Welcome

Detailed 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

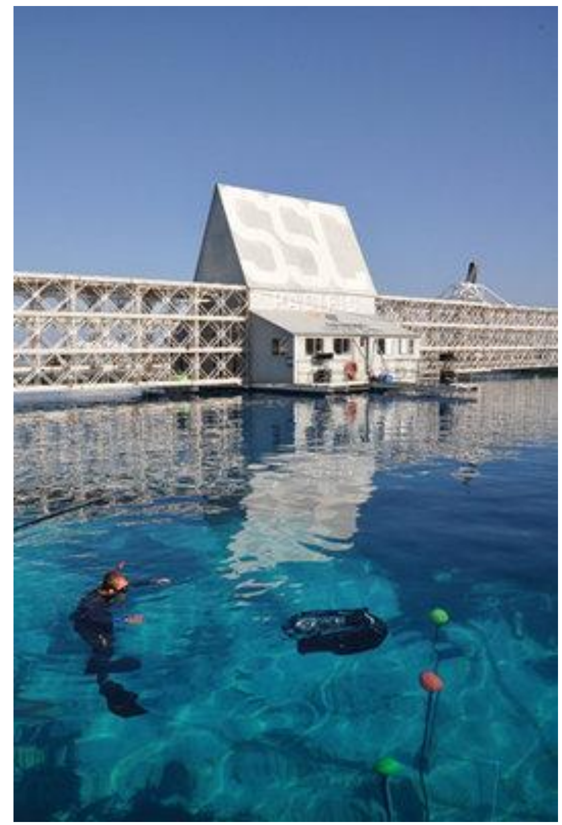
Kashief Moody
Secretary

Tra Hunter
Treasurer

SSC Pacific TRANSDEC Pool

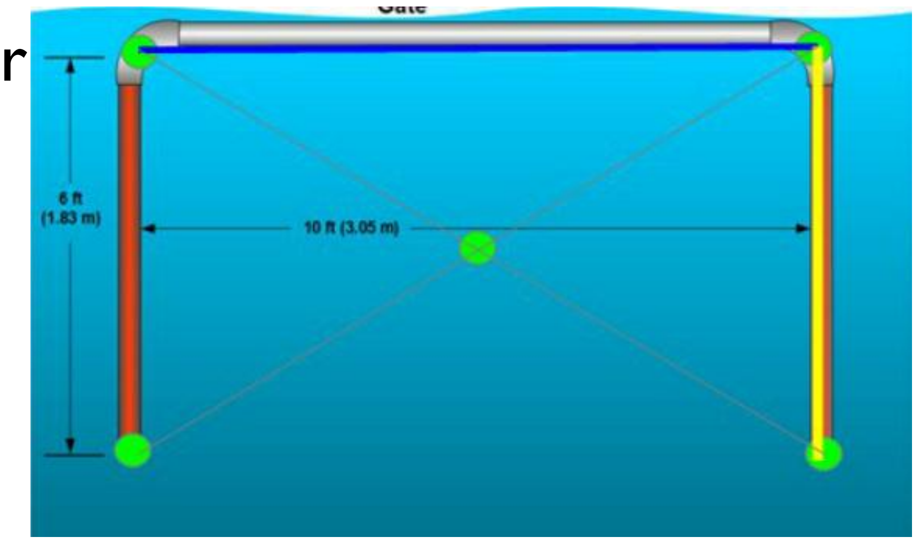
AUVSI foundation
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

ONR
Office of Naval Research



"Ides of Transdec" Mission Tasks

- **Training (Gate)**
- *Training* (Touch Buoys)
- *Obstacle Course* (Pass Over PVC)
- *Gladiator Ring* (Drop Markers in Bins)
- *Kill Caesar* (Launch Torpedoes Through PVC Cutouts)
- *Laurel Wreath* (Locate, Recover, Surface, and Release)



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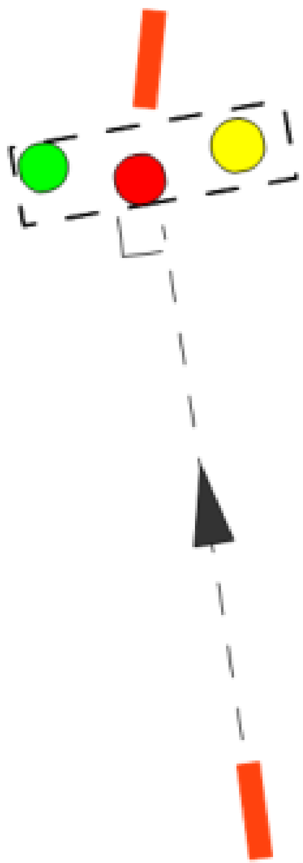

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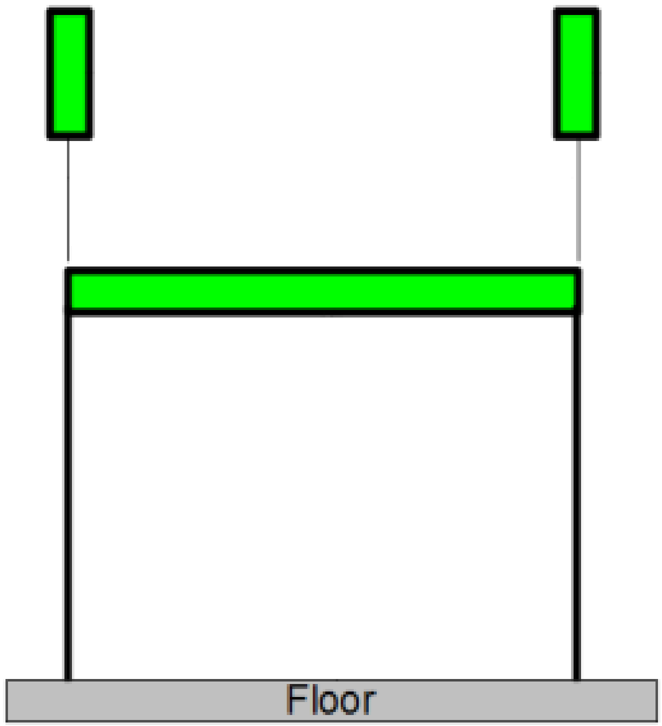

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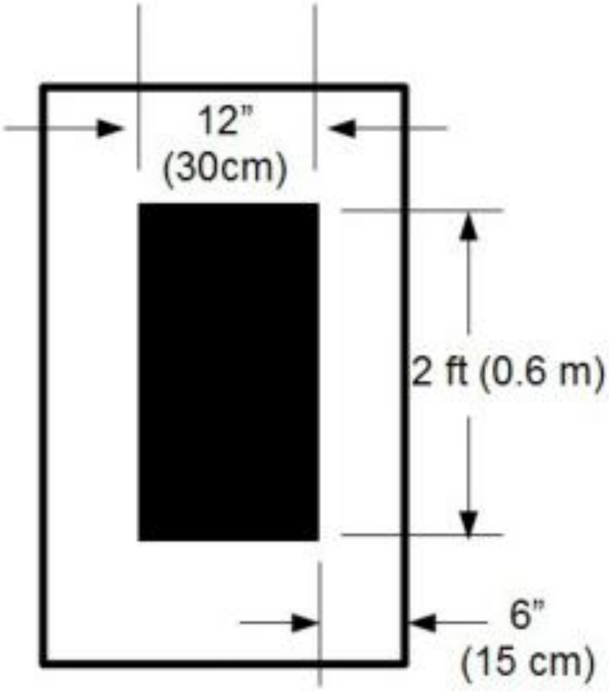

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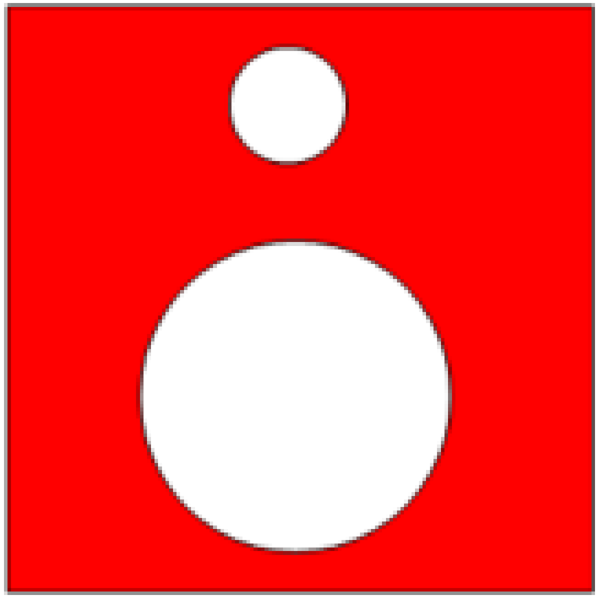

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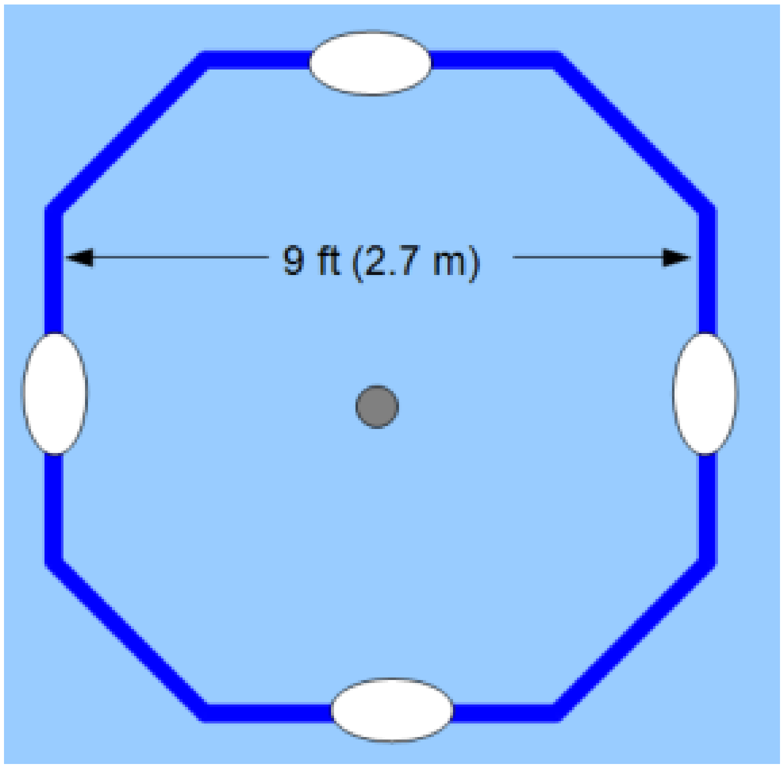
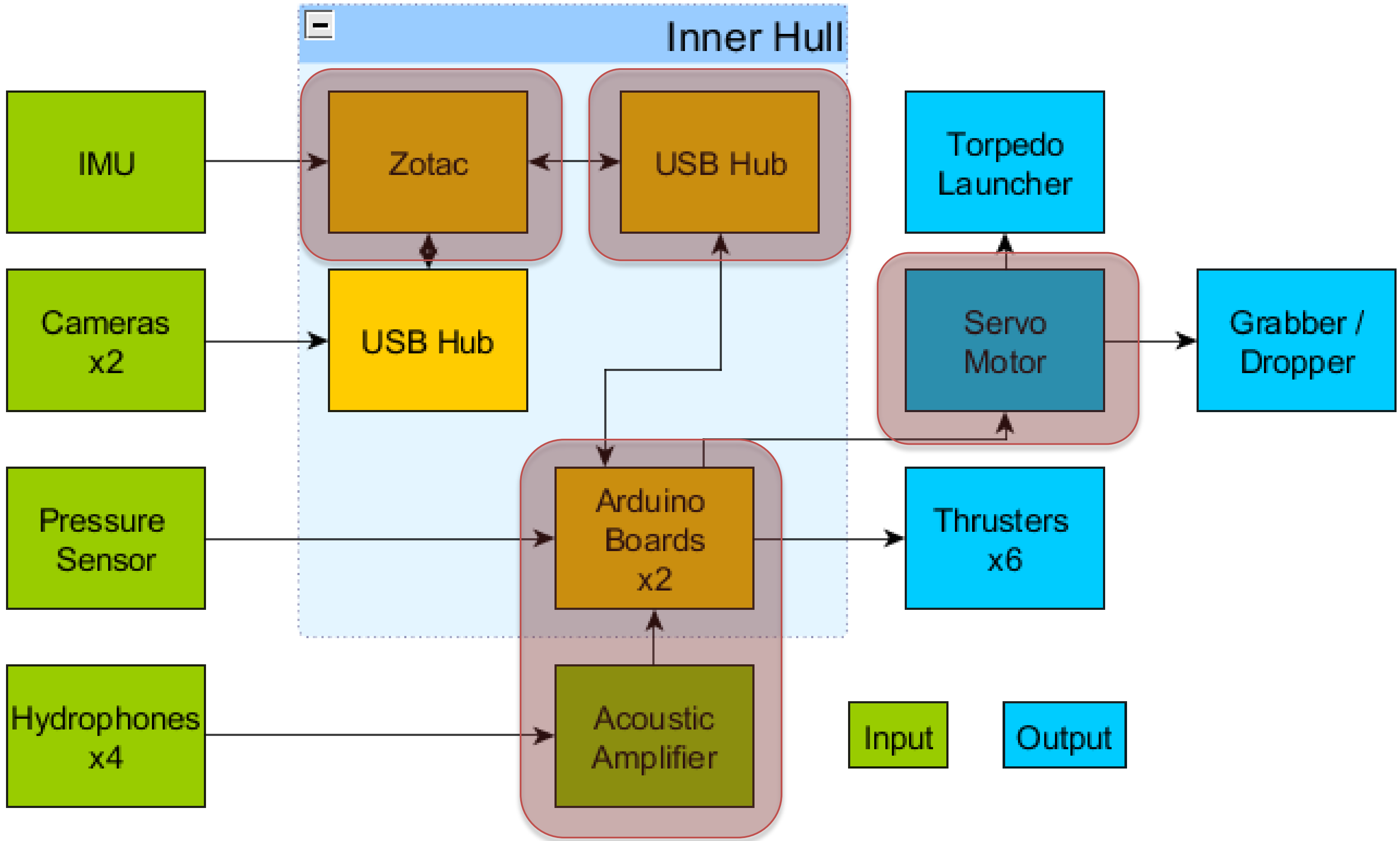
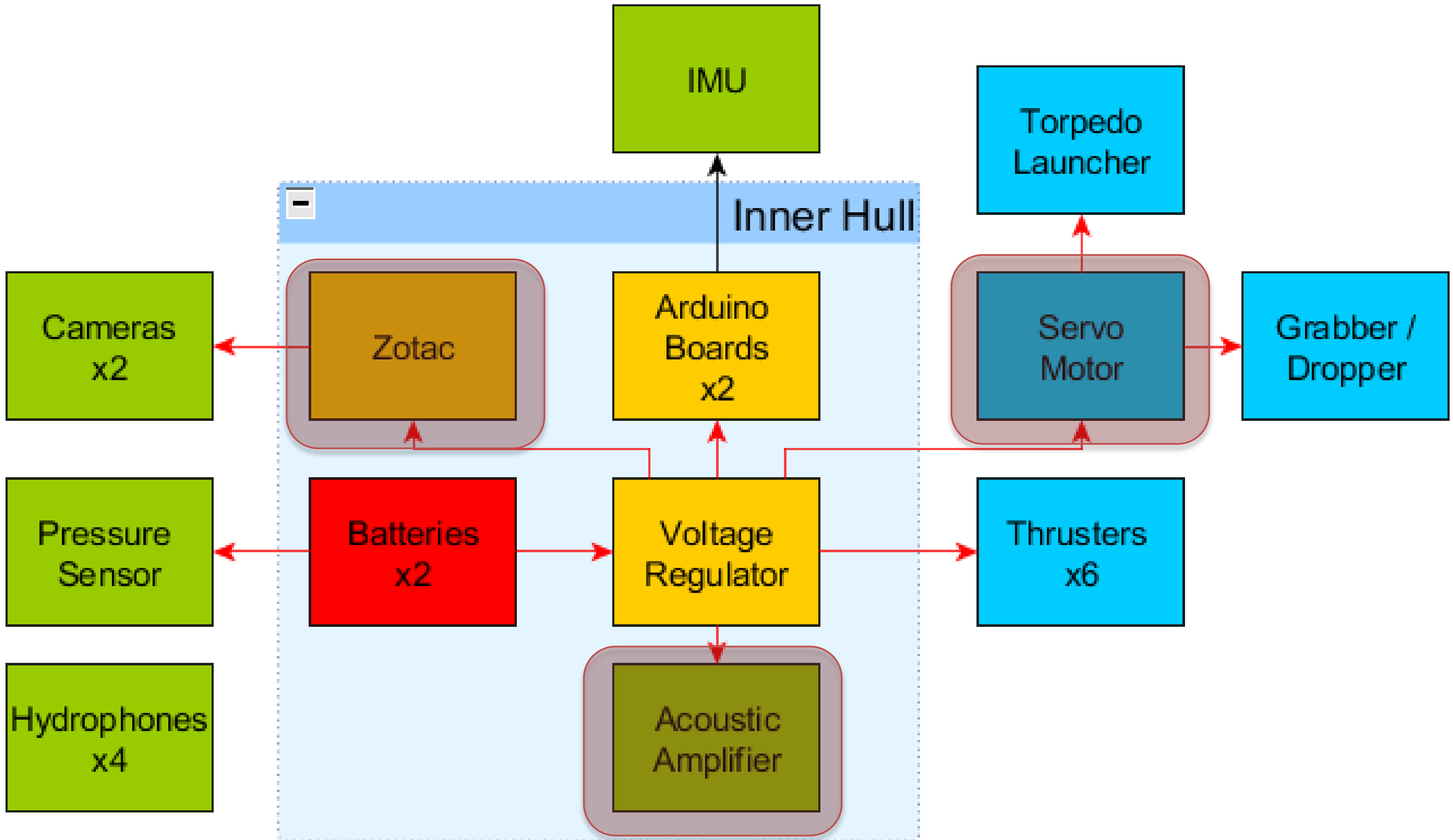


