Welcome

Conceptual Design Review

Team Robosub

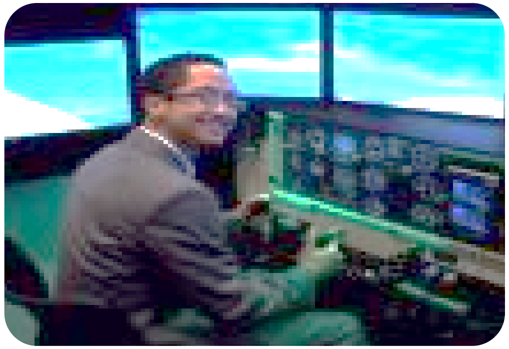
Project Advisors:

Dr. Bruce Harvey Dr. Chiang Shih

Team Members

ECE

Antony Jepson *Lead PM*



Ryan Kopinsky
Secretary

Hang Zhang
Treasurer

ME

Eric Sloan
PM

Kashief Moody
Secretary

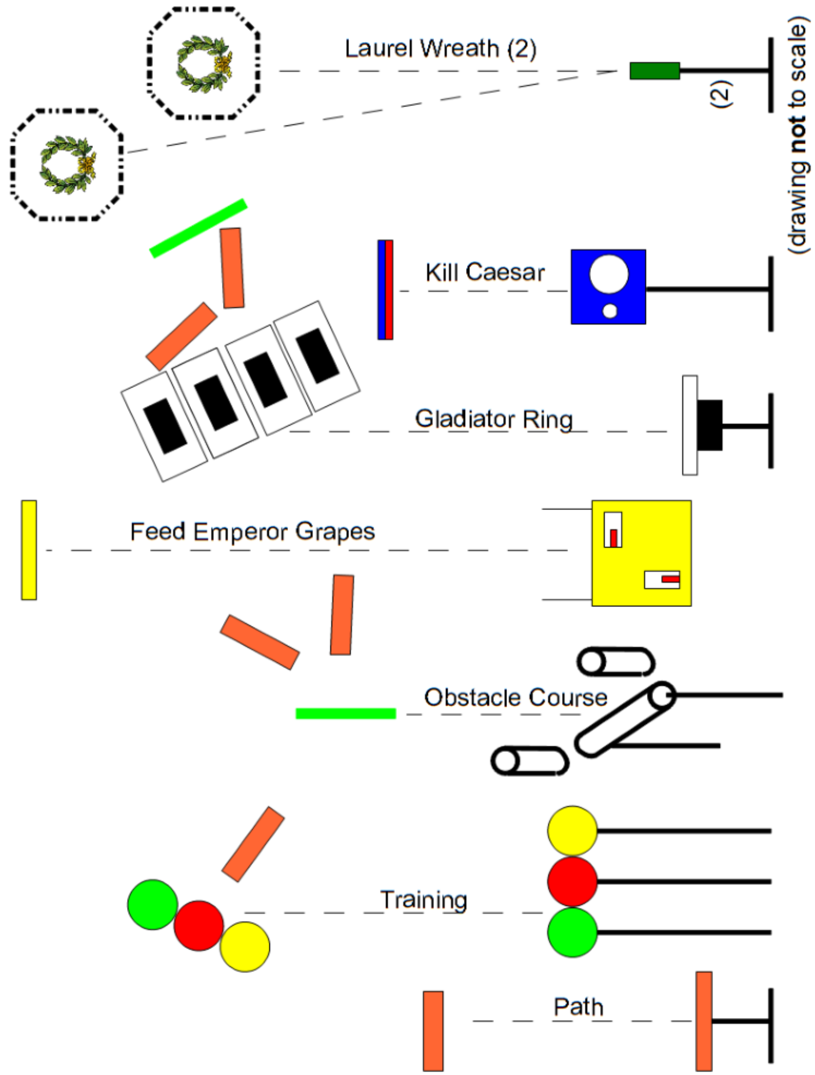
Tra Hunter
Treasurer

Problem Statement

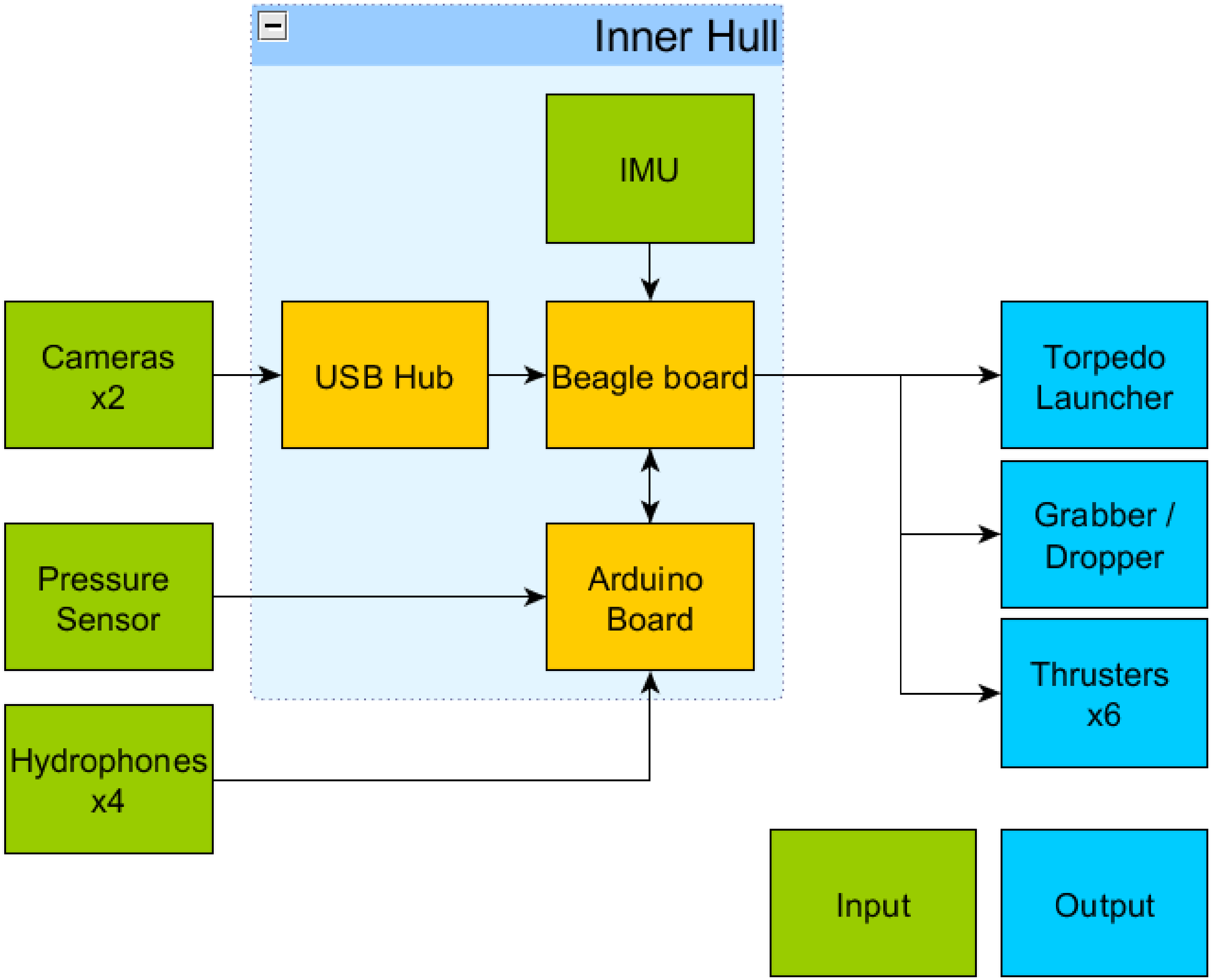
- Design and develop an AUV that can compete at the Robosub 2012 competition. Must be capable of:
  - Autonomous operation
  - Complete underwater tasks
- Intent to compete form ($500)

“Ides of Transdec”

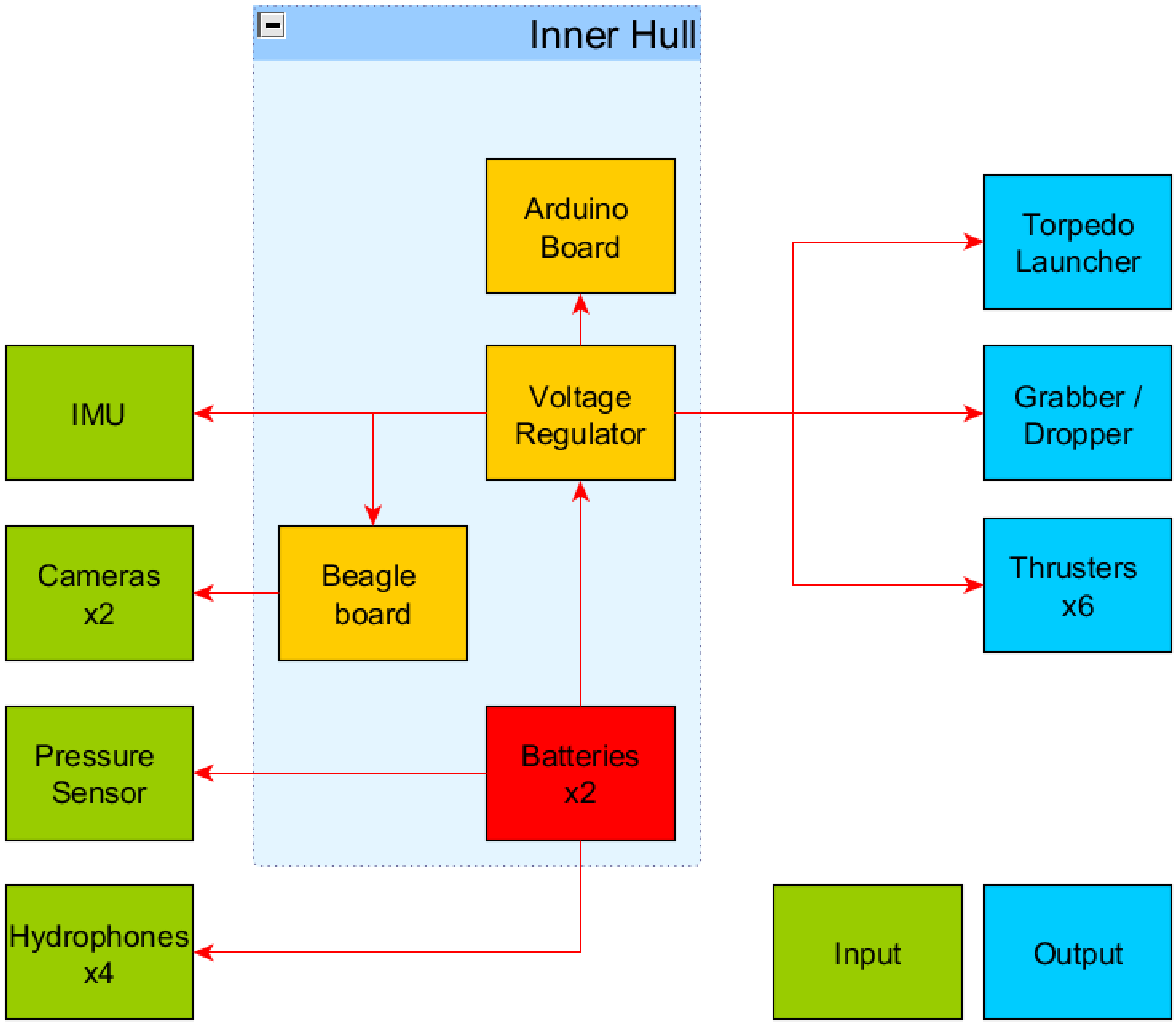
1. Path
2. Buoys
3. Obstacle Course
4. Gladiator Ring
5. Kill Caesar
6. Laurel Wreath



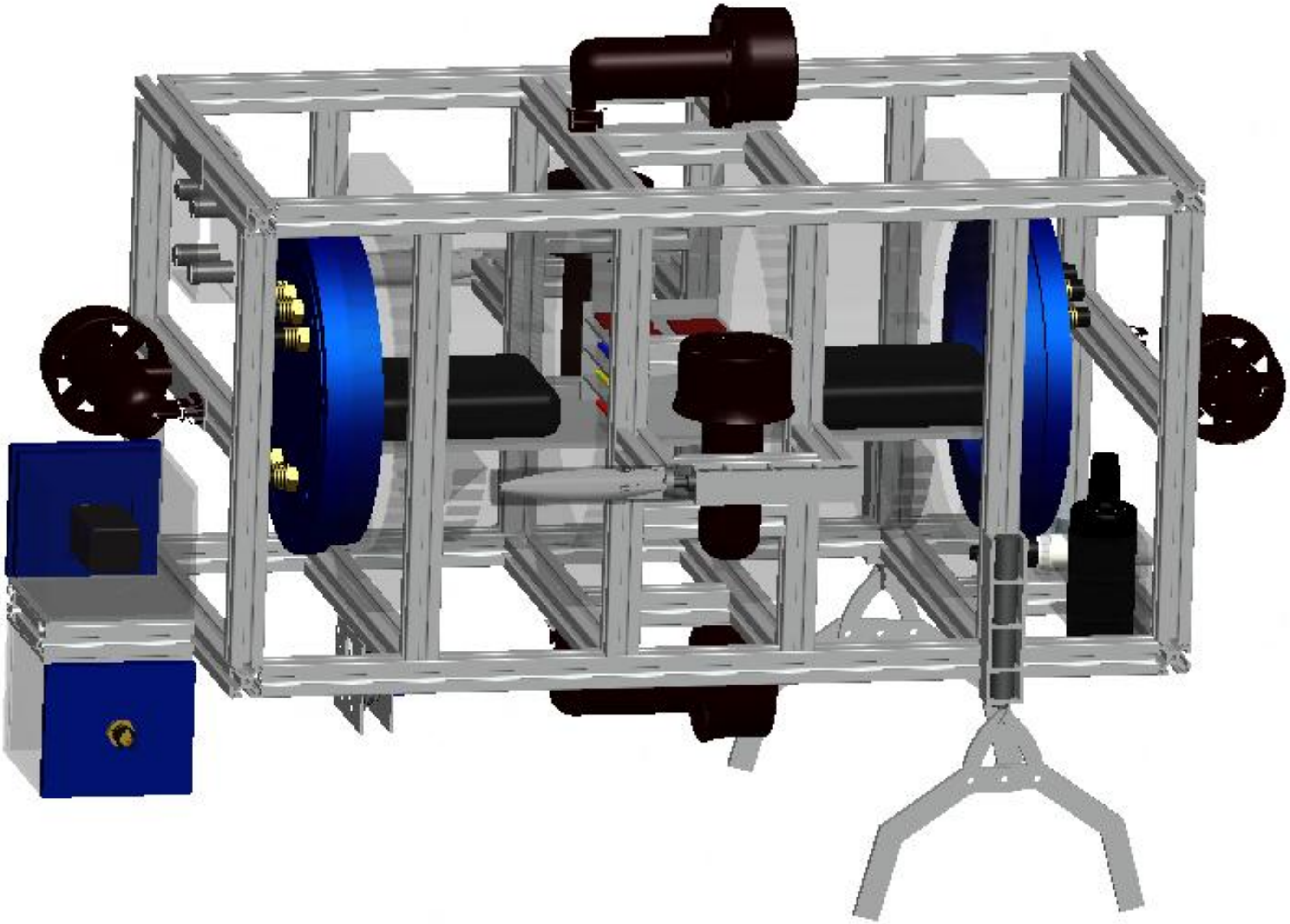
Design Overview



Design Overview



Design Overview



Guidance System

Antony Jepson

Guidance System Overview

Objective

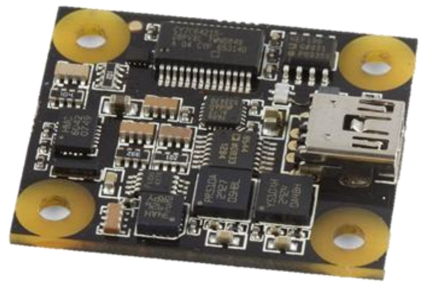
- Track vehicular heading and contribute to AUV's internal model of its position.

