Design and Development of an Autonomous Underwater Vehicle

Semester Update
Presentation
Team 23
February 16th, 2016

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The Competition

- AUVSI International Robosub Competition
- Objective of the competition:
  - Design an autonomous underwater vehicle to perform a series of tasks
- Rules posted as of January 2016

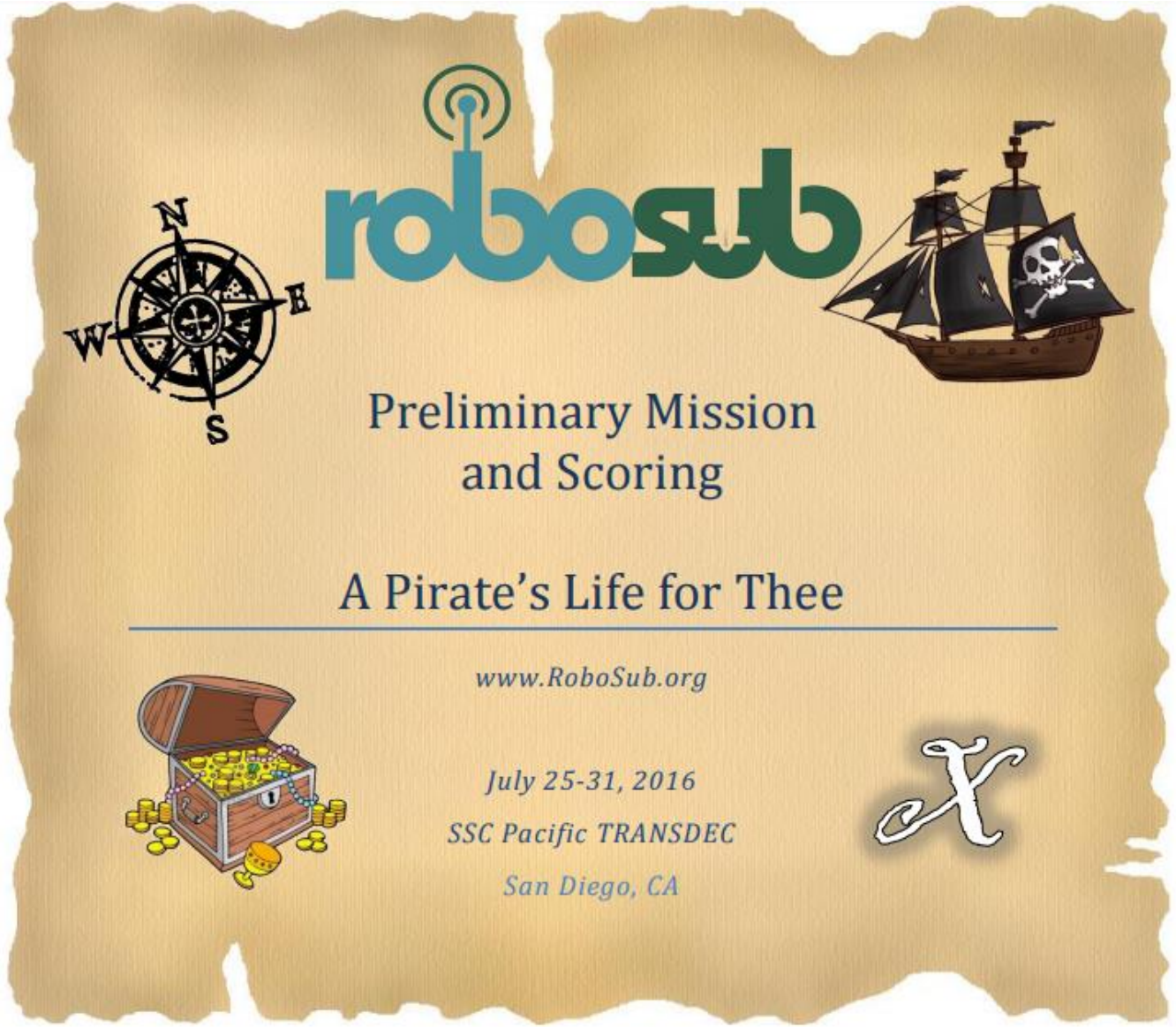


Figure 1: Robosub Competition Rules Cover Image

Competition Tasks

1. Follow path markers between tasks
2. Interact with colored buoys
3. Pass over an Obstacle
4. Drop markers at a specified location
5. Fire Torpedoes through a specific target
6. Locate an object and pickup and move to a specified location

