

# Motorized Ballast Underwater System

EECS 373 - Introduction to Embedded Systems.

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## Background

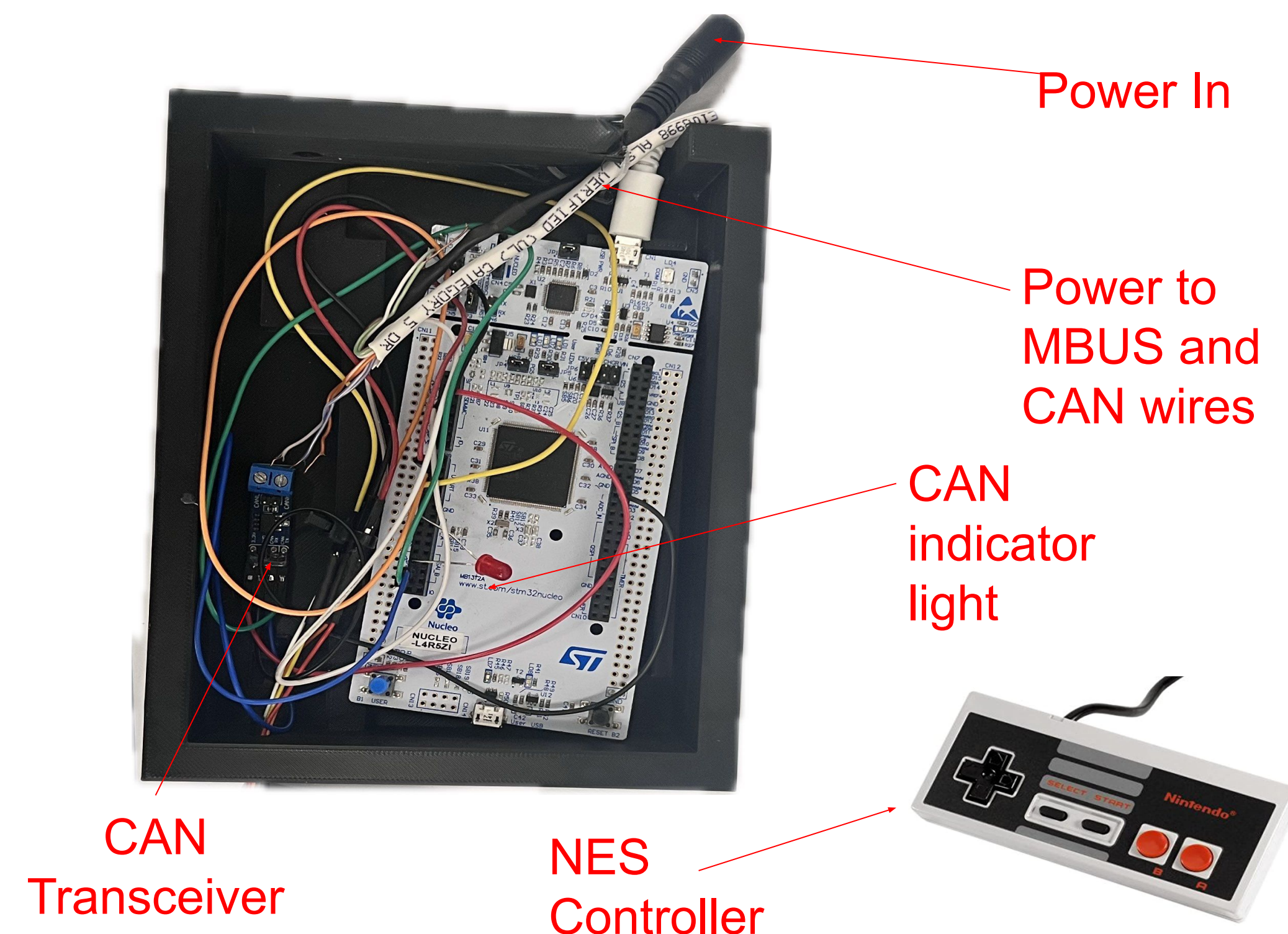
### MBUS Capabilities

- Collect and transmit real-time data in marine environments.

