UMassAmherst
Midway Design Review

Triton

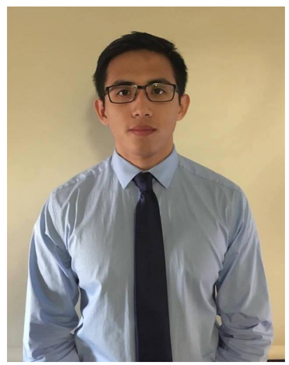
Team 11
December 9, 2016

Department of Electrical and Computer Engineering

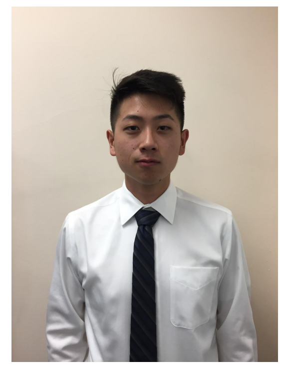
Triton

- ECE Advisor: Prof. Andras Moritz
- MIE Advisor: Prof. Frank Sup

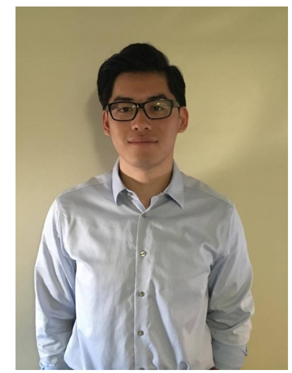
Emil Safonov, CSE



Calvin Tran, EE



Kevin Tong, ME



Tony Hua, ME

Extended Underwater Monitoring of Biological Phenomena

- No economical solution for underwater monitoring
- UMass-Amherst ecologists interested in studying spawning behavior of declining populations of river herring
- Triton will allow researchers to observe and record underwater biological phenomena

Requirements Analysis: Specifications

- Must be able to operate up to 20 feet in depth under freshwater
- Must have an operational distance of up to 300 feet from base station
- Must be able to achieve run time and HD quality video feed up to 3 hours
- Must be able to provide sufficient video quality and lighting for operator to discriminate target underwater object(s) under average condition
- Should be capable of storing 3 hours of footage
  - 1080p, 72 Gigabytes of data
- Should be able to readjust its orientation through control loop

Requirements Analysis: Inputs and Outputs

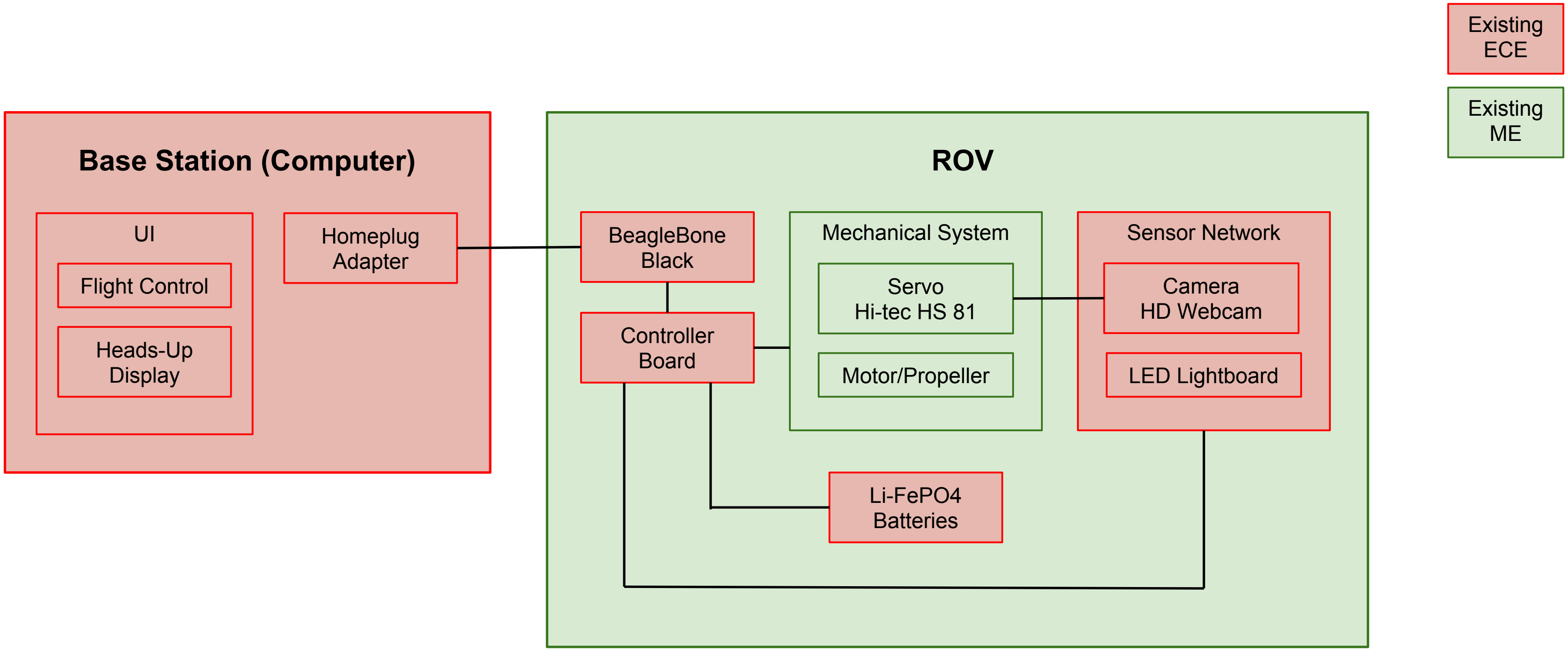
Inputs:

- IMU (depth, compass)
- Moisture level
- HD 1080p Webcam
- User control

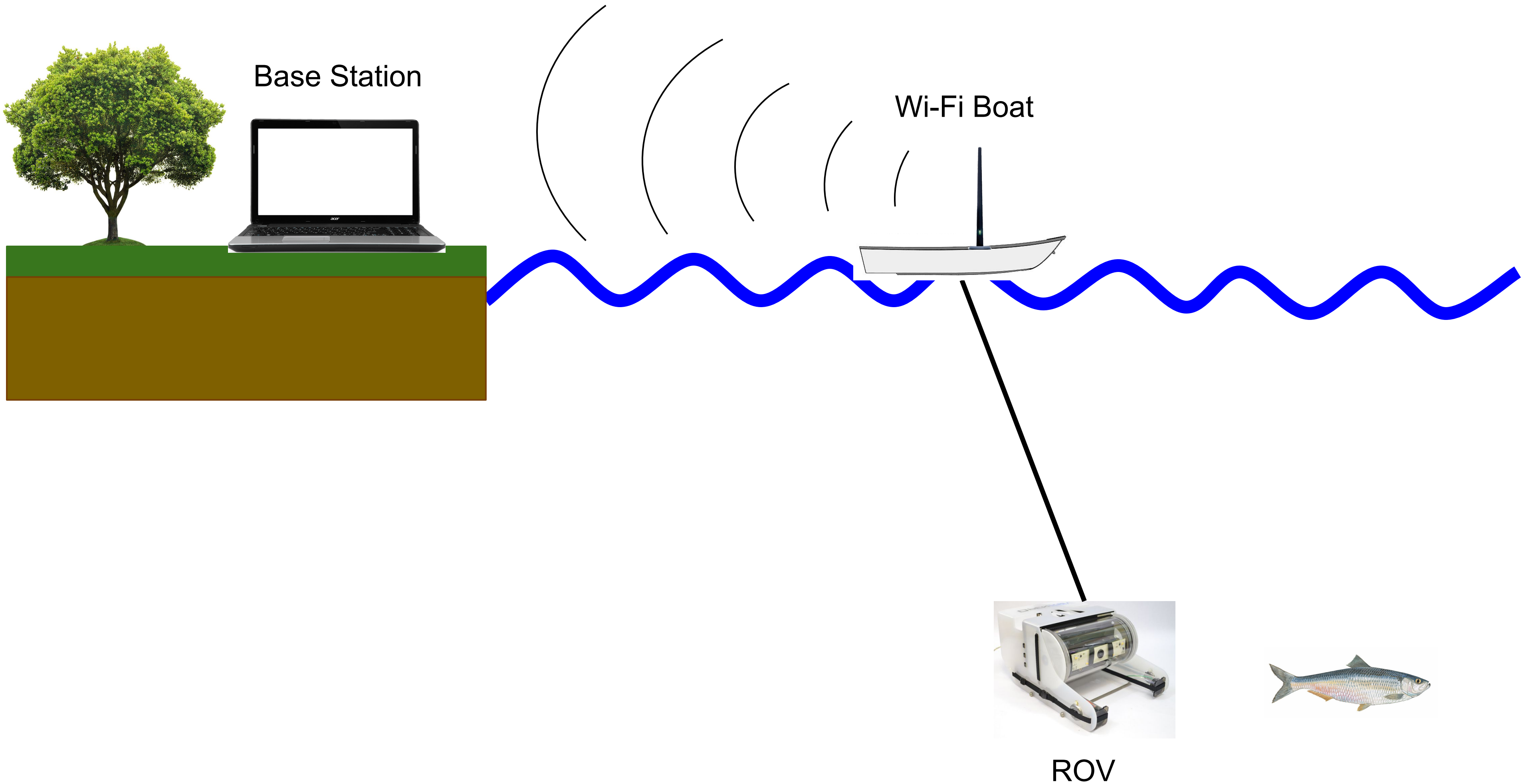
Outputs:

- Orientational data/depth
- Water leakage alert
- Live video feed
- Distance reading