Requirements

- Measure
  - yaw, pitch, and roll
  - acceleration
  - heading
  - depth
- Locate Pinger
- Control thrusters

Guidance System Overview

Arduinoboard-UNO



Phidget 3/3/3 IMU

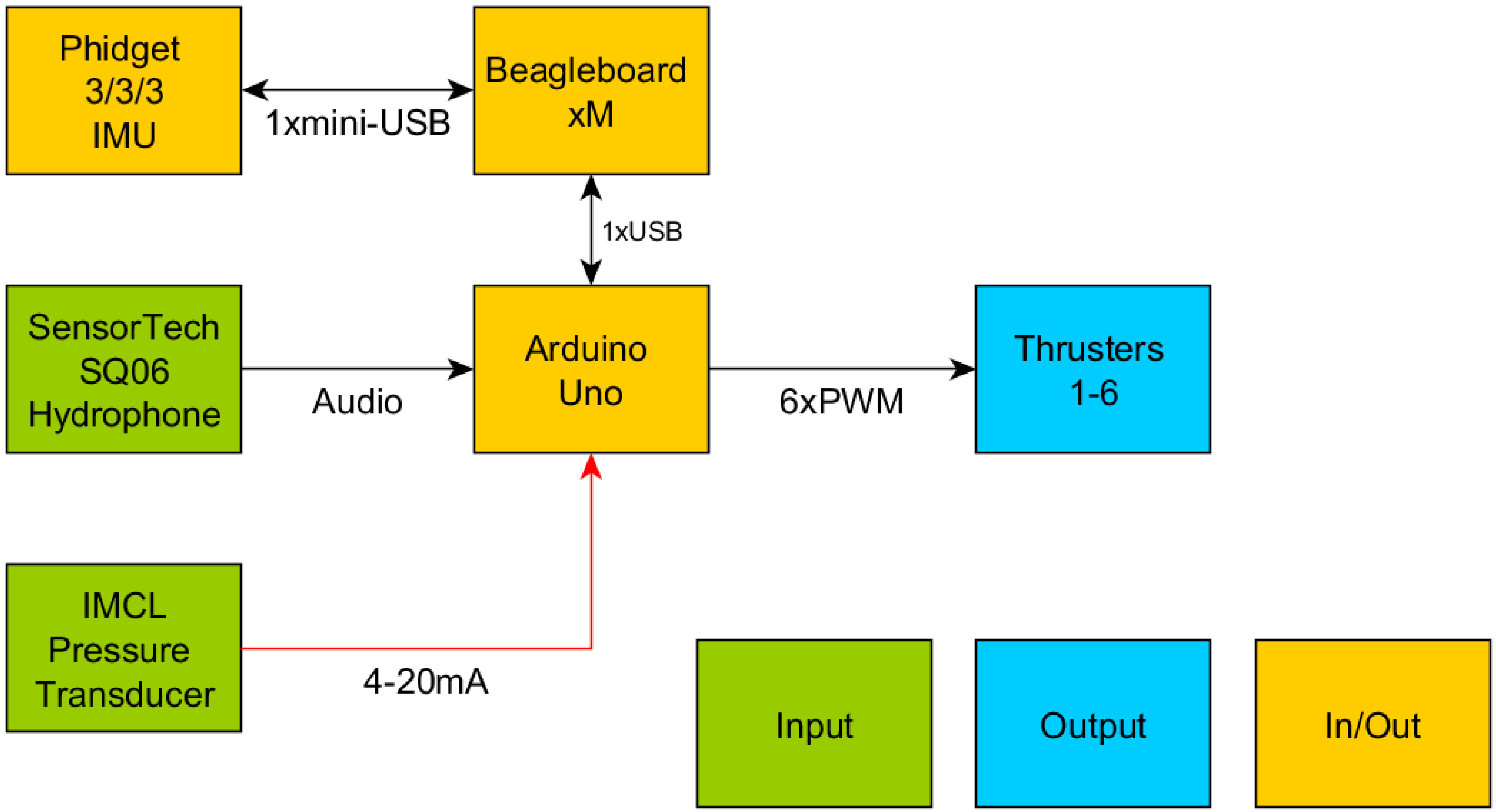
SQ06 Hydrophone (x4)

Thrusters x6

Beagleboard-xM

IMCL Submersible Pressure Sensor

Guidance System Overview



Risk Analysis – Technical

Risk	Components used for the guidance system are incorrectly calibrated.
Probability	Moderate
Consequence	Severe
Strategy	1. Soak instruments in the water for at least 10 minutes before performing a calibration. 2. Perform multiple calibrations (initial sensor readings) before continuing on with the competition.

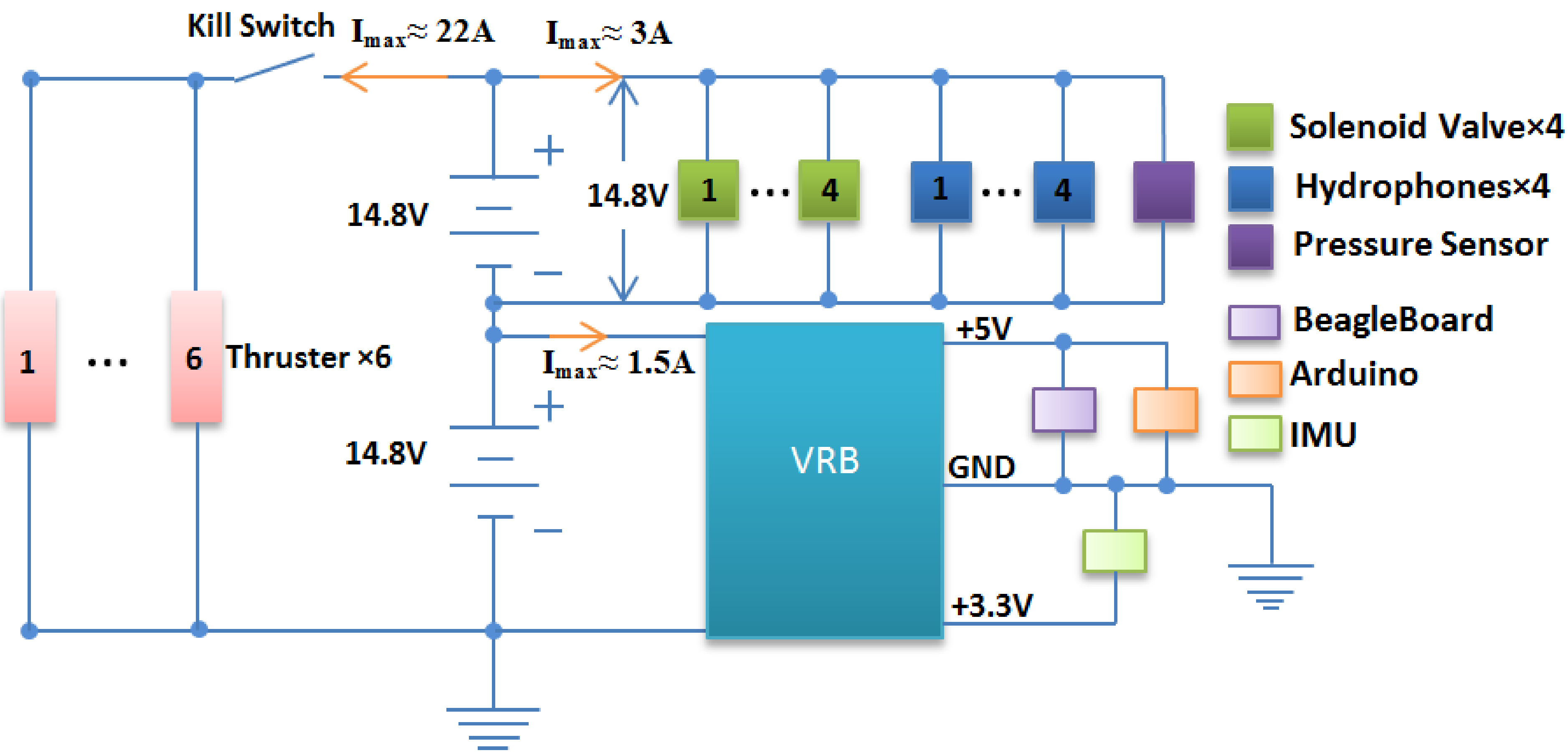
Risk Analysis – Technical

Risk	Components used are not accurate enough for useful measurements in the AUV
Probability	Low
Consequence	Moderate
Strategy	1. Test components thoroughly for accuracy. 2. Order new components if necessary.