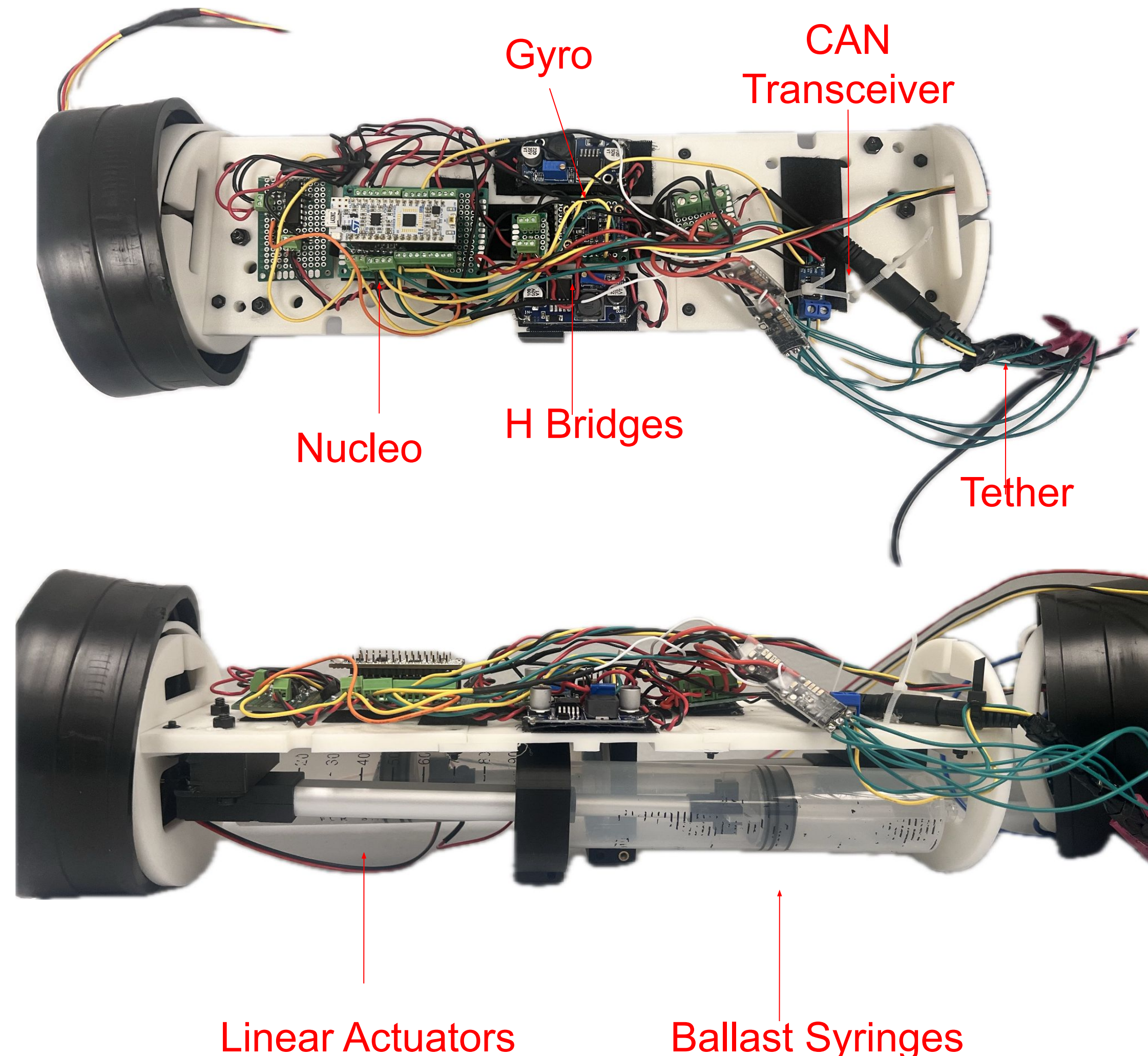
### Applications

- Exploring marine environments.
- Provides a platform for implementation of additional sensor packages.

### Ground Station



### MBUS Electronics



## Implementation

### Position Control System

- Linear Actuators fill and empty two internal syringes to adjust buoyancy, controlled via H-bridge.
- Two thrusters provide horizontal movement, controlled via PWM with speed adjustments based on user input.

### Ground Station

- MBUS is connected to the surface by a Tether.
- Bi-Directional communication via the CAN bus supports user input and sensor data output.
- NES controller serves as input device, while data can be displayed real time on an external display.

### Mechanical Structure

- PVC pipe hull and silicone end caps provide a watertight enclosure.
- Waterproof cable glands and epoxy are used to interface with external components.

### Sensor Suite

- **Speed:** Interrupt-driven pulse counter increments as water flows through flow meter

$$\text{Pulse (Hz)} = [7.5 \times \text{Flow Rate } Q \text{ (L / min)}]$$

- **Heading:** In IMU mode (gyroscope and accelerometer), sensors provide relative heading
- **Depth:** Raw temperature and pressure data from pressure sensor → temperature-compensated pressure → depth

$$(P = \rho gh)$$

## Challenges

### Waterproofing

- Leaks from the syringe to external interface.
- Mechanical spacers to relieve stress on tubing.