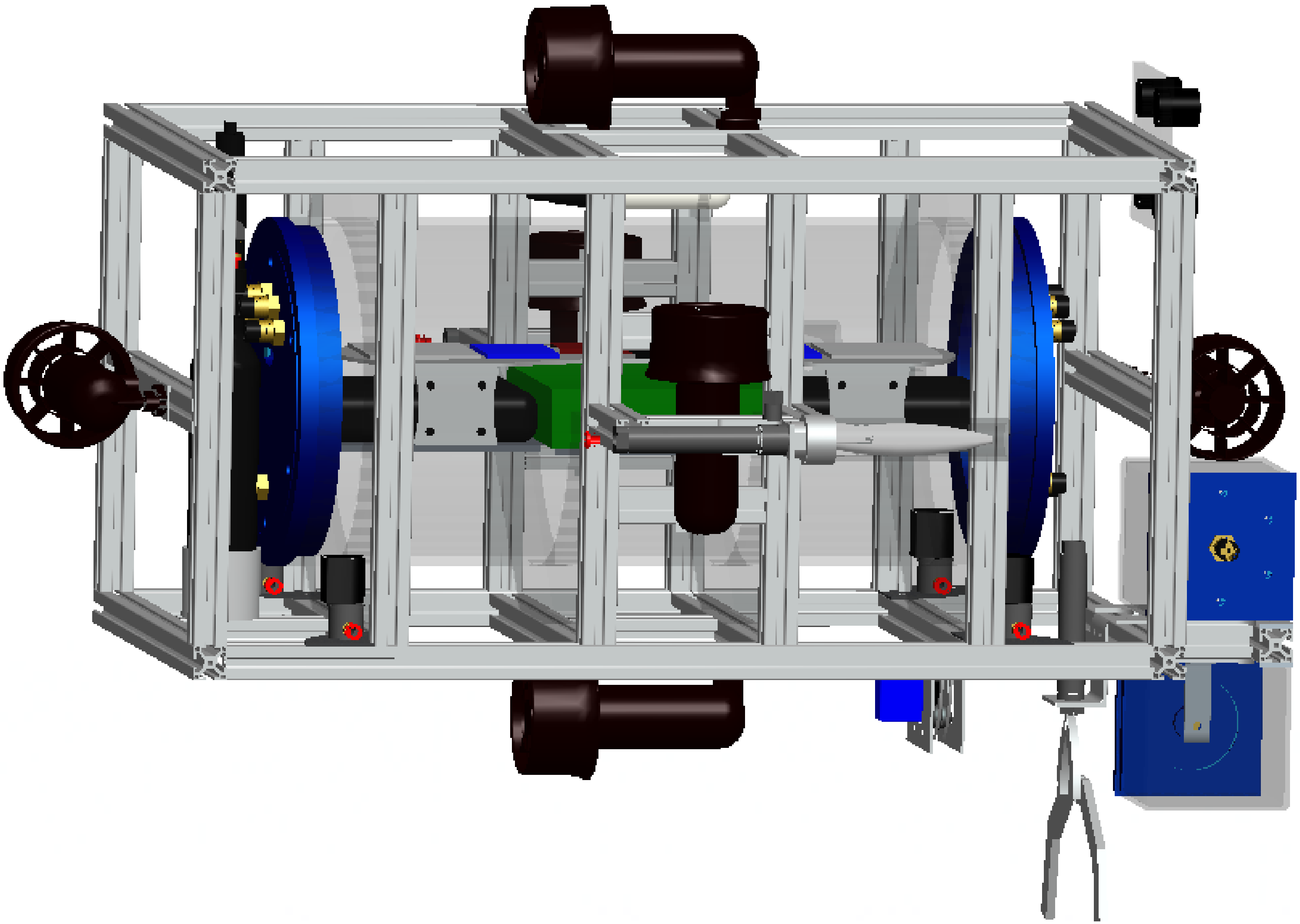
System Outline



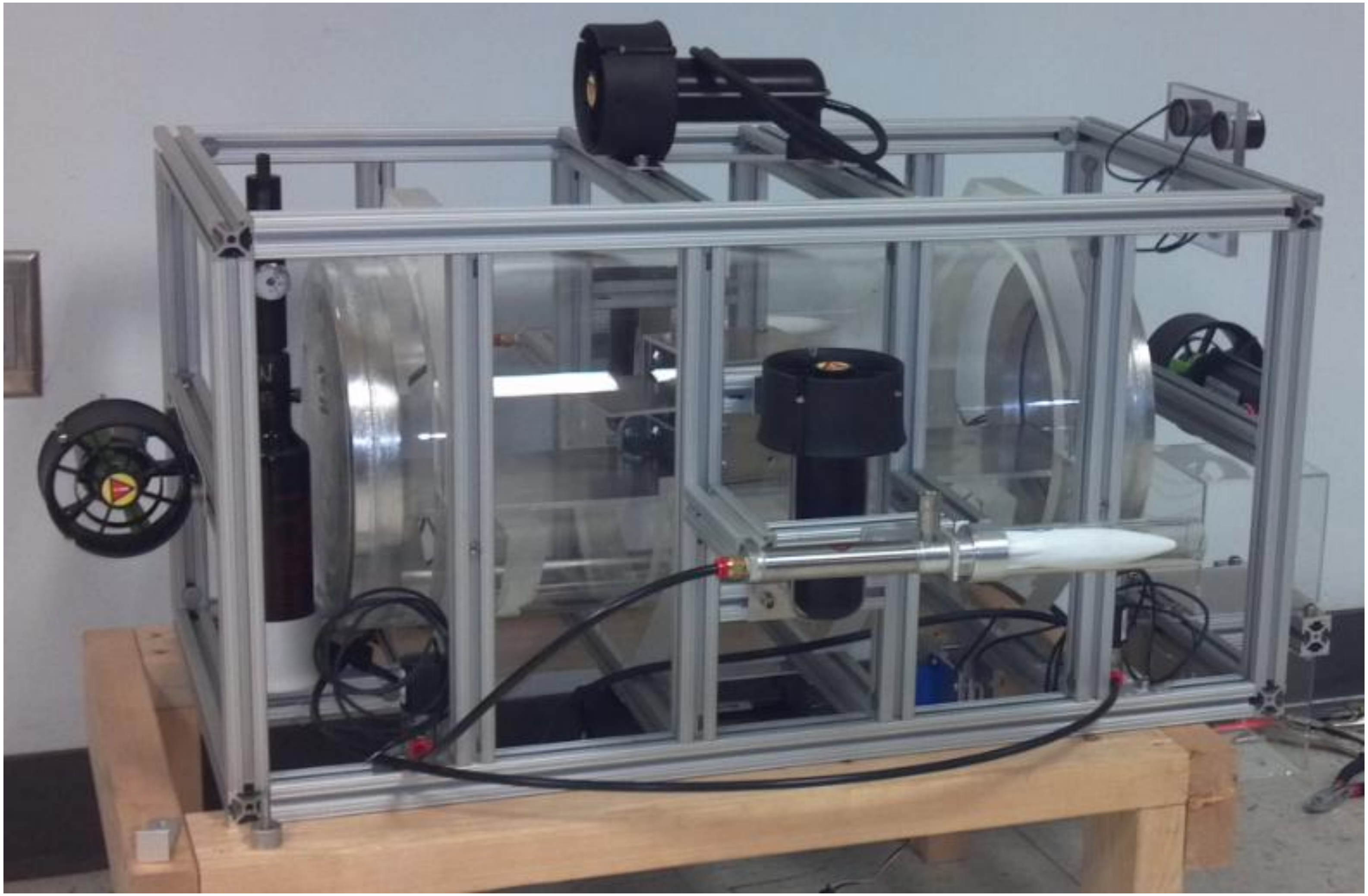
Power Outline



AUV Design (Revised) – Angled View



AUV Design – Current Status



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

Guidance System Status

Current

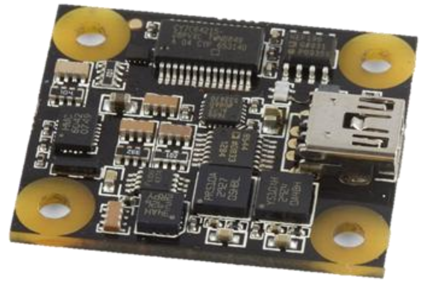
- ✓ Measure pitch
- ✓ Measure yaw
- ✓ Measure roll

Remaining

- Determine heading
- Determine depth
- Locate pinger

Guidance System Overview

Arduinoboard-UNO



Phidget 3/3/3 IMU

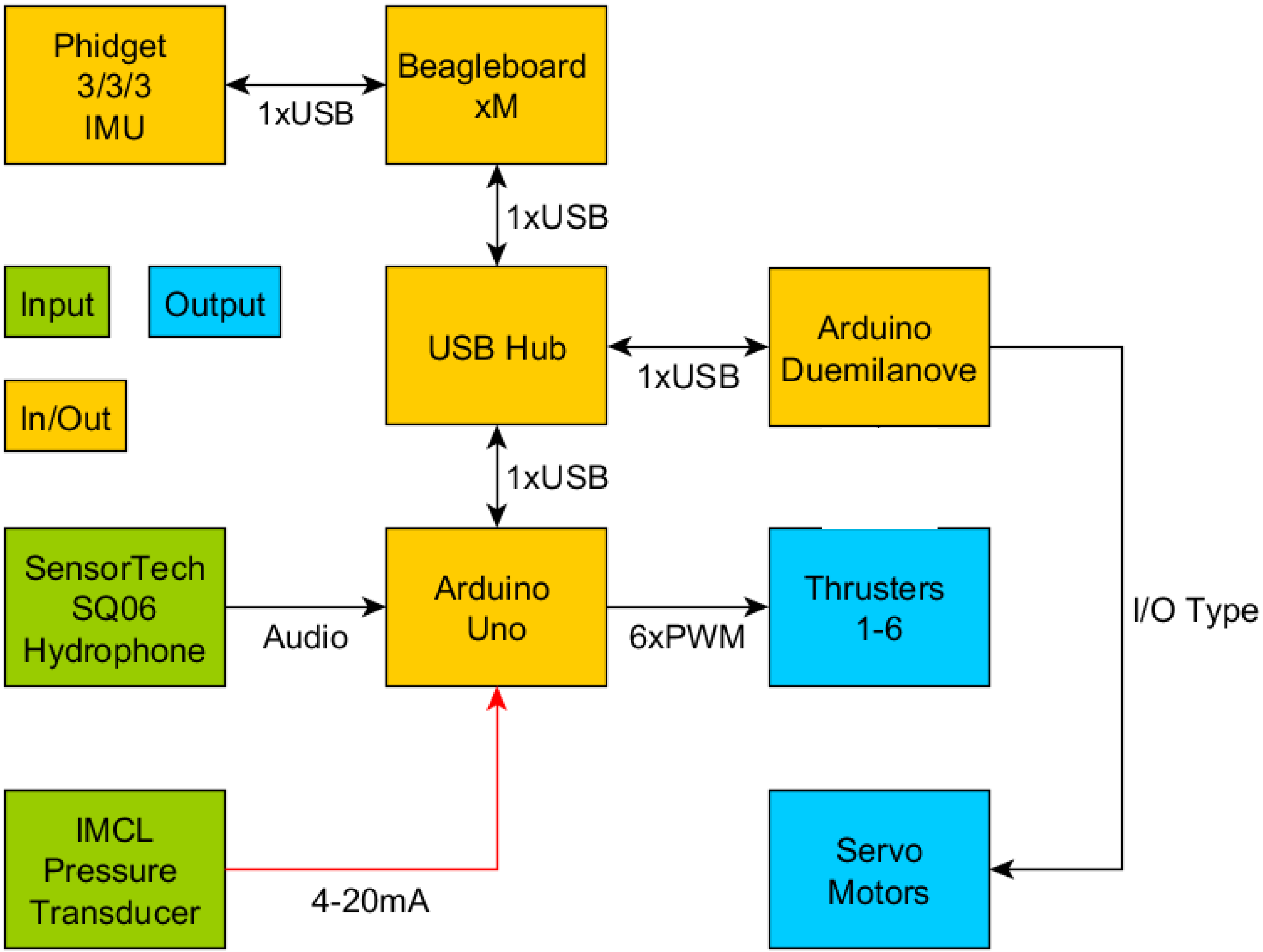
SQ26 Hydrophone (x4)