Electrical System and Main Controller

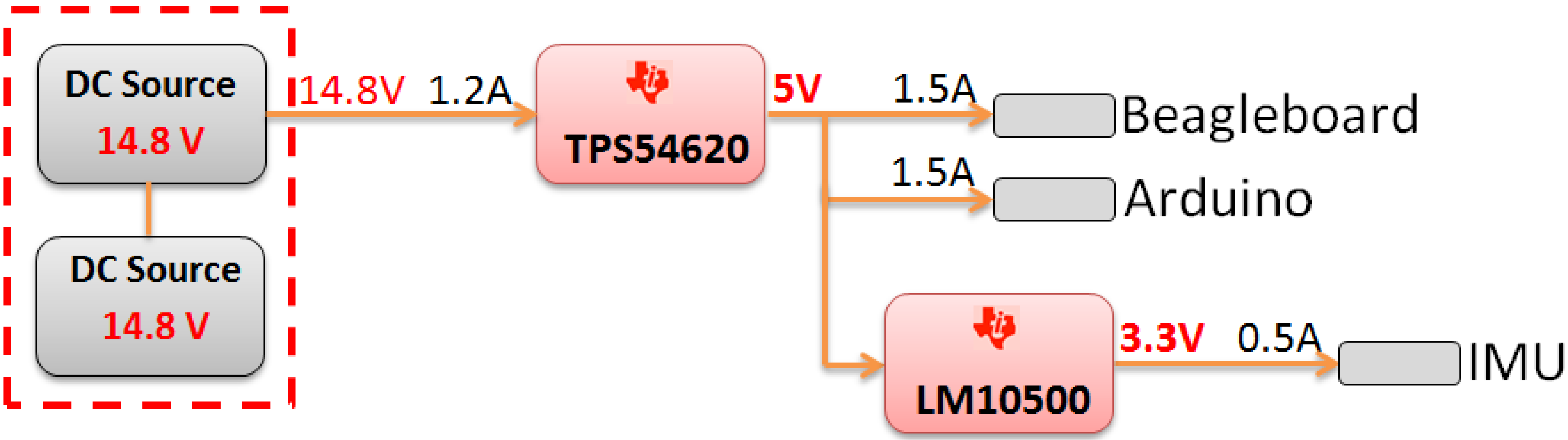
Hang Zhang

Electrical System Diagram



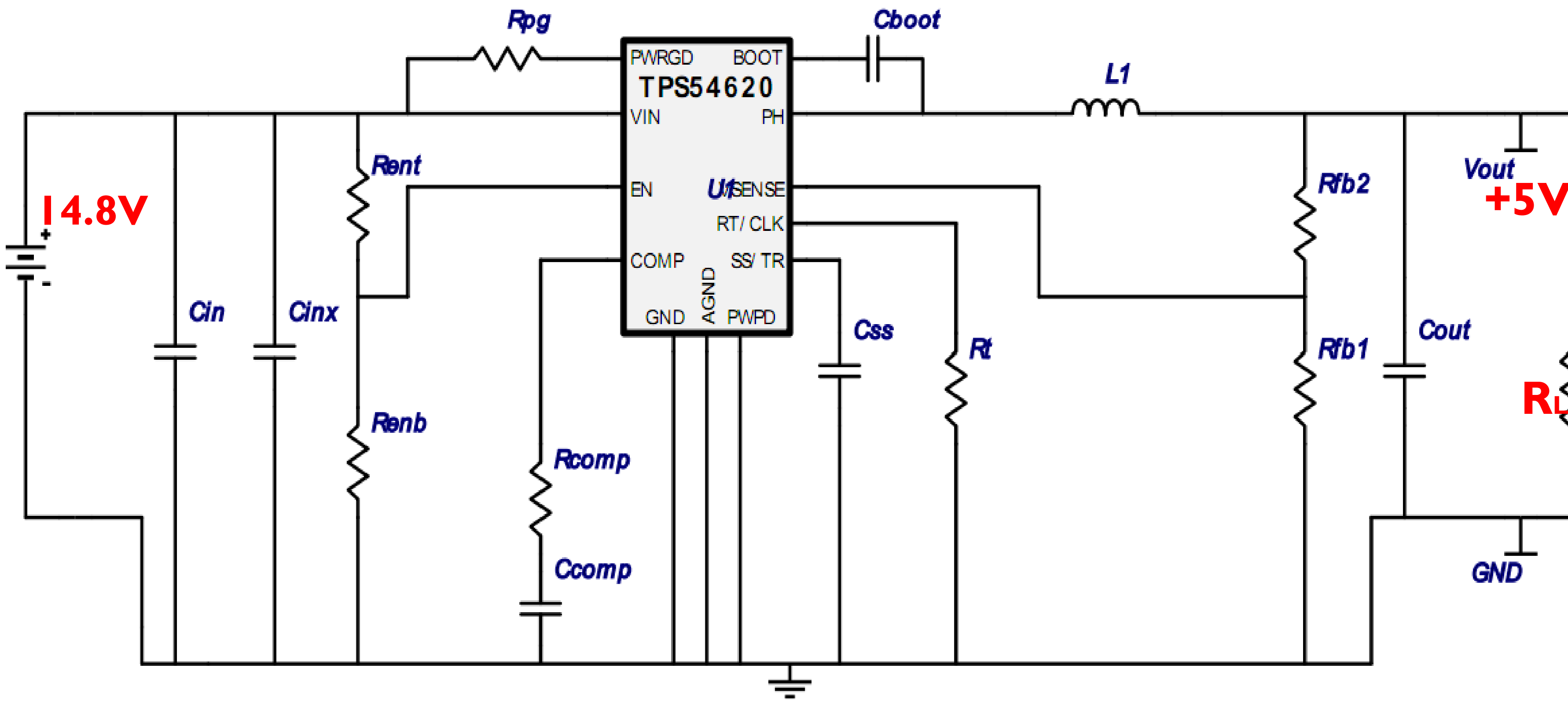
Hang

Voltage Regulator Board

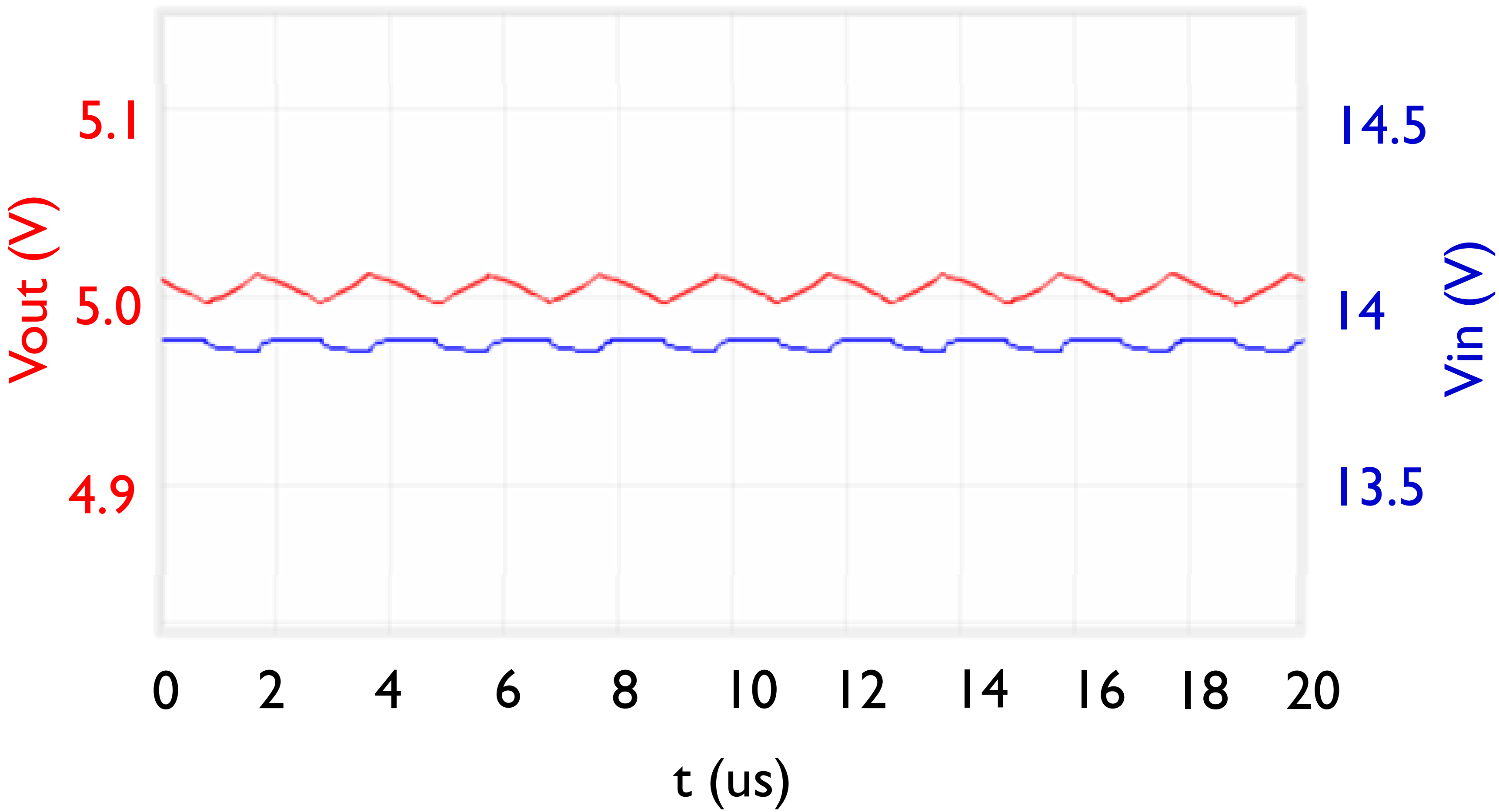


Power Dissipation:	1.2W
Efficiency:	93.2%
Cost:	$6.13

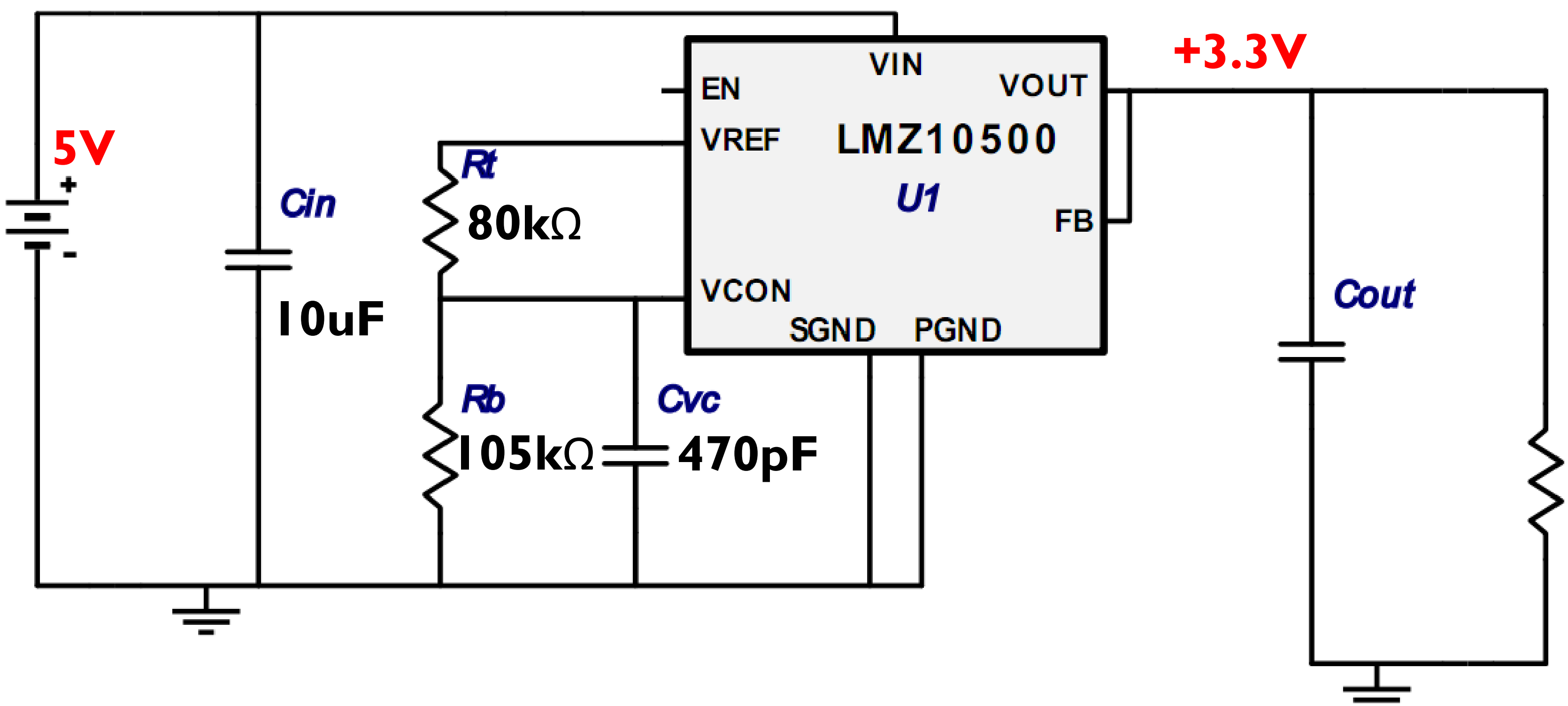
Voltage Regulator Board



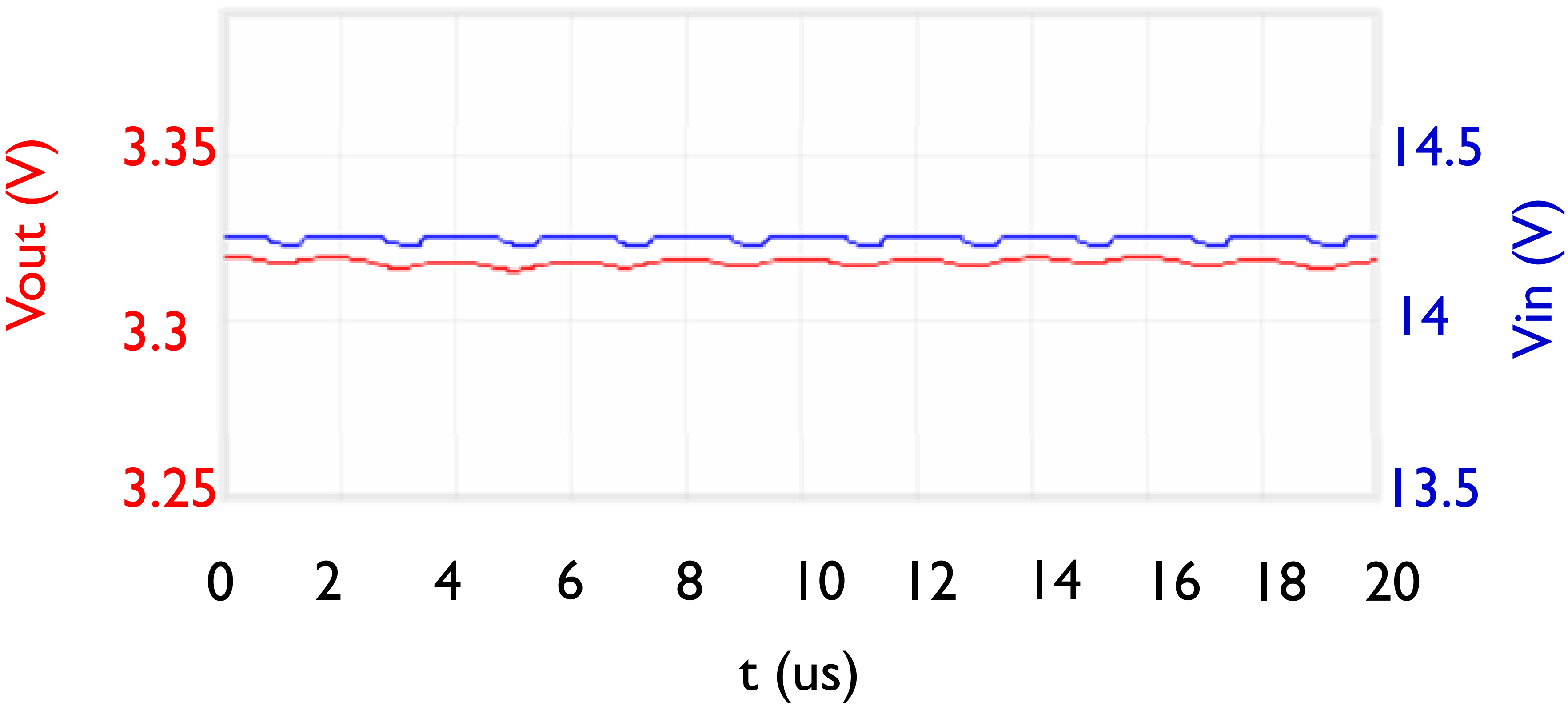
Voltage Regulator Board



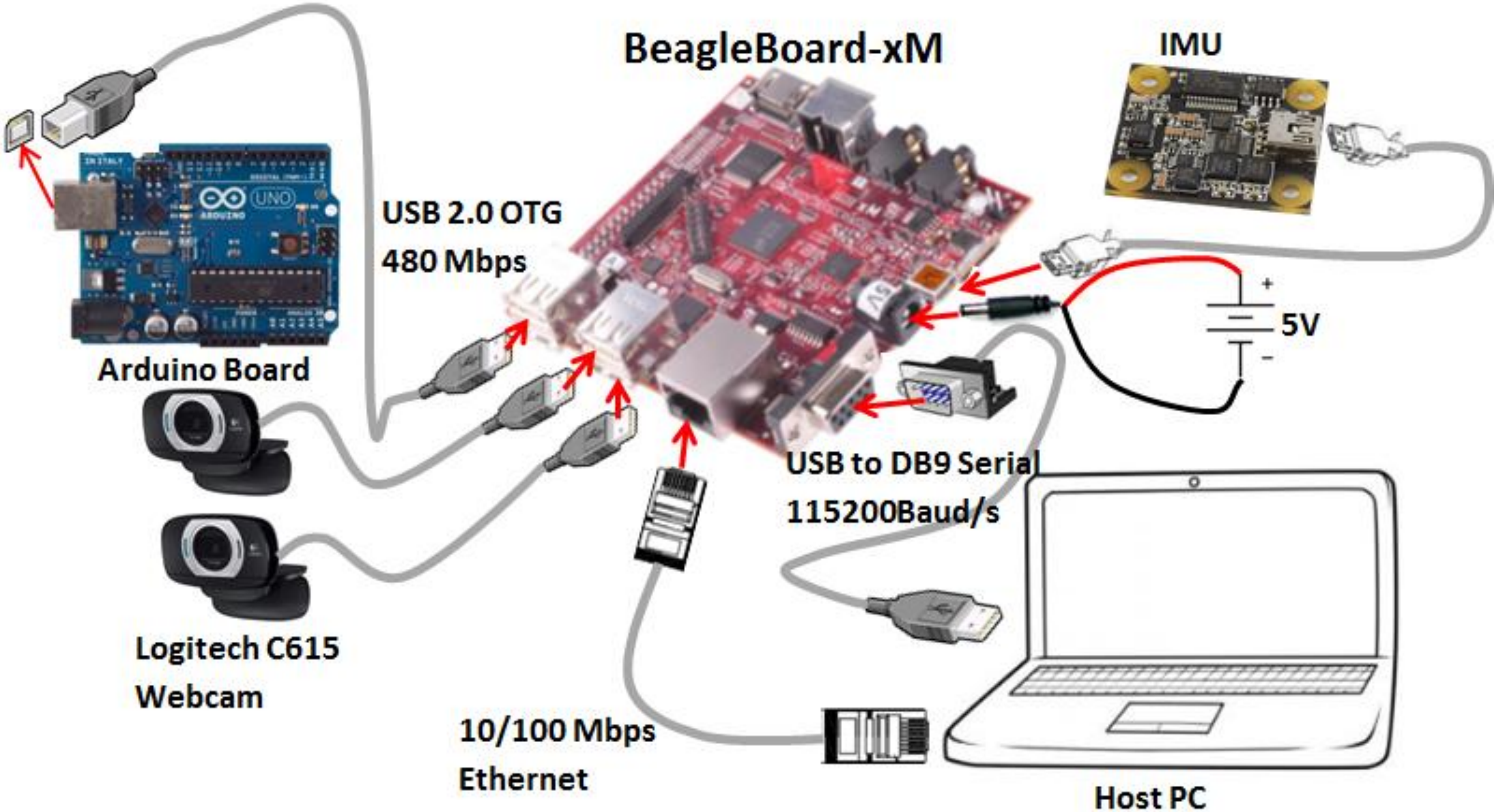
Voltage Regulator Board



Voltage Regulator Board



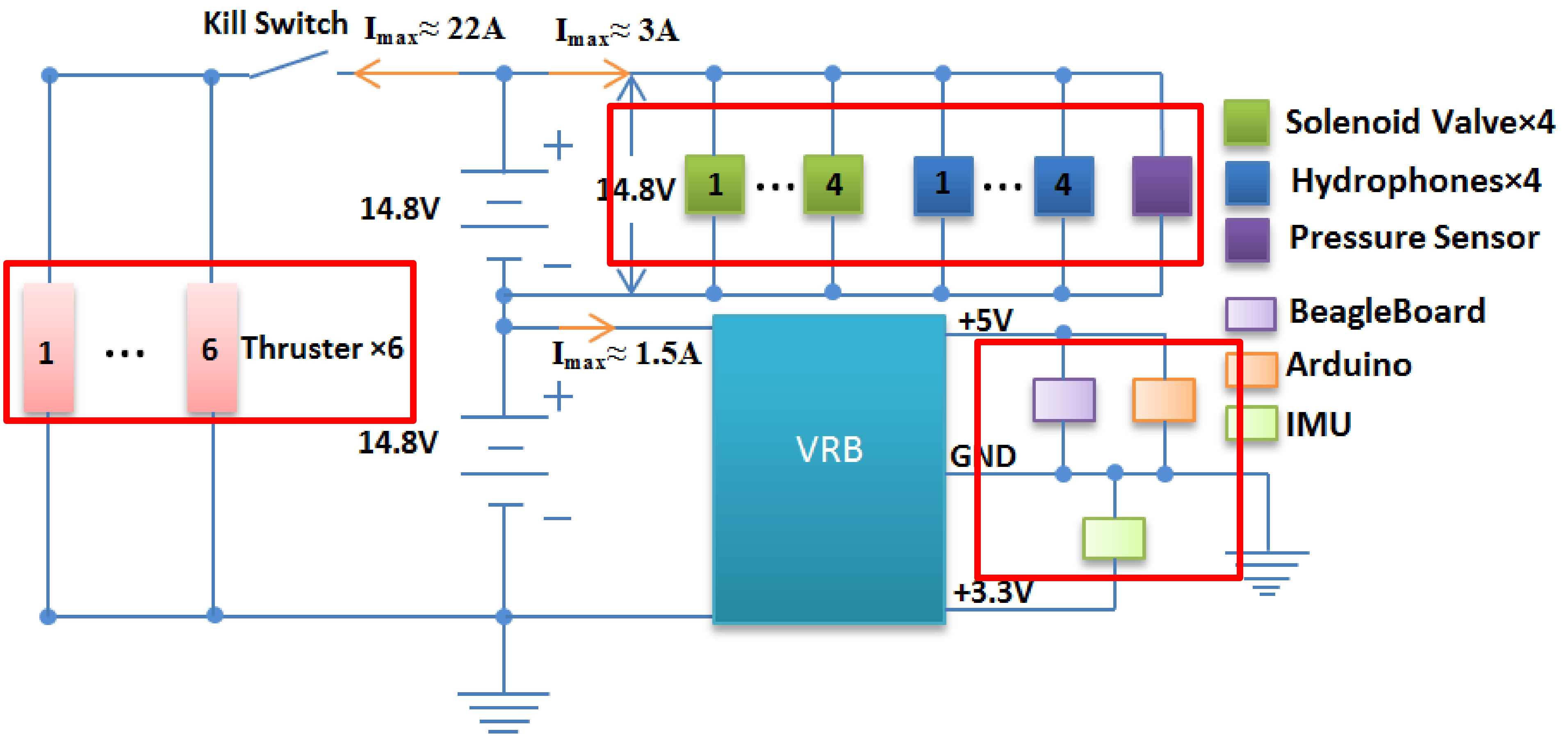
Main Control Unit



Risk Analysis – Technical

Risk	All thrusters draw maximum current concurrently results in power deficiency of other components
Probability	Very Low
Consequence	Catastrophic
Strategy	1. Limit the current through software control 2. Conduct extensive tests to minimize the probability of such situation

Risk Analysis – Technical



Risk Analysis – Technical

Risk	All thrusters draw maximum current concurrently results in power deficiency of other components
Probability	Very Low
Consequence	Catastrophic
Strategy	1. Limit the current through software control 2. Conduct extensive tests to minimize the probability of such situation

Risk Analysis – Technical

Risk	Modification on electrical system design
Probability	Low
Consequence	Minor
