# NAU AUVSI RoboSub 2016

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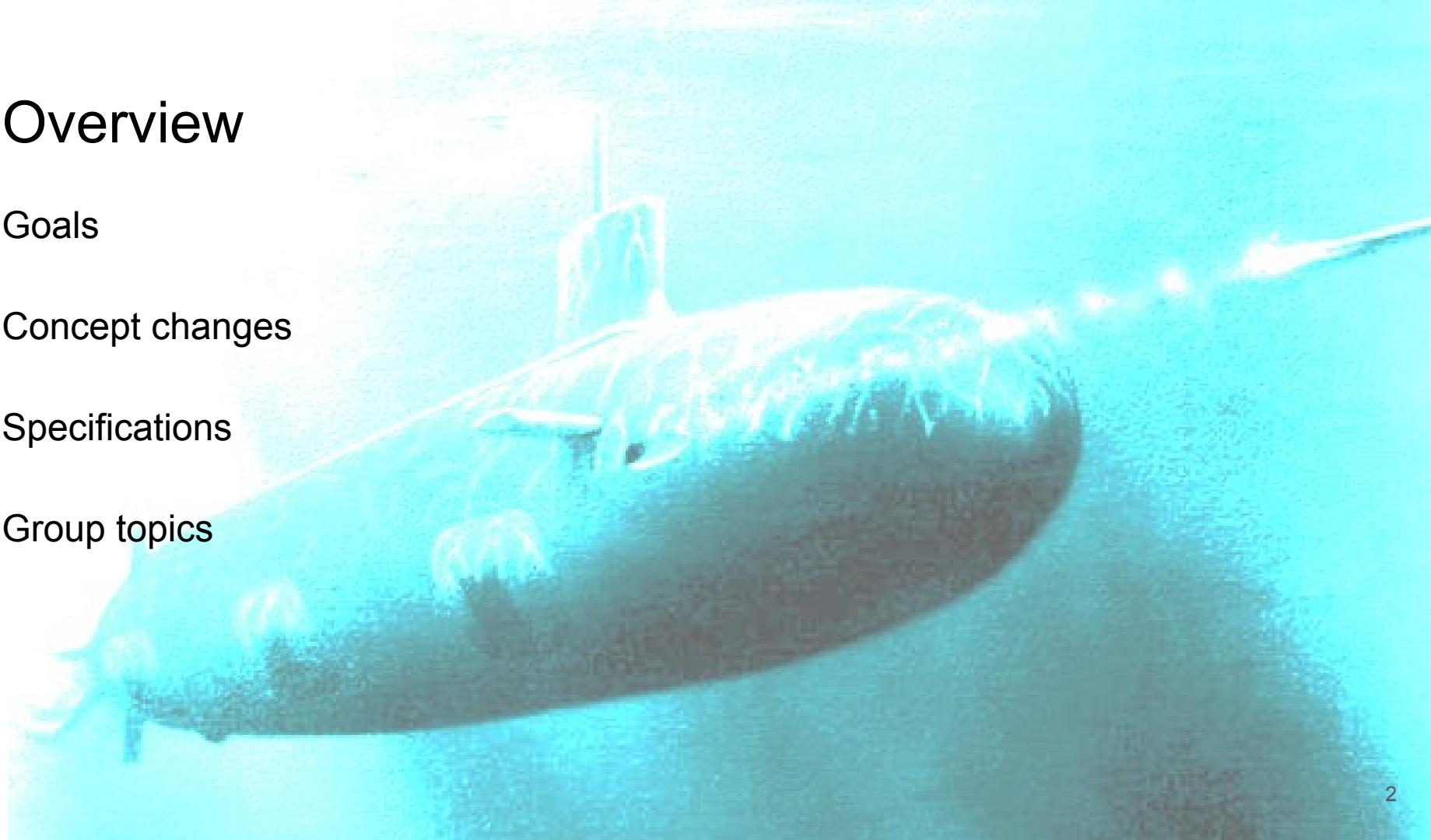
# Overview

Goals

Concept changes

Specifications

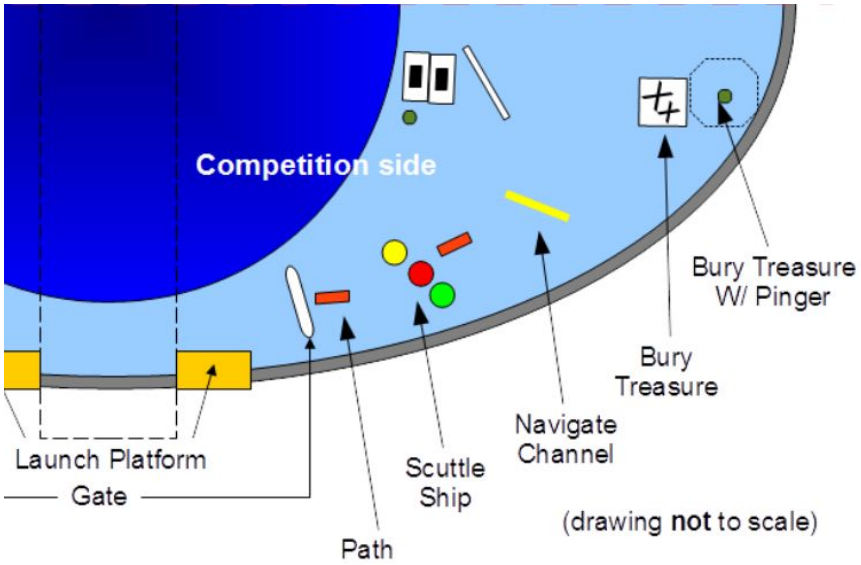
Group topics



# Goals

- Design the “Trident” autonomous underwater vehicle
- Compete in 2016 robosub competition in SD, CA.
- Test in the WAC
- Improve algorithms, electronics and mechanical design