Thrusters x6

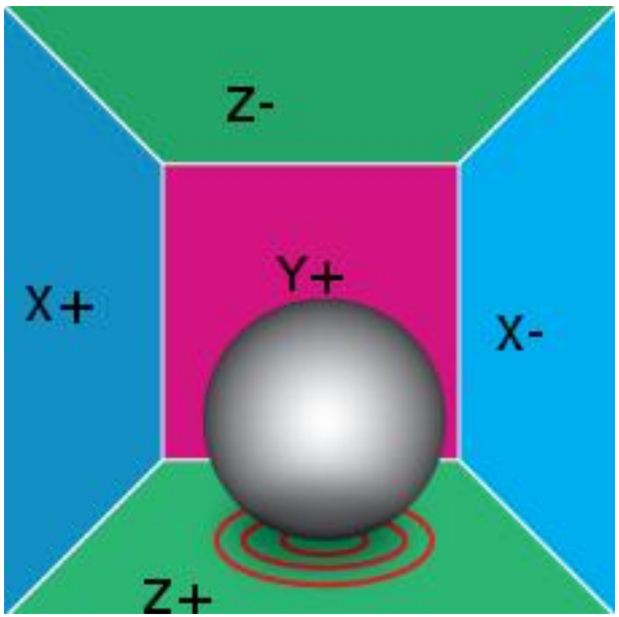
Beagleboard-xM

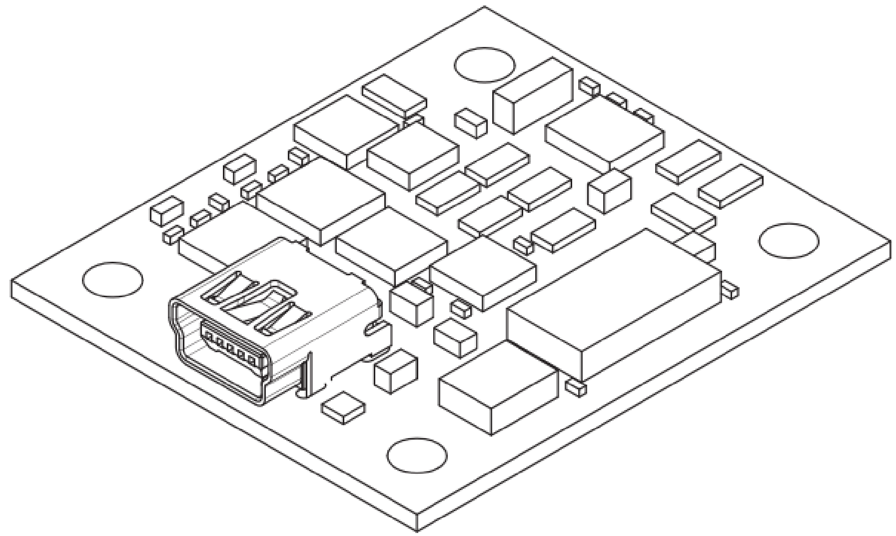
IMCL Submersible Pressure Sensor

Guidance System Overview



Method





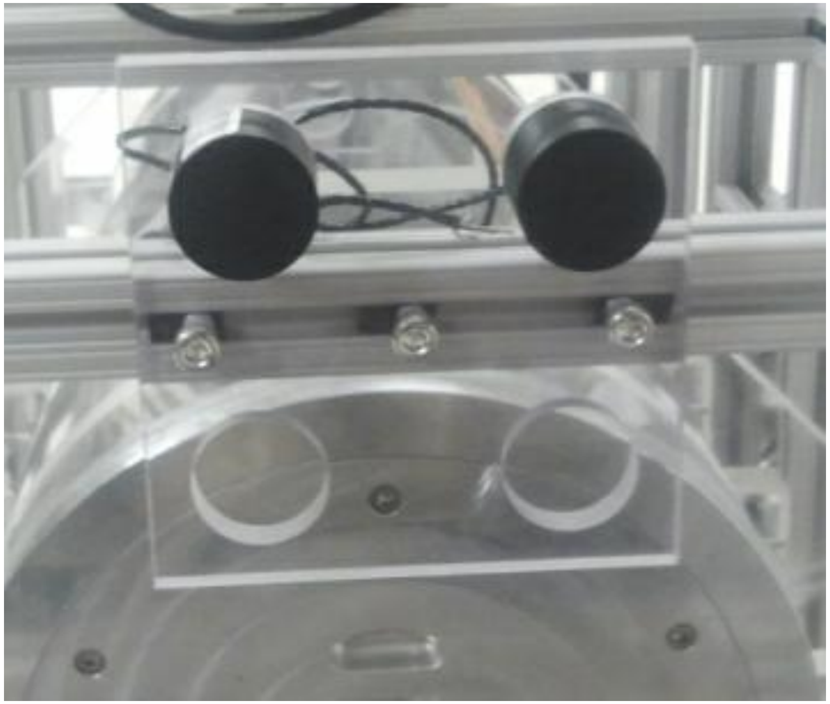
Phidget 3/3/3 Mechanical Drawing

Adapted from: http://www.starlino.com/imu_guide.html

Code Sample

```
int CCONV SpatialDataHandler(
  CPhidgetSpatialHandle spatial,
  void *userptr,
  CPhidgetSpatial_SpatialEventDataHandle *data,
  int count)
SpatialData {
     double acceleration[3];
     double angularRate[3];
     double magneticField[3];
     Timestamp time;
};
static const double tol_accel_0 = 0.2;
static const double tol_accel_1 = 0.2;
static const double tol_accel_2 = 0.2;
```

Guidance System Components



Hydrophone Mounting Rack

Risk Analysis

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. 3. Combine measurements from different sensors to increase precision.

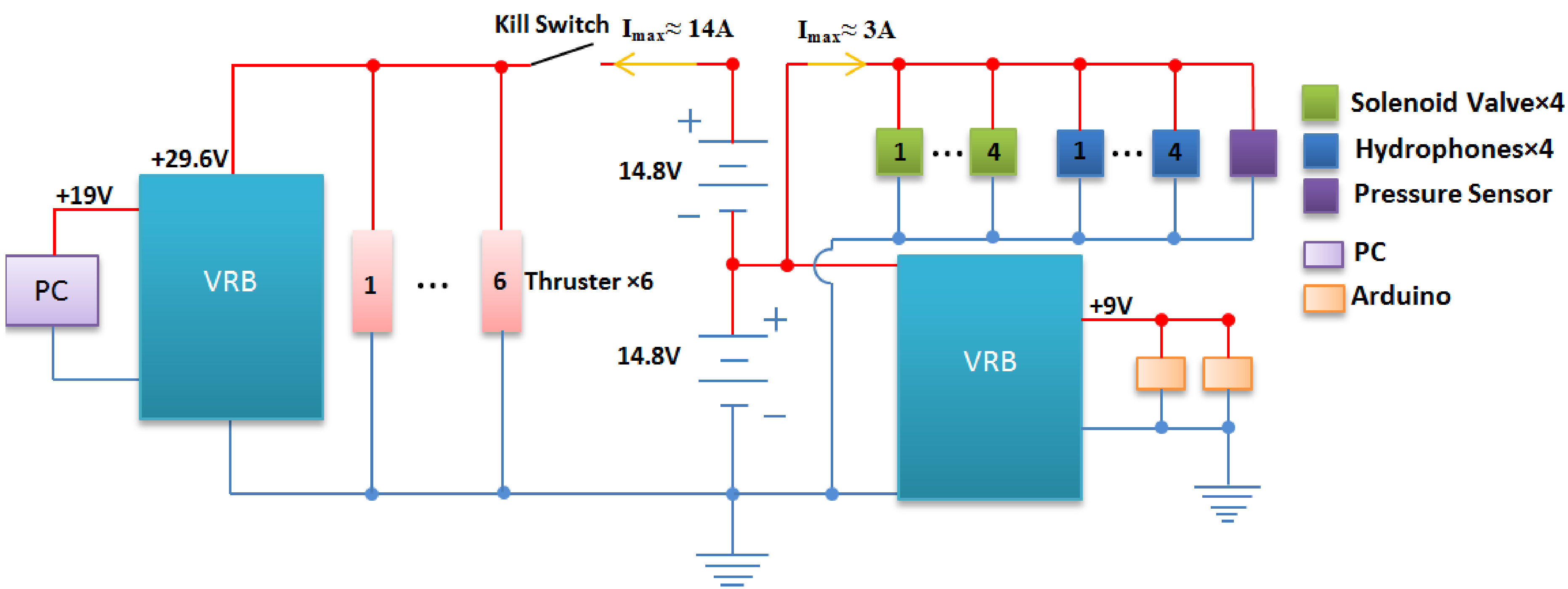
Test Plan / Report

Test Description	Pass / Fail	Notes
Frequency response test	P	Works up to 37kHz
Depth sensor test	N/A	Pending arrival.

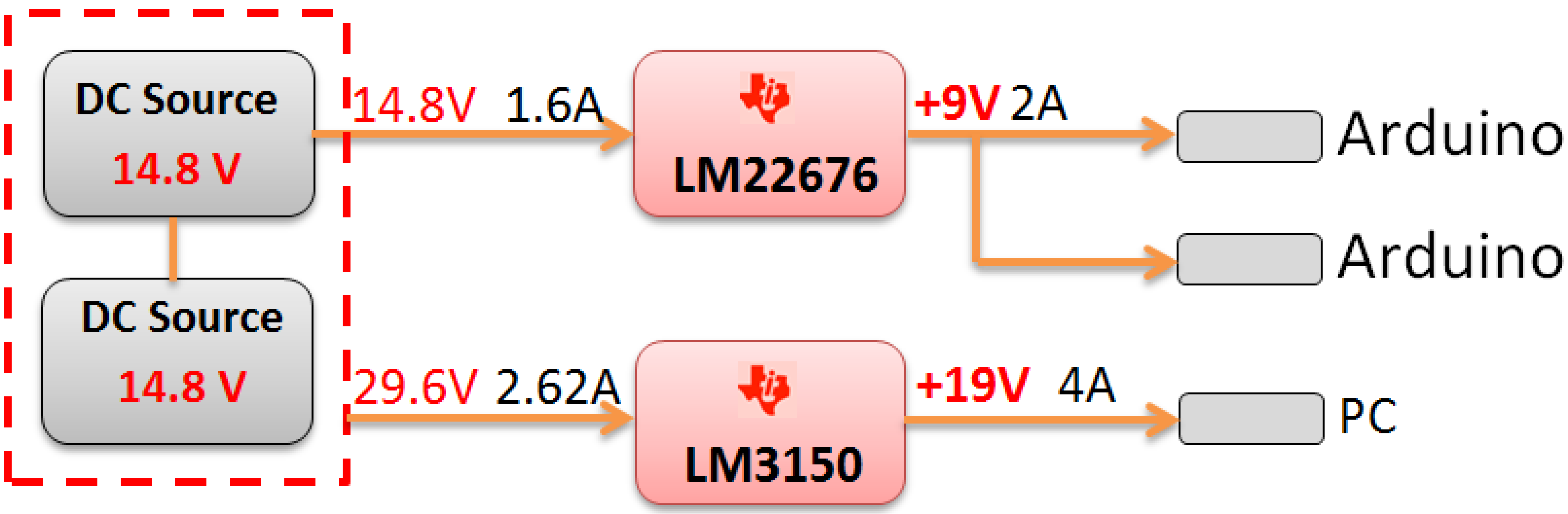
Electrical System and Main Controller

Hang Zhang

Electrical System

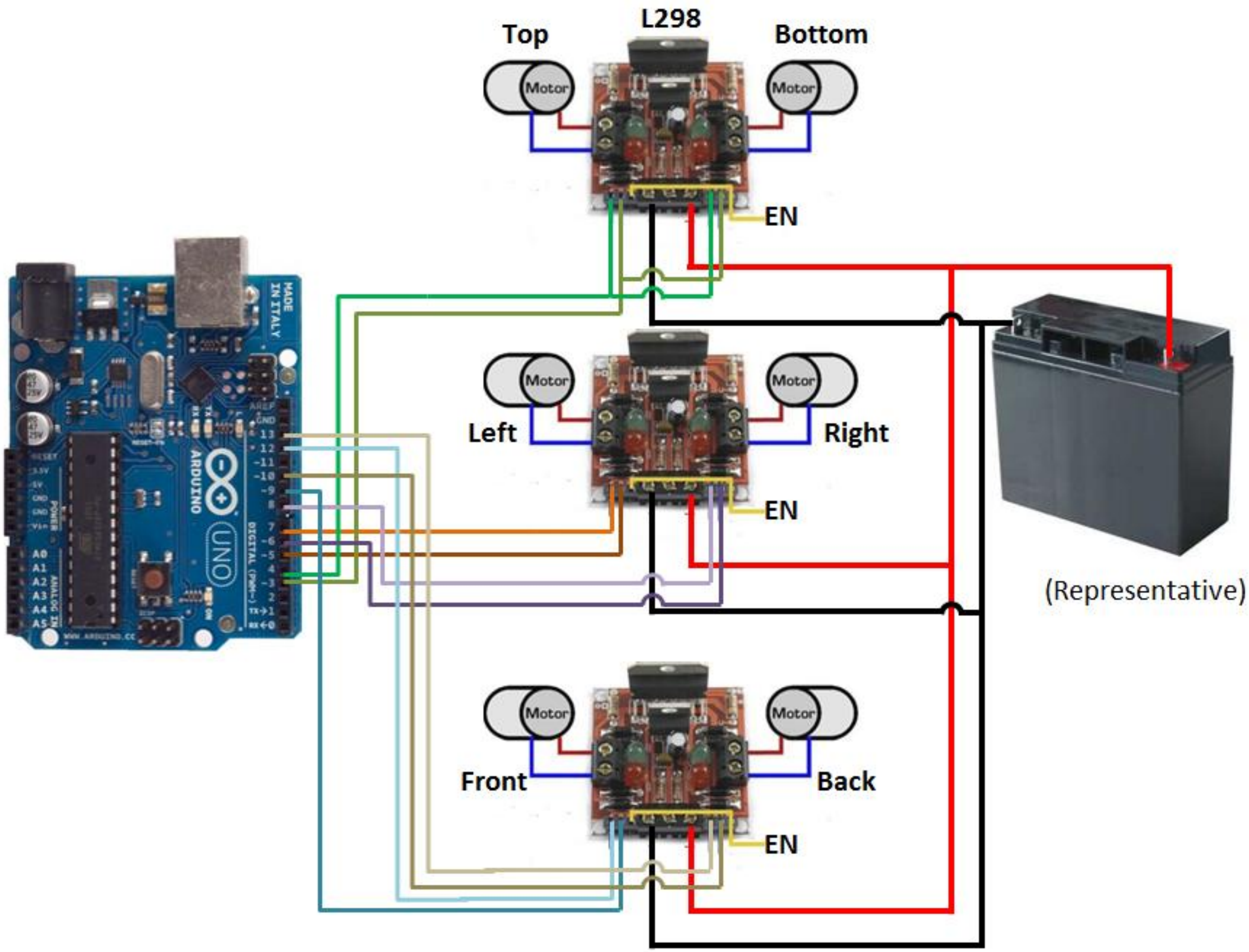


Voltage Regulator Board



Voltage Regulator Board Summary	
Total System Efficiency	**95.6 %**
Total System Cost	**$50**
Total System Power Dissipation	**2.84 W**