Strategy	1. Ensure correct designs to minimize the possibility of redesigning the circuit 2. If current batteries do not supply enough power, add additional batteries 3. Have an additional voltage regulator board as back up

Risk Analysis – Technical

Risk	Beagleboard-xM malfunction
Probability	Low
Consequence	Catastrophic
Strategy	1. Have the old version of Beagleboard as a backup 2. Use Beagleboard-xM properly to avoid static charges that may cause damage to the board. 3. Over current protection to the board 4. Ensure good heat dissipation within the pressure vessel 5. Ensure water tight of the pressure vessel

Computer Vision

Ryan Kopinsky

Computer Vision Overview

Objective

- Provide the AUV with path and task information.

Requirements

- Identify the path for guidance through the obstacle course
- Identify the tasks in the obstacle course.

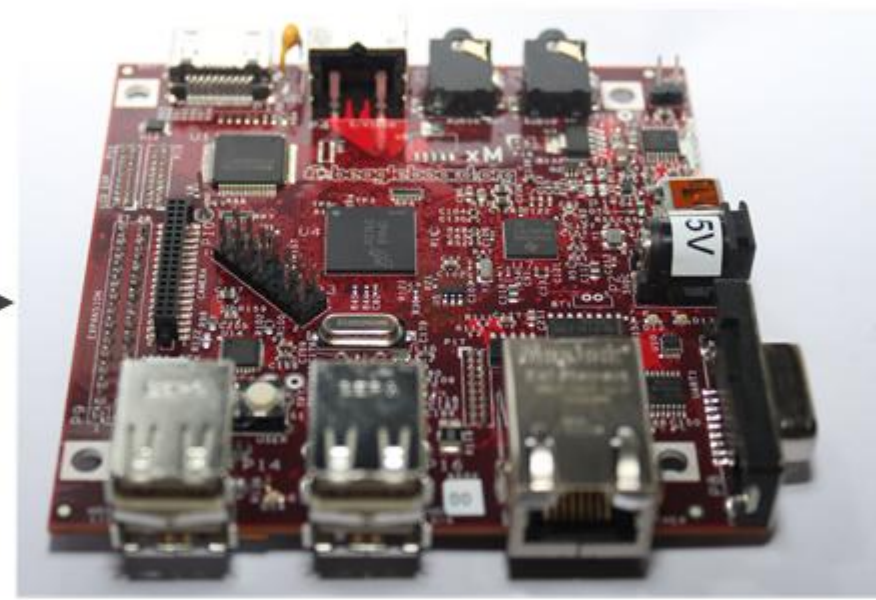
Hardware

Logitech C615

Auto-Light
Auto-Focus
1080p

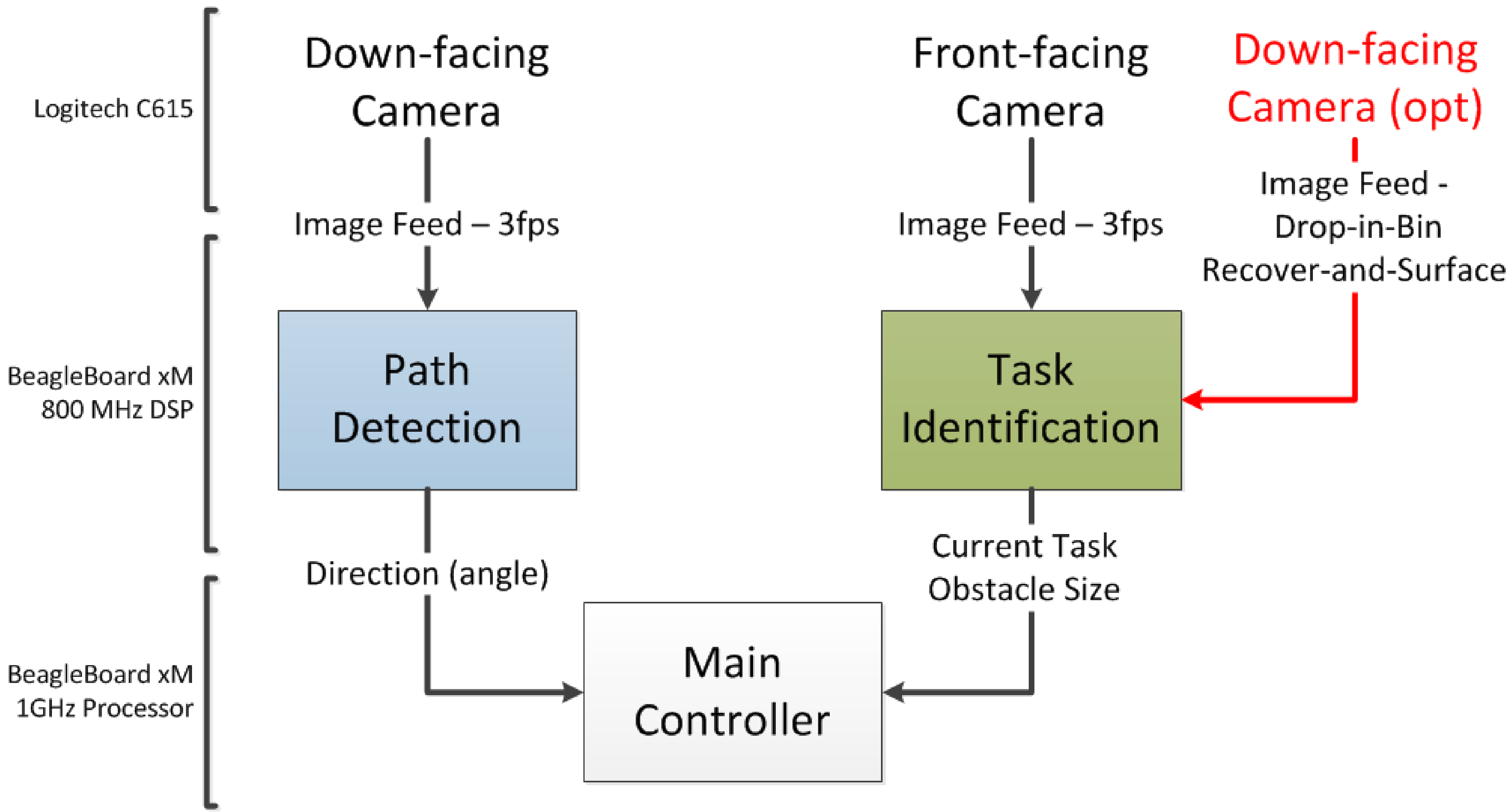
USB 2.0 →

BeagleBoard xM



A8 1GHz Processor
800MHz DSP

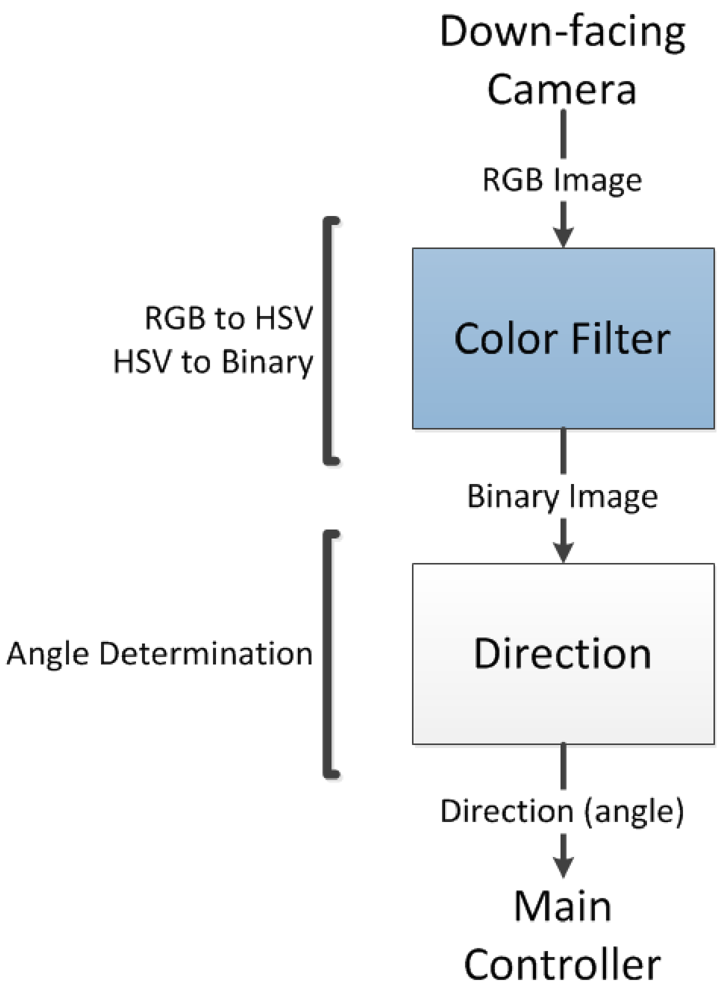
Software



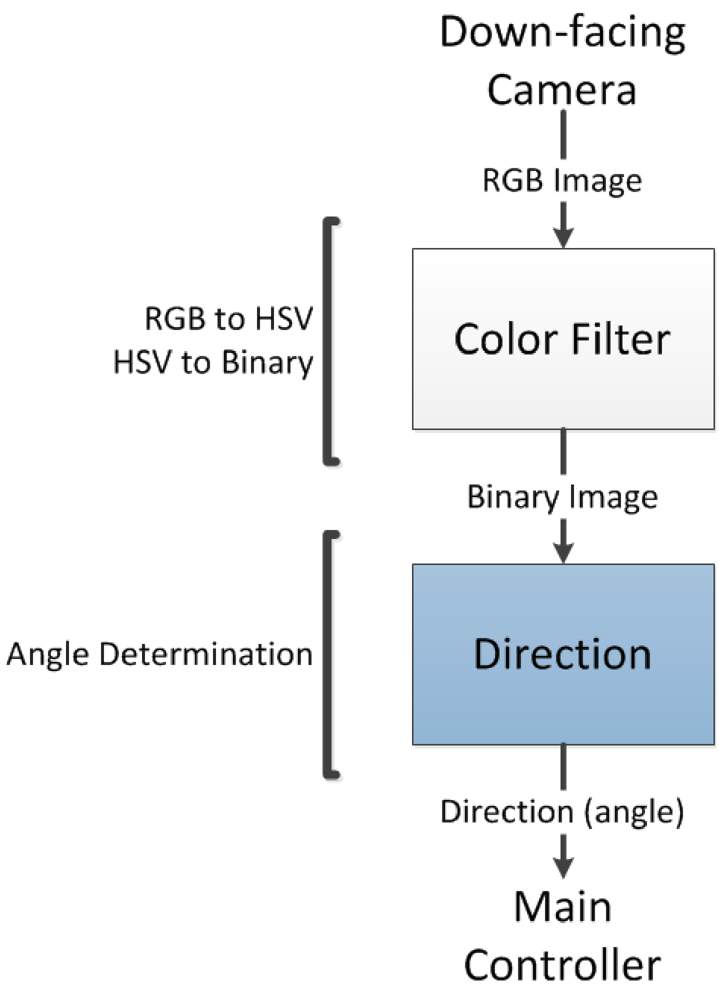
Logitech C615
BeagleBoard xM
800 MHz DSP
BeagleBoard xM
1GHz Processor
Down-facing
Camera
Image Feed – 3fps
Path
Detection
Direction (angle)
Front-facing
Camera
Image Feed – 3fps
Task
Identification
Current Task
Obstacle Size
Down-facing
Camera (opt)
Image Feed -
Drop-in-Bin
Recover-and-Surface
Main
Controller