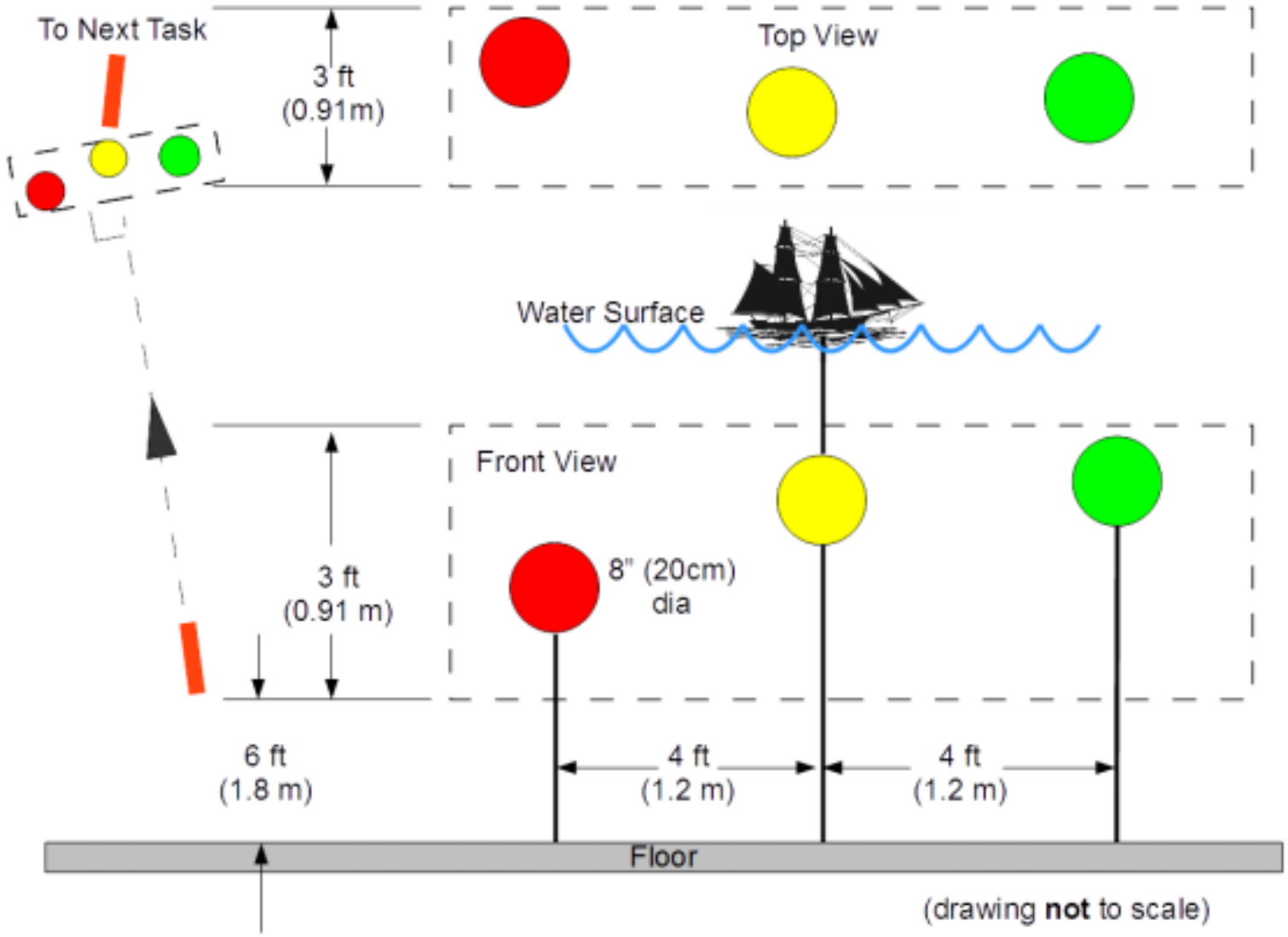


Figure 2: Buoy Interaction Task

Team Robosub Breakdown

- ME Semester Objectives
  - Fabricate, test, and transfer electronics to new hull
  - Finish air system adaptation and integrate with gripper
  - Physical systems integration of subsystems
- ECE Team Work
  - Replaced broken CPU with upgraded version (Zotac Mini PC)
  - Beginning to implement a new shape identification program
  - Parsed through the inherited code and begun modularizing for efficiency
  - Development of the gripper

Project Background

- The AUV
  - Designed and Built in 2013
  - Weighs about 84 lbf
    - Contains 22.5 pounds of weights within the hull
  - Components
    - 6 Seabotics thrusters
    - Zotac Mini Computer
    - Arduino Mega and Uno
    - 3 Motor Controllers
    - an Inertial Measurement Unit(IMU)
    - 2 Cameras
    - Depth Sensor

Figure 3: Current AUV

The Hull

- From old to new
  - Decrease weight by 13 lbf
  - Decreased buoyancy by 28 lbf
  - Decreased volume by 900 in^3
- Switching from aluminum to stainless steel for higher density
- 6 toggle latches instead of 16 nuts and bolts for easier access
- Electrical insulation for inside hull
  - Reorganization of internal electronics

Table 1: Hull Properties

Property	Equations	Old Hull	Revised Hull
Material Density (lb/in3)	m/V	0.0975	0.2781
Dimensions (inches)	*L x W x H*	22x15x6	12x18x5
Weight (lbf)	*m* x *g*	84	71
Buoyancy (lbf)	ρ_{water} x $V_{displaced}$ x *g*	100	72