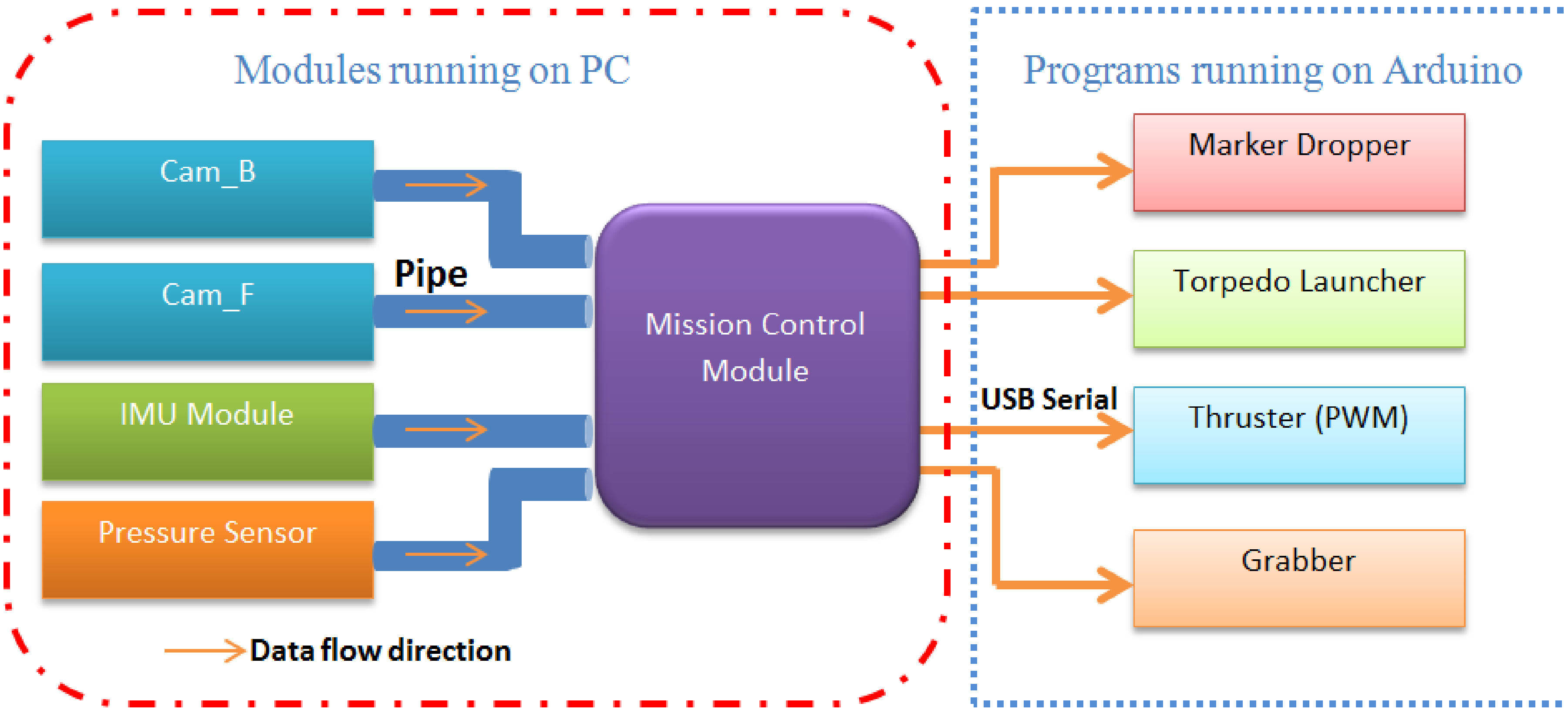
Propulsion System



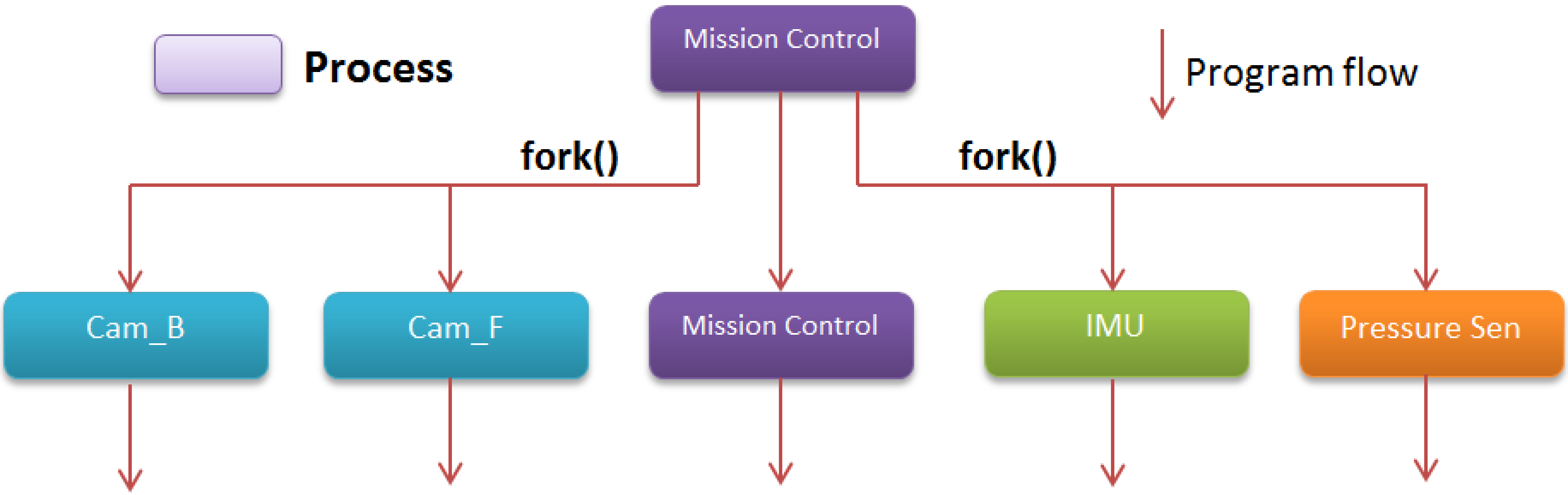
Propulsion System (Code Snippet)

```
int T_TB = 3;                    //Top and Bottom Thruster, connected to pin 3
int TDir = 4;                    // Direction of the thruster
int val;
void setup() {
    pinMode(TDir,OUTPUT);
    pinMode(T_TB,OUTPUT);
}
void loop() {
    val = read_speed();
    …
 }
 void turn_left(int val) {
    analogWrite(TDir,LOW);
    analogWrite(T1_L,val);
    Serial.print("Thruster is now rotating to the LEFT at speed: ");
    Serial.println(val);
 }
```

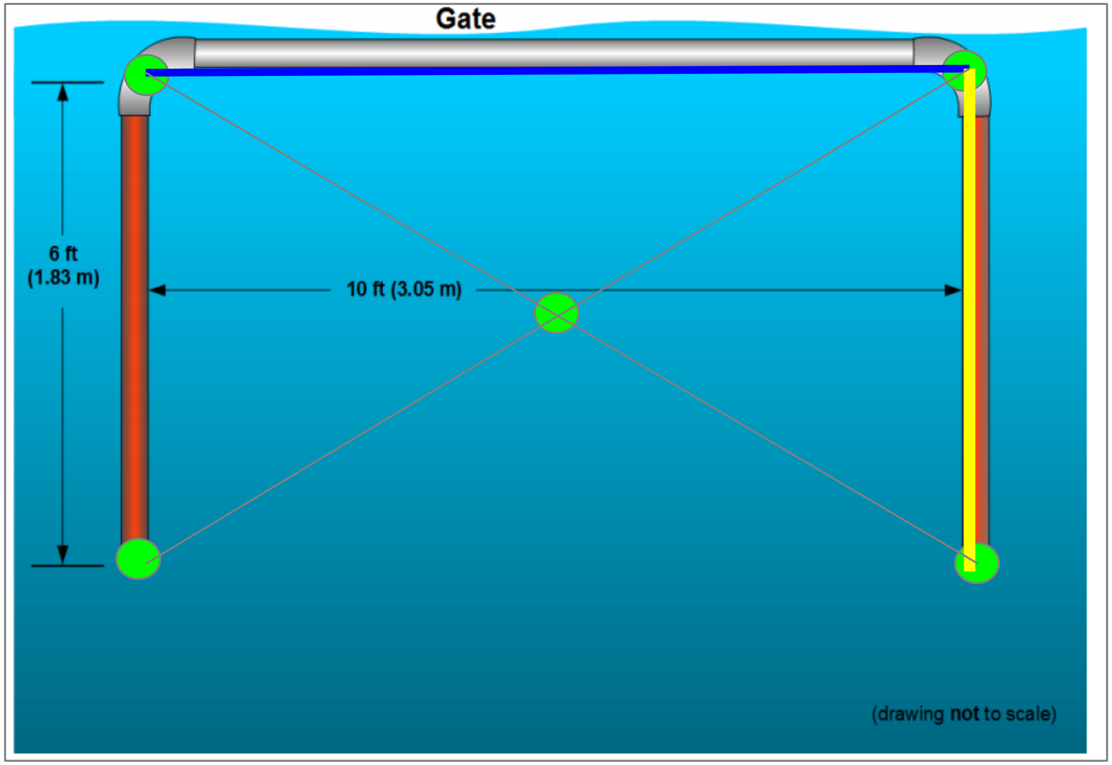
Mission Control



Mission Control



Mission Control (Gate Passing)



Risk Analysis

Risk	Vehicle Balance Problem
Probability	High
Consequence	Severe
Strategy	1. Develop a good algorithm for balancing the vehicle using data from IMU 2. Conduct extensive tests under different environment or conditions

Test Plan / Report

Test Description	Pass / Fail
Thruster bidirectional rotation	Pass
Communication between Arduino and Host	Pass
Linux inter process communication	Pass
Depth Maintainability	N/A
Vehicle Speed	N/A
Vehicle Balancing	N/A
Competition Timing	N/A

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.

Status

Current	Remaining
Camera Enclosures	System Upgrade
OpenCV on BBxM	Underwater Testing
Path Detection on BBxM	Path Detection
	Task Identification