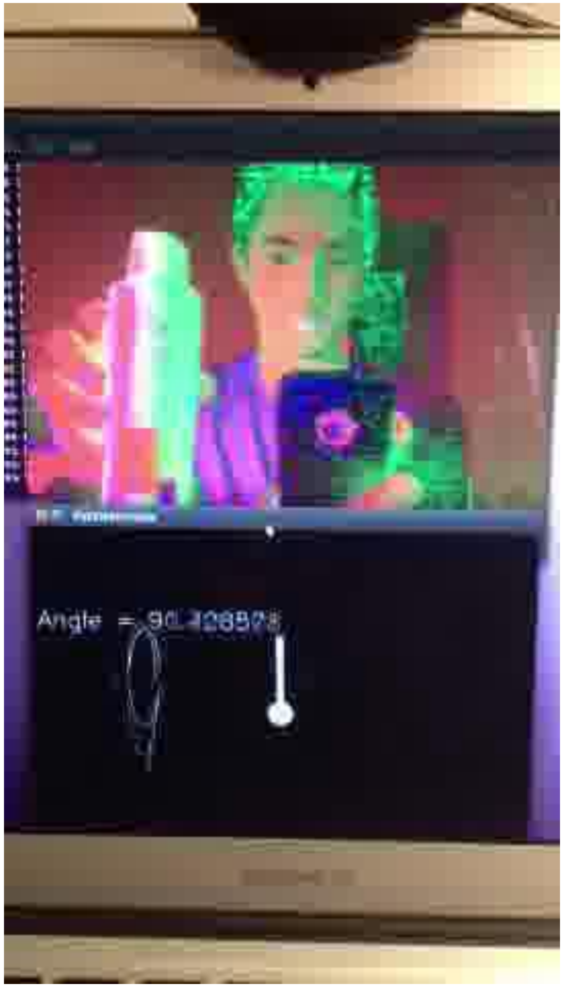
Ryan

Path Detection



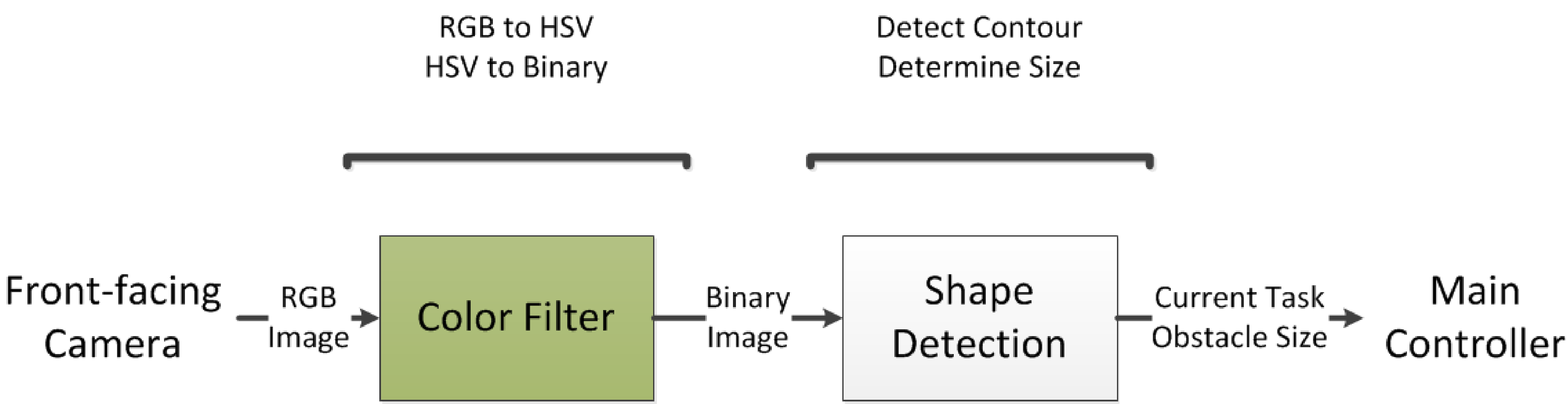
Path Detection



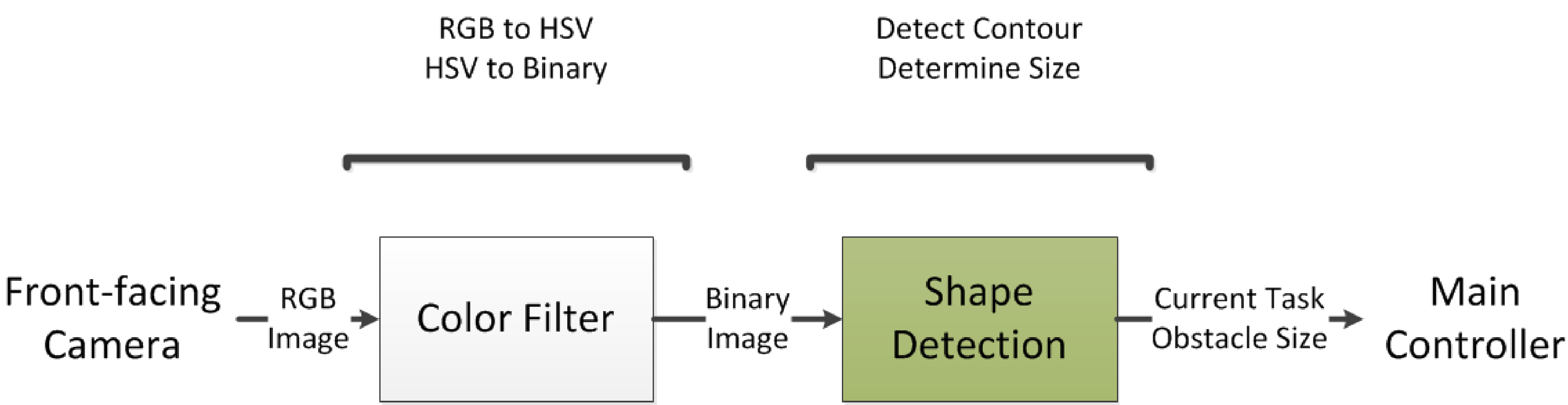


Ryan

Task Identification



Task Identification



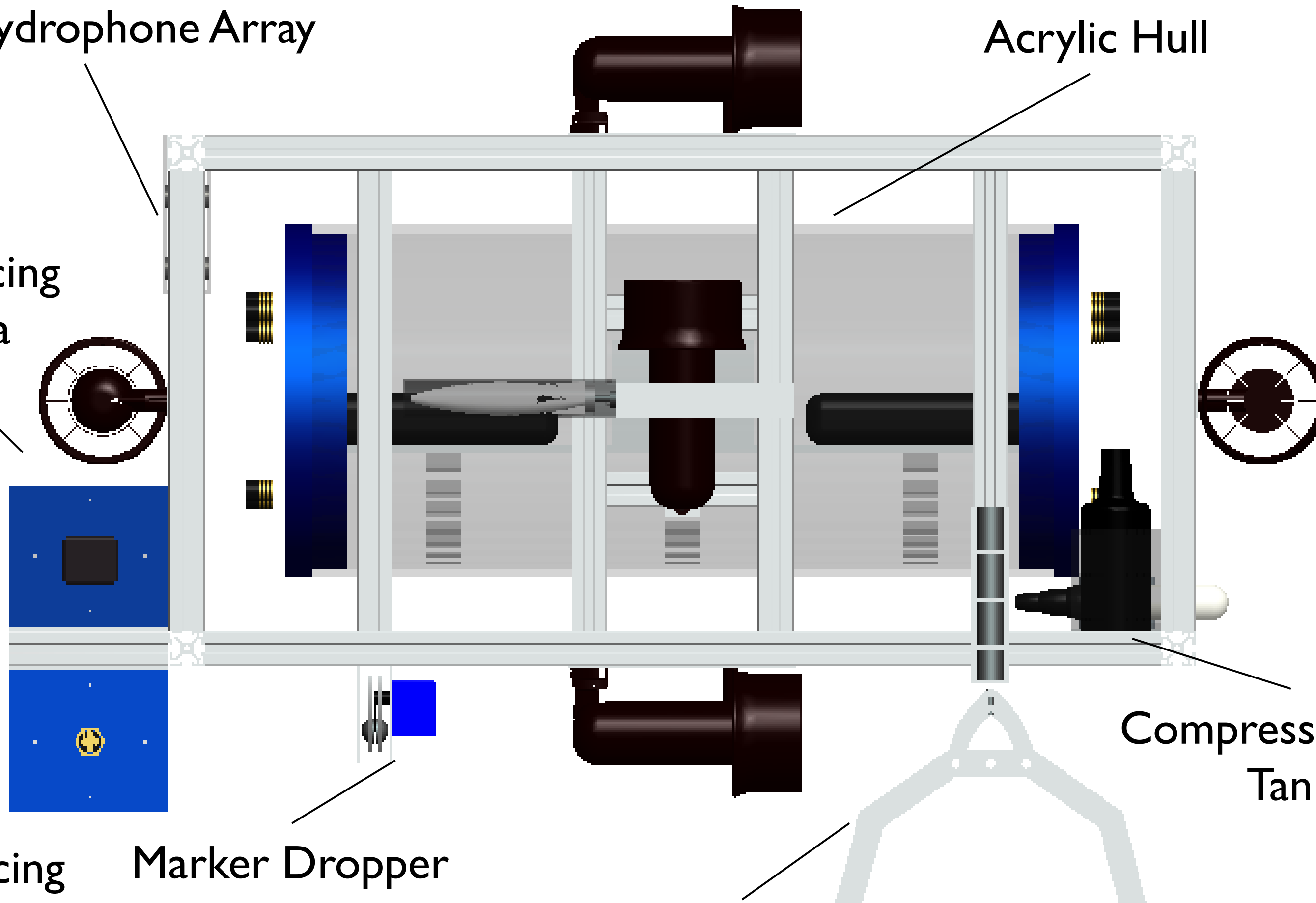
Risk Analysis – Technical

Risk	Probability	Severity	Mitigation Strategy
Camera Failure	Very Low	Catastrophic	Avoid
Splicing Distortion	Low	Severe	Avoid
Incorrect Color Classification	Very Low	Moderate	Extensive Testing
Incorrect Path Detection	Low	Severe	Extensive Testing
Incorrect Size Determination	Low	Moderate	Extensive Testing
Incorrect Shape Detection	Low	Severe	Extensive Testing
Incorrect Task Identification	Low	Severe	Extensive Testing

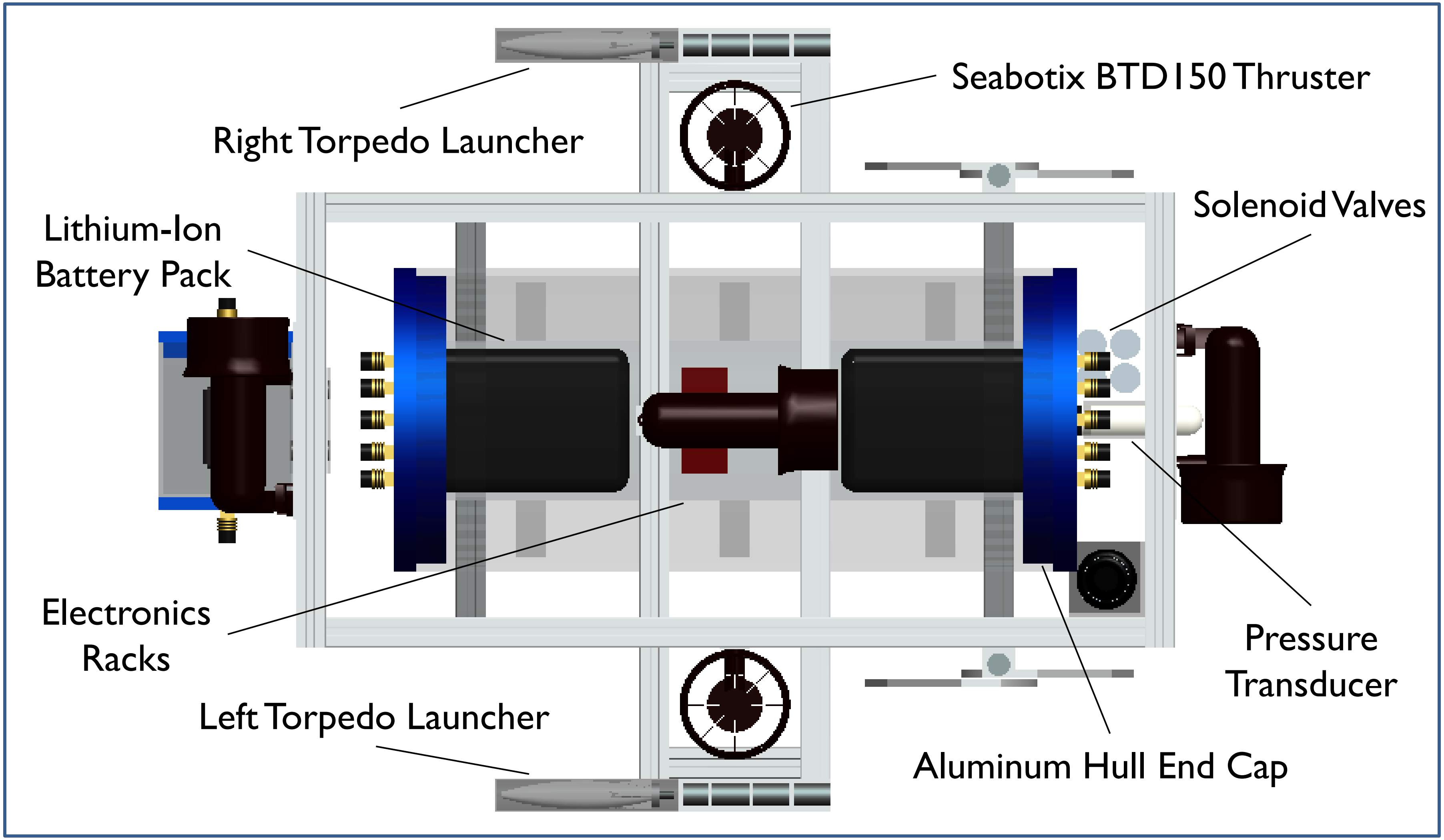
Hull / Frame and Vehicle Propulsion System