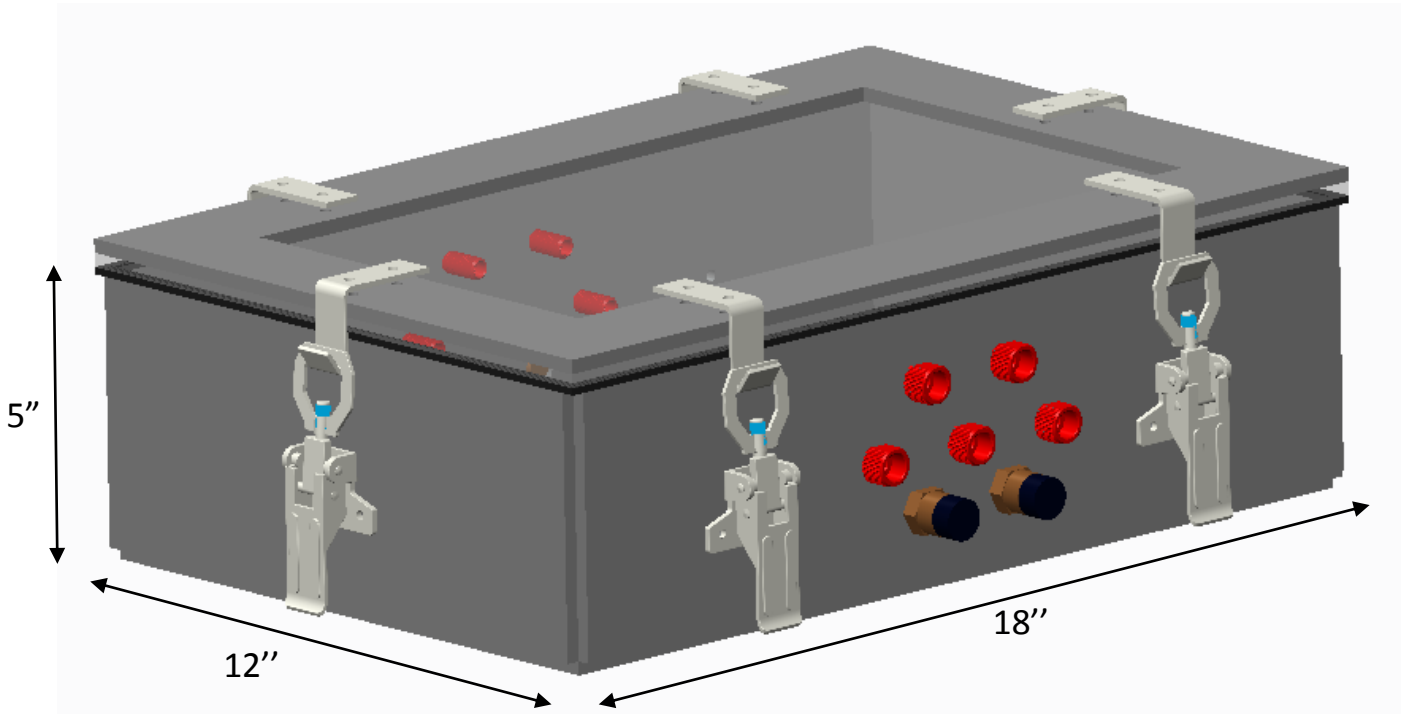


Figure 4: Modified Hull

Waterproof Electrical Connectors

- Decision was made to keep some existing ports and replace others
- 4 Seacon heavy duty ports will be salvaged from old hull to accommodate thrusters and cameras
- 10 new cable penetrators will replace remaining Seacon ports
  - Pros: Cheap
  - Cons: Held with permanent marine epoxy

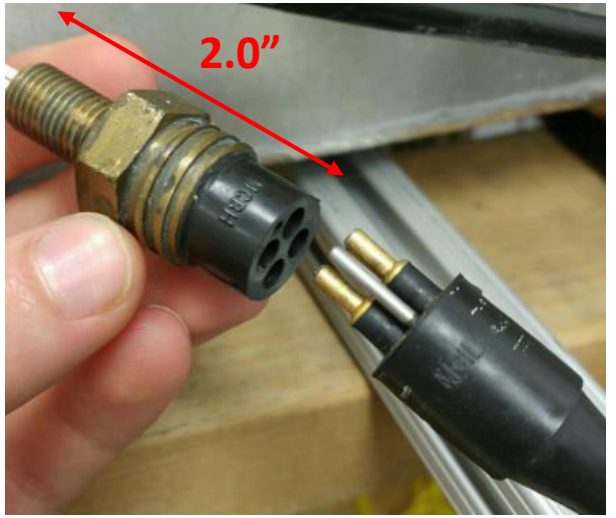


Figure 5: Seacon Port

Table 2: Port Comparison

Item	Old hull	New hull
Seacon ports	$100 X 16	$100 X 4
Cable penetrators	$4 X 0	$4 x 10
Total Cost	$1600	$440

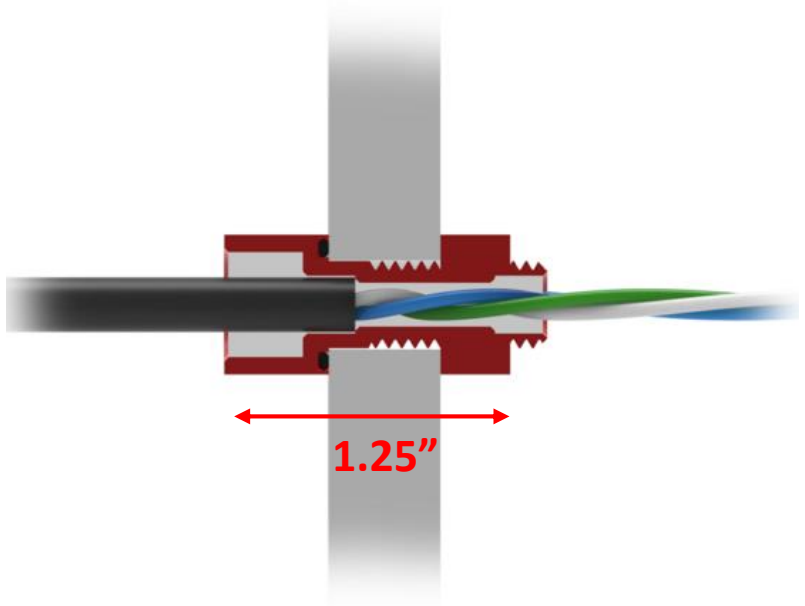


Figure 6: Cable Penetrator Cross Section

Reorganization of Internal Electronics

- Original layout
  - Motor controllers in breadboard
  - Arduinos laying around
  - Wires everywhere
- Messy
- Not organized