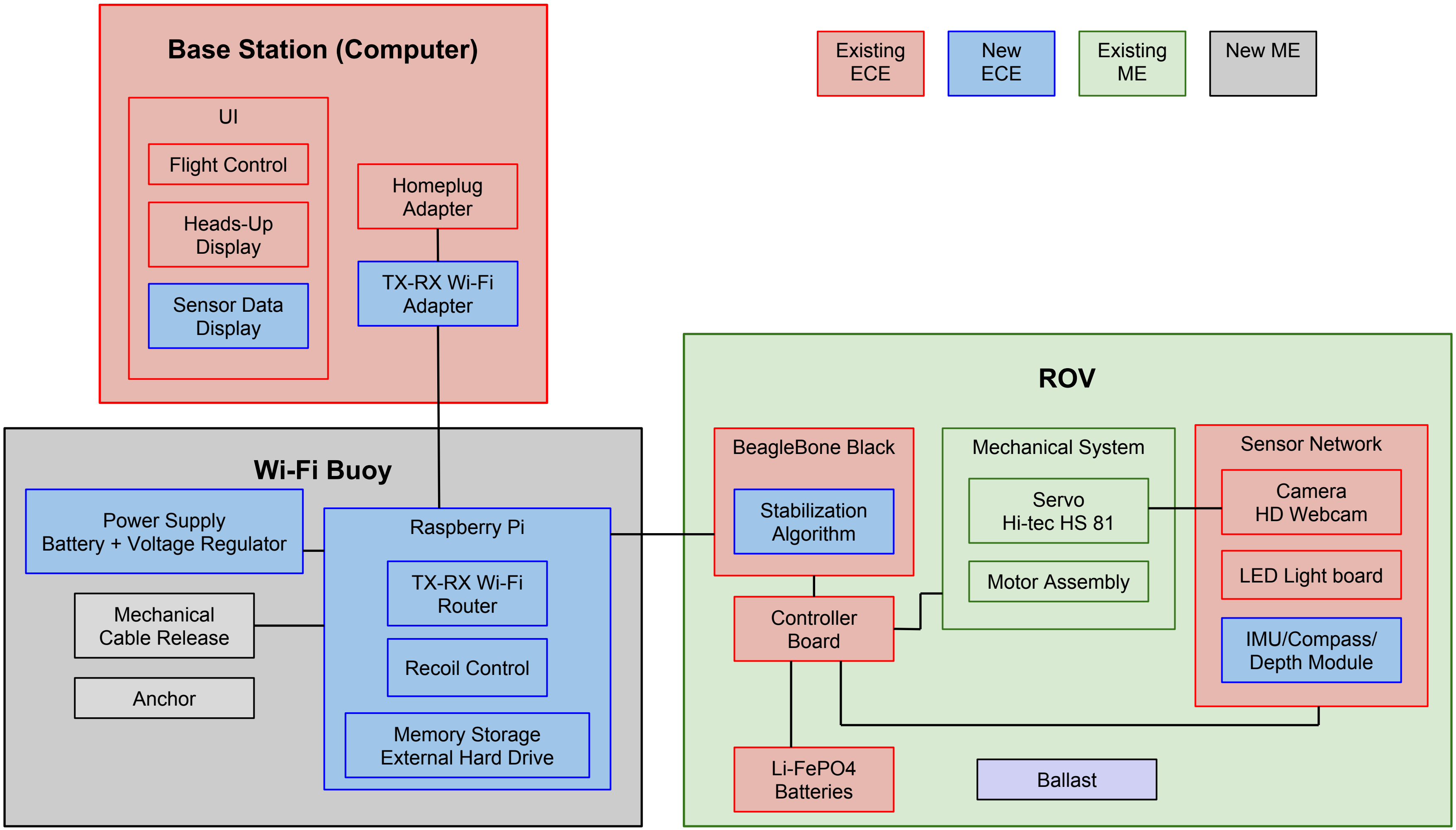
System Block Diagram of Stock ROV



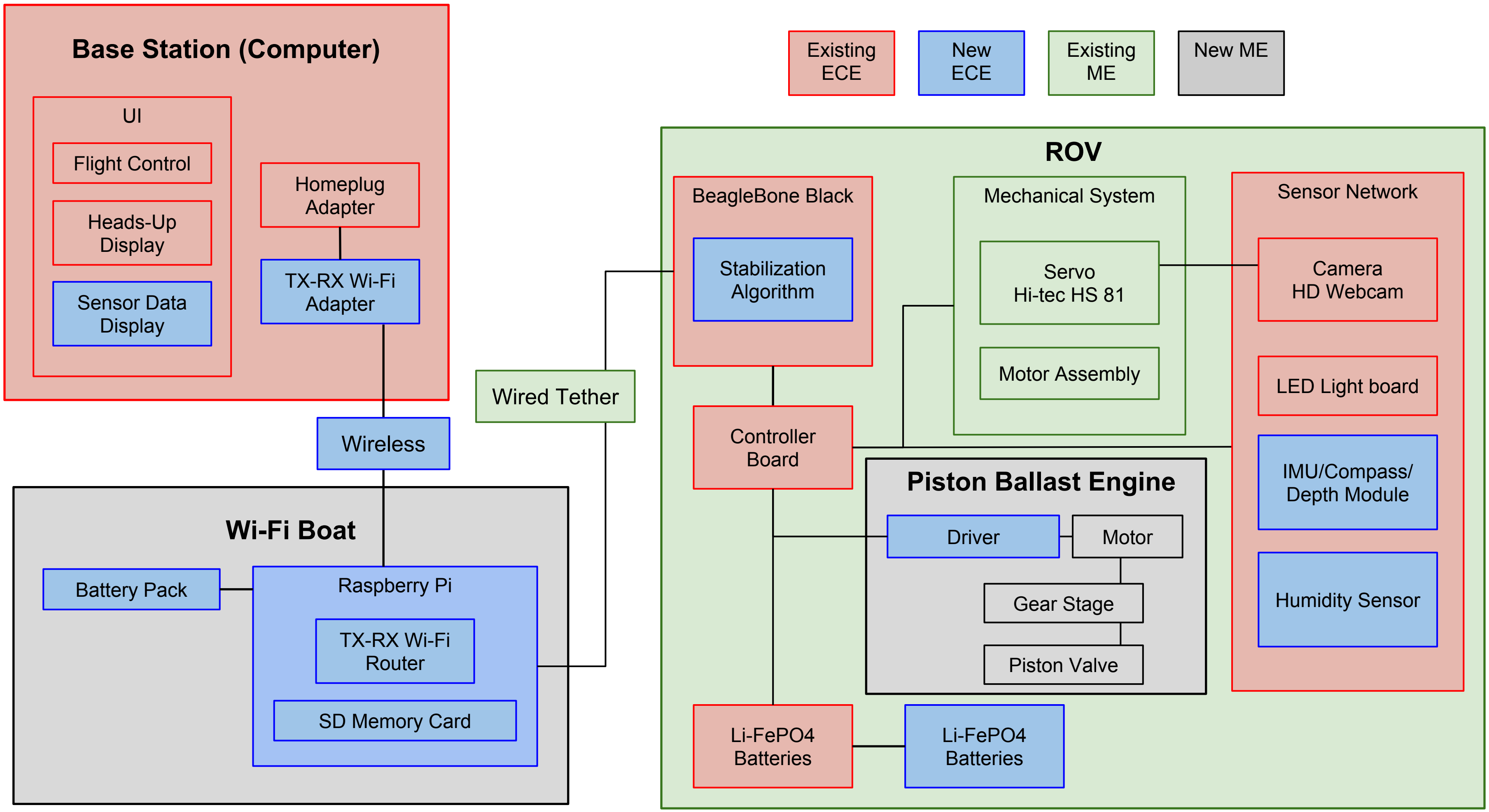
Visual Representation



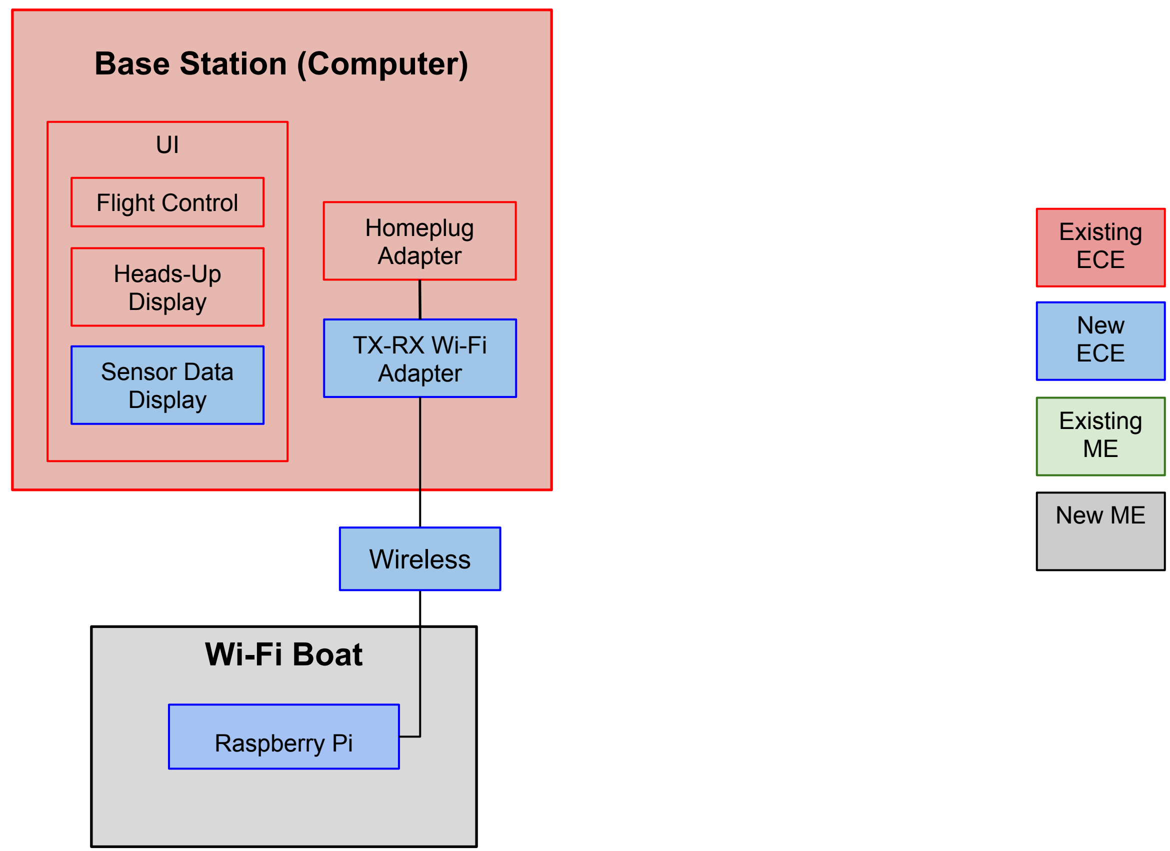
Our Previous Solution: Block Diagram



Our Redesigned Solution: Block Diagram



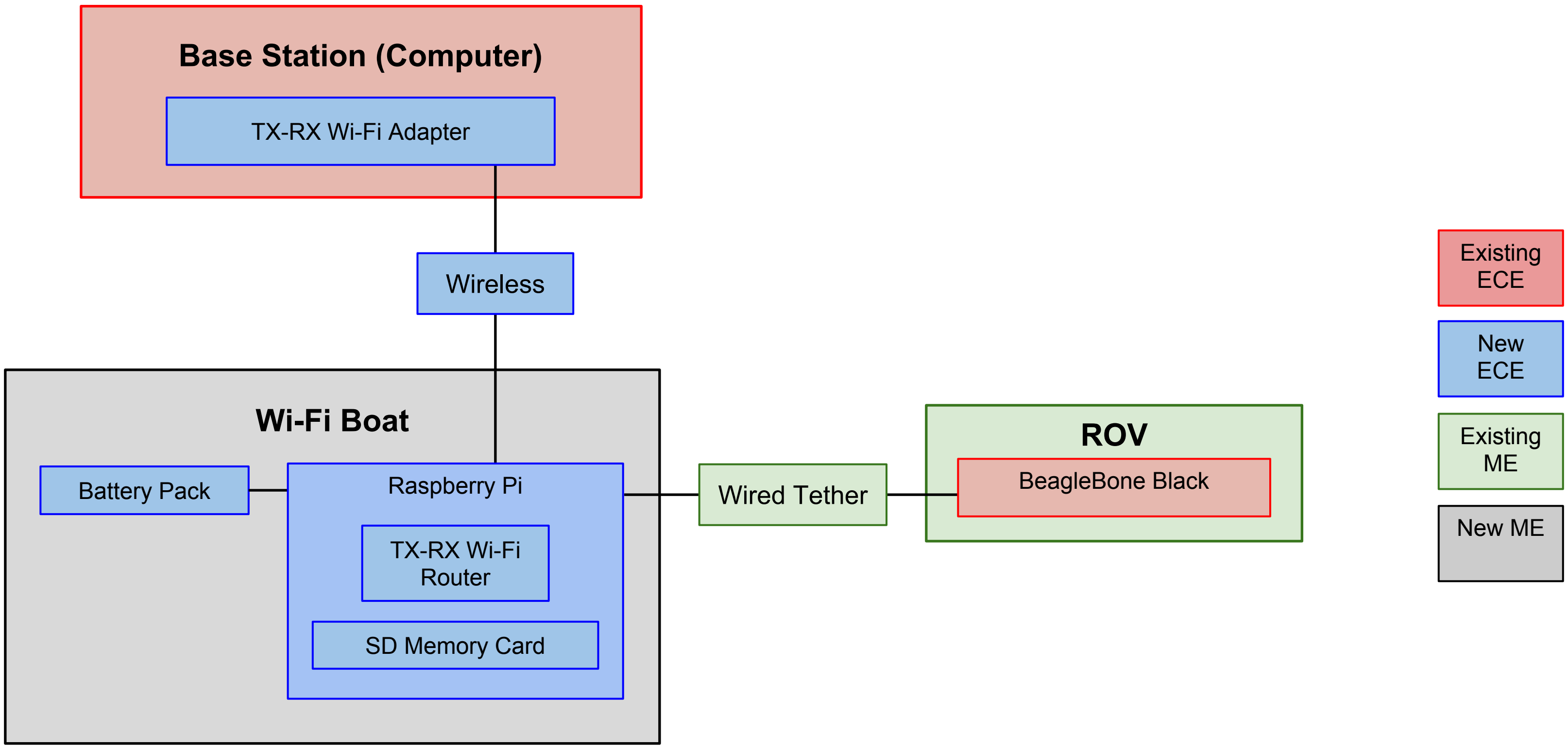
Base Station



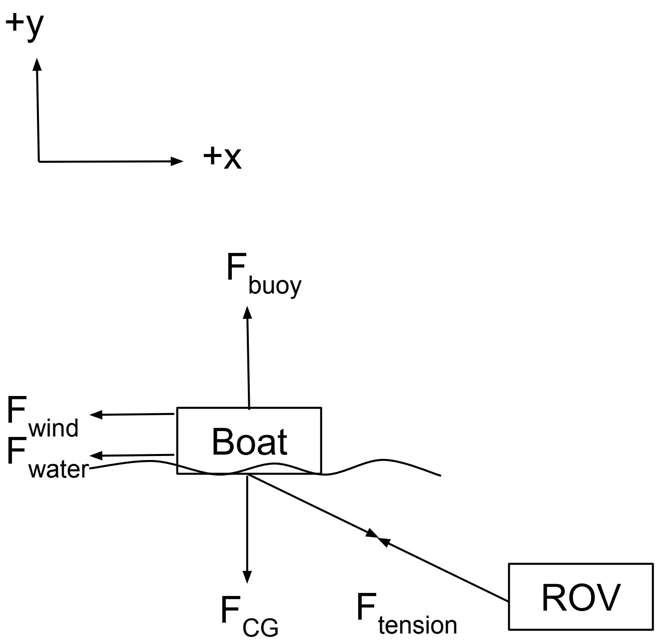
WiFi Setup - Raspberry Pi and Ethernet Adapter

- Test results
  - 2.4 GHz band - 250 Feet
  - Latency
    - Wired: 30-120 ms
    - Wireless: 50-300 ms at < 250 ft.
  - Power Usage
    - 4200 mAh with WiFi for raspberry pi and adapter
  - Video Quality: 720p, 5-30 frames per second (wireless)

Radio Boat


Base Station (Computer)
TX-RX Wi-Fi Adapter
Wireless
Wi-Fi Boat
Battery Pack
Raspberry Pi
TX-RX Wi-Fi Router
SD Memory Card
Wired Tether
ROV
BeagleBone Black
Existing ECE
New ECE
Existing ME
New ME