Eric Sloan

Overview – Side View



Overview – Top View



Mass Properties Analysis

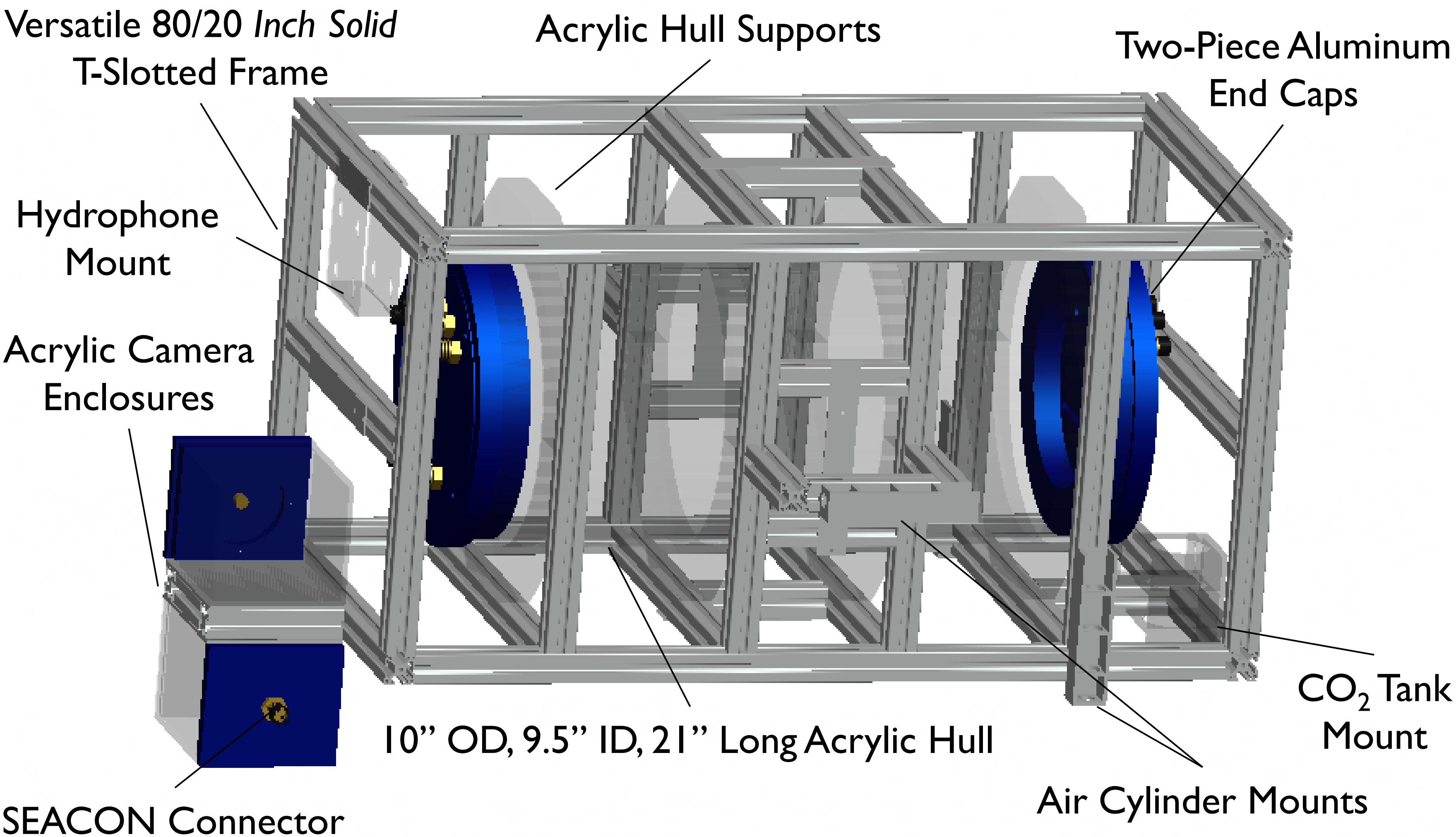
- System Density ≈ 0.0363 lbf/in^3
- System Weight ≈ 92.3 lbf
- Density of Salt Water ≈ 0.0370 lbf/in^3
- Slightly Positively Buoyant (i.e. ΣF_y ≈ 1.50 lbf)

Eric

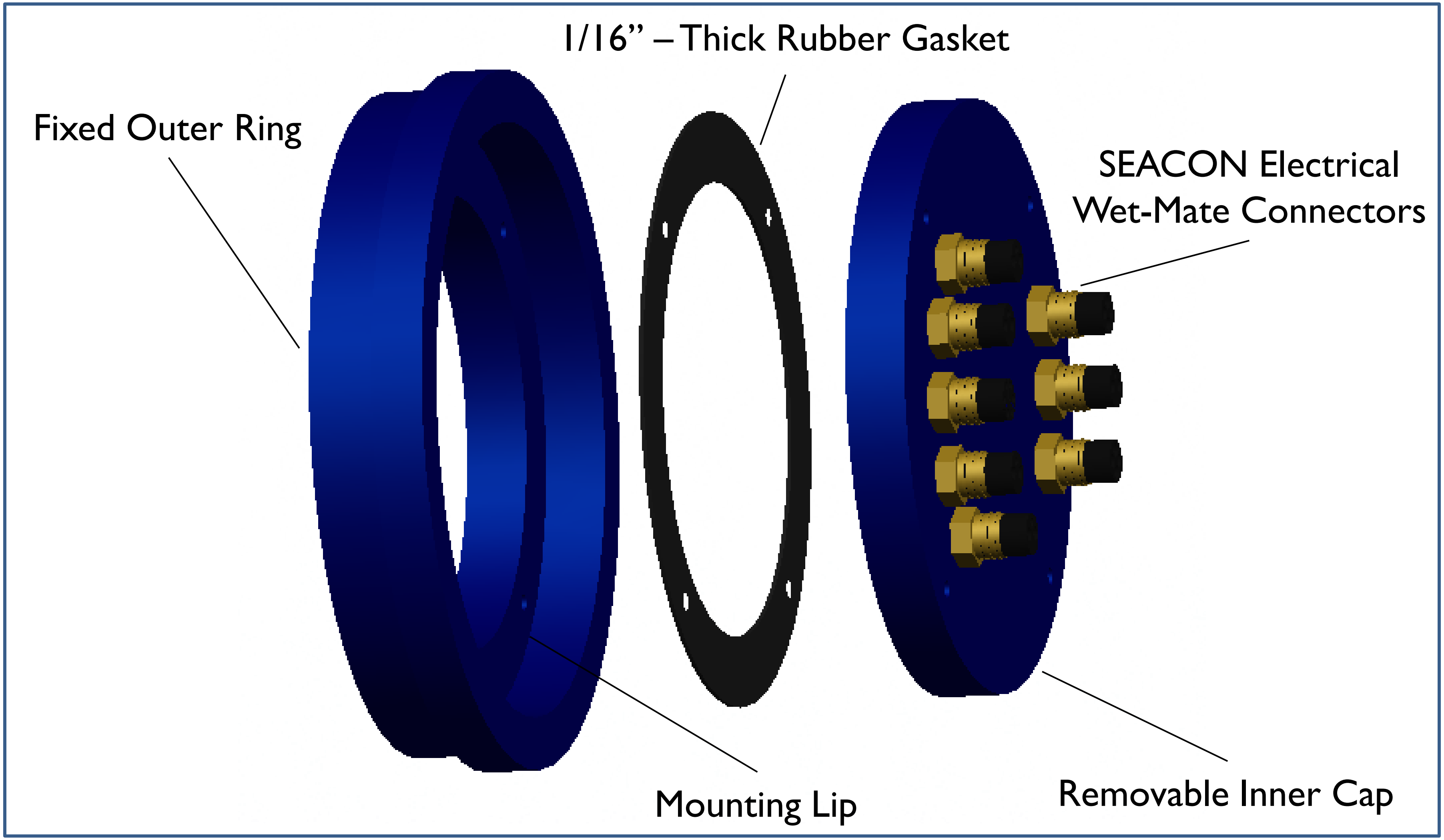
Risk Analysis – Technical

Risk	Vehicle density greater or less than optimal target density
Probability	Low
Consequence	Moderate
Strategy	1. Symmetrically add material of greater or less density than the vehicle's target density to either side of the bottom of the AUV until the nominal system density has been obtained.

Hull / Frame


Versatile 80/20 *Inch Solid* T-Slotted Frame
Acrylic Hull Supports
Two-Piece Aluminum End Caps
Hydrophone Mount
Acrylic Camera Enclosures
10" OD, 9.5" ID, 21" Long Acrylic Hull
CO_2 Tank Mount
Air Cylinder Mounts
SEACON Connector

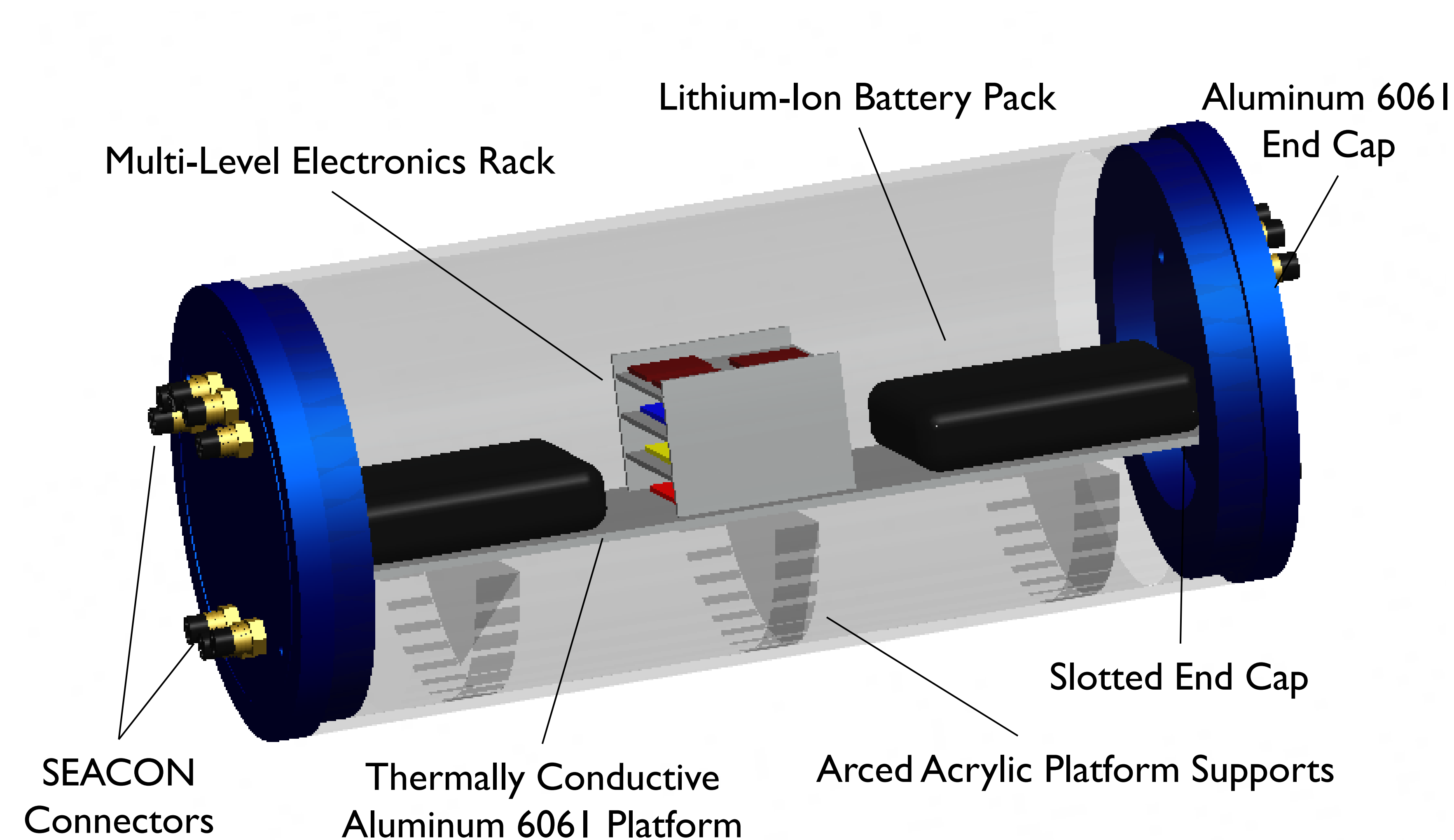
End Cap Design



Interior Layout of Hull

- Requirements of the Interior Layout of the Hull
  - House electronics in a secure, easily accessible manner
  - Effectively dissipate heat away from the electronics and into the surrounding saltwater environment

Interior Layout of Hull



Risk Analysis – Technical

Risk	Electronics overheat due to insufficient heat dissipation system
Probability	Low
Consequence	Moderate
Strategy	Install a battery-powered fan inside the hull in order to circulate the heat away from the electronics and into the surrounding air inside the hull. The fan would induce forced convection, and provide the necessary heat extraction from the electronics.