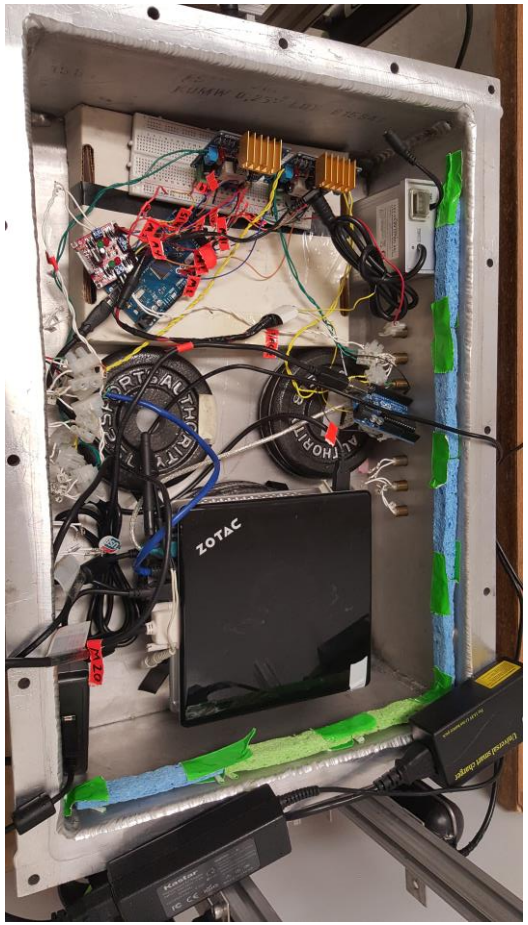


Figure 7: Original Hull Interior

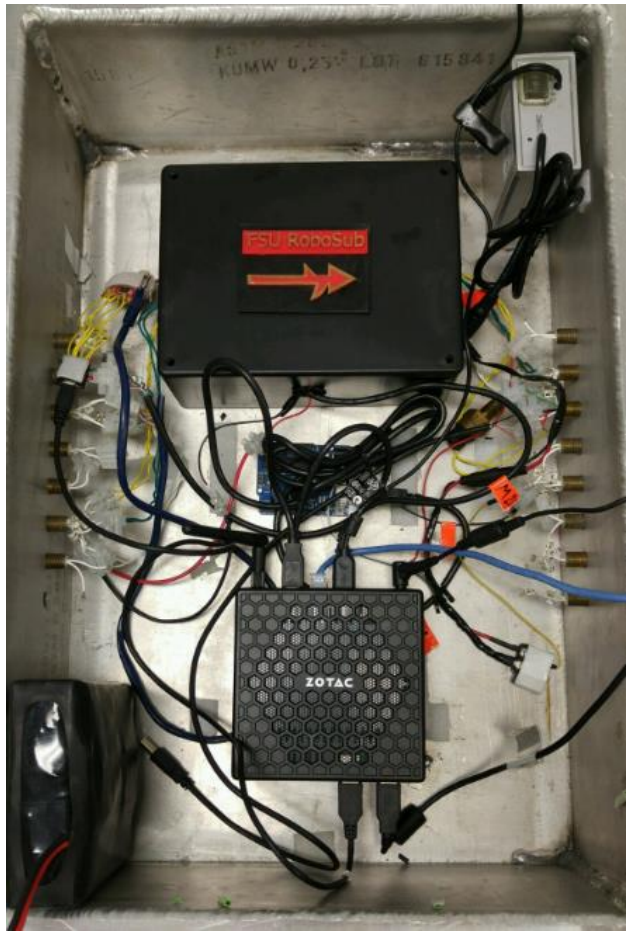


Figure 8: Updated Hull Interior

- Eliminated breadboard
  - Reorganized in black box
    - 3 Motor controllers
    - 1 Arduino Mega
- Further improvements
  - Implement cooling fans
    - Ensure electronics do not overheat

Robosub Signal Diagram

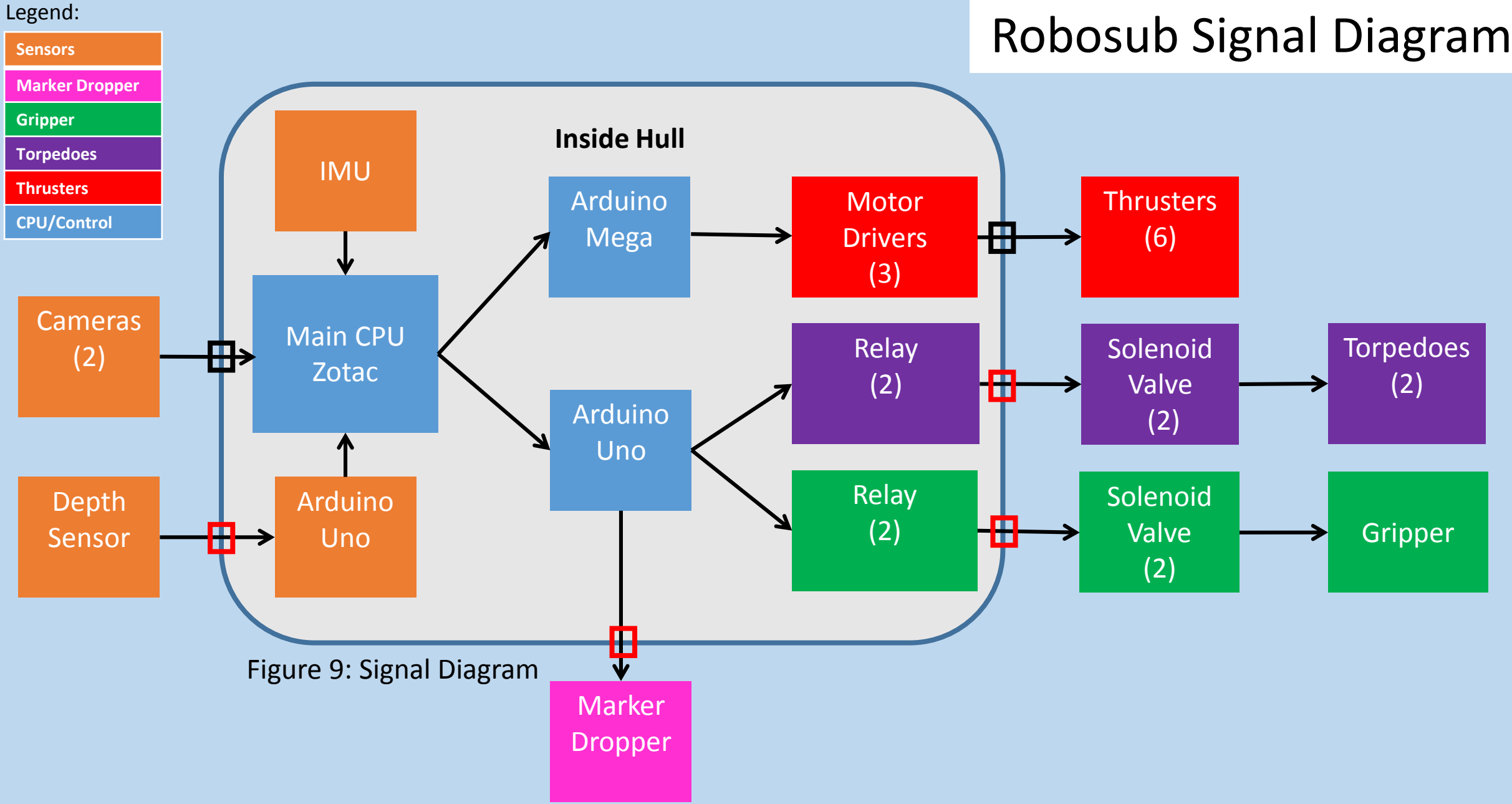


Figure 9: Signal Diagram

Air System

- Ordered Components arrived and assembled
  - Actuators
  - Tubing
  - Airtight and waterproof seals
  - Electronic relays for actuators
  - 12v battery
- Functioning Code
  - Can launch left and right torpedo bases off of keyboard input
  - Next Step is changing keyboard input to identifying image