Progress

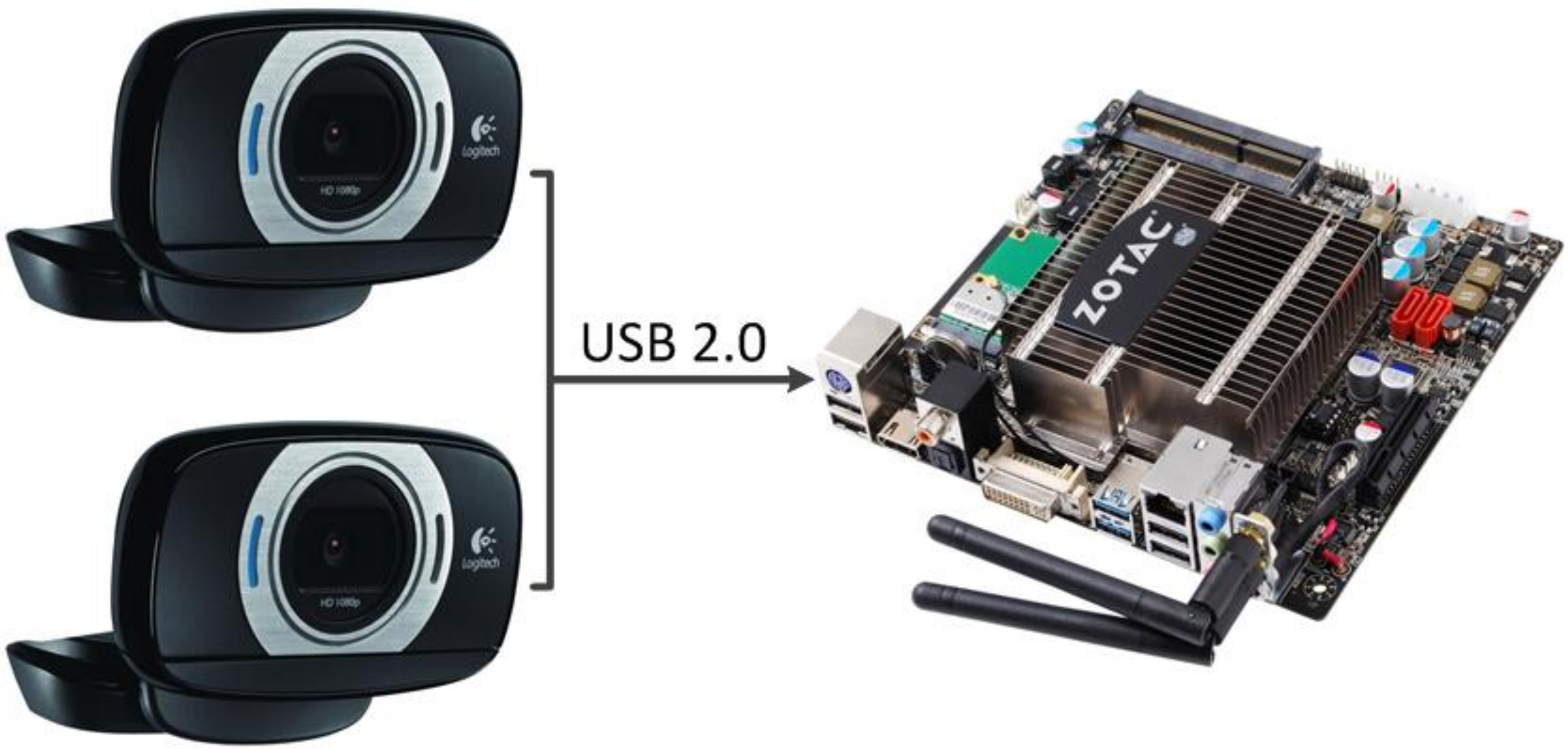
Hardware

Ryan

Hardware – System Upgrade

Logitech C615

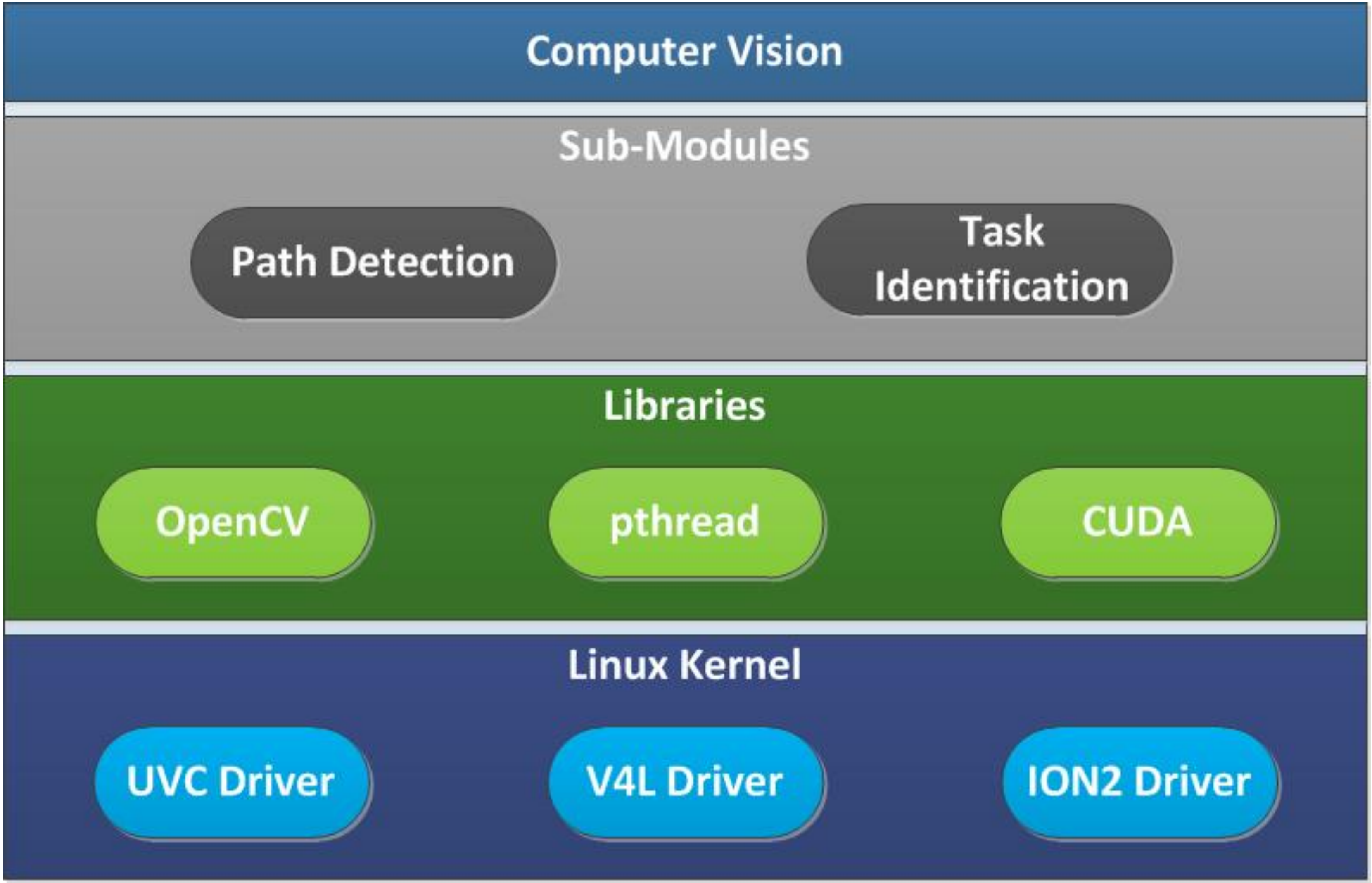
Zotac Zbox ID41 Plus



Auto-Light
Auto-Focus

Intel Atom D525 1.8GHz Dual-Core CPU, 2GB RAM, 250GB HDD, 512MB NVIDIA ION2 GPU

Software


Computer Vision
Sub-Modules
Path Detection
Task Identification
Libraries
OpenCV
pthread
CUDA
Linux Kernel
UVC Driver
V4L Driver
ION2 Driver

Path Detection Algorithm

1. **Initialize variables and structures**
   1. `CvCapture *capture`
   2. `IplImage *frame, *hsv_frame, *thresholded`
2. **`capture = cvCaptureFromCAM(0)`**
3. **Loop**
   1. `frame = cvQueryFrame(capture)`
   2. `cvCvtColor(frame, hsv_frame,CV_BGR2HSV)`
   3. `cvInRangeS(hsv_frame, hsv_min, hsv_max, thresholded)`
   4. `cvDilate`
   5. `cvFindContours`
   6. `cvFitEllipse2`
   7. Determine angle (major axis of ellipse and x-axis)

Ryan

New Risks

Risk	Probability	Severity	Mitigation Strategy
Camera Range	Low	Severe	Buy Better Camera
Insufficient Performance BBxM	Moderate	Severe	Switch to PC Platform*

*Due to insufficient performance, the system has been upgraded.

Test Plan / Report

Test Description	Pass / Fail	Notes
Logitech C615 on BBxM	P	640x480 at 3fps 320x240 at 10fps
Basic OpenCV on BBxM	P	640x480 at 1fps
Path Detection on BBxM	F	Not enough performance to run mission controller and path detection
Stress Test on BBxM	F	Very slow when processing a lot of data/images
Stress Test on Zotac ID41	N/A	Will be done on Wednesday, February 8, 2012

Mechanical Overview and Hull/Camera Enclosures

Eric Sloan

Eric

Status

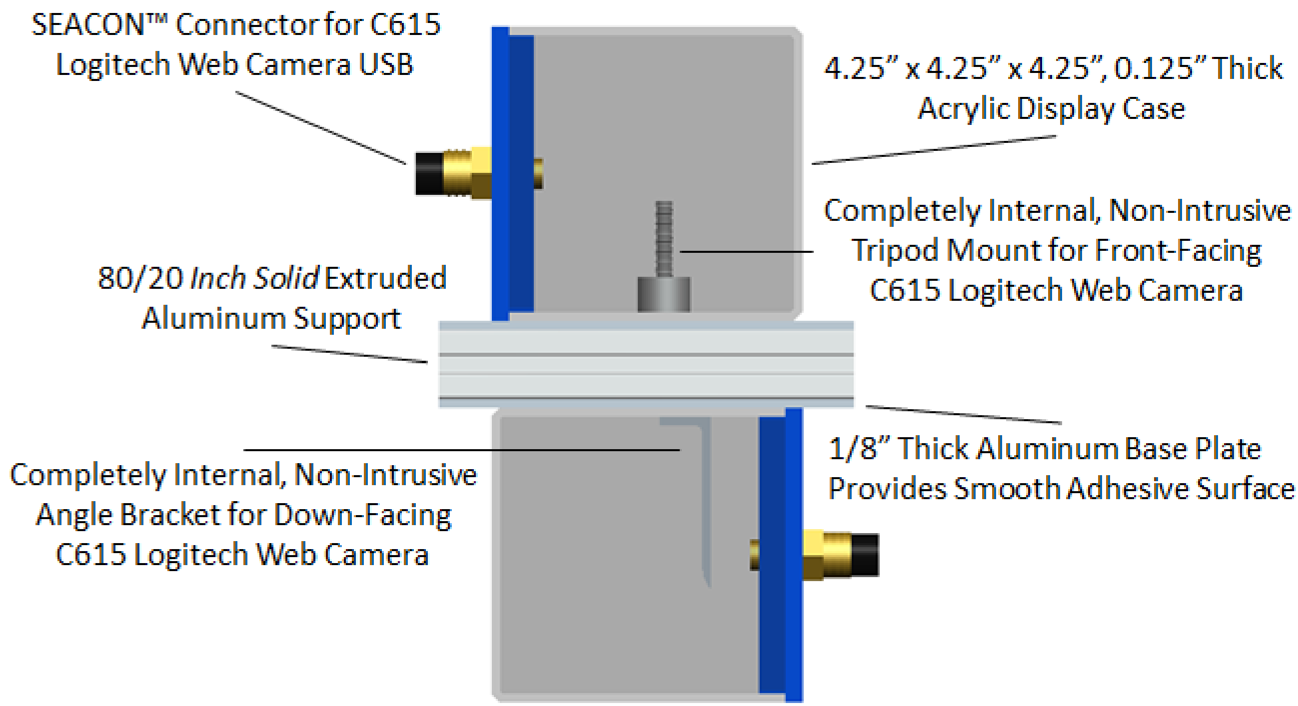
Current

- Frame
- Hull
- Camera Enclosures
- Compressed Air Distribution System
- Torpedoes
- Torpedo Launchers
- Marker Dropper
- Thrusters
- Pressure Transducer
- Hydrophones Array

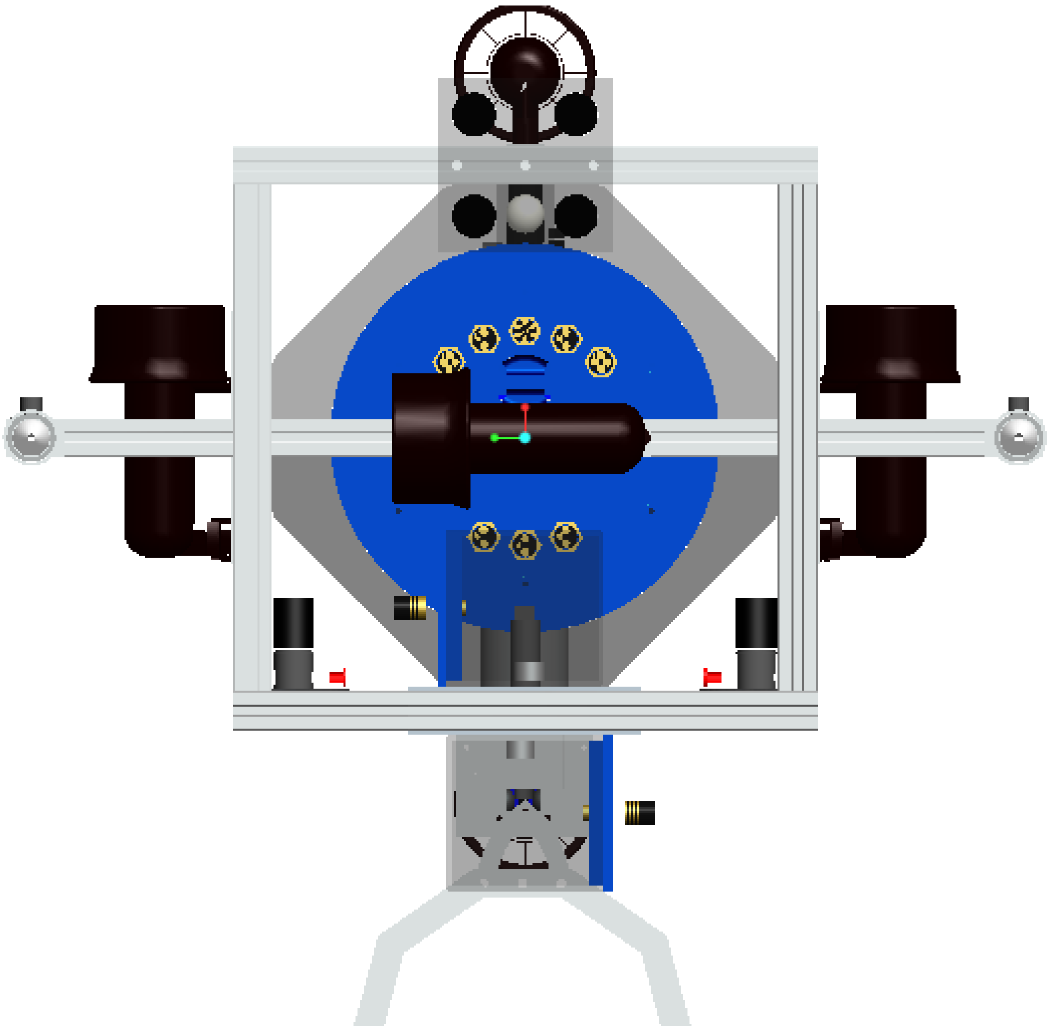
Remaining

- Revised Electronics Rack
- Grasp/Release Mechanism Jaws
- SEACON™ Connectors
- PCB Versions of Solenoid Valve and Hydrophones Interface Circuits
- Installation of Electronics Inside Hull

Camera Enclosures (Revised)