# Competition Tasks



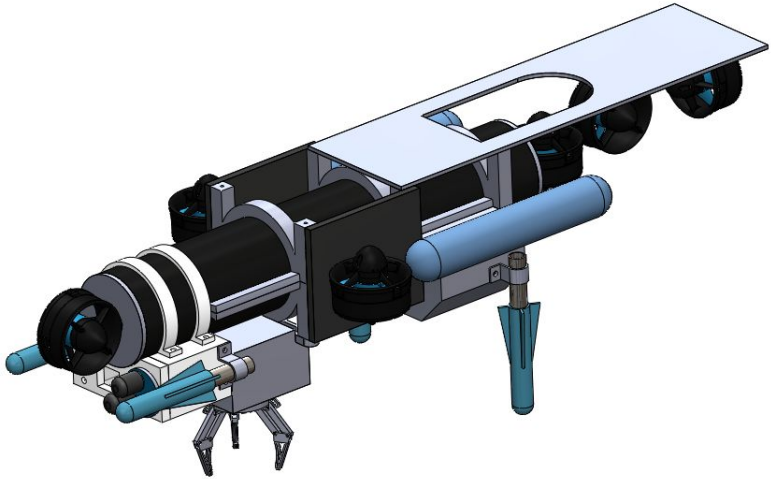

- Detect path markers; orange lines
- Bump buoys in order; red then green, then drag yellow buoy downward
- Navigate through U-shaped PVC channel
- Drop markers in 1 of 2 bins
- Fire torpedos at 1 of 4 targets; various sizes
- Pickup objects near pinger and place next to associated “X”
- Surface in correct area; octagon shape

# Competition Constraints

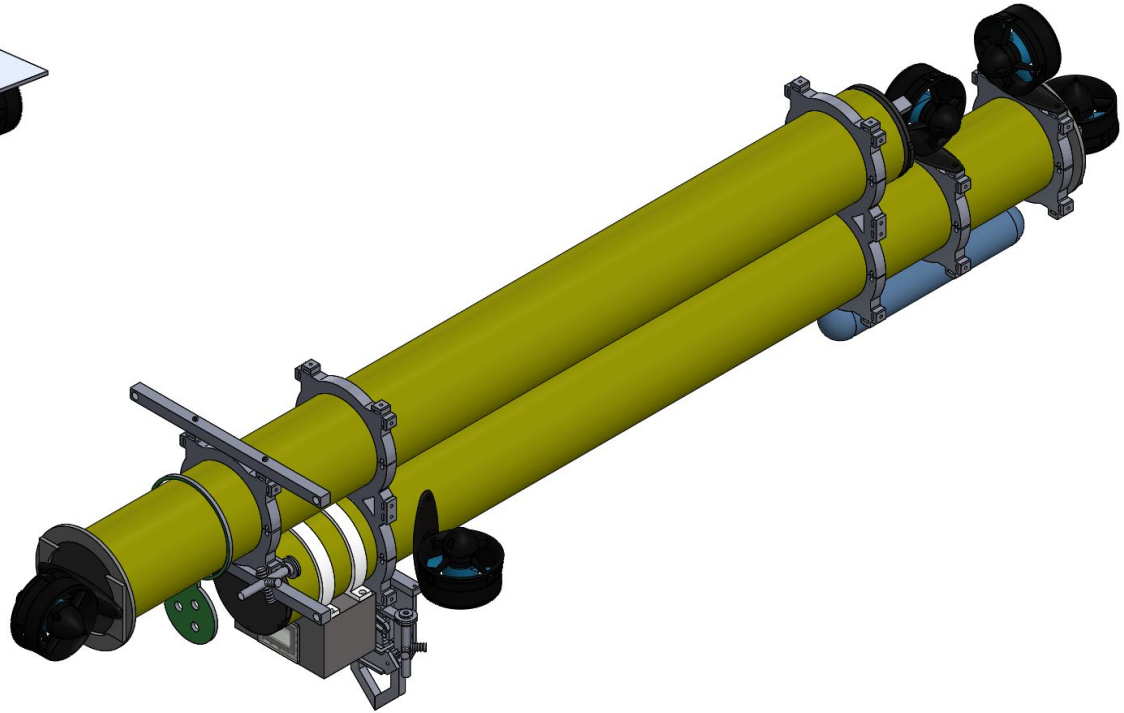
- Submarine must fit in a 1.83 m x 0.91 m x 0.91 m box
- Weigh less than 38 kg for no penalty
- At least 1% buoyant
- Waterproof killswitch which can engage by divers