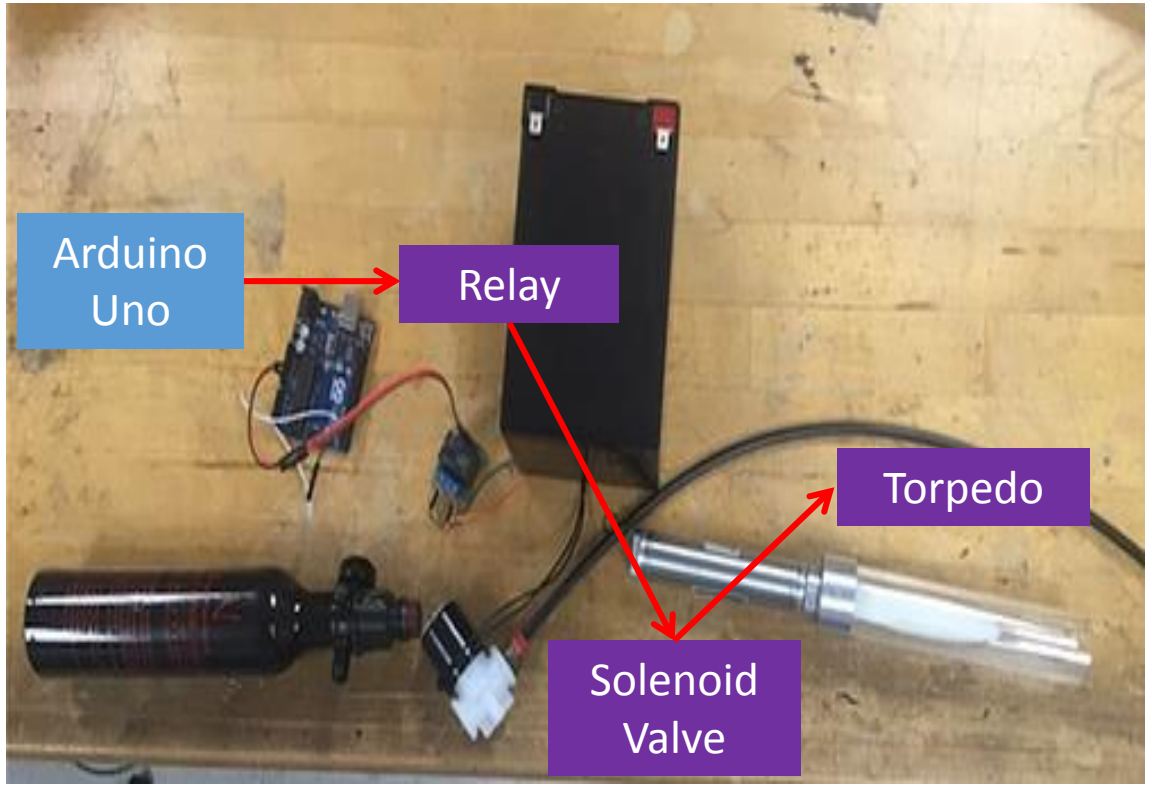


Figure 10: Air System Configuration

Torpedo Development

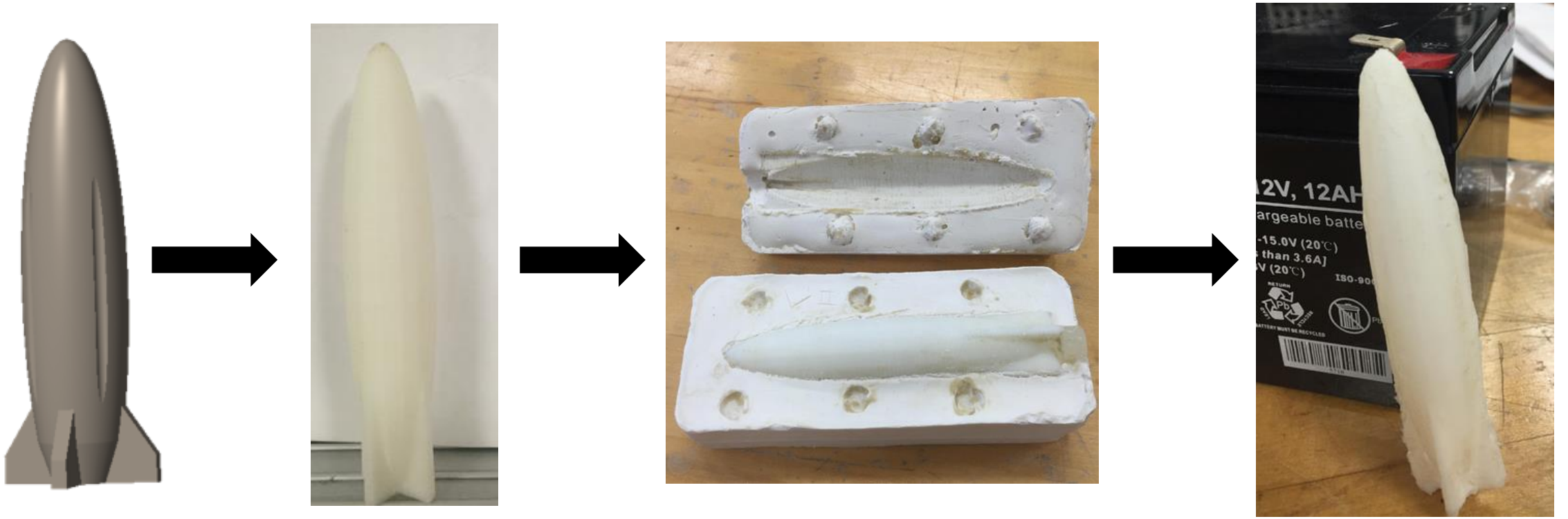


Figure 11: Air System Configuration

CAD design

- Small fins for easy mold release
- Small diameter to ensure piston fit

3D printed torpedo

- High buoyancy abs plastic
- Rapid prototyping

Plaster mold

- Plaster of Paris
- Mold around 3D printed torpedo
- Recoverable molds

Simpact 85A urethane rubber

- Relatively high density rubber (sinks in water)
- Easy pour but short pot life for rubber positive mold