Boat Design

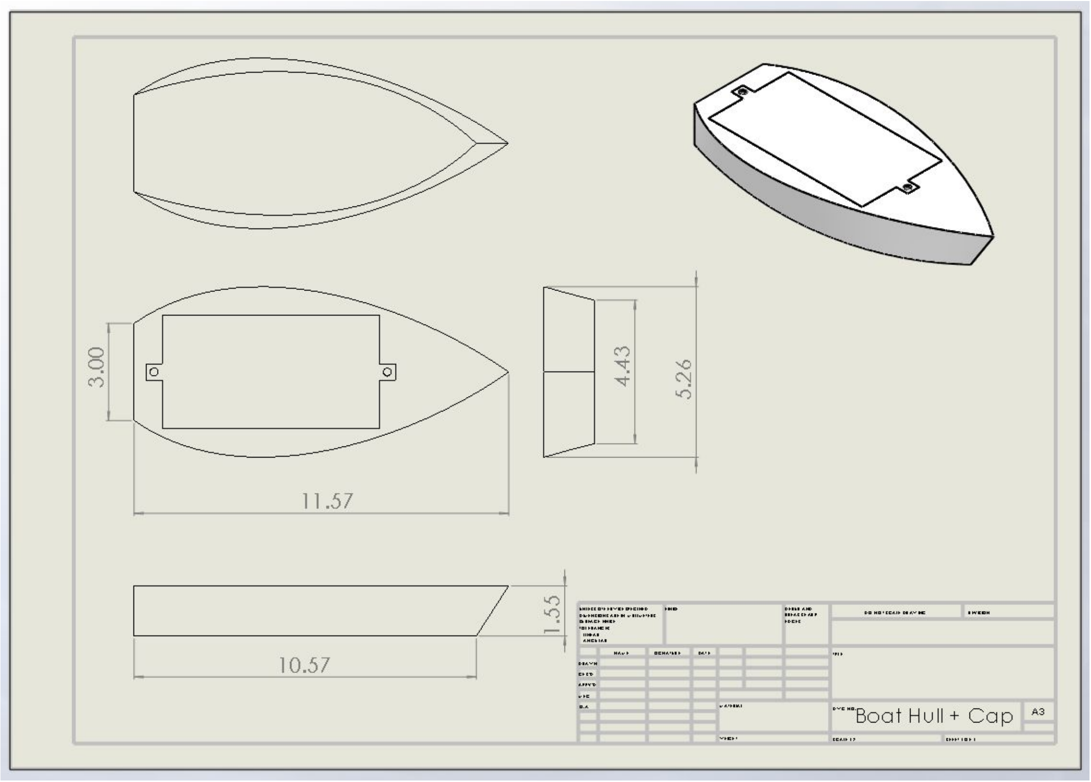


ΣF_y: $F_{CG} - F_{buoy} = 0$

ΣF_x: $F_{tension} - F_{wind} - F_{water} = 0$

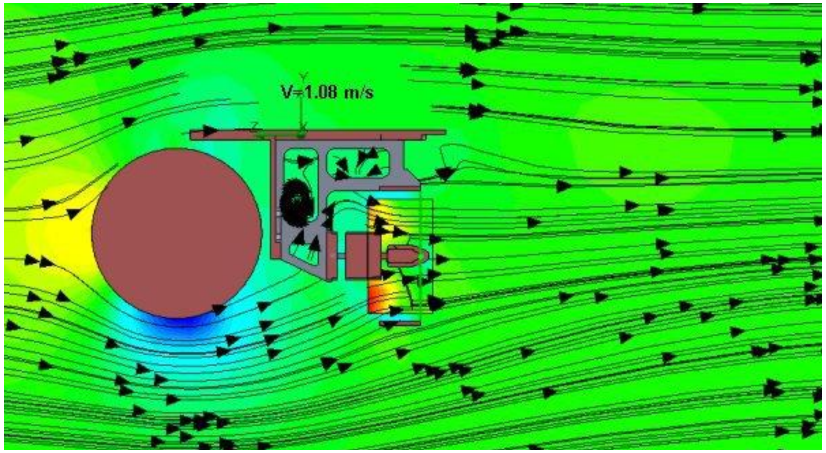
Archimedes' Principle: $F = \rho g V$

Flat Bottom Boat

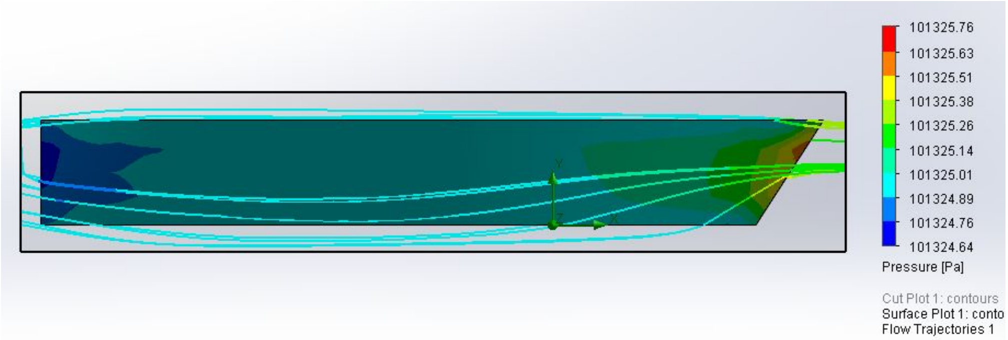


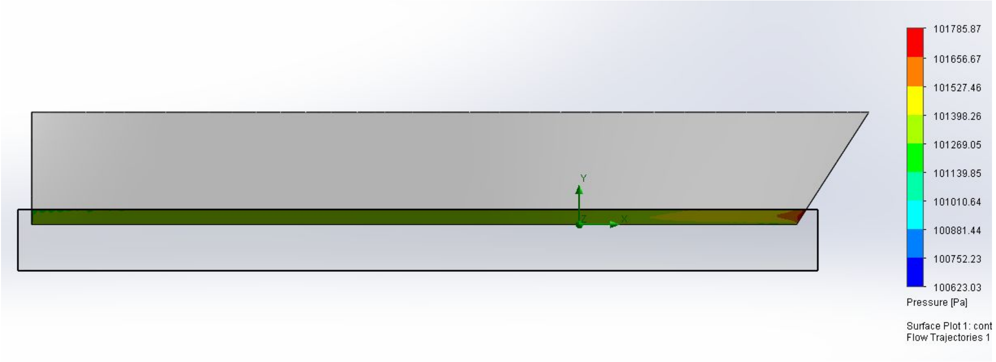
Computational Fluid Analysis

ROV



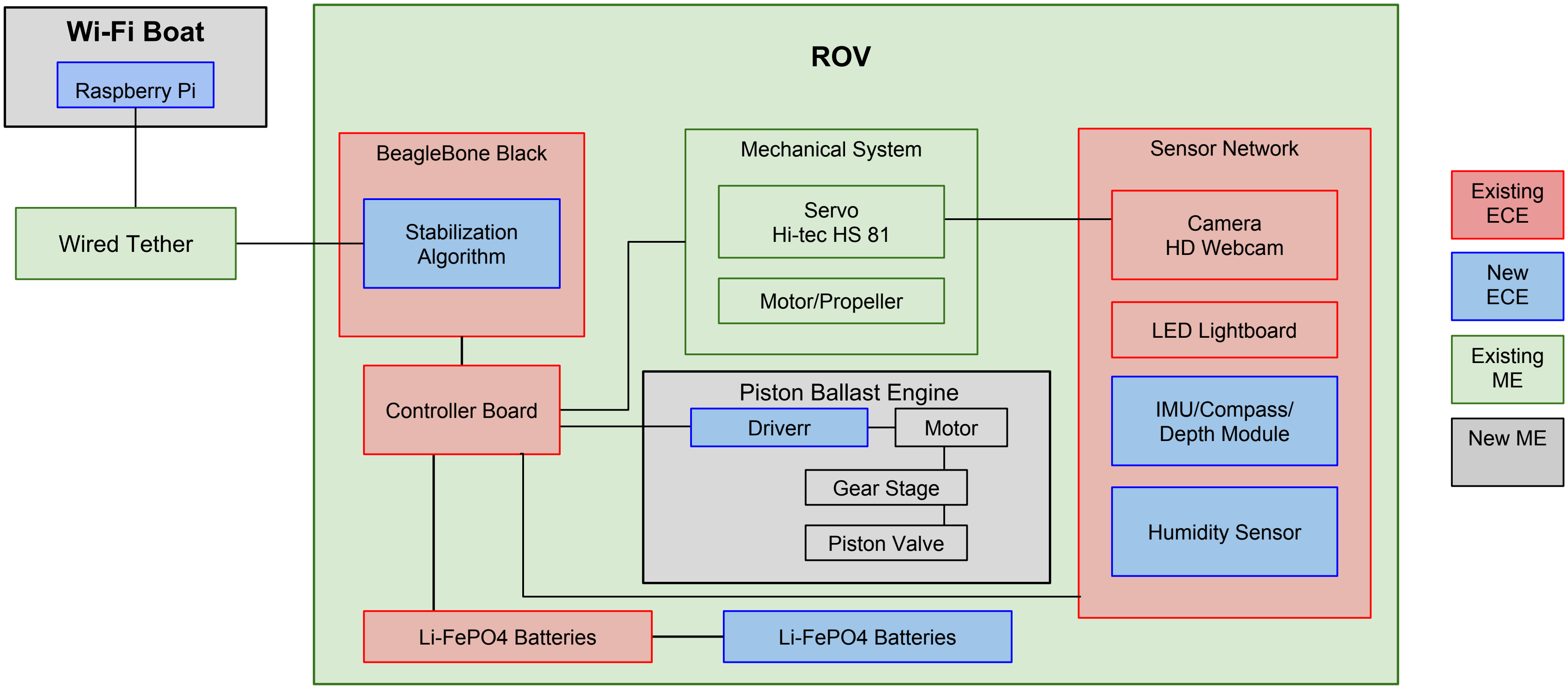
Boat





Top speed = 1 m/s
Total force on ROV = 7.0 N
Max thrust output of each motor = 6.76 N
Thrust output of each motor = 3.5 N
Air drag = 0.0012 N
Water drag at 0.20 inches = 0.0016 N
0.0089% increase in power consumption