# Concept

OLD



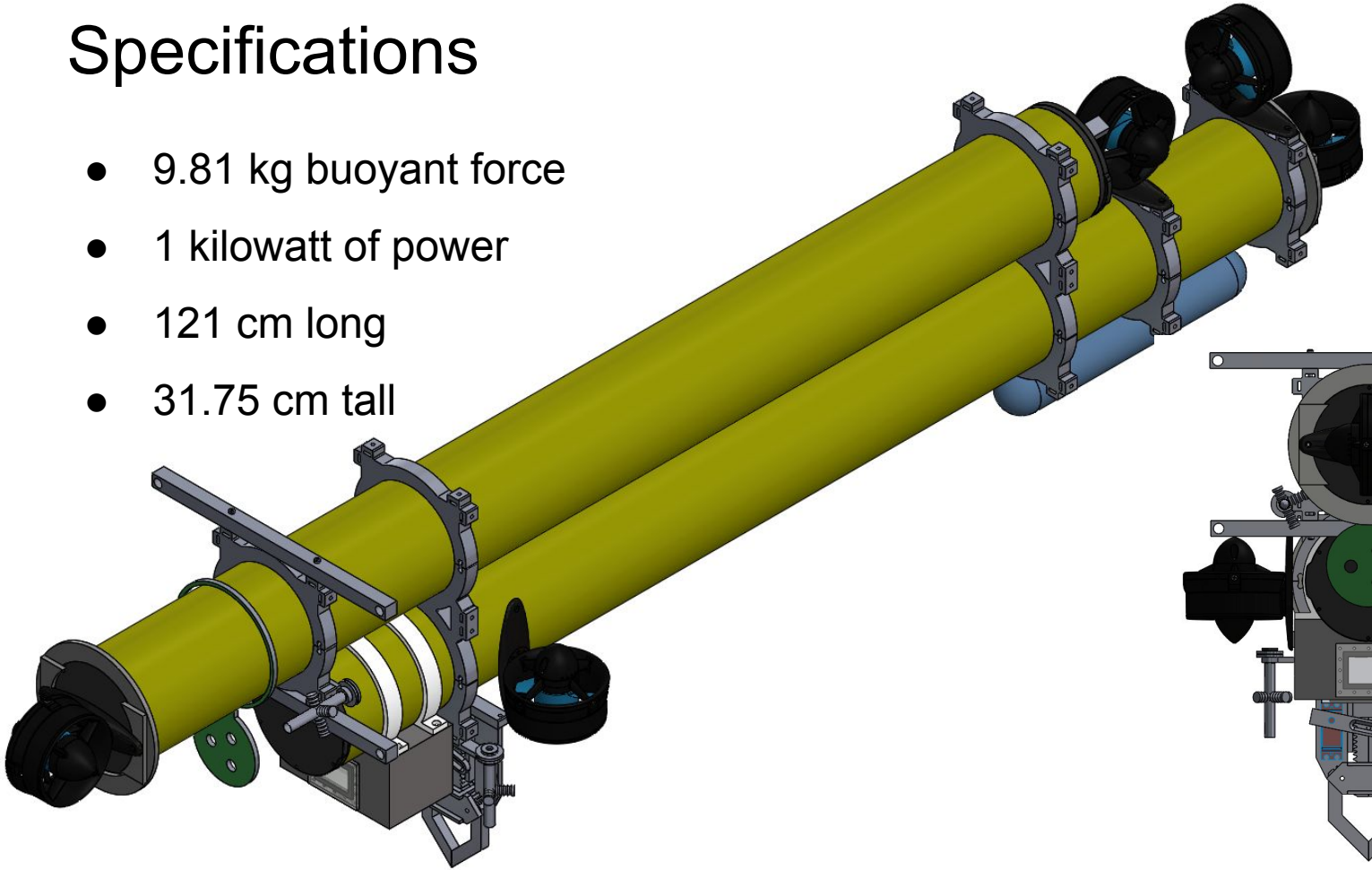
NEW

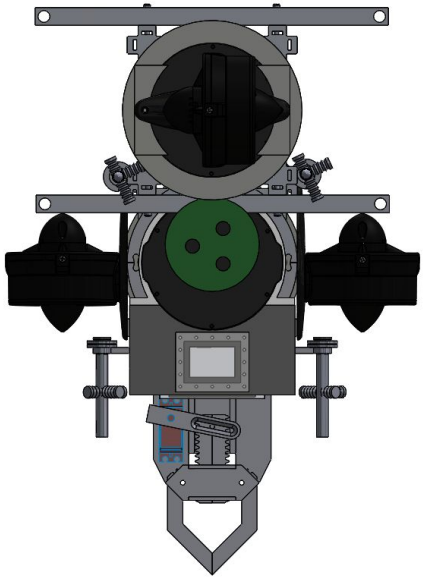


Changes: clamping, torpedo, external frame, camera window, through ports

# Specifications

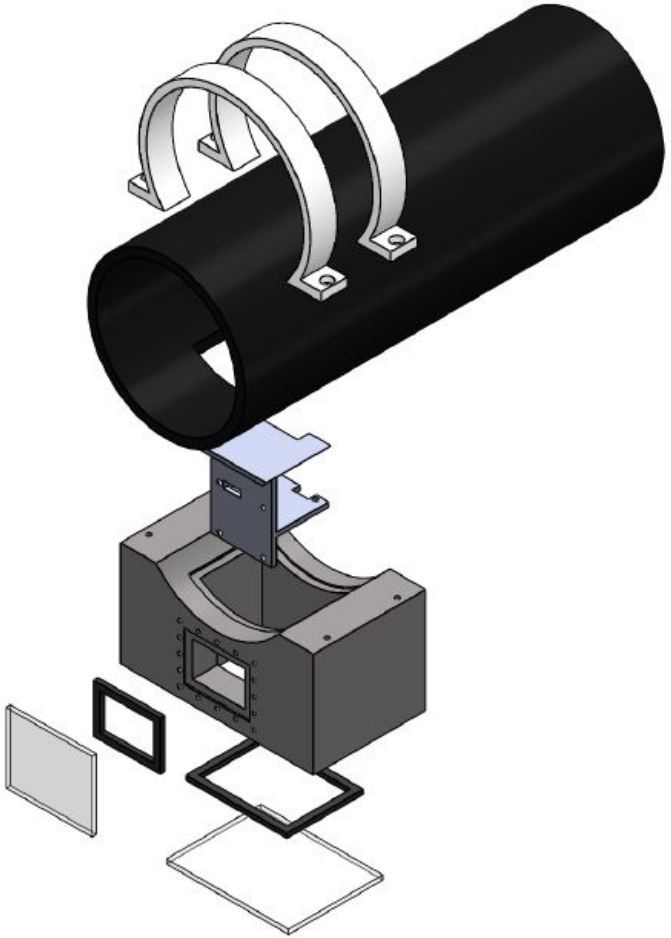
- 9.81 kg buoyant force
- 1 kilowatt of power
- 121 cm long
- 31.75 cm tall





# Camera Box

- Front and bottom facing cameras
- Acrylic windows sealed with epoxy
- Epoxy and clamps to fasten to body