Torpedoes Completed

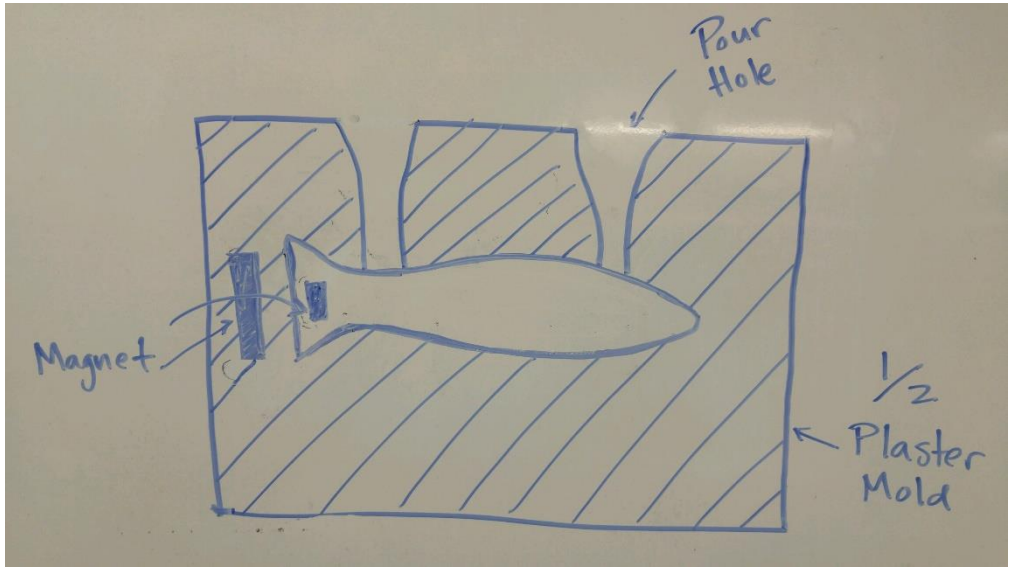


Figure 12: Magnet Embedded Torpedo Process

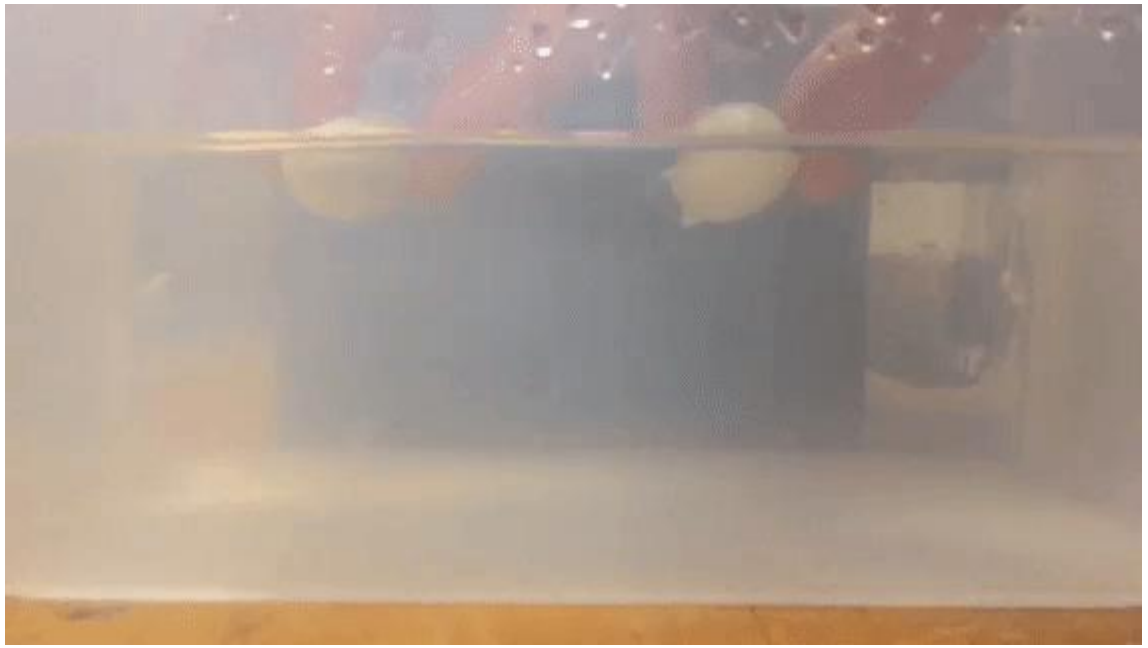


Figure 13: Torpedo Buoyancy Test

Next step

- Optimize for buoyancy (towards neutrality)
- Embed surface magnets to the torpedo back

Successful Testing

- Rubber torpedo successfully negatively buoyant
- Improvement over old design

Gripper Development

Figure 14: Old Mechanism

- Lack of actuation mechanism
- Large ineffective claws

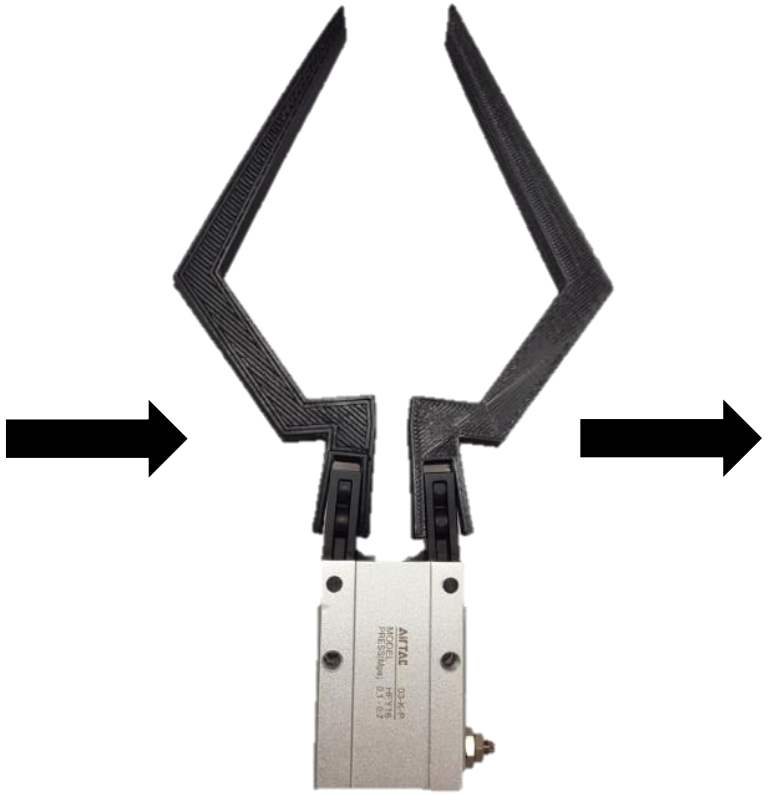


Figure 15: Gripper Prototype

- Purchased pneumatic actuator
- 3D printed gripping mechanism

- ME team next step
  - Create appropriate mounting platform for gripper on submersible frame
  - Find and implement component for air system integration

