TEAM HYDRA

Swimming Swarm Team 1

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CREATING THE NEXT®

Vision

Develop a swarm robotics system of six autonomous underwater vehicles (AUVs) that would aid in the search and retrieval missions for flight recorders

Objectives

Design and prototype a system that will allow six robots to collaborate with one another in an underwater setting

Specifications

- Vehicle specifications
- Testing Specifications
- Approach

Key Milestones

- Select and order hardware 1/24/18
- Finalize software 2/22/18
- Create control flow 2/28/18
- Integrate software and hardware 3/4/18
- Tests single robot 3/4/18
- Create multiple robots 4/8/18
- Test multiple robots 4/22/18
- Design expo 4/24/18

VISION

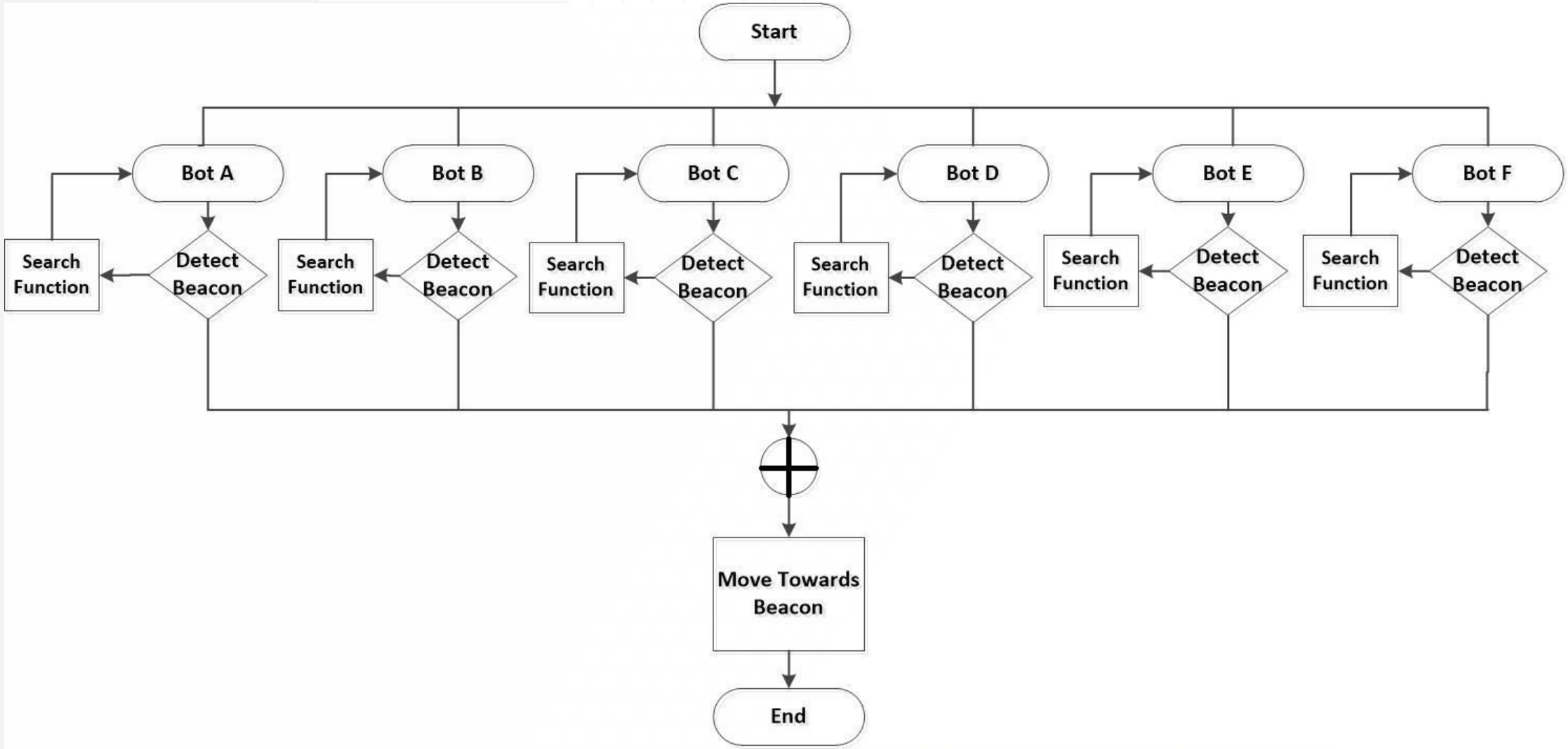
- Flight recorder retrieval is a time-sensitive mission
- Aid in search and retrieval missions for flight recorders
- How?
  - Develop six swarm AUVs
  - Implement leader-follower swarming algorithm to execute underwater search missions

OBJECTIVES

Each HydraBot will:

- Listen for pulses from a locator beacon
- Maintain formation and move towards signal
  - Use leader-follower swarming algorithm
  - Communicate through optical signals

OVERALL WORKFLOW

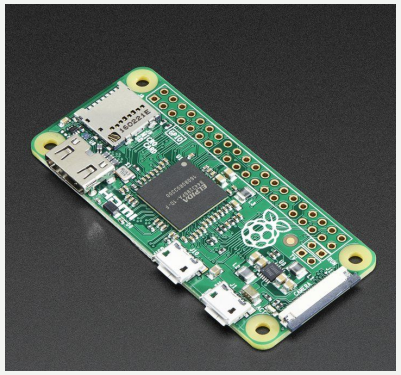


SPECIFICATIONS: CHASSIS AND ACTUATORS

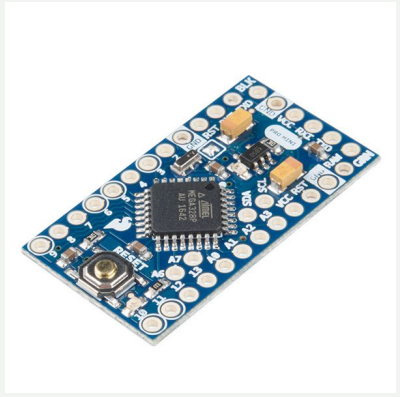
Tupperware Enclosure
Price: $7.99
Purpose: Waterproof enclosure for all electronics
Specification: 7.9" L x 5.4" W x 2.5" H