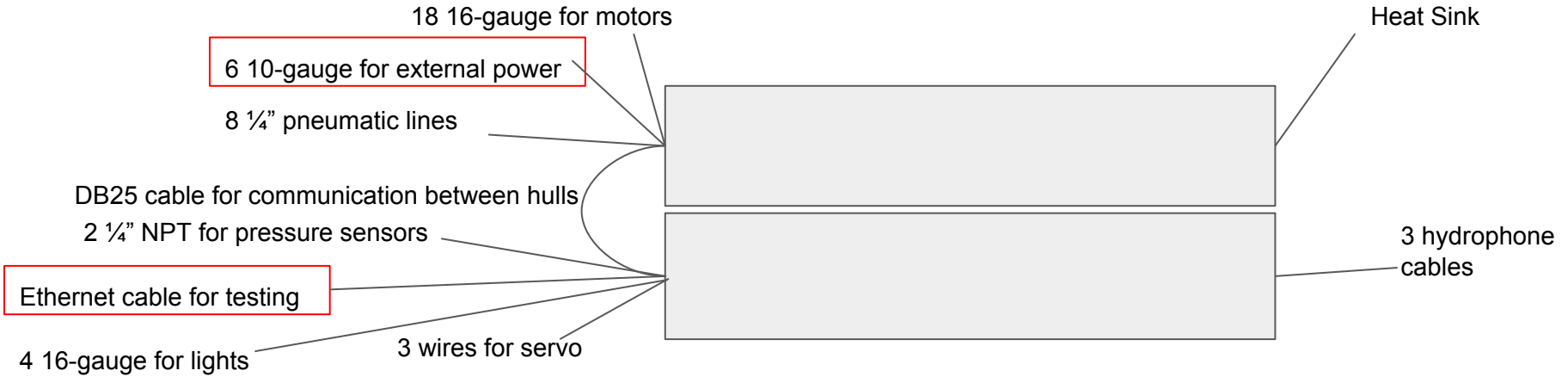


# End Caps

- Gasket
- Aluminum end caps
- Drill holes for wires
- Secure with silicone sealant

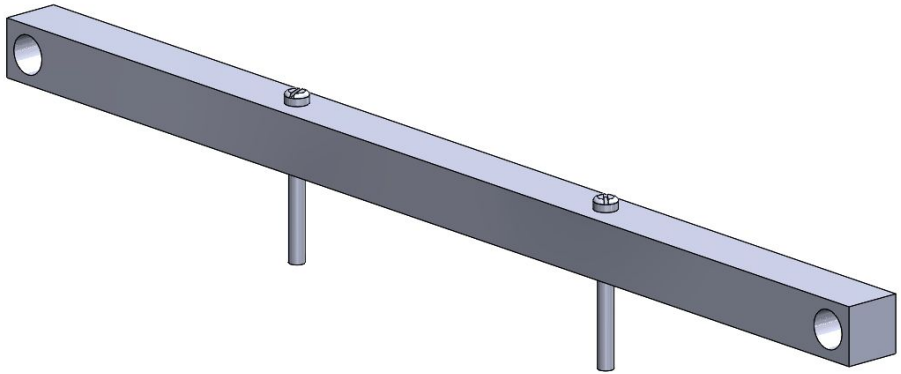
# Through ports

- Permanent cables sealed through endcaps with removable connectors inside
- Removable cables (red boxes) use external pvc connector caps
    - for testing purposes



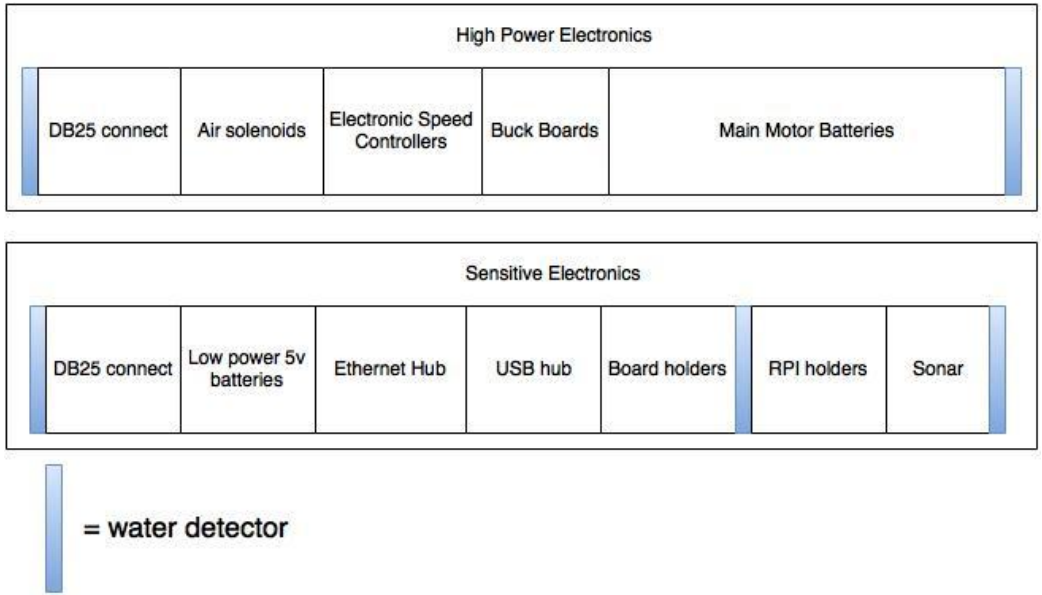
# Light (Princeton Tec Attitude)

- Depth : 500 ft.
- Power 30 Lumens.
- Lamp 3 Ultrabright LEDs.
- Powered by aux board

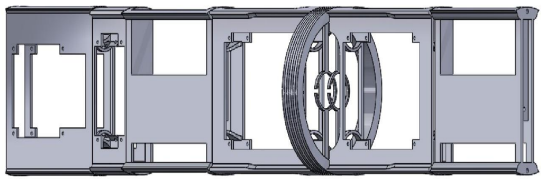


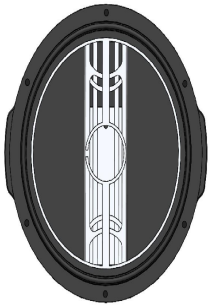
# Internal Frame Concept

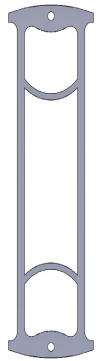
- Modular design
  - Mix and match sections
- Fix slide for fix orientation
- Heat sinks for:
  - Electric Speed Controllers (ESCs)
  - Batteries