ROV

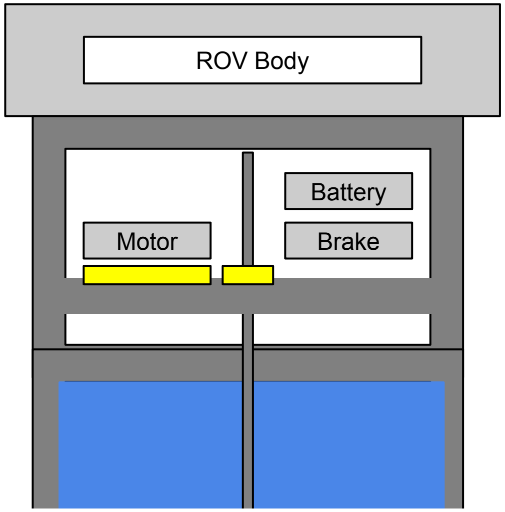

Wi-Fi Boat
Raspberry Pi
Wired Tether
ROV
BeagleBone Black
Stabilization Algorithm
Controller Board
Mechanical System
Servo
Hi-tec HS 81
Motor/Propeller
Piston Ballast Engine
Driverr
Motor
Gear Stage
Piston Valve
Sensor Network
Camera
HD Webcam
LED Lightboard
IMU/Compass/
Depth Module
Humidity Sensor
Li-FePO4 Batteries
Li-FePO4 Batteries
Existing ECE
New ECE
Existing ME
New ME

Piston Ballast Engine

- Requirements
  - System attains neutral buoyancy at operating depth (~20ft)
  - Improves total power efficiency of the ROV system

- Primary Components
  - Stepper motor
  - Solenoid-actuated brake
  - 12v Power Supply

General schematic of piston

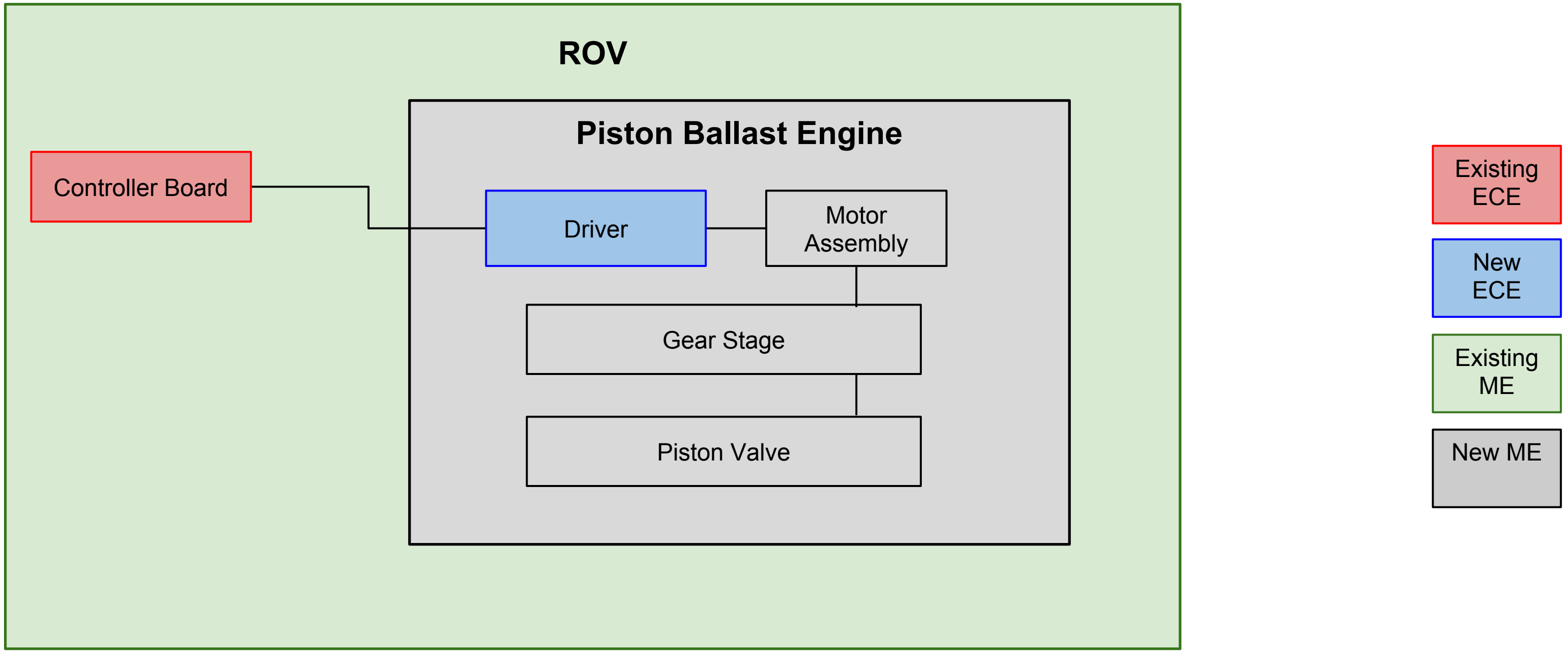


Piston Ballast Engine

- Stepper motor
  - Precise control of rotor position and speed
  - Maximum torque at low speed
  - Low efficiency, high load when performing no work
  - No position feedback

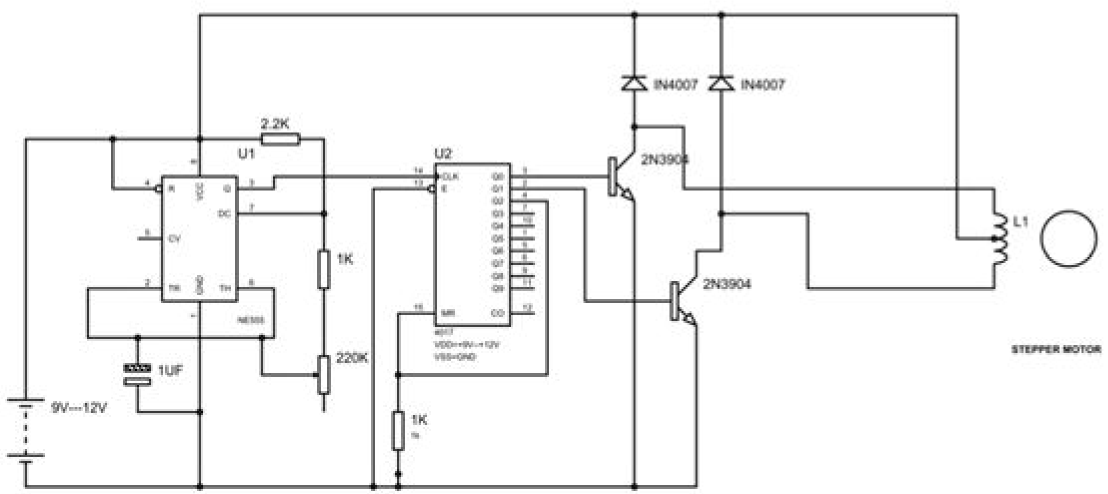
- Piston Materials
  - Acrylic or 3D printed w/ hydrophobic coatings
  - O-rings seals and silicone lubricant