Underwater DC Motor
Price: $30.00
Purpose: To move the propellers
Specification: 25A, 230V, 30000rpm

SPECIFICATION: CONTROLLERS

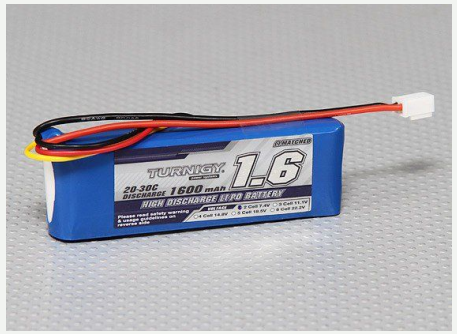


Raspberry Pi Zero
Price: $5.00
Purpose: Main processor
Specification: 512MB SDRAM, 1GHz ARM11 core, 40-pin GPIO



Arduino Pro Mini
Price: $9.95
Purpose: GPIO expander
Specification: ATmega328, 150mA, max 12V

SPECIFICATION: POWER



Lipo Pack Battery

Price: $7.64

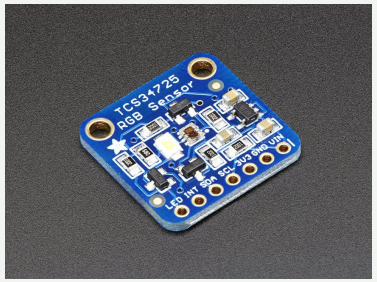
Purpose: Power Raspberry Pi, Arduino Pro Mini, and motors

Specification: Turnigy 1600mAh 2S 20C (discharge rate)

Battery Life: ~30 min

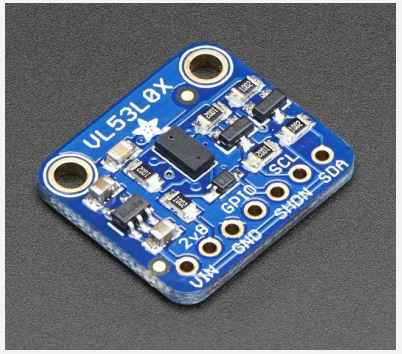
SPECIFICATION: COMMUNICATION

RGB LED
Price: $1.95
Purpose: Send signals through different colors
Specification: 2.0V (R), 3.2V (G), 3.2V (B)

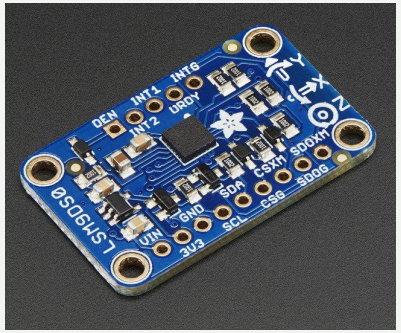


RGB Color Sensor
Price: $7.95
Purpose: Detect different colors
Specification: 5V max input, light-to-frequency converter reads an 8 x 8 array of photodiodes.

SPECIFICATION: SENSORS



Time-of-Flight Sensor
Price: $14.95
Purpose: Distance measurement to maintain position within swarm
Specification: 50mm to 1200mm of range distance



Inertial Measurement Unit
Price: $24.95
Purpose: Receive feedback to create PID controller
Specification: 9-DOF Accel/Mag/Gyro+Temp

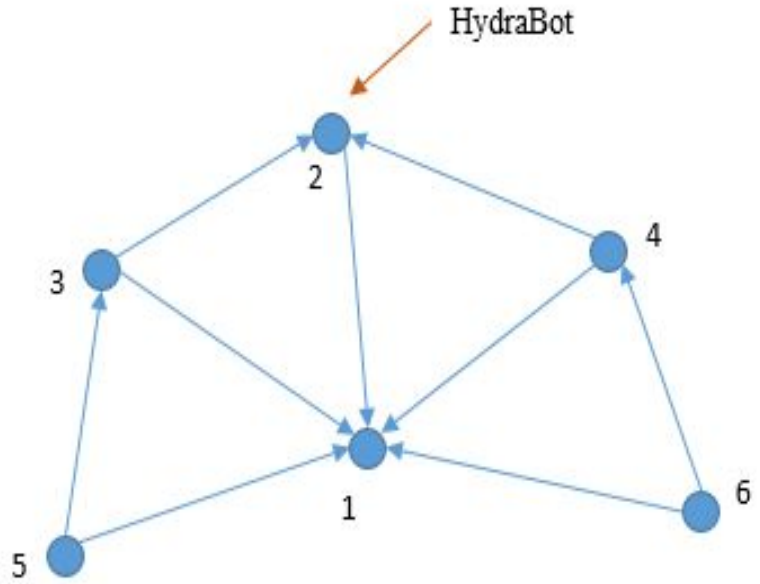
Acoustic Transmitter/Receiver
Price: $10.35
Purpose: Detect the audio beacon of blackbox and move swarm
Specification: 4.5 meter max, 5V max

TOTAL COST ESTIMATE