CO_2 Distribution System and Torpedo Launcher

Kashief Moody

CO_2 Distribution System

Objective

- Distribute pressure-regulated CO_2 to the grasp/release mechanism and torpedo launchers upon command from the main control unit

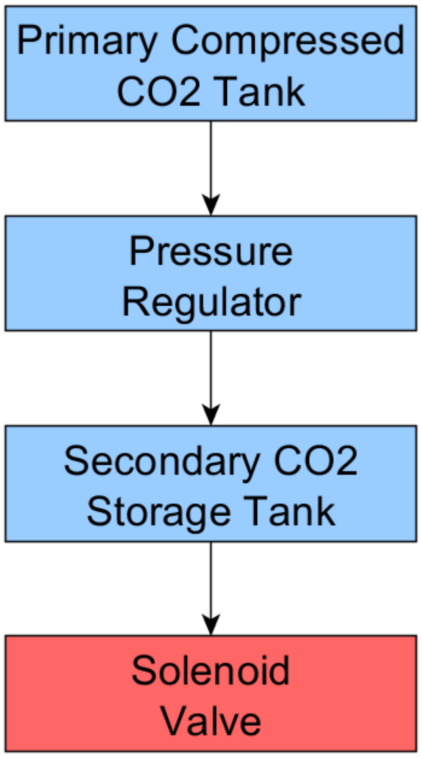
Requirements

- Store CO_2 used for mechanical sub-systems.
- Reduce nominal pressure of CO_2 to a desired operation pressure
- Allow individual actuation of the grasp/release mechanism and torpedo launchers

Major Changes

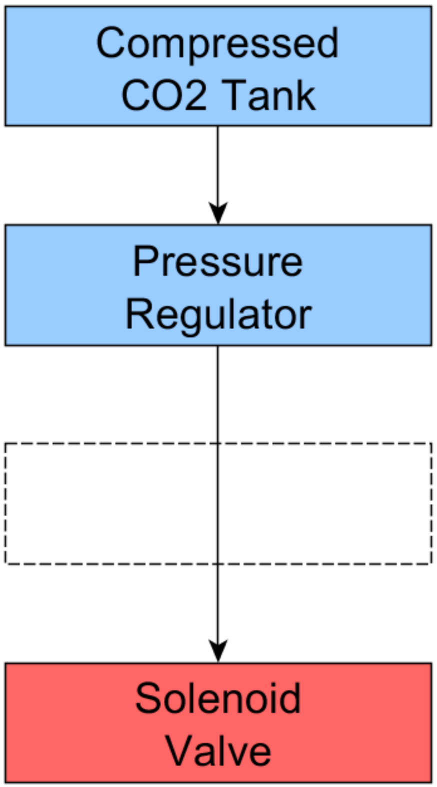
Original Proposed Design

Implemented a secondary CO_2 storage tank

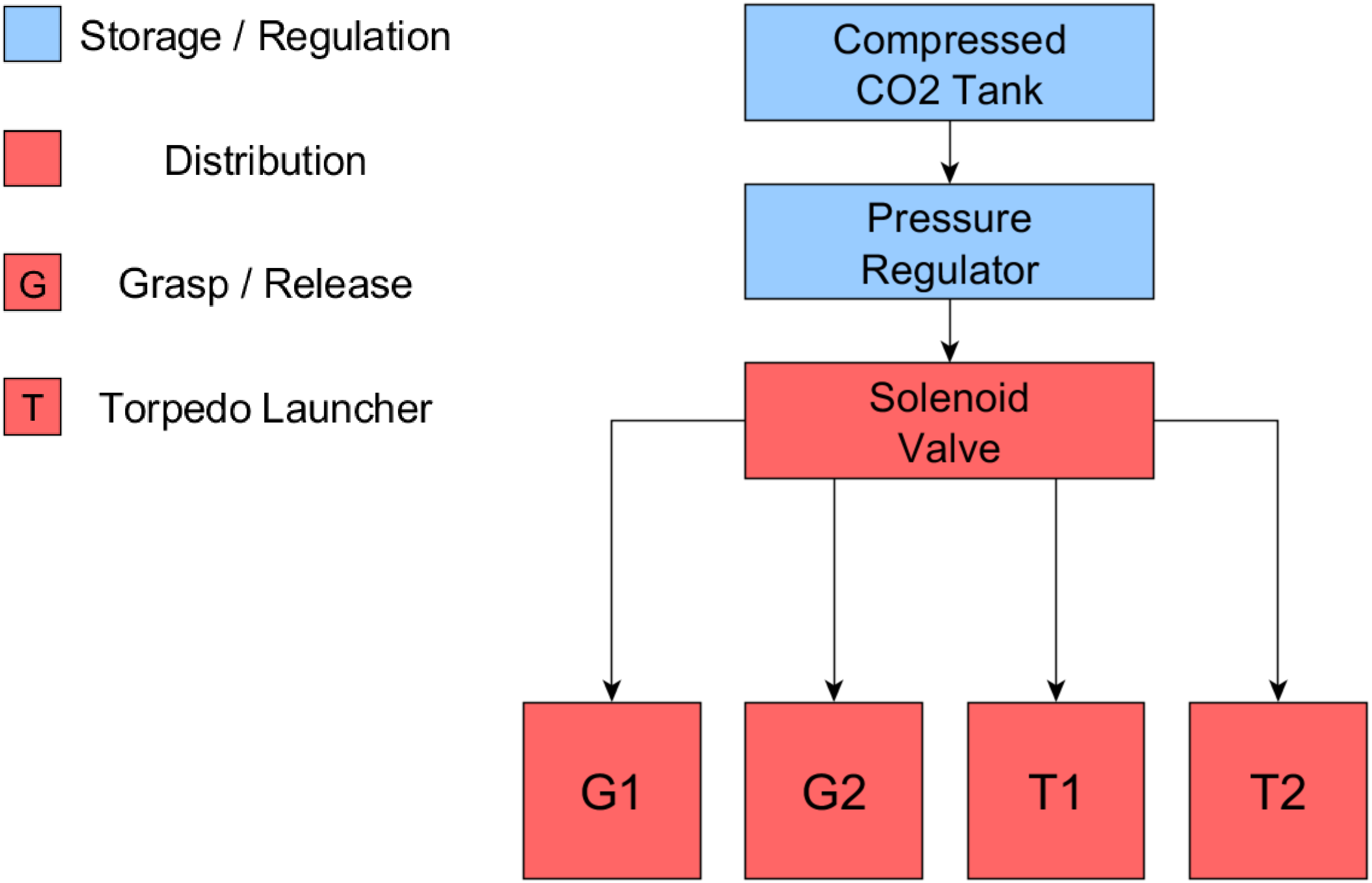


Final Proposed Design

Removed secondary CO_2 storage tank



System Diagram



Components

Components of the CO_2 Distribution System	
Component	**Description**
Compressed CO_2 tank	Storage capacity of 4 oz, lightweight aluminum material with a high-quality brass pin valve
Pressure Regulator	Yet to be finalized
Solenoid Valve	4 submersible stainless steel solenoid valves, will require 12 VDC each and are 1" in diameter by 2.5" in height
Network of Tubing	1/8" – diameter clear tubing and 3-way splitter

Risk Analysis – Technical

Risk	CO2 Distribution System malfunction
Probability	Moderate
Consequence	Severe
Strategy	1. Verify the proper pressure of all the CO2 lines 2. Regulate the pressure at the outlet of the compressed CO2 tank to the desired operational level 3. Purchase a backup CO2 tank (inexpensive) in case the supply runs out, or runs low at the competition site

Torpedo Launchers Overview

Objective

- Secure the air cylinder and torpedo and increase the accuracy of launching technique
- Individually shoot torpedoes through designated PVC cut-outs (Kill Caesar)

Requirements

- Cylindrical barrel
- Semicircle end cap
- Air cylinder mount
- Air cylinder
- Disk attachment

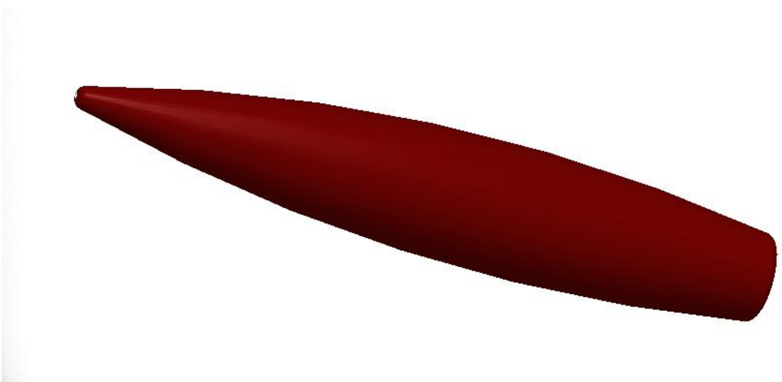
Major Changes

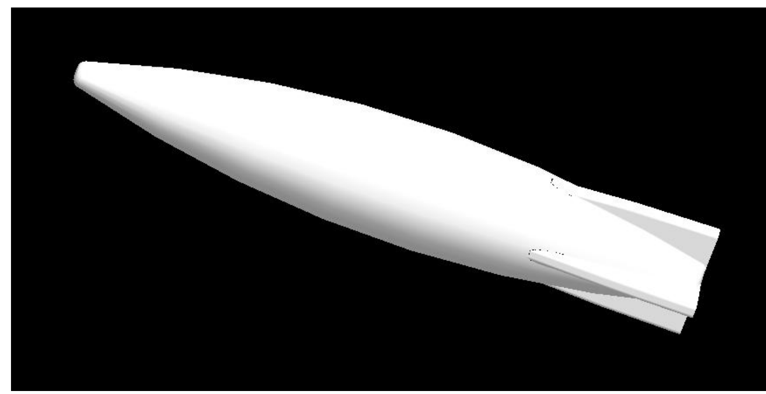
Original Proposed Design

- Implemented smooth torpedoes

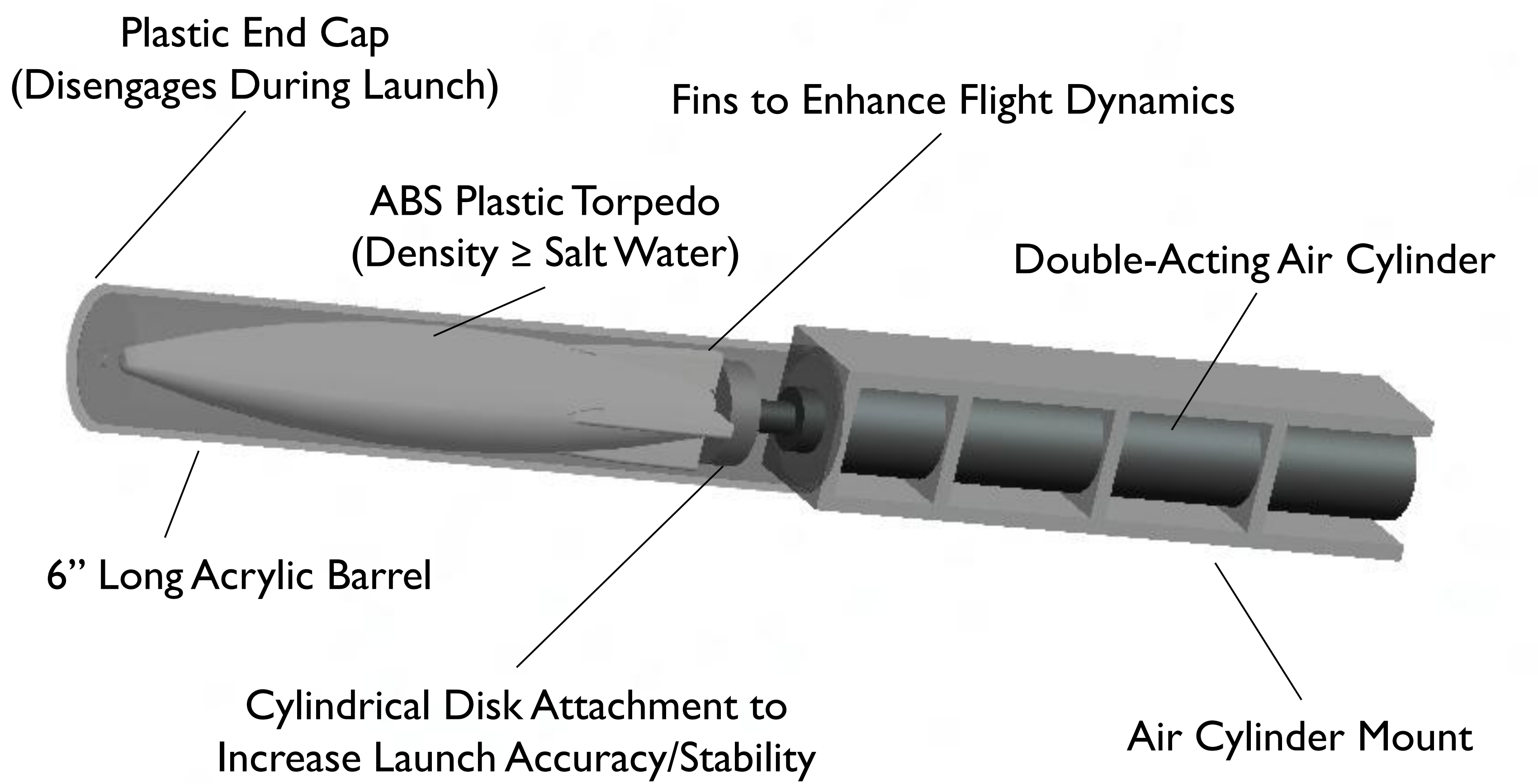
Final Proposed Design

- Fins attached to the tail of the torpedoes





Torpedo Launcher



Risk Analysis – Technical

Risk	Torpedo Launcher Malfunction
Probability	Moderate
Consequence	Minor
Strategy	1. Use an alternative end cap design or temporary securing method

Grasp / Release Mechanism
Marker Dropper

Tra Hunter

Grasp / Release Mechanism Overview

Objective

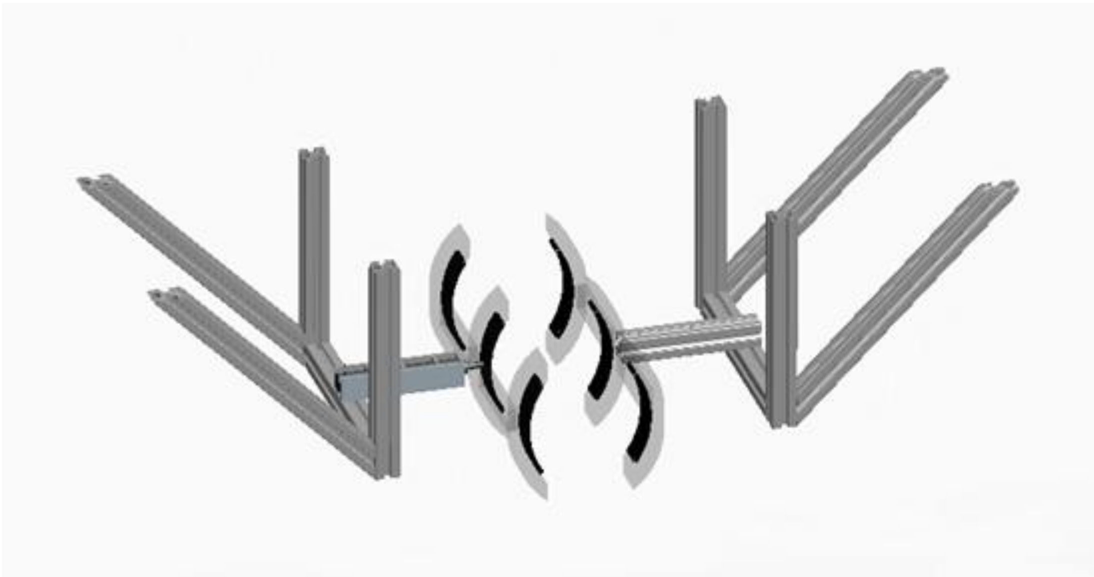
- Complete the Laurel Wreath (PVC recovery and octagon) section of the obstacle course.