- ECE team next step
  - Iterating design for larger gripping surface
  - Development of high friction gripping surface

Marker Dropper Development

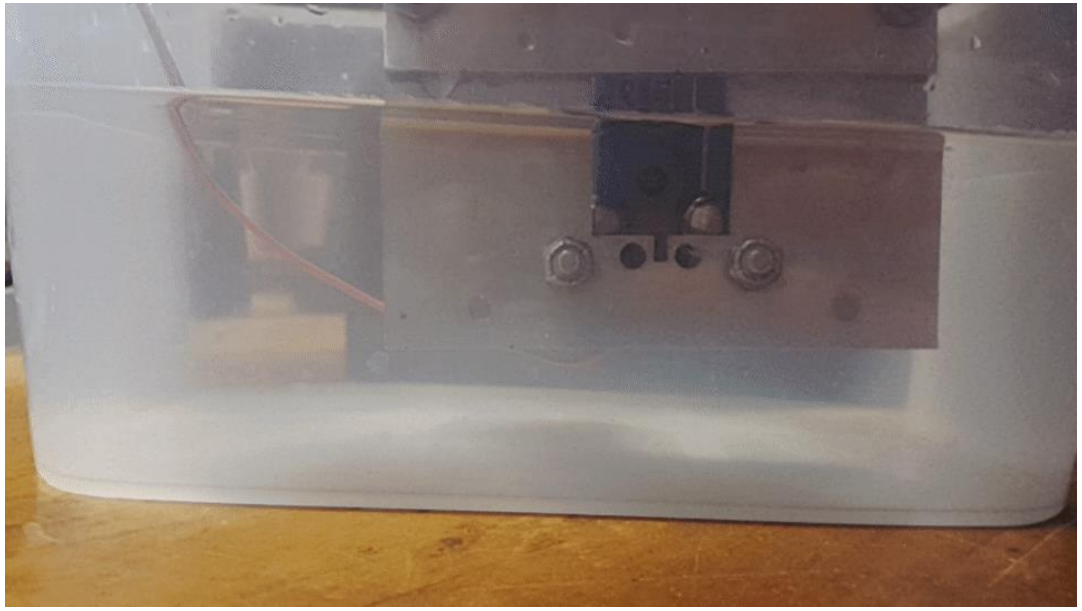


Figure 16: Marker Dropper Development

Old System

- Normal DC motor
- Poor waterproofing
- Usable frame

New actuator

- waterproof servo
- Adjusted bracket positioning to allow the servo arm enough space to move

Tested servo underwater

- Markers successfully drop when prompted by user
- Mount to frame

Next step

- Integrate with main CPU (working with ECE Team)

Gantt Chart Spring 2016

	Task Name
1	**Completion of the 2016 Robosub**
2	**Hull**
3	finalize drawings
4	fabricate design
5	test design
6	implement
7	**Torpedoes**
8	ordering parts
9	constructing pneumatics
10	test fire
11	integrate with camera
12	debug
13	**Marker Dropper**
14	integrate with camera
15	debug
16	**Gripper**
17	test prototype
18	finalize claws
19	attach and integrate
20	debug
21	**DEBUG**