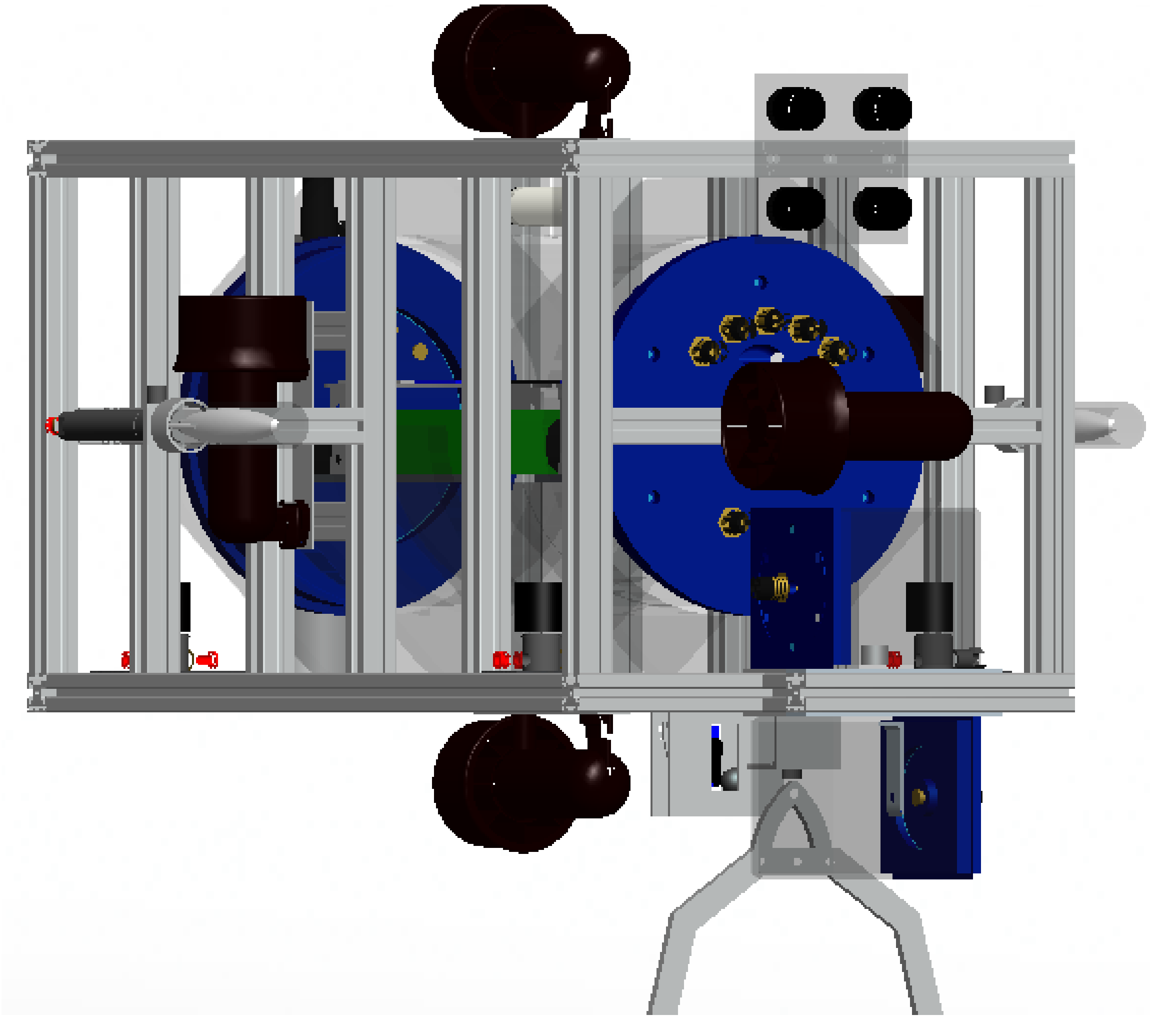


Final AUV Design (Revised) - Front



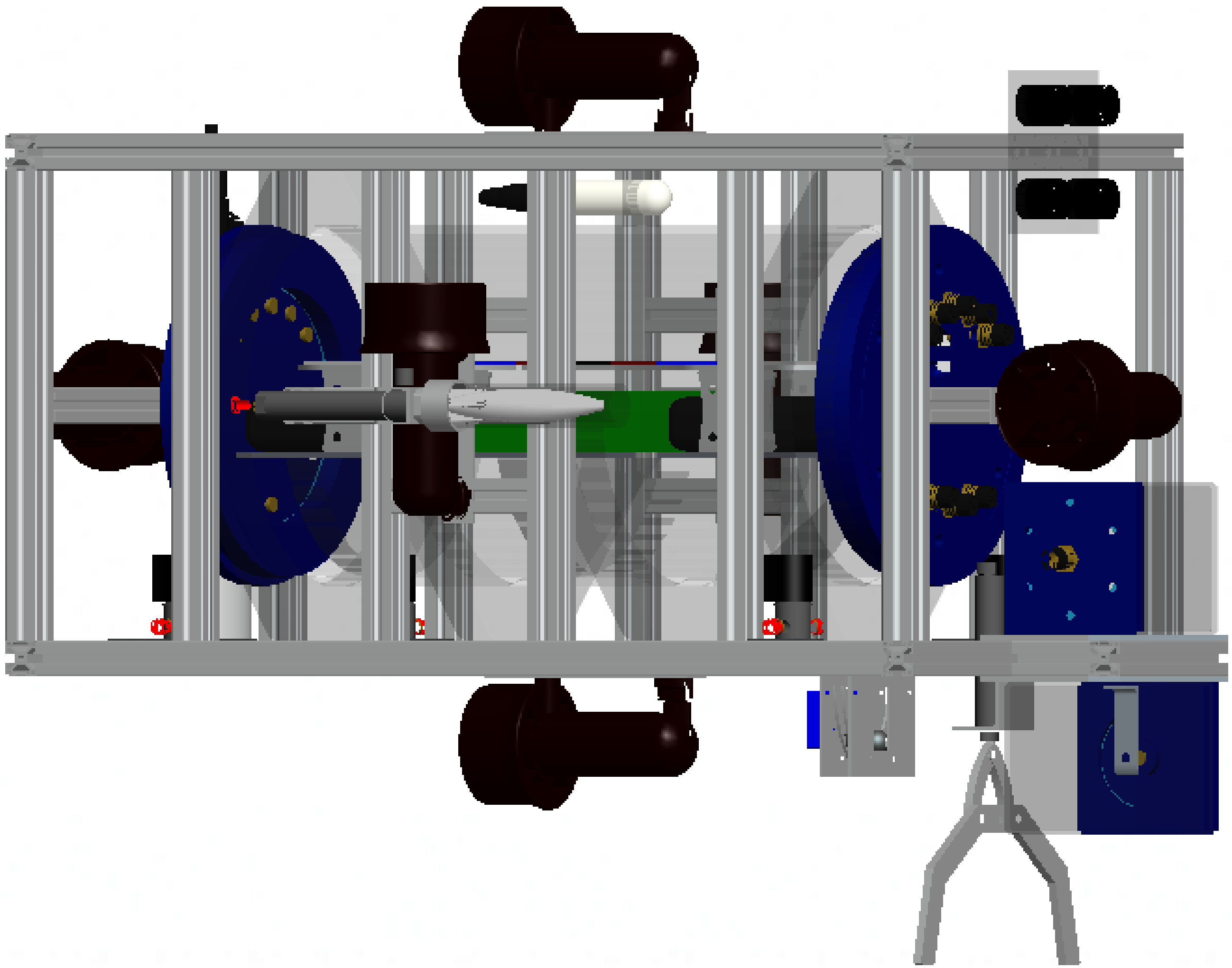
Eric

Final AUV Design (Revised) - Side

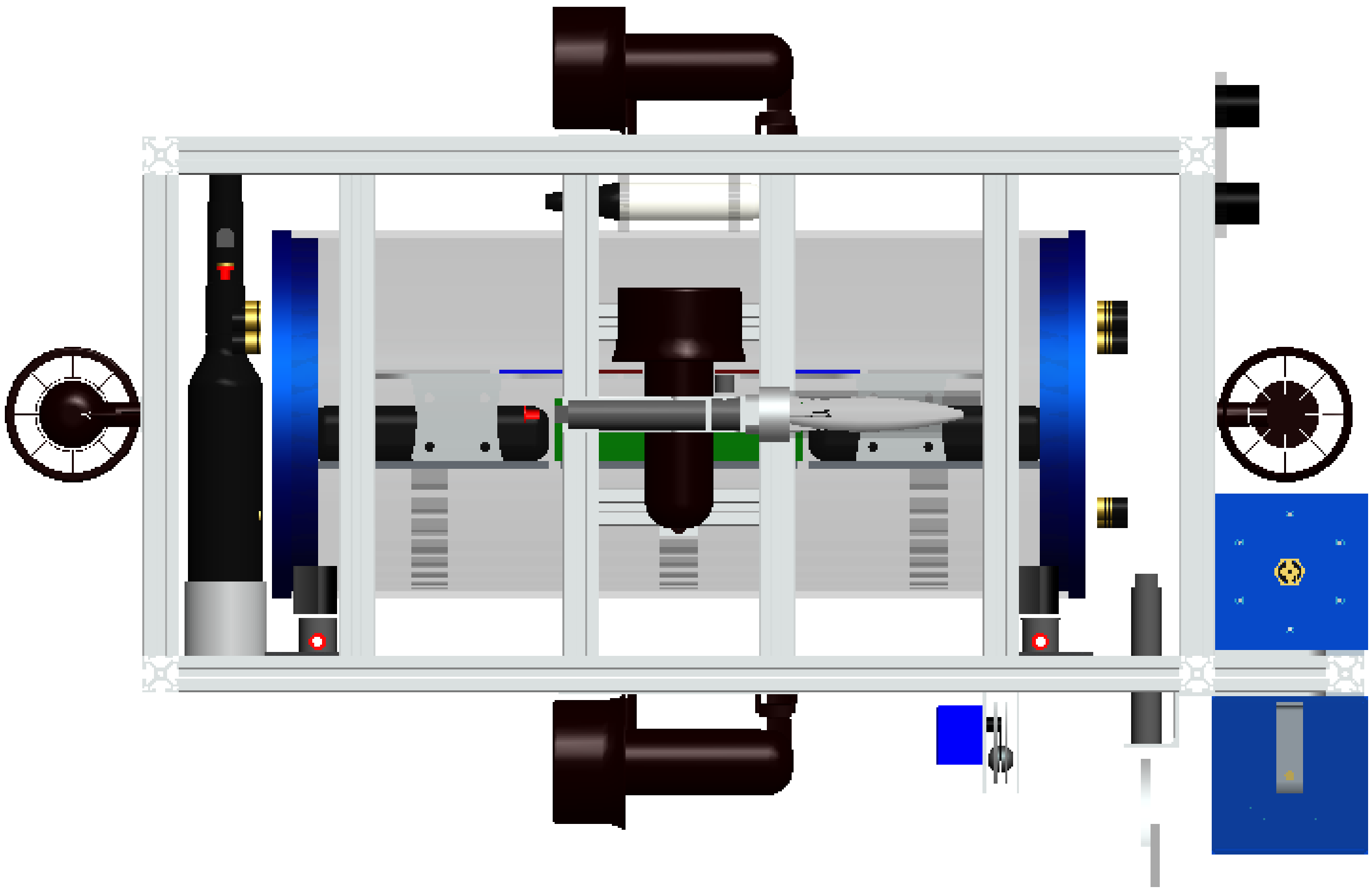


Eric

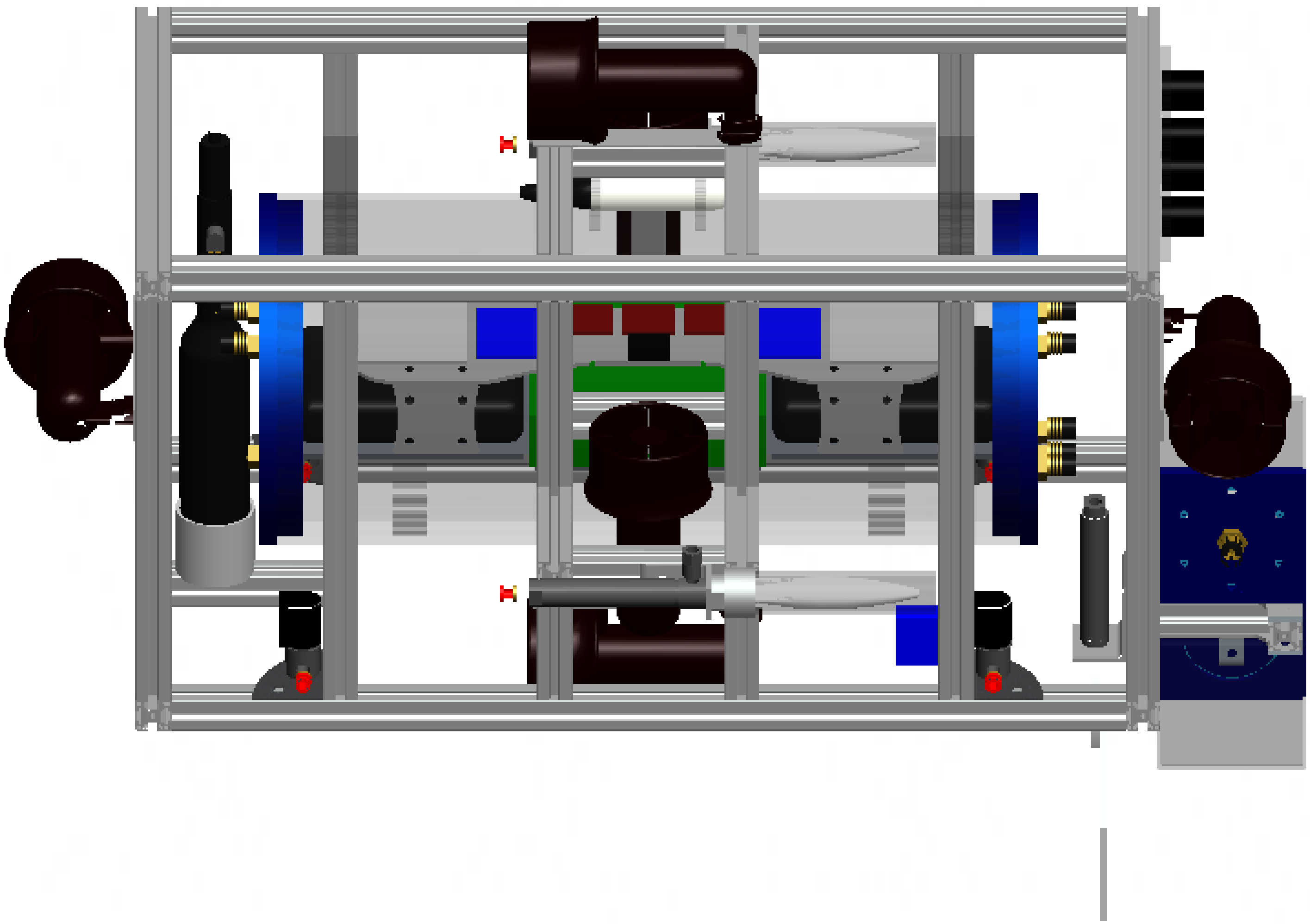
Final AUV Design (Revised) - Side



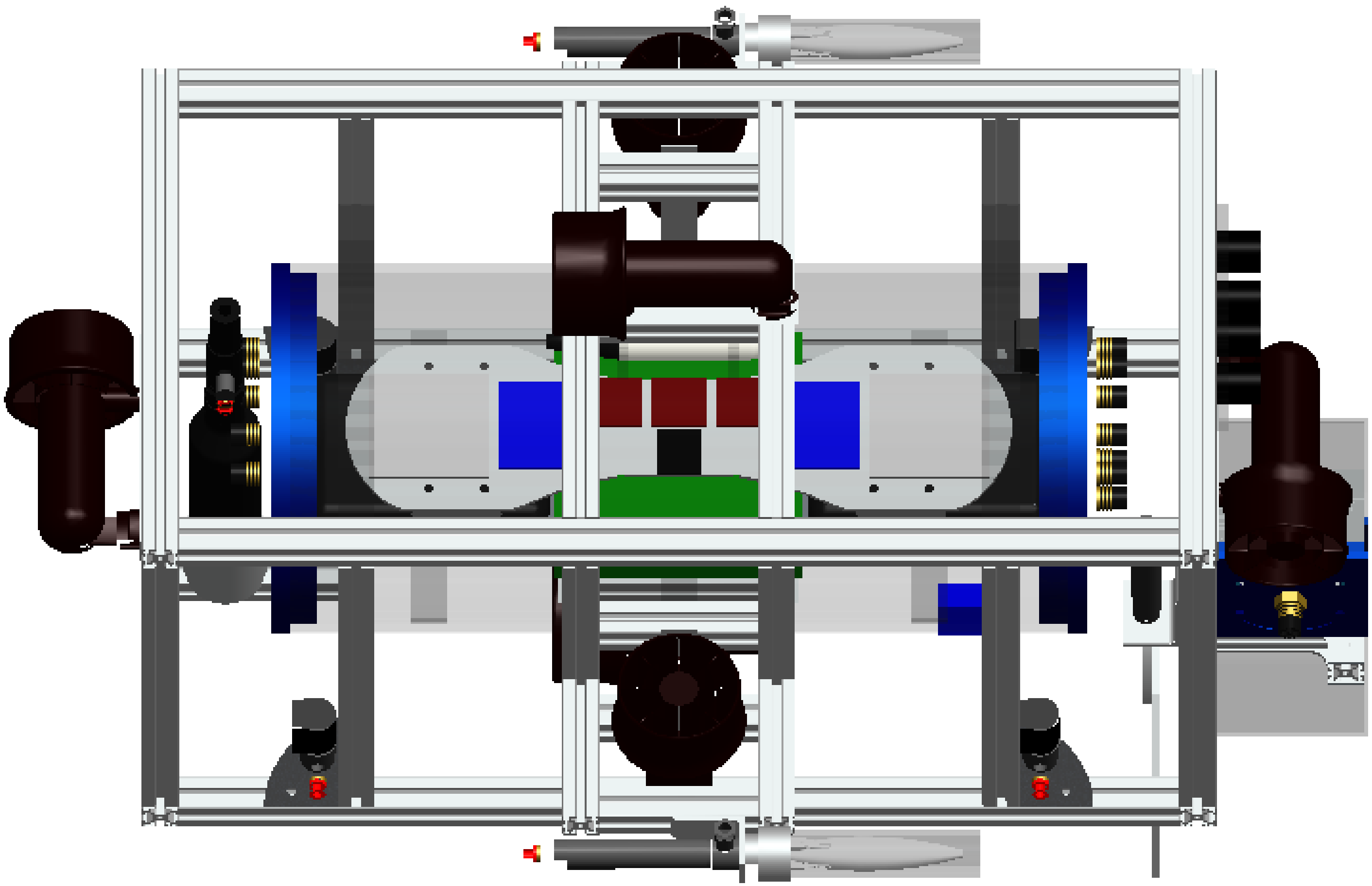
Final AUV Design (Revised) - Side



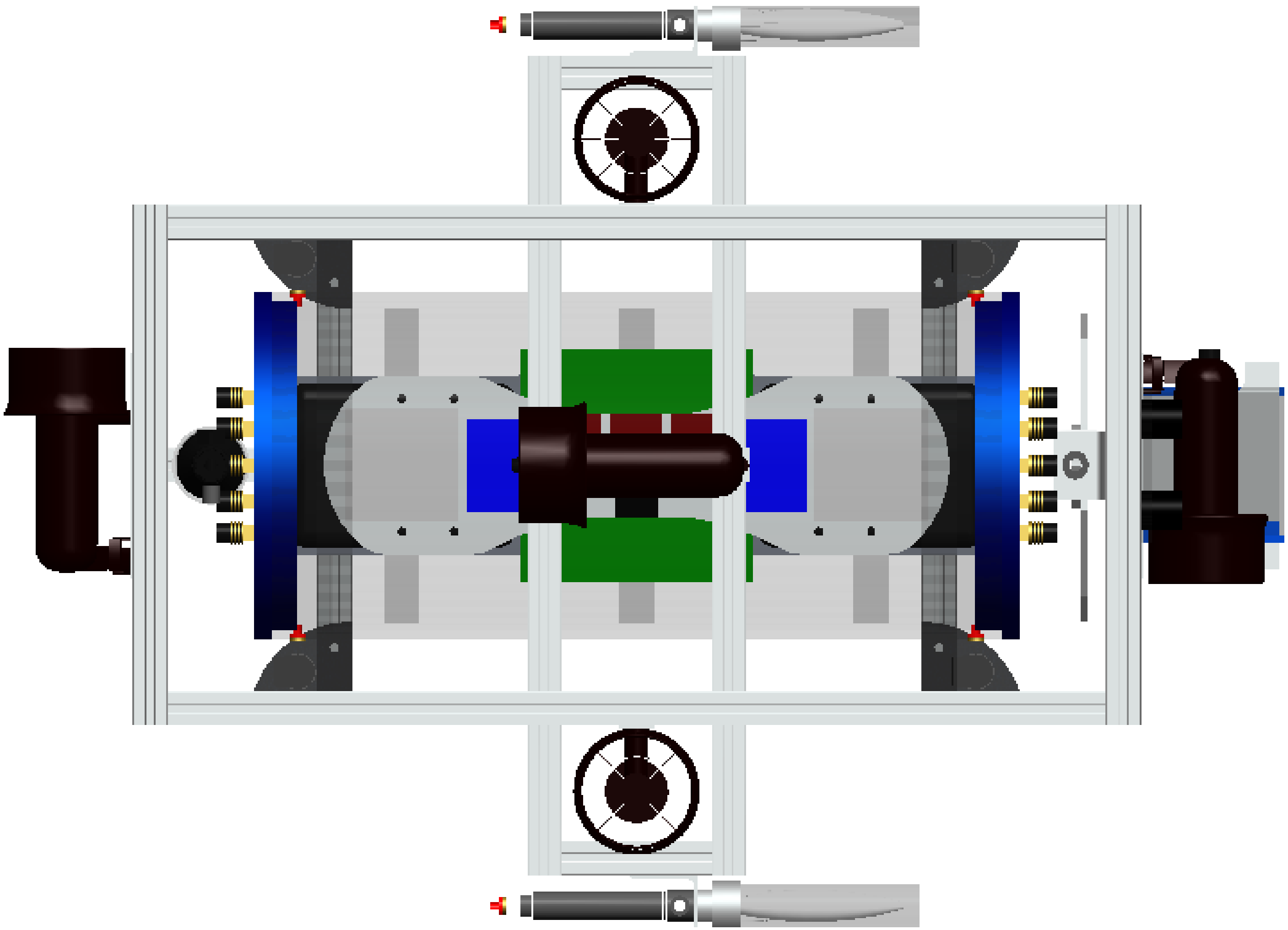
Final AUV Design (Revised) - Top



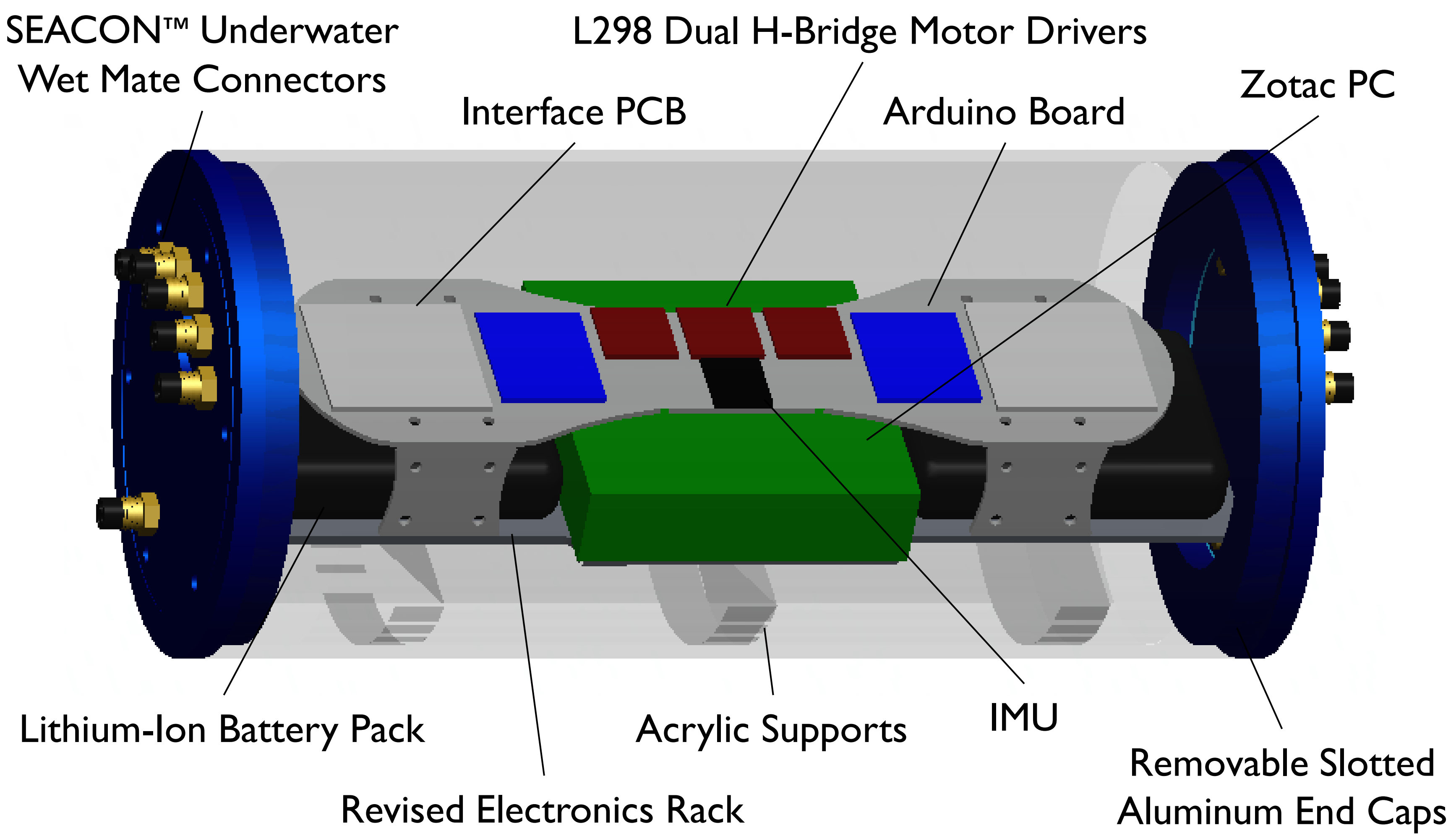
Final AUV Design (Revised) - Top



Final AUV Design (Revised) - Top



Interior Hull Layout (Revised)



Risk Analysis

Risk	**Vehicle density greater of less than optimal target density**
Probability	Low
Consequence	Moderate
Strategy	Symmetrically add "dummy mass" to adjust the vehicle's density while naturally balancing the vehicle

Eric

Test Plan / Report

Test Description	Pass / Fail	Notes
Watertight Test – Hull (Pre-SEACON)	Pass	No leakage
Watertight Test – Camera Enclosures (Version 1)	Pass	No leakage