Requirements

- Grasp an identified object
- Hold object while vehicle surfaces
- Submerge and release object

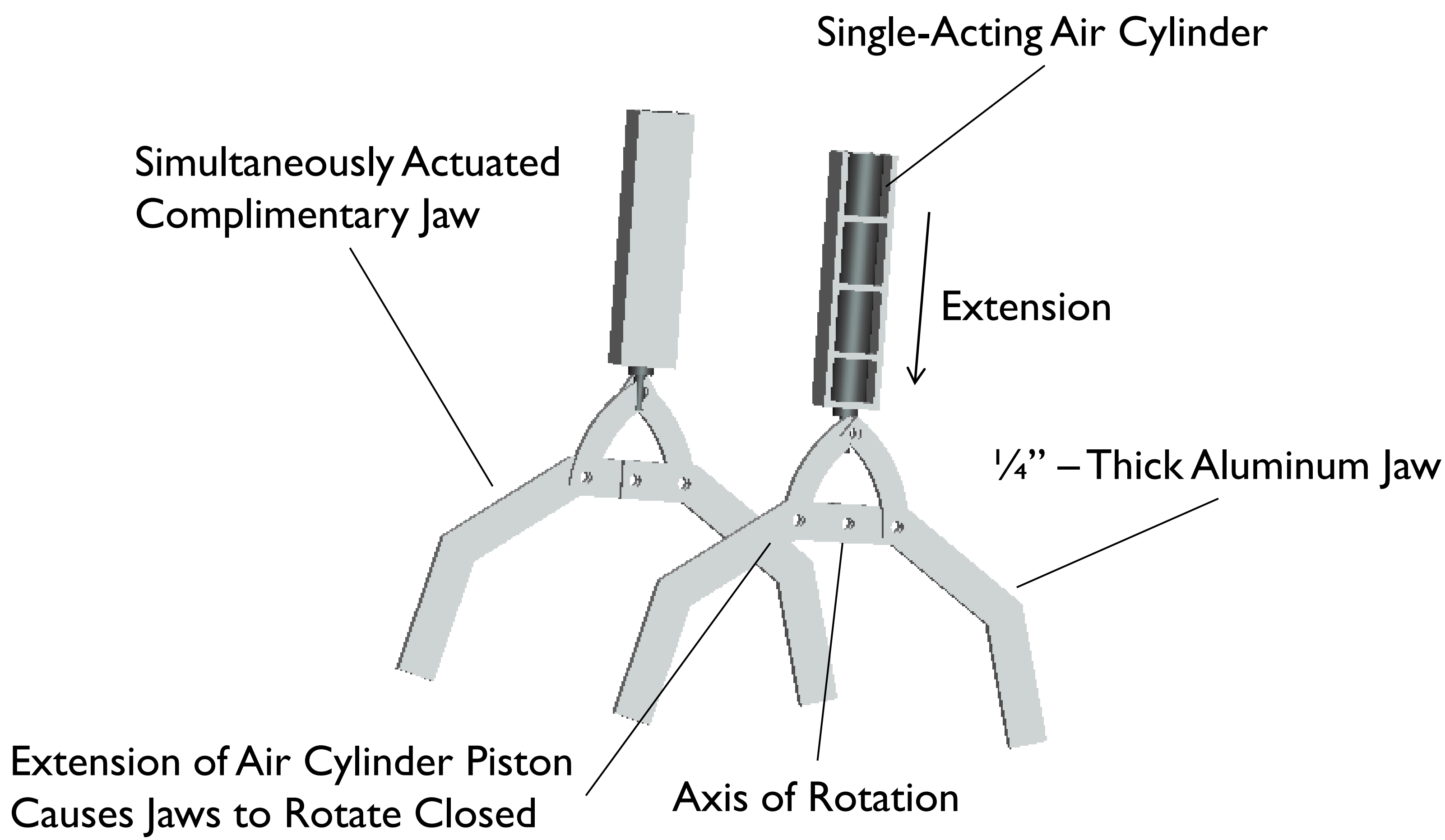
Grasp / Release Mechanism

- Design Changes
  - Rotational instead of linear motion
  - Changed from an array of claws to two synchronized jaws



Original Grasp / Release Mechanism Design

Grasp / Release Mechanism



Risk Analysis – Technical

Risk	Jaws Do not Rotate Properly to Successfully Grasp Object or Solenoid Valve Malfunctions
Probability	Low
Consequence	Moderate
Strategy	1. Verify proper rotation of the grasping jaws during the range of motion of the corresponding single-acting air cylinder 2. Verify proper actuation of the corresponding solenoid valves

Marker Dropper

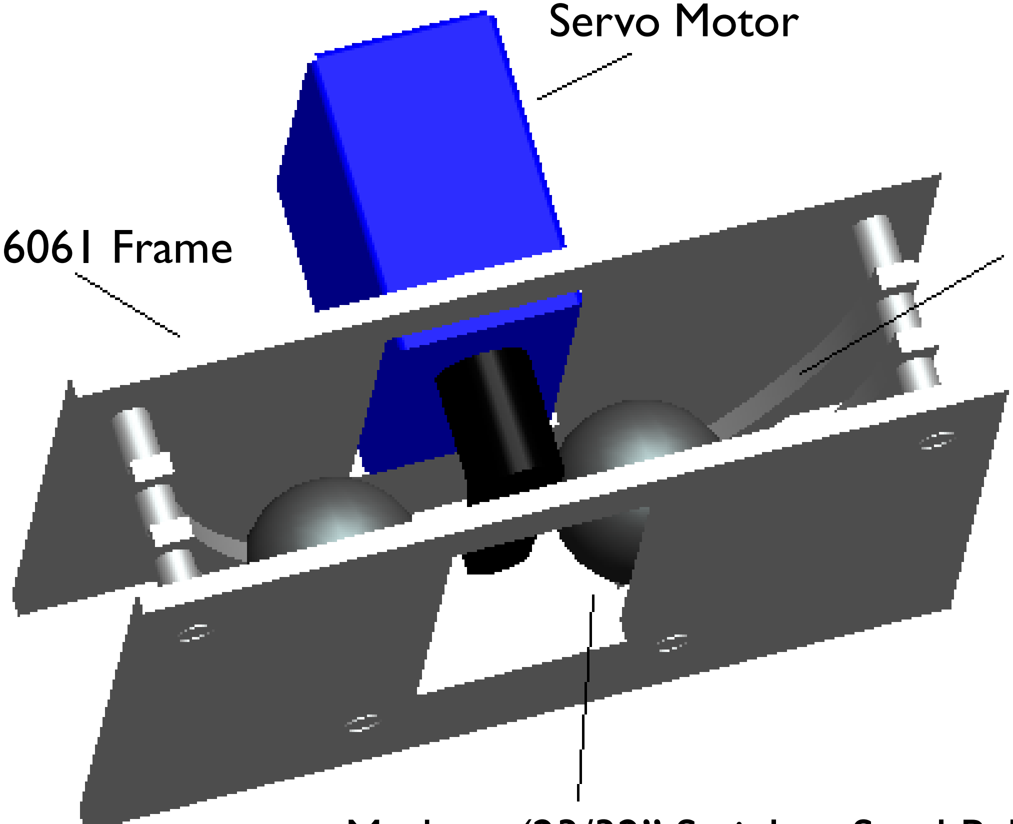
Objective

- Complete the Gladiator Ring (Drop-In Bins) section of obstacle course

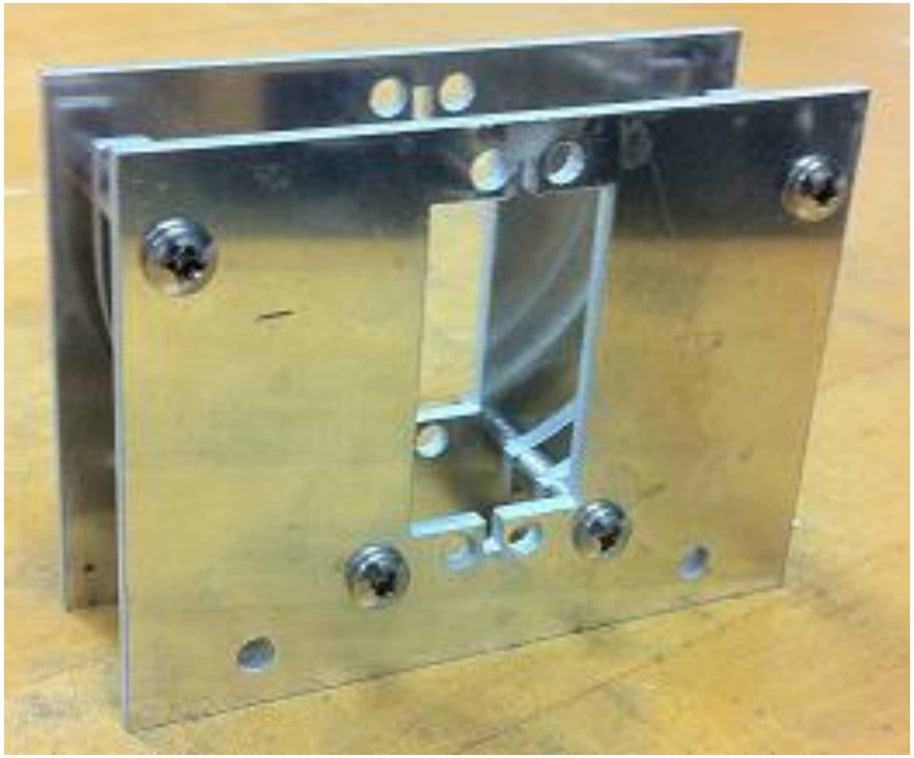
Requirements

- Secure two markers until actuated
- Drop the markers individually upon command

Marker Dropper



Marker Dropper



Risk Analysis

Risk	Servo Motor Fails to Rotate or Electrical Wires Compromised
Probability	Very Low
Consequence	Moderate
Strategy	Consider purchasing an identical backup servomotor

Budget

Tra Hunter

Budget

Current Project Expenditures	Total Price
Raw Materials (i.e. acrylic, aluminum, gasket rubber, etc.)	$957.25
CO_2 Distribution System Components (i.e. solenoid valves, air cylinders)	$343.82
Seabotix BTD150 Thrusters x 2	$1,005.18
Frame (i.e. 80/20 T-slotted aluminum, corner connectors)	$342.69
10” OD, 9.5” ID, 21” Long Acrylic Hull	$310.19
Arduino Uno Board x 2	$59.90
Cables and Adapters	$9.90
Miscellaneous (i.e. Laser pointer)	$48.36
Current Project Expenditures	**$3,077.29**

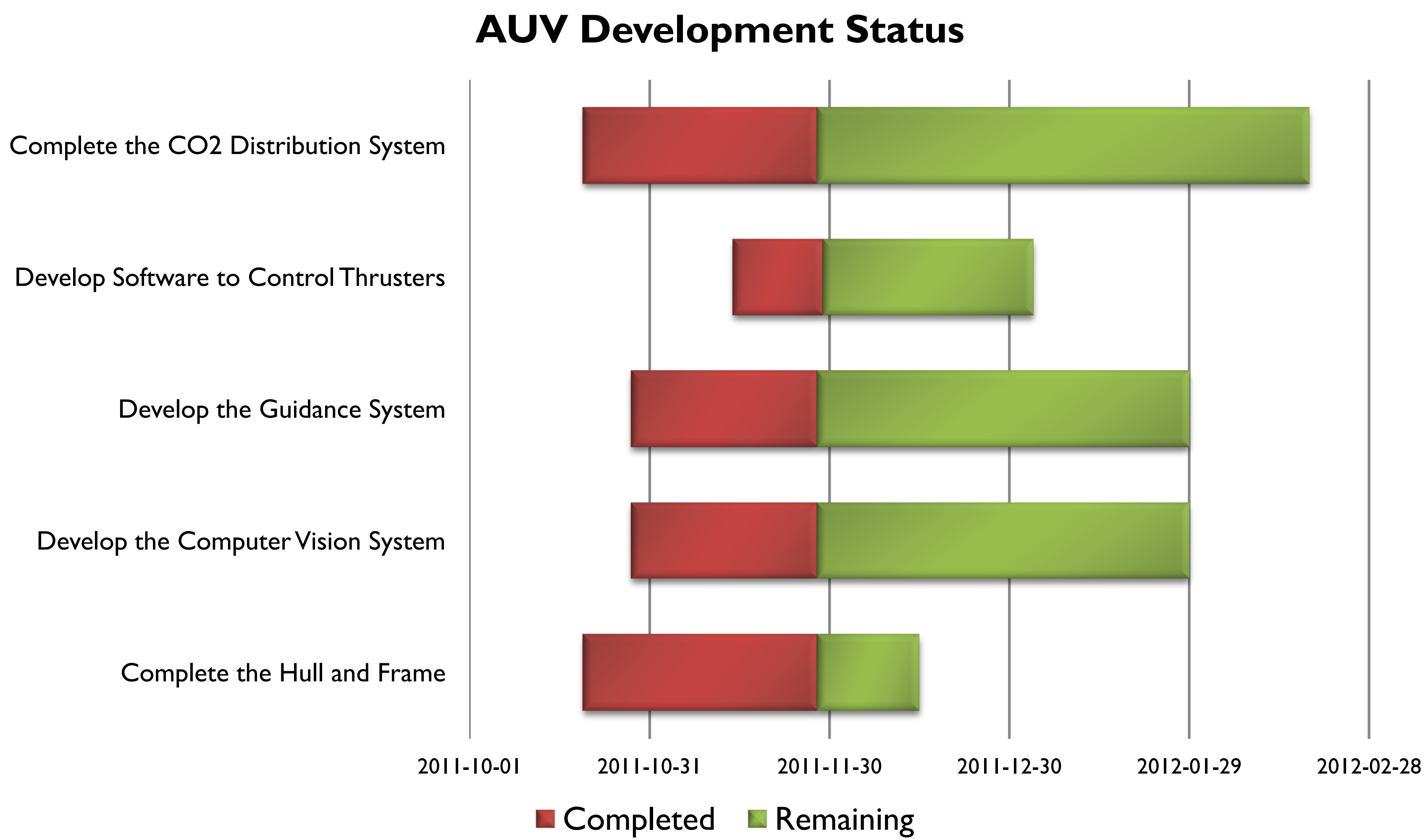
Budget

Projected Remaining Expenditures	Price
SEACON Connectors and Cables	Quote Pending
BeagleBoard-xM	$150.00
SQ06 Hydrophones x 4	Quote Pending
Sensor Tech Pressure Transducer	Quote Pending
Inertial Measurement Unit	$150.00
Compressed CO_2 Tank	$20.00
Logitech C615 Web Cameras	$110.00
Competition Entrance Fee	$400.00
Travel, Lodging, and Shipping (to San Diego, CA)	$5,000.00
Projected Remaining Expenditures	**$7,150**
GRAND TOTAL	**$10,200**
Current Total Budget	$7,432.72
Remaining Balance	-$2,770

Schedule

Antony Jepson

Schedule


AUV Development Status
Complete the CO2 Distribution System
Develop Software to Control Thrusters
Develop the Guidance System
Develop the Computer Vision System
Complete the Hull and Frame
2011-10-01
2011-10-31
2011-11-30
2011-12-30
2012-01-29
2012-02-28
Completed
Remaining

Overall Risk Assessment

Antony

Risk Analysis – Technical

- Control issues (difficult)
  - Non-linear, time-varying behavior
  - Hydrodynamic effects

Risk Analysis – Schedule

Risk	Team Member Availability
Probability	Low
Consequence	Severe
Strategy	1. Share work across sub-teams. 2. Re-use and distribute when possible.

Risk Analysis – Schedule

Risk	Mis-estimated Schedule
Probability	Moderate
Consequence	Severe
Strategy	1. Over-estimate schedule times rather than under-estimate. 2. Have "races-to-the-finish" to catch up.

Risk Analysis – Budget

Risk	Over-estimate budget
Probability	Moderate
Consequence	Moderate
Strategy	1. Carefully estimate our budget 2. Avoid unnecessary purchases 3. Seek additional sponsorship

Questions?