# Internal Frame Assembly

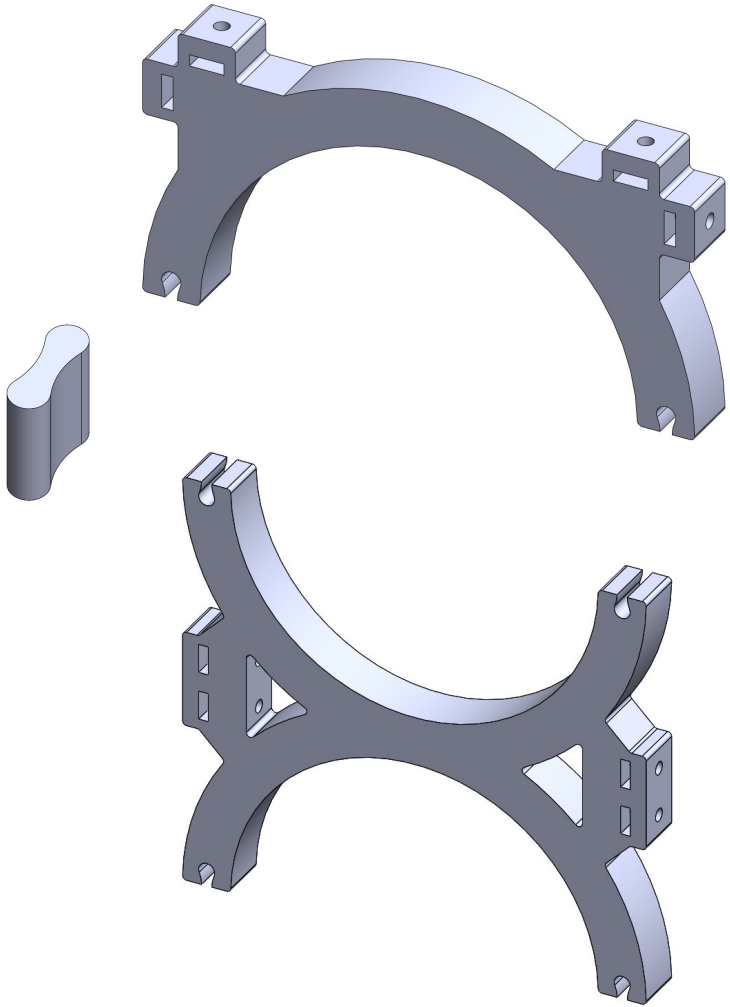






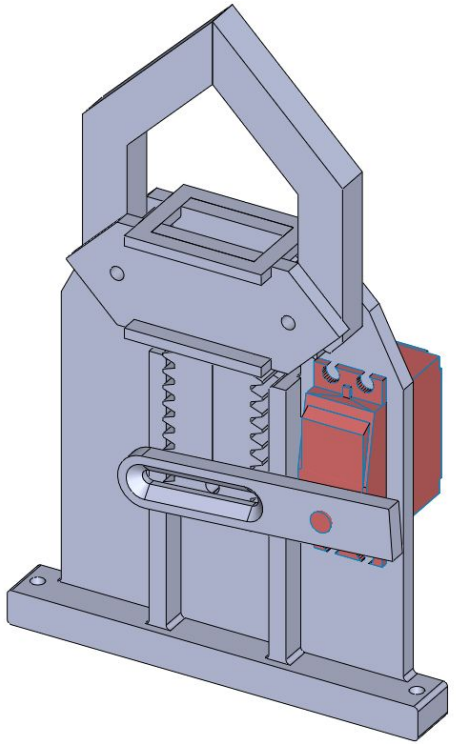
# External Frame / Brackets

- 3D printed design
- Lightweight
- Modular
  - Easy to remove/replace
- Multipurpose
  - Thrusters
  - Air tanks
  - Clasp
  - Light strip

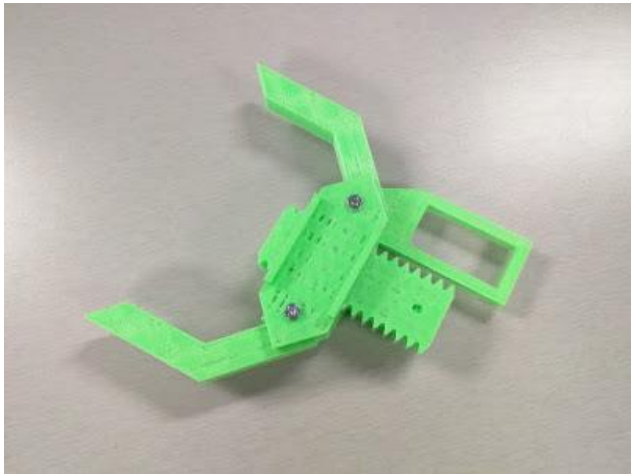


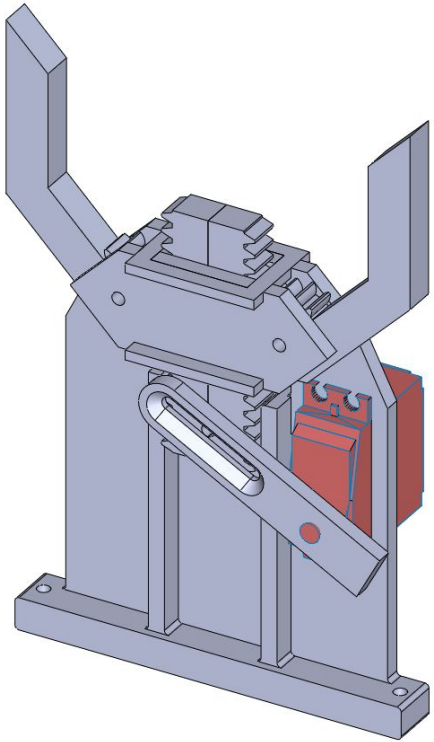
# Clamp / Clasp

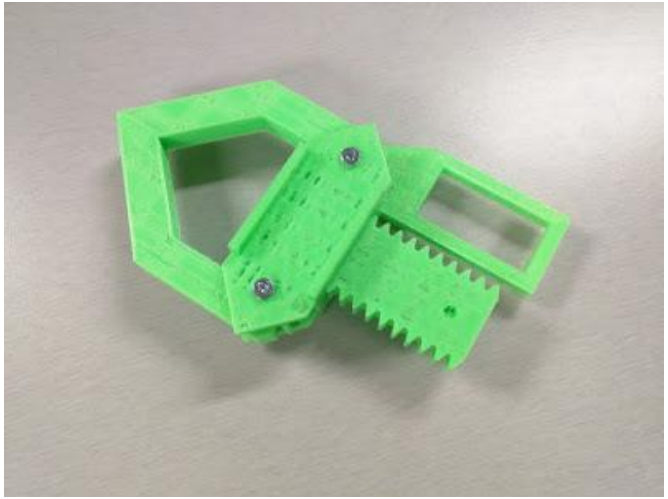
- Powered by servo
  - Pin in slot for simplicity
- Possibly interlocking “fingers”
- Currently 3D printed
  - Considering moving to sheet/machined metal
- Can be actuated with pneumatic slide if needed
- Multi-purpose
  - Picks up lid
  - Picks up last obstacle