Preliminary Weight Test	Pass	On pace for projected total AUV weight of 84 lb
Watertight Test – Camera Enclosures (Version 2)	N/A	Will be completed and tested this week
Watertight Test – Hull (Post-SEACON)	N/A	Will be conducted upon arrival and integration of SEACON™ connectors

Compressed Air Distribution System and Torpedo Launcher

Kashief Moody

Compressed Air Distribution Overview

Objective

- Distribute pressure-regulated air to the grasp/release mechanism and torpedo launchers upon command from the Arduino Duemilanova Board

Requirements

- Store air used for mechanical sub-systems.
- Reduce initial air pressure to a desired operational pressure
- Allow individual actuation of the mechanical sub-systems

Status

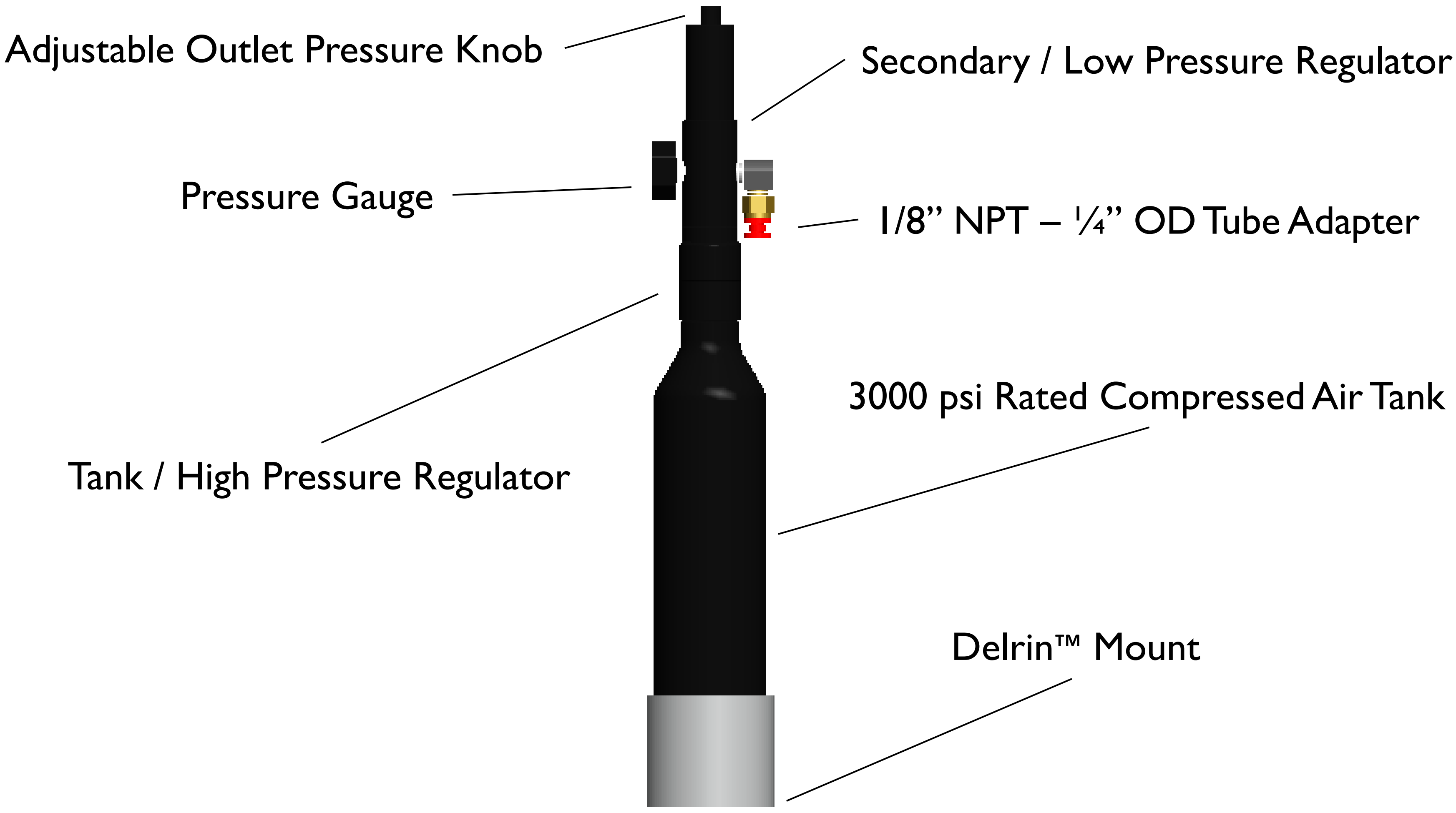
Current

- System completed

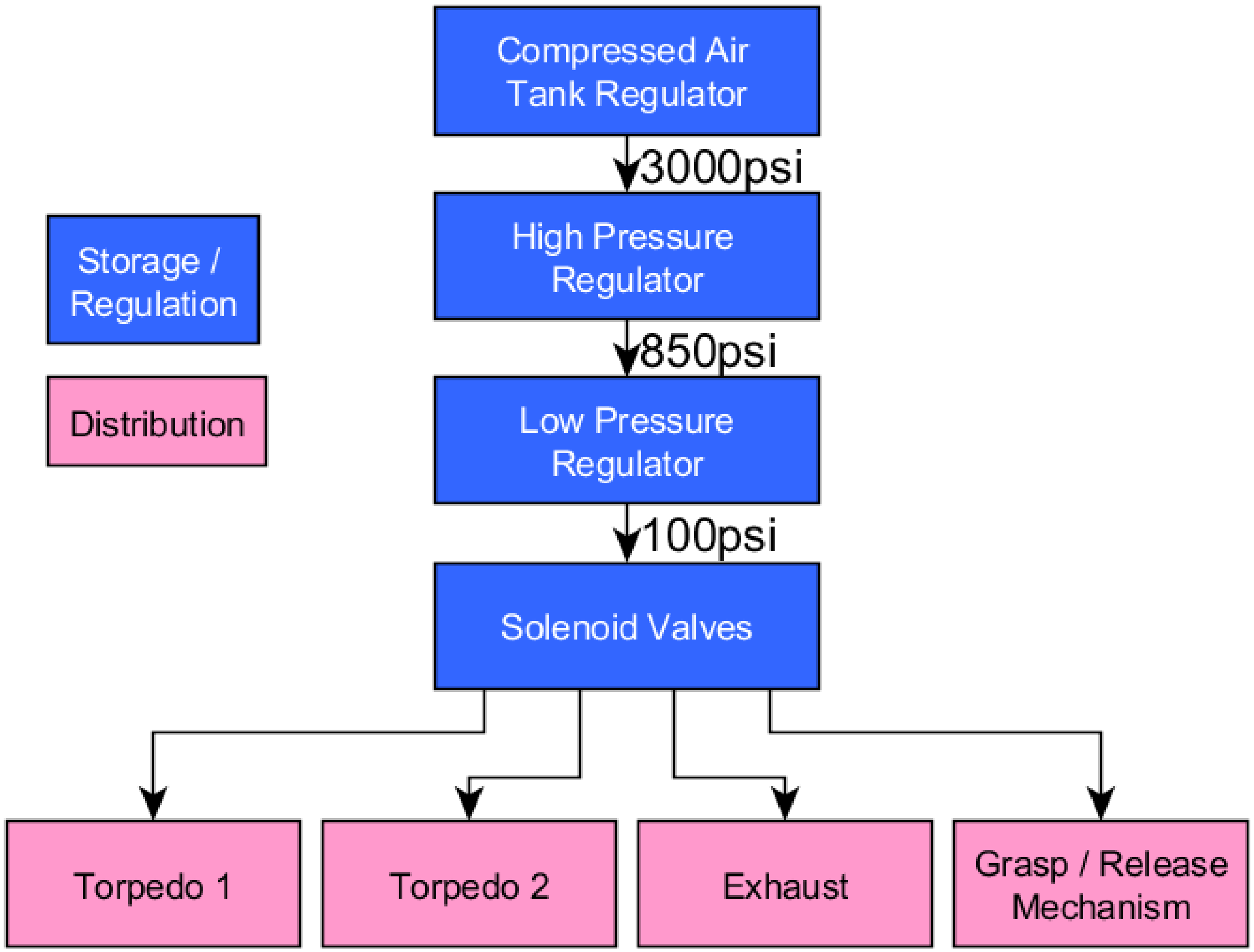
Remaining

- Test for leakage through gas lines when submerged
- Optimize operational air pressure (≈ 100 psi)