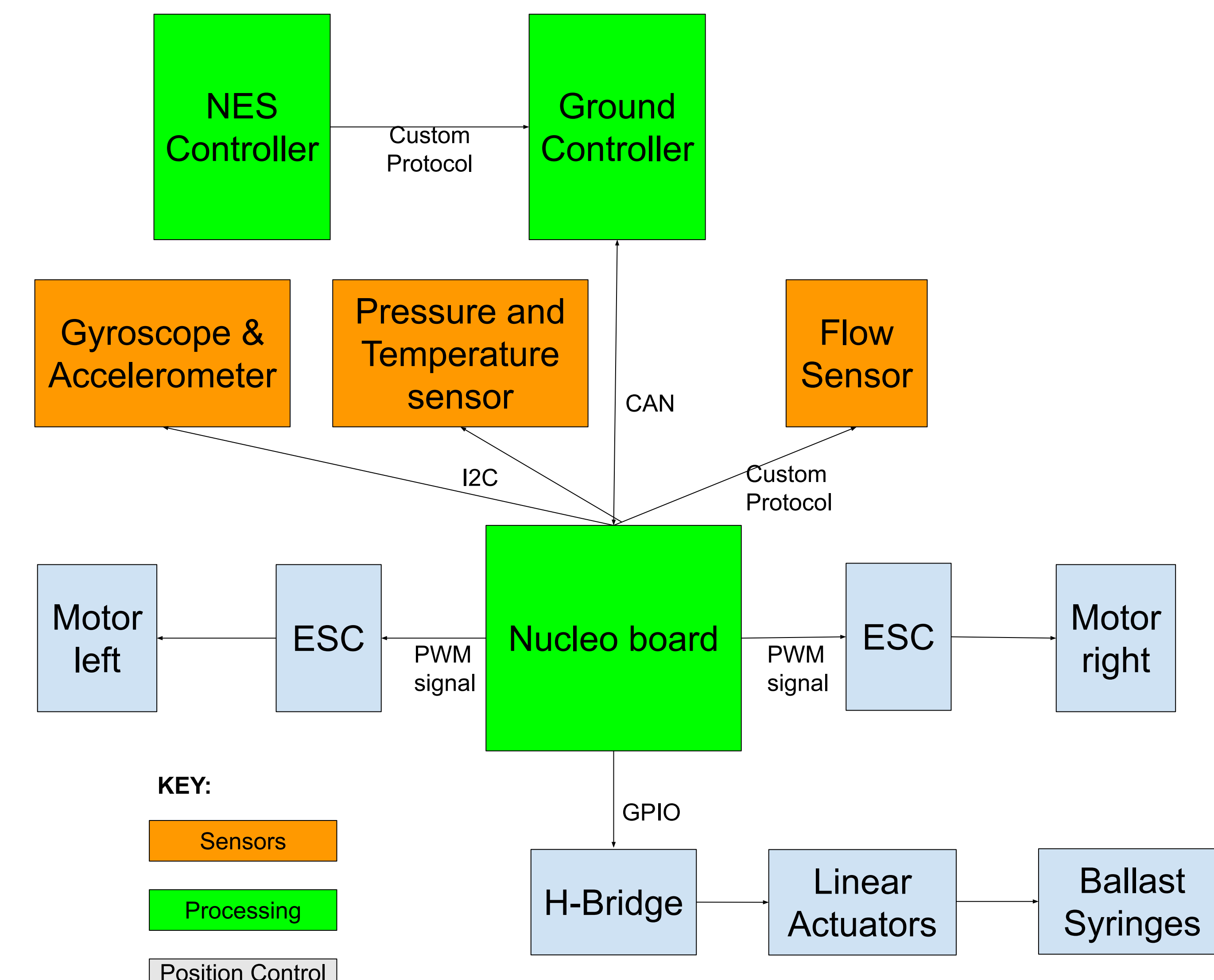
### CAN

- CAN reliability was inconsistent.
- Soldered connections to the CAN transceivers.

### System integration

- Tested all components individually.
- Abstracted code into multiple, modular libraries.

### MBUS Dataflow



## Future Work

### Acoustic Navigation

- Implementation of 2 hydrophones to allow for receiving and seeking acoustic signals.

### Camera and Vision

- Addition of a camera to allow for longer distance and less ideal conditions, and additional data.