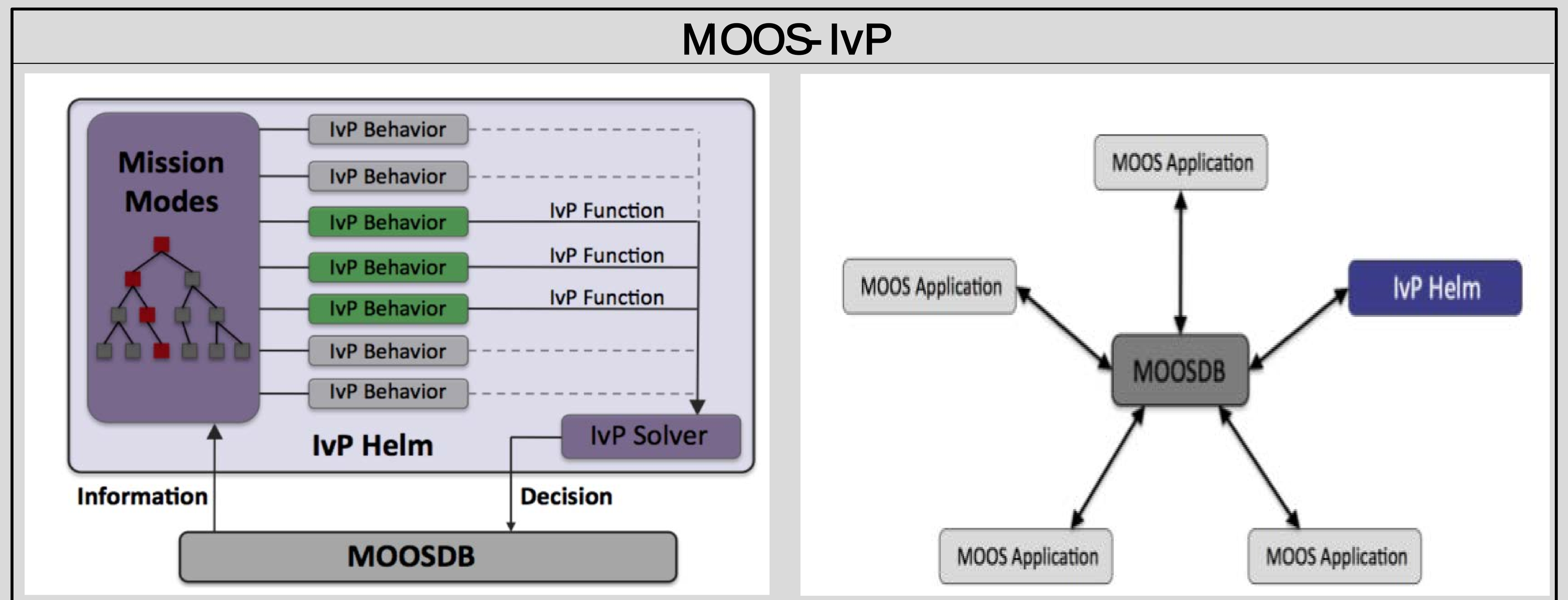
Modularity:
Modularity is defined as the degree to which a system's components may be separated and recombined on other similar systems.

The main goal of this year's ASV is to create an entirely modular design so that any component, necessary for autonomy, may be taken off an existing vessel and placed on a similar one with minimal adjustments

Long Term:
Implement multivehicle operations where multiple Autonomous Surface Vehicles (ASVs) Unmanned Underwater Vehicles (UUVs) and Unmanned Aerial Vehicles (UAVs) all share information and work together as one autonomous network to accomplish tasks.