Compressed Air Tank and Regulators



System Diagram



Test Plan / Report

Test Description	Pass / Fail	Notes
Solenoid Valves	Pass	Actuate at 4 V – 5 V rather than the specified 12 V
Pressure Regulation/Gas Line Leakage	Pass	Pressure regulation scheme functioned as planned

Torpedo Launchers Overview

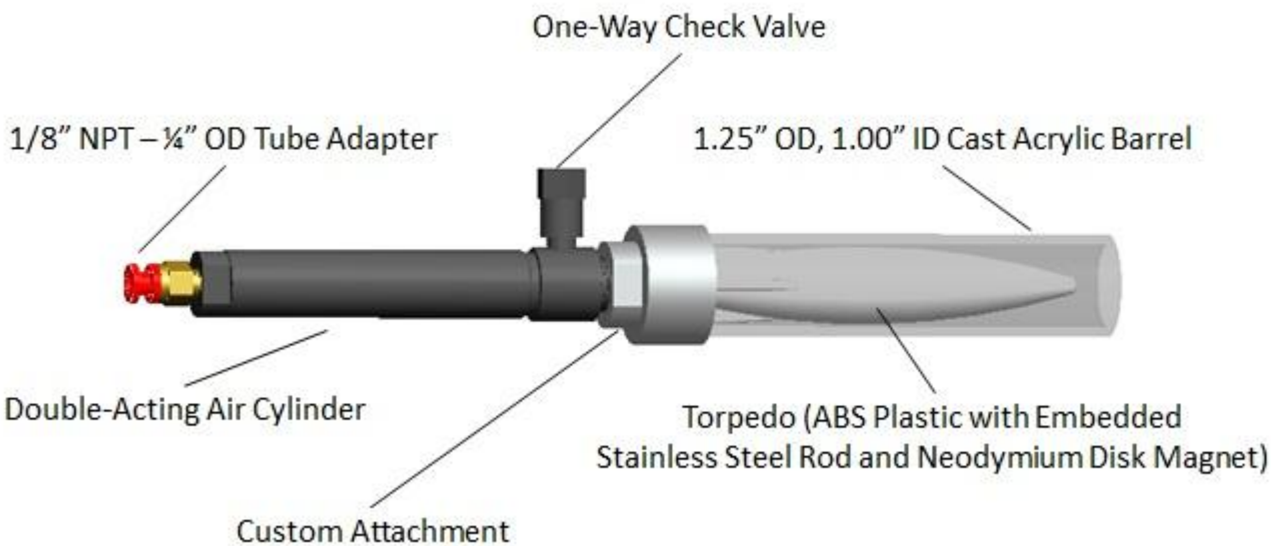
Objective

- Individually launch torpedoes through designated PVC cut-outs (Kill Caesar)

Requirements

- Secure the torpedoes prior to actuation
- Accurately and consistently launch the torpedoes at a sufficient speed when actuated
- Proper density, balance, and hydrodynamics of torpedoes

Torpedo Launcher Design (Revised)



Status

Current

- System completed

Remaining

- Test underwater

Test Plan / Report

Test Description	Pass / Fail	Notes
Torpedo Performance (Density, Balance, Hydrodynamics)	Pass	
Torpedo Launcher Test - Air	Pass	Accurately flew 8 – 10 feet prior to landing
Torpedo Launcher Test - Water	N/A	Will take place following integration of SEACON™ connectors and electronics

Grasp / Release Mechanism and Marker Dropper

Tra Hunter

Grasp / Release Mechanism Overview

Objective

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

Requirements

- Grasp a laurel wreath rescue object
- Hold rescue object while vehicle surfaces
- Submerge and release the laurel wreath

Status

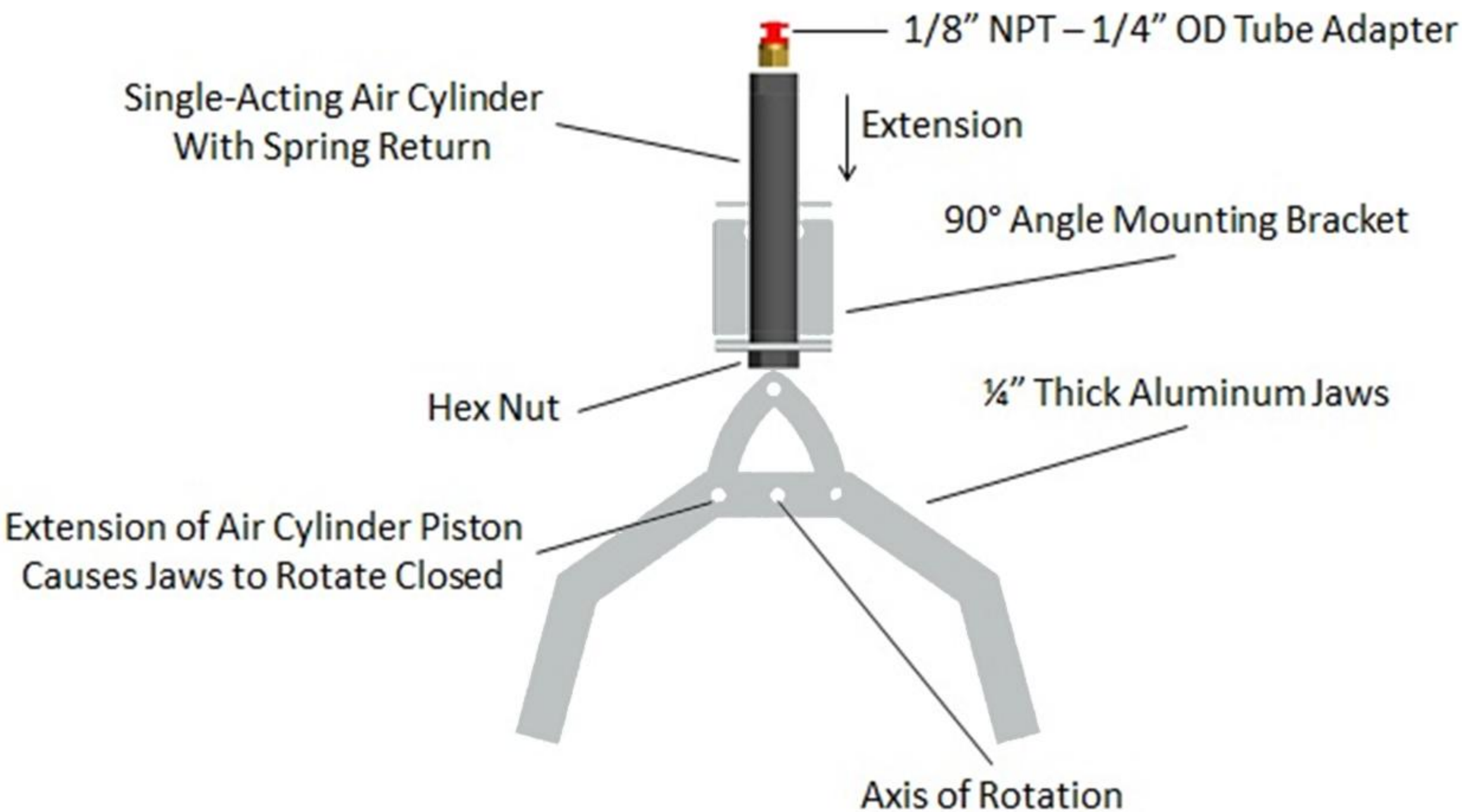
Current

- Finalize details of jaw design
- Test single-acting air cylinder with compressed air distribution system

Remaining

- Manufacture components
- Test integrated mechanism both in air and under water

Components


1/8" NPT – 1/4" OD Tube Adapter
Single-Acting Air Cylinder
With Spring Return
Extension
90° Angle Mounting Bracket
Hex Nut
¼" Thick Aluminum Jaws
Extension of Air Cylinder Piston
Causes Jaws to Rotate Closed
Axis of Rotation

Test Plan / Report

Test Description	Pass / Fail	Notes
Single-acting air cylinder test	P	
Grasping capabilities	N/A	Pending construction

New Risks

Risk	Mechanism Grasps Either Too Slow or Too Fast
Probability	Moderate
Consequence	Low
Strategy	Adjust regulated compressed air pressure as needed without significantly compromising performance of torpedo launchers

Marker Dropper Overview

Objective

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

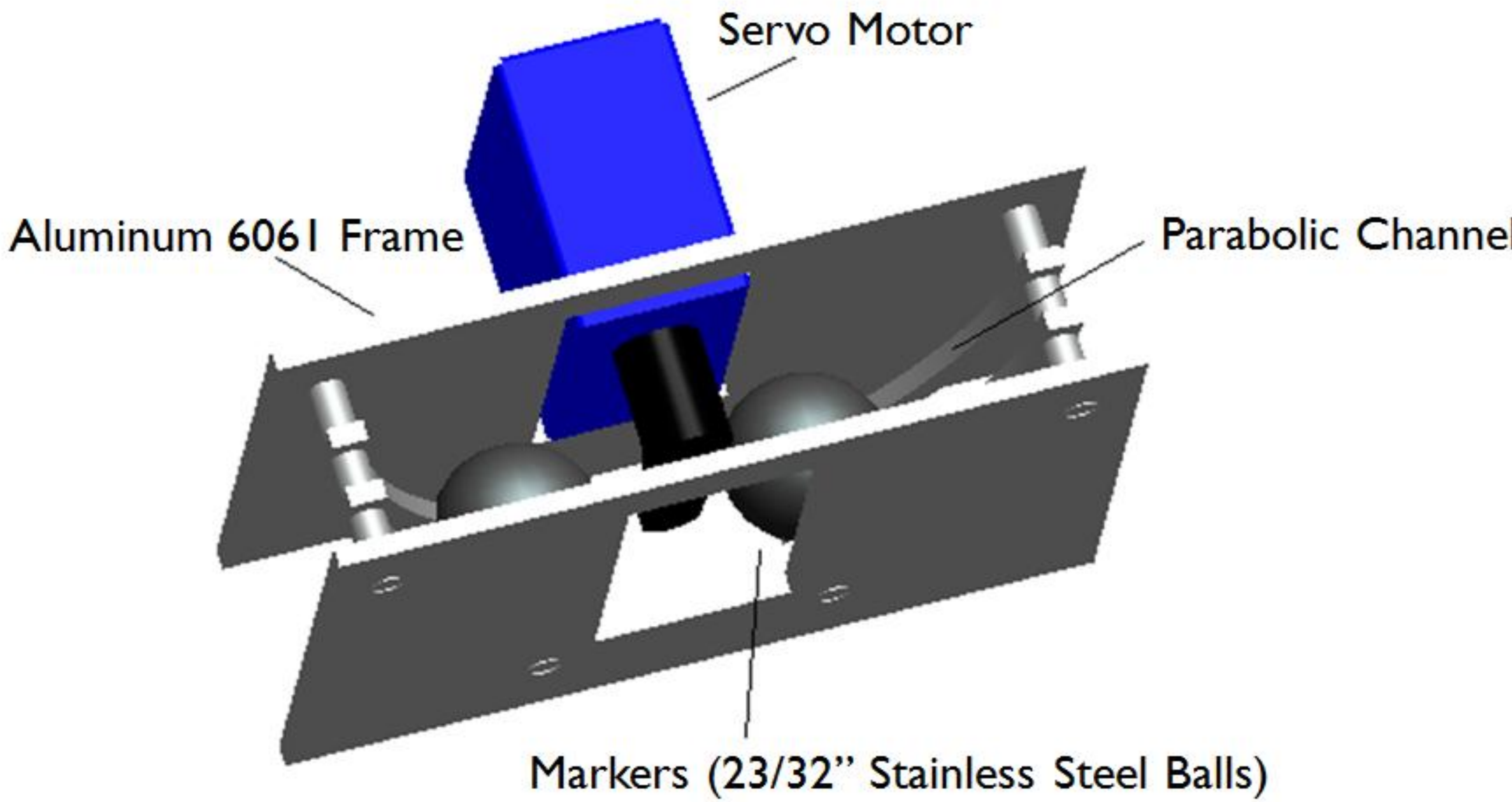
Requirements

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

Status

Current	**Remaining**
Mounted on bottom of AUV	Find alternate servo motor
Determine servo condition	Integrate servo into electrical system
	Test accuracy

Components


Servo Motor
Aluminum 6061 Frame
Parabolic Channel
Markers (23/32" Stainless Steel Balls)

Test Plan / Report

Test Description	Pass / Fail	Notes
Servo motor test	Fail	Order new servo
Ball drop test	N/A	Pending construction

Budget

Tra Hunter

Current Budget

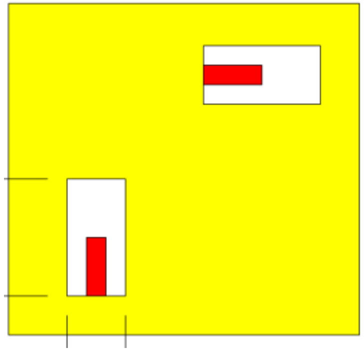
Fall Expenditures		**$4,479.36**
Spring Expenditures	Compressed Air Tank, Regulators, Gas Lines	$313.71
	SQ26-01 Hydrophones (2)	$415.00
	Redesigned Camera Enclosures	$52.50
	IMCL Submersible Pressure Transducer	$407.47
	Miscellaneous (Nuts, Bolts, Adapters, Adhesives, Sealants, Raw Materials)	$487.95
Remaining Expenditures	SEACON™ Connectors (2)	$150.00
	Zotac Zbox	$300.00
	Miscellaneous (Nuts, Bolts, Servo Motor)	$50.00
Travel/Shipping/Lodging Expenditures		$6,700.00
Competition Fee		$500.00
Total		**$13,855.99**
Current Budget		$9,433.00
Remaining Balance		-$4,422.99

Overall Risk Assessment

Antony

Risk Analysis – Technical

Risk	Cannot Complete All Competition Tasks
Probability	Very High
Consequence	Low
Strategy	Maximize score on existing tasks



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

Schedule

Antony

Questions?