# Clasp design

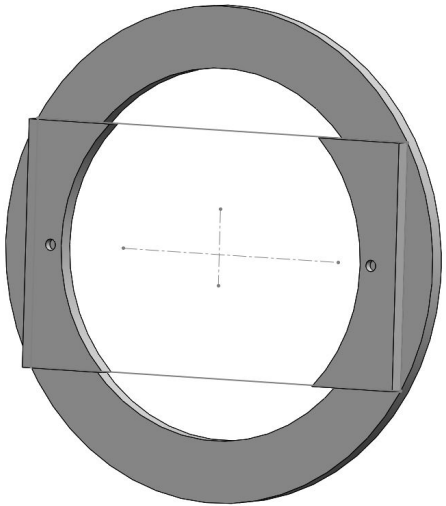






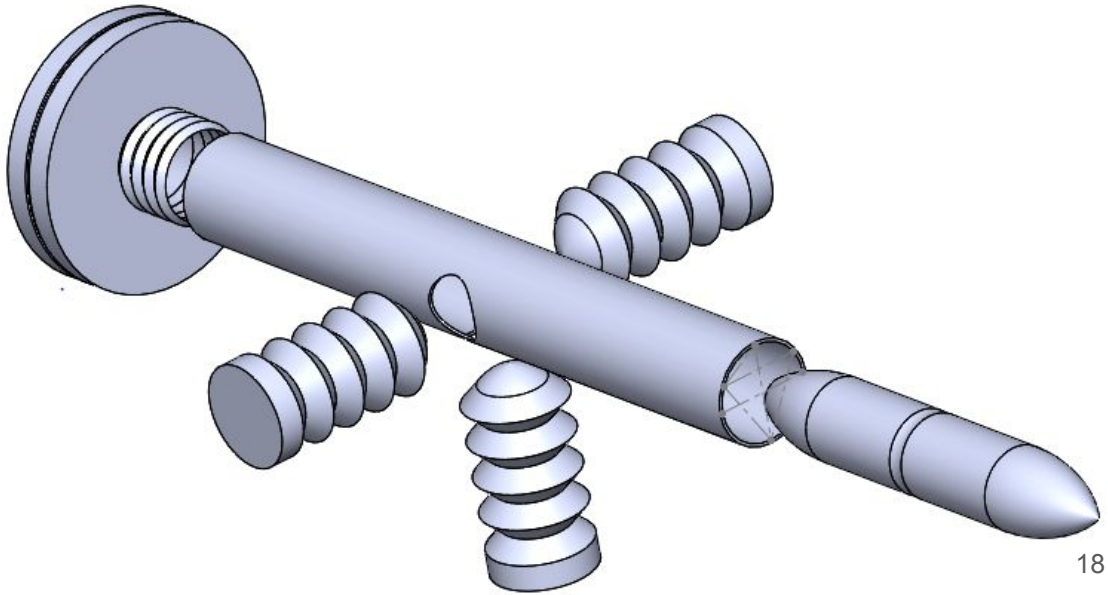
# External Bracket Mounting System

- To mount thrusters
- Removable



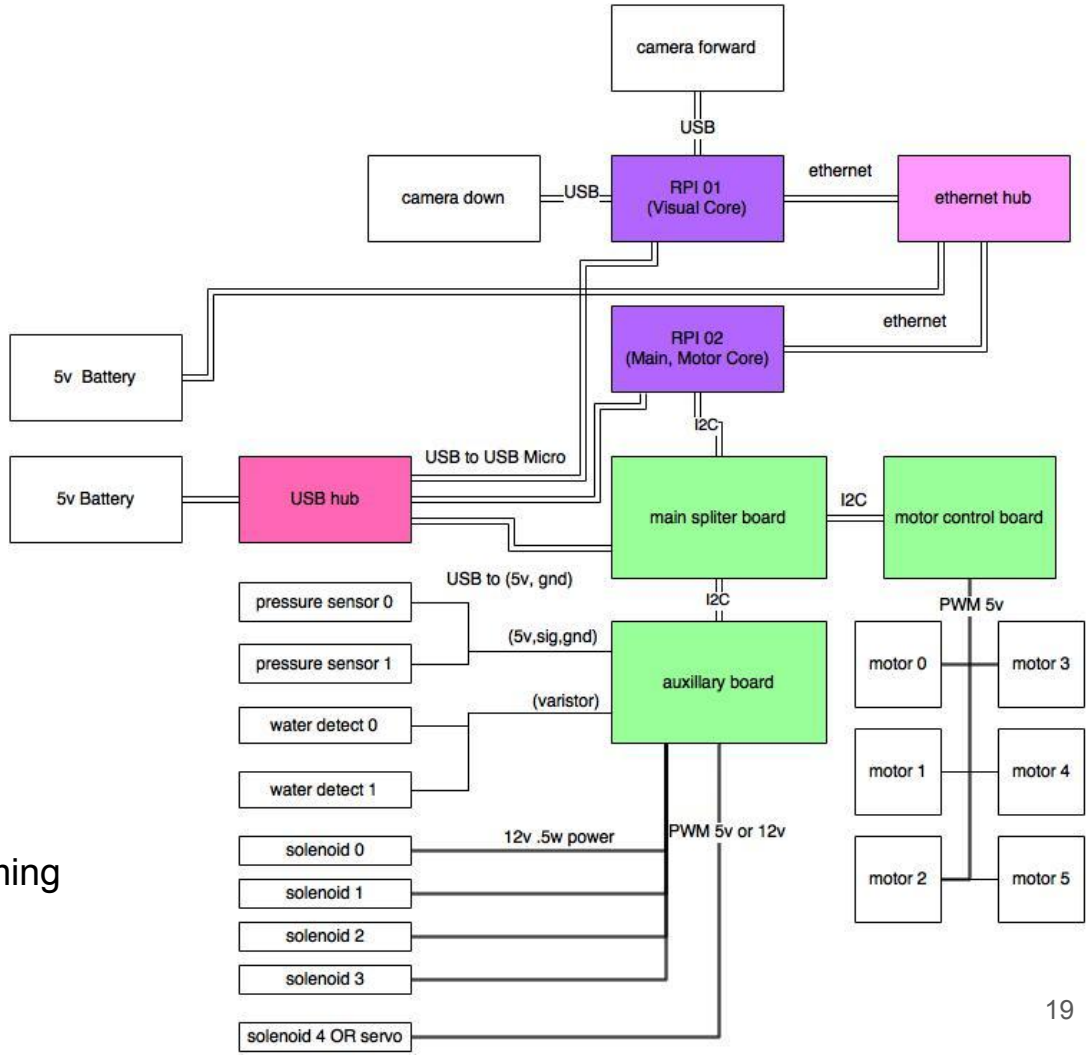
# Torpedo System

- Triggered by pneumatic system
- Aerodynamic shape
- Ball plungers hold the torpedo stable

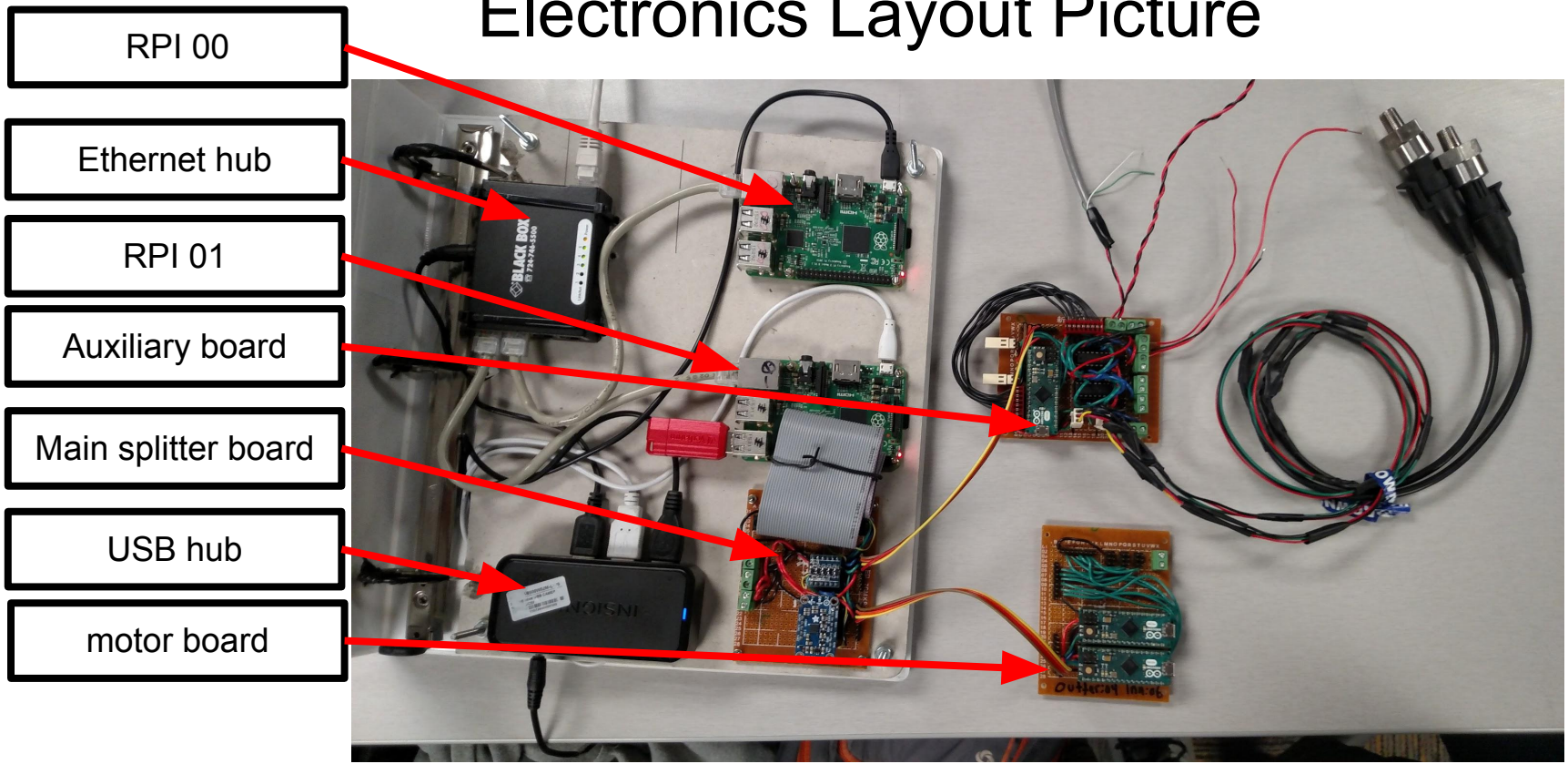


# Electronics Layout

- Modular
  - Add modules
  - Exchange modules
  - Isolate modules
- Expandable
  - I2C
  - Dynamic hardware
    - PWM or solenoid
    - Opto iso option
    - Extra ethernet ports
  - Dynamic software
    - Object Oriented programming
    - Modular programs
    - Individually testable

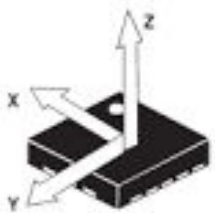


# Electronics Layout Picture



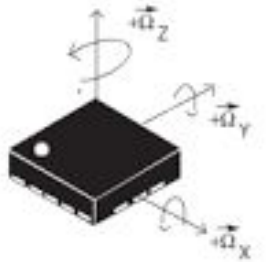
# Inertial Measurement Unit (IMU)