Data Processing, Autonomy and Controls

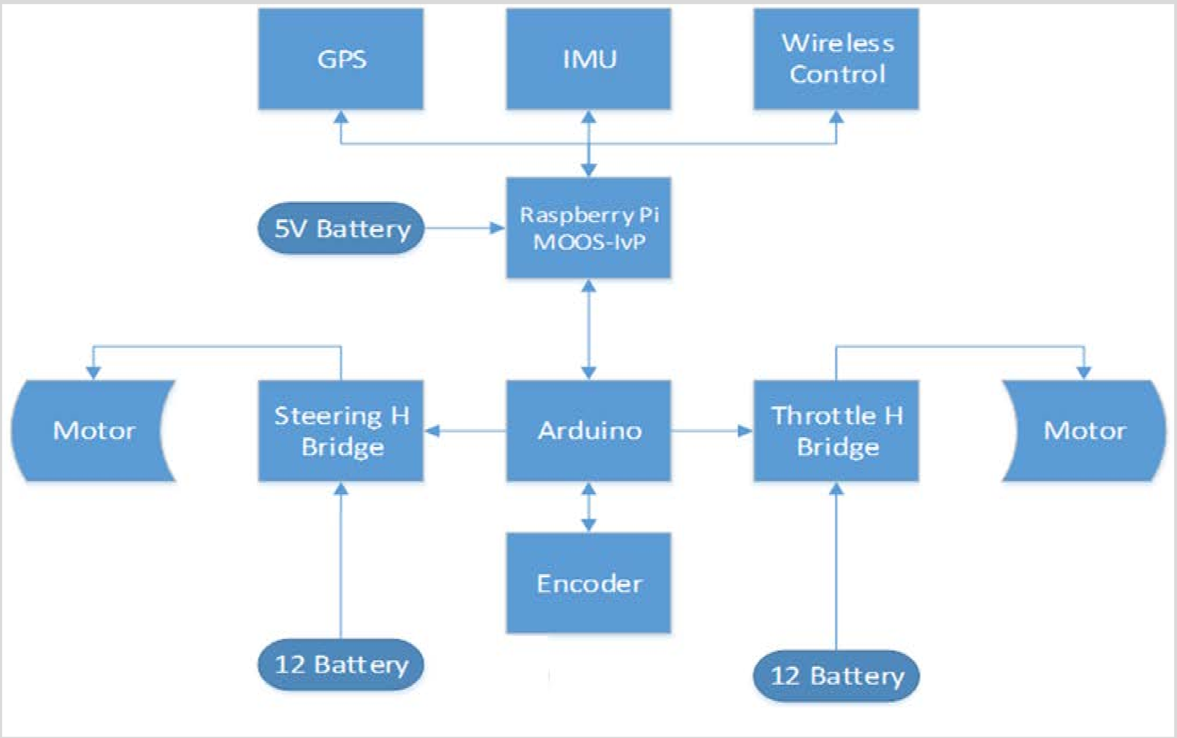


IvP Helm:
The IvP helm is able to take information from MOOS and make control decisions for the ASV. Complex autonomous scenarios can be developed from pre-made or custom behaviors.

MOOSDB:
Stores information related to its operating mission and coordinates communication between sensors and other processes. MOOS applications can interface with the MOOS database.

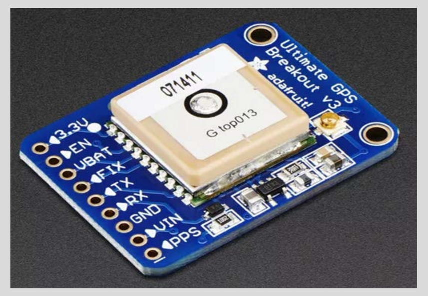
Raspberry Pi:
The "Brain", stores Sensor Drivers and MOOS-IVP

ArduinoMega2560:
Stores both manual (RC) and automated motor and rudder control.

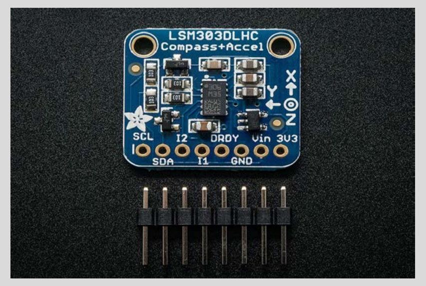


Setup:
The MOOS-IvP framework is capable of building highly capable autonomous systems. It allows the all the sensors and components onboard the ASV to work together to achieve autonomy.

Sensor Suite & Functionality



GPS:
Adafruit Ultimate GPS Breakout used for vehicle position and speed.



IMU:
Inertial Measurement Unit: Adafruit triple-axis accelerometer + magnet board LSM303 is used to provide heading information. (9 DOF)

LiDAR:
Light detection and ranging system. Used Scanse Sweep LiDAR for object detection and avoidance system. (Range: 40 m)

Results

The first stage of autonomy has been completed and has been implemented on to the ASV3 platform. This allows the ASV3 platform to self-navigate to pre-programed points, using the GPS and IMU sensor inputs along with MOOS to accomplish this. The obstacle avoidance and target recognition (stages 2 and 3 respectively) have successfully worked in computer simulations. Further implementation of the second and third stages of autonomy on the ASV3 platform will begin when the LiDAR sensors are delivered to the team from the manufacturer. The ASV team has also successfully created a modular design for automation, which will soon be implemented on multiple platforms. This will allow the team to achieve the end goal of having the ASV2 and ASV3 platforms fully autonomous and interacting . The ASV team is confident that the end goal is achievable by the end of the semester.