Piston Ballast Engine



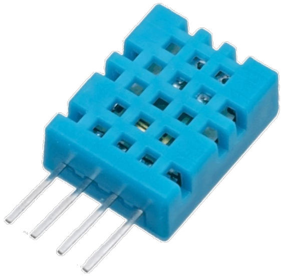
PCB: Ballast Driver

- Control stepper motor
- Idle, increase, decrease

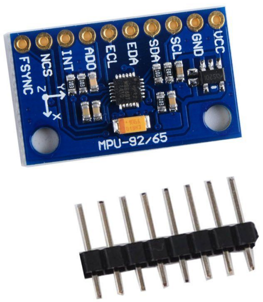


Sensors

- DHT11
  - Moisture
  - Temperature



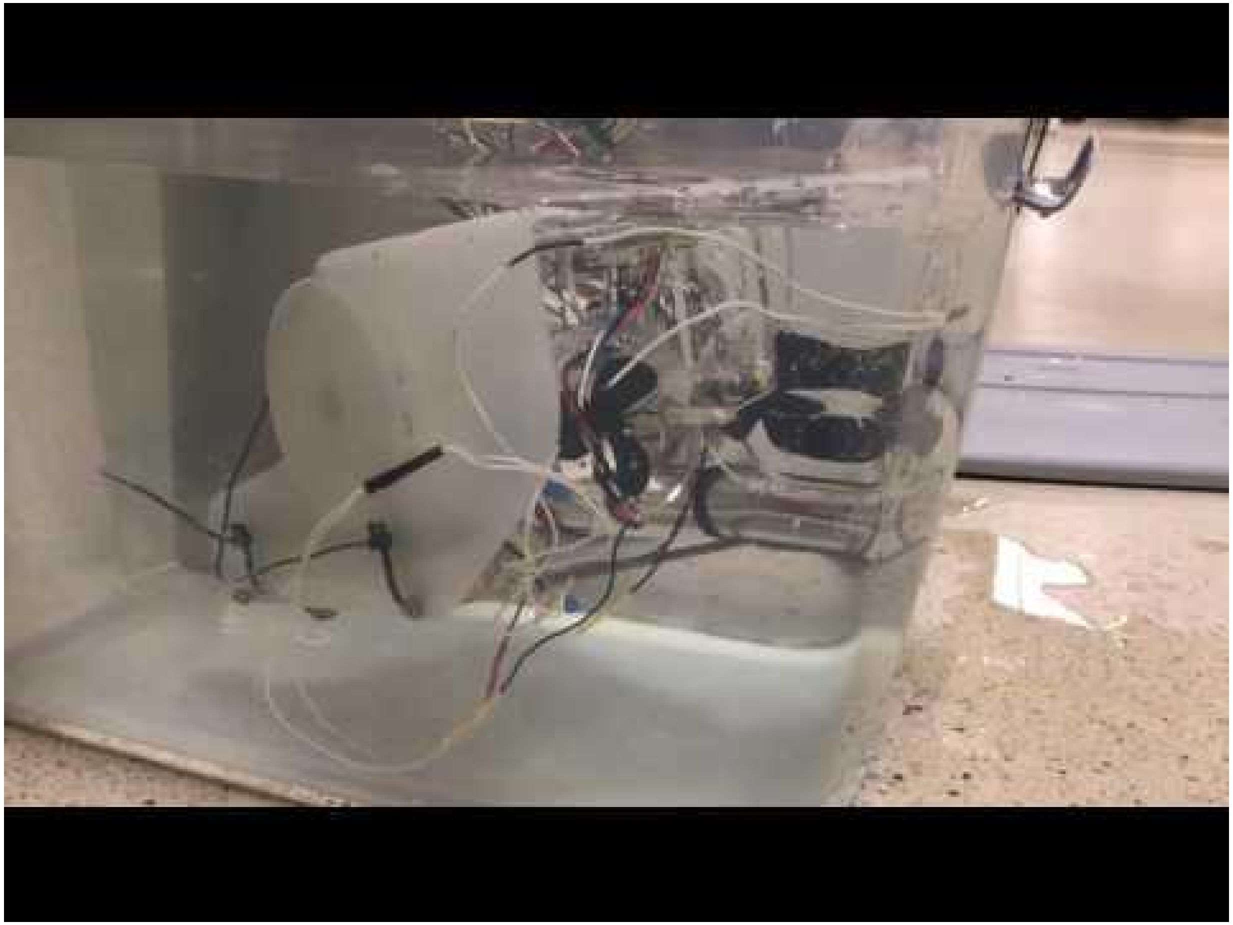
- MPU-9250
  - Acceleration
  - Compass
  - Depth