- 9 Degrees of Freedom 9-DOF (Magnetometer, linear Acceleration, Gyro)
- For orientation of sub in water
- Complementary Filter algorithm
- Problems encountered
  - Time relative measurements drifts gyro readings
  - Movement changes downward accel readings
  - Motor flux changes magnetometer readings
  - Sensors need offsets
  - I2C line sharing and timing
  - Only will obtain rotation orientation




Accelerometer


Magnetometer

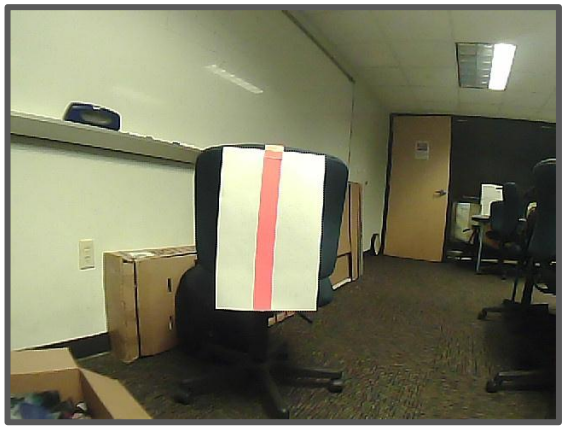


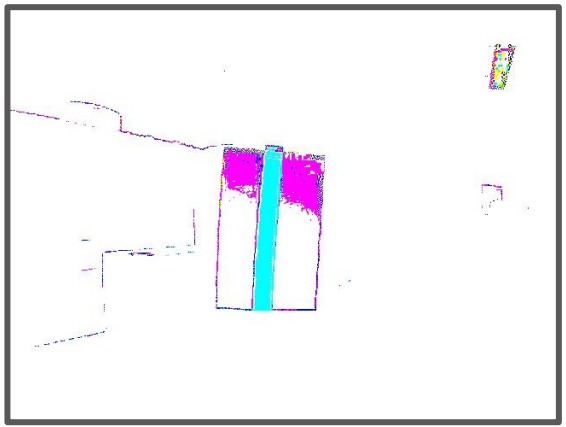

Gyroscope

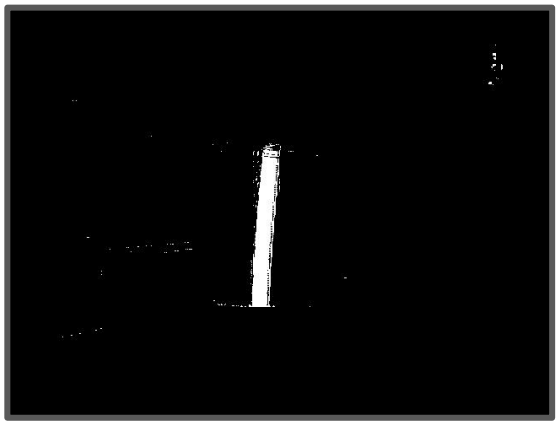
# Image Detection / Processing: Line Follow Stages

Steps Used:

1. Capture image
2. Apply threshold; loop through threshold parameters to adjust for light (simplify)
3. Create and apply color array mask to image

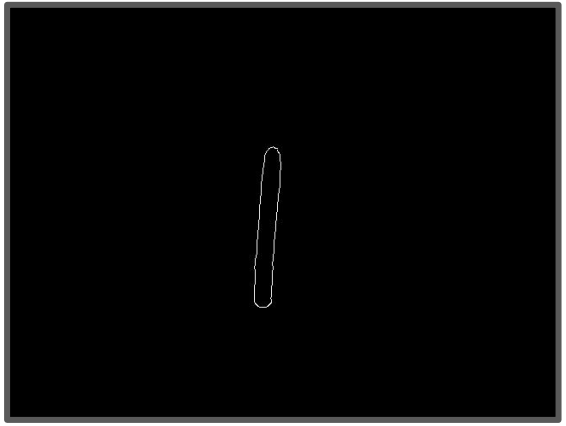


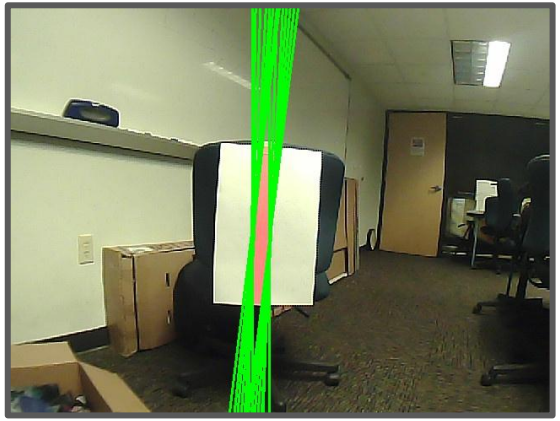




# Image Detection / Processing: Line Follow Stages

4. Blur image to filter out excess noise
5. Apply edge detection algorithm
6. Apply Hough Line transform algorithm
7. Average lines offsets and theta
8. Send data to motor module





# Software Completion

- Visual module
  - 00% Variable line feedback (plane stable counter action )
  - 30% Color and obj detection (X,Y ref)
  - 30%  Variable color ability
- Motor module
  - 60% Rotational PID feedback
  - 99% IMU feedback
  - 40% Abstracted motor commands
  - 10% Comp and user motor interface
- Auxiliary module
  - 80% Pressure and WD sensors data
  - 99% Torpedo firing
  - 50% Lights on/off PWM?
- Main abstract drive
  - 05% Fuzzy logic?
  - 05% Main linear AI block
  - 30% Queued data logger with RTC
- Multi-platform manager
  - 20%  Queue command talk (QCT)
  - 30% Locks and synchonity
  - 40%  Timing
- Thread managers
  - 20% QCT
  - 99% Locks
  - 90% Timing

# Conclusion

- Need more development in
  - Software
  - Testing software
  - Testing mechanical prototypes
- Create simpler solutions
- Majority of design done
- Fabrication is under way