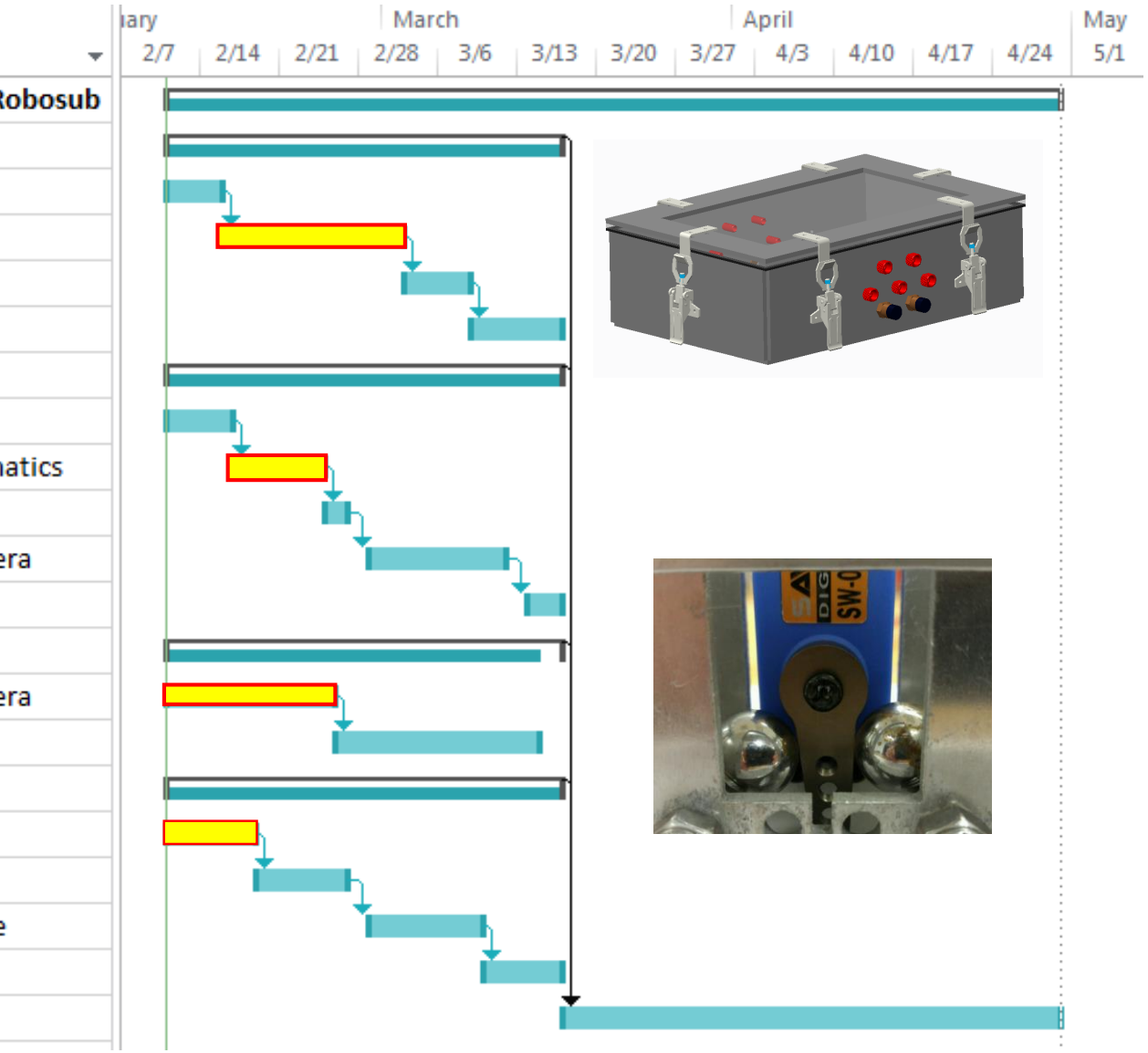


Figure 17: Time allocation and scheduling for spring 2016 semester

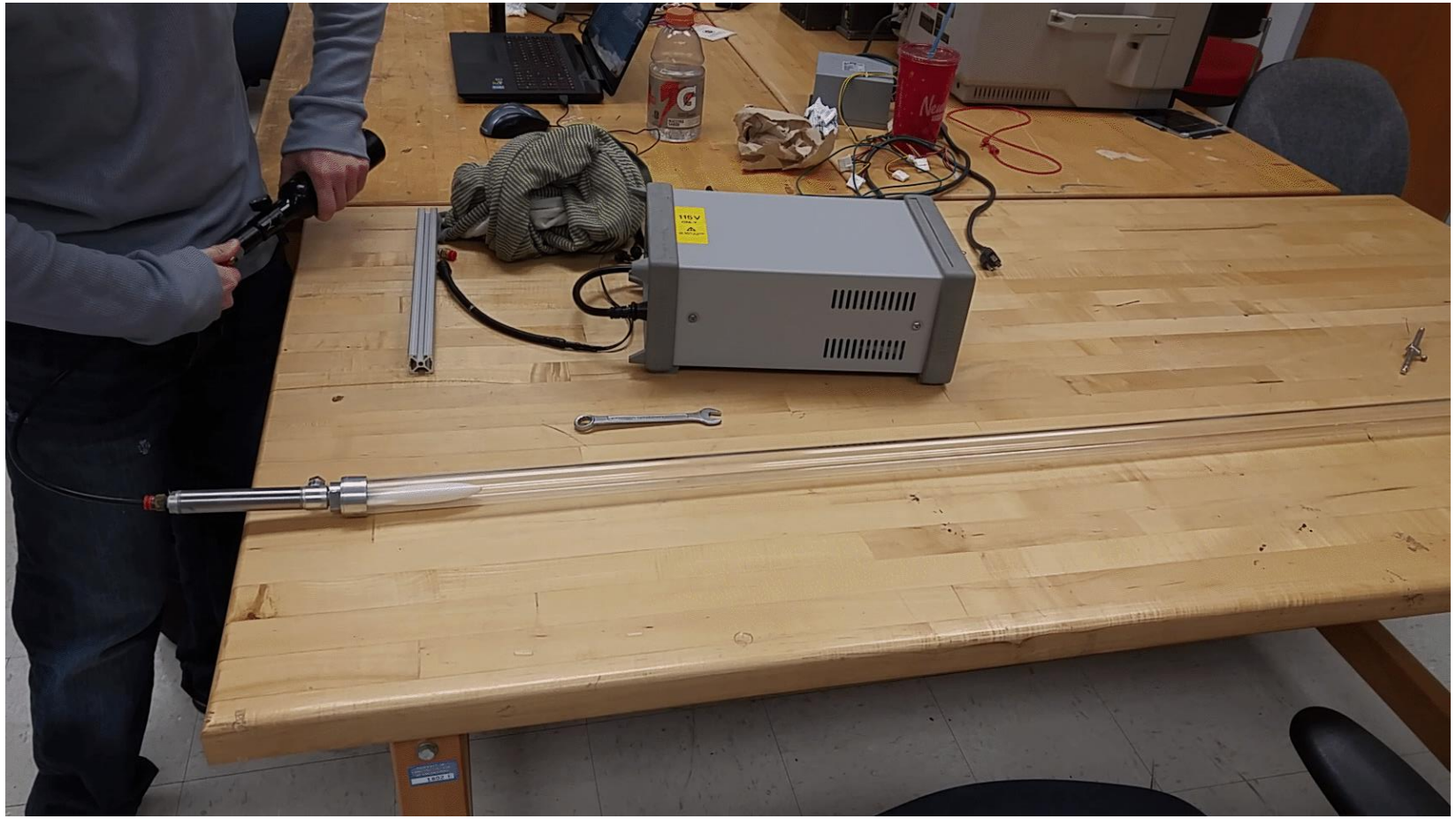
Testing Schedule

Test	Date	Notes
Gate Navigation	January 22	Computer malfunction
✓ Marker Dropper	January 22	Success
✓ Torpedoes	February 1	Success
Gripper and Air Systems	February 1	Regulator error postponed
Testing of New Hull	March 3	Fabrication this week
Systems Integration	Monthly	

Conclusion

- Built and tested torpedos and marker dropper
- Reorganized, electrically insulated, and modularized hull electronics
- All mechanical parts for pneumatics system on the way, already integrated electrically
- Hull design and CAD finalized and on it’s way to fabrication

Questions?



References

- [1] Auvsifoundation.org, "Home - Foundation", 2016. [Online]. Available: http://www.auvsifoundation.org/home. [Accessed: 16- Feb- 2016].
- [2] Onr.navy.mil, "Office of Naval Research Home Page", 2016. [Online]. Available: http://www.onr.navy.mil/. [Accessed: 16- Feb- 2016].
- [3]F. Engineering, "FAMU-FSU College of Engineering :: Welcome", *Eng.fsu.edu*, 2016. [Online]. Available: http://www.eng.fsu.edu/. [Accessed: 16- Feb- 2016].