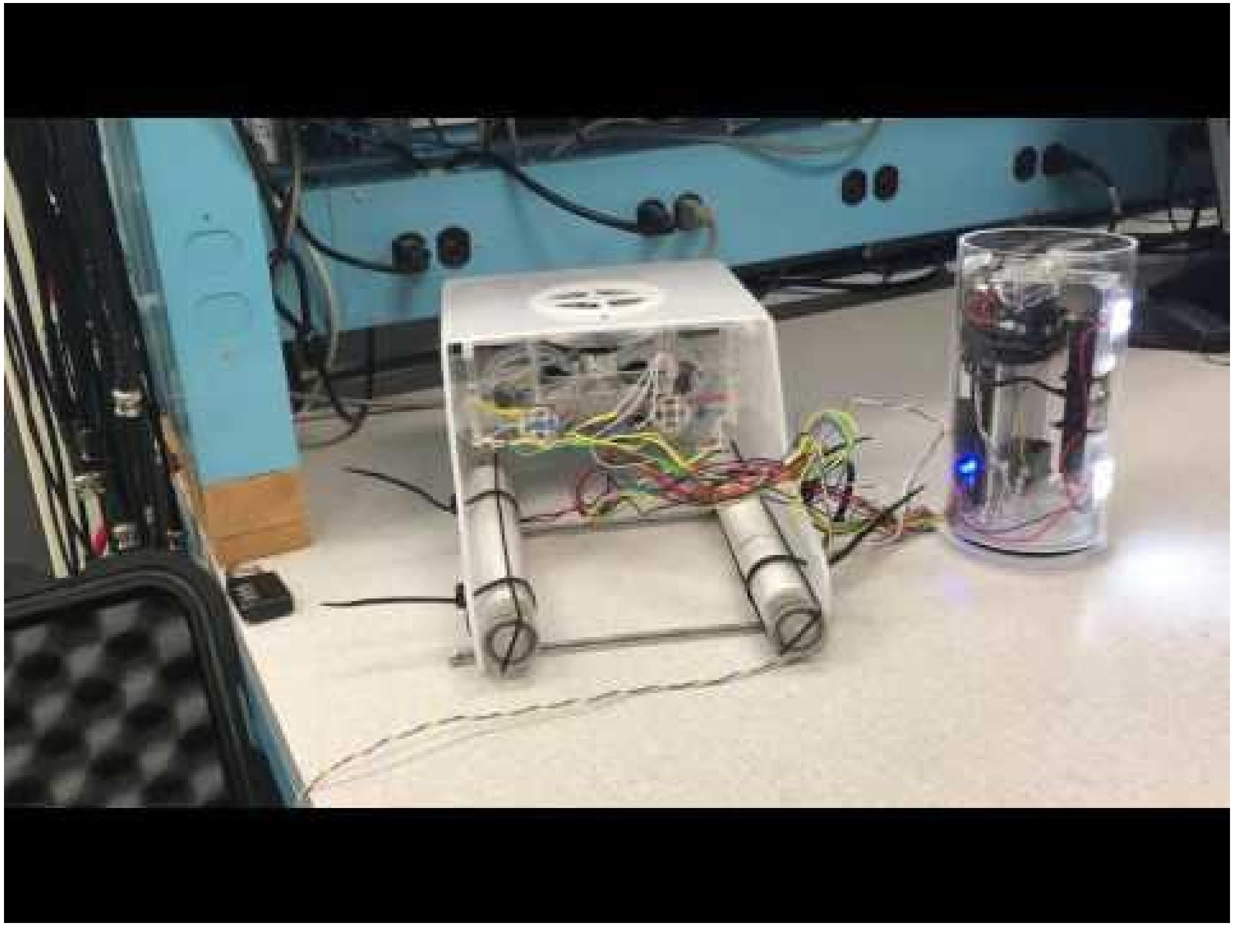
Previously Proposed MDR Deliverables

- Live video stream
- Responsive flight controls
- Maintains depth underwater
- Prototype of WiFi setup
    - Working range of around 300 feet*
    - Showcase of video feed and controls through WiFi
- Demonstration of OpenROV in pool

ROV Pool Demonstration



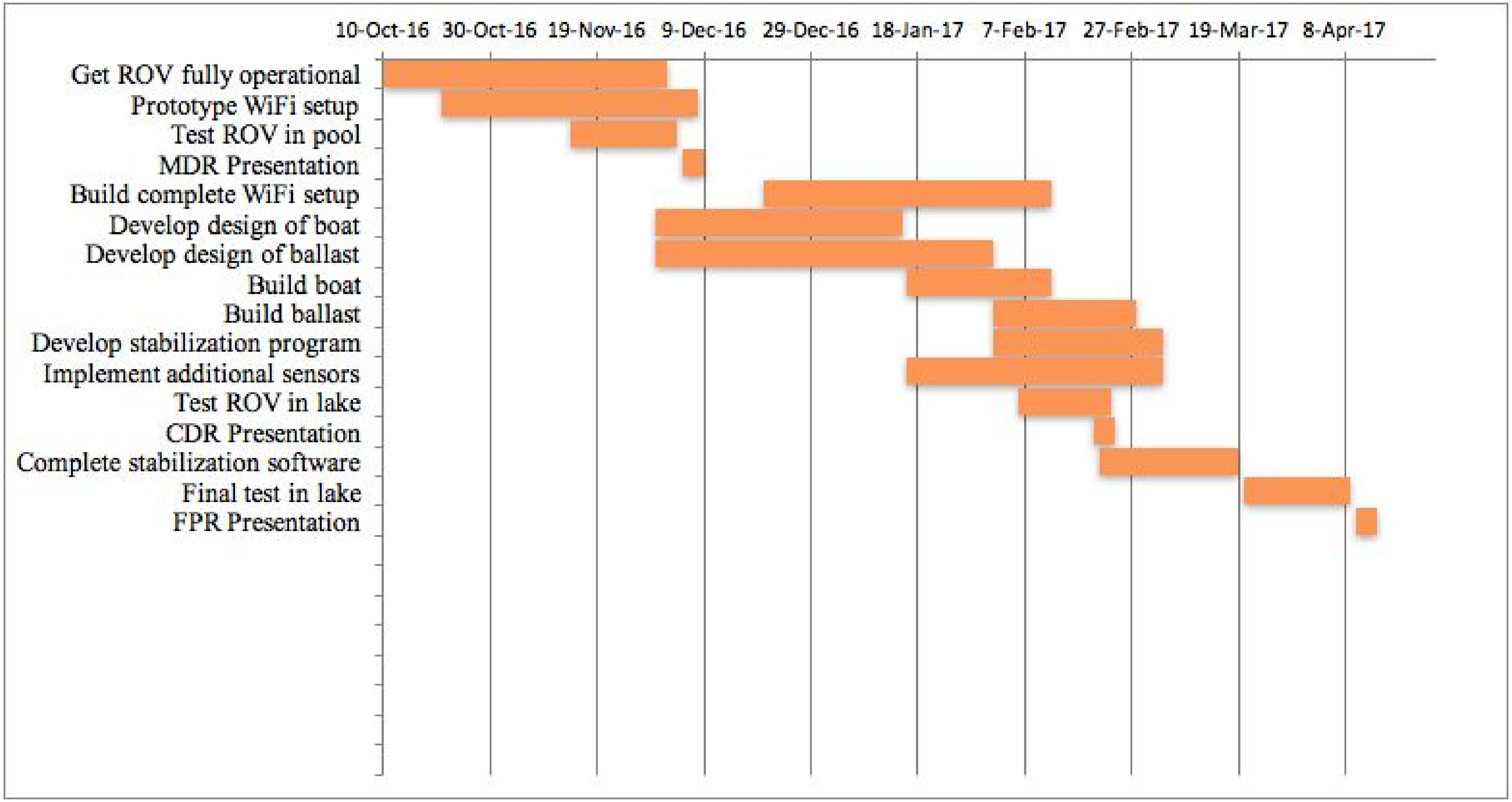
Wi-Fi Demostration



Proposed CDR Deliverables

- Demonstration of ROV in lake setting
  - Attainable depth of 20 feet
  - Finalized Wi-Fi boat and Wi-Fi network
    - Demonstration of video feed and motor controls via WiFi
    - Working range of about 300 feet
  - Functional prototype of ballast system
    - Variable displacement of environment water
    - Controllable by operator
    - Functional solenoid-actuated brake
  - Implementation of humidity sensor and IMU
  - PCB
    - Driver circuit for the auto ballast system

Proposed Timeline



Cost of Materials

Item	Item Cost	Shipping Cost
BeagleBone Black	56.61	0
USB WiFi Module	19.95	8.59
Syringes (4)	2.12	10.00
Acrylic Cement	11.81	0
Cement Applicator	5.75	0
MPU-9250	9.99	0
DHT11 Humidity Sensor	5.00	0
PCB	80.00	10.00
External Battery Power	15.99	0
Arduino Uno	16.06	0
Battery Tube	39.00	10.00
3D Printed Components	50.00	0
	Total Cost	350.87
	Budget Leftover	149.13

Thank You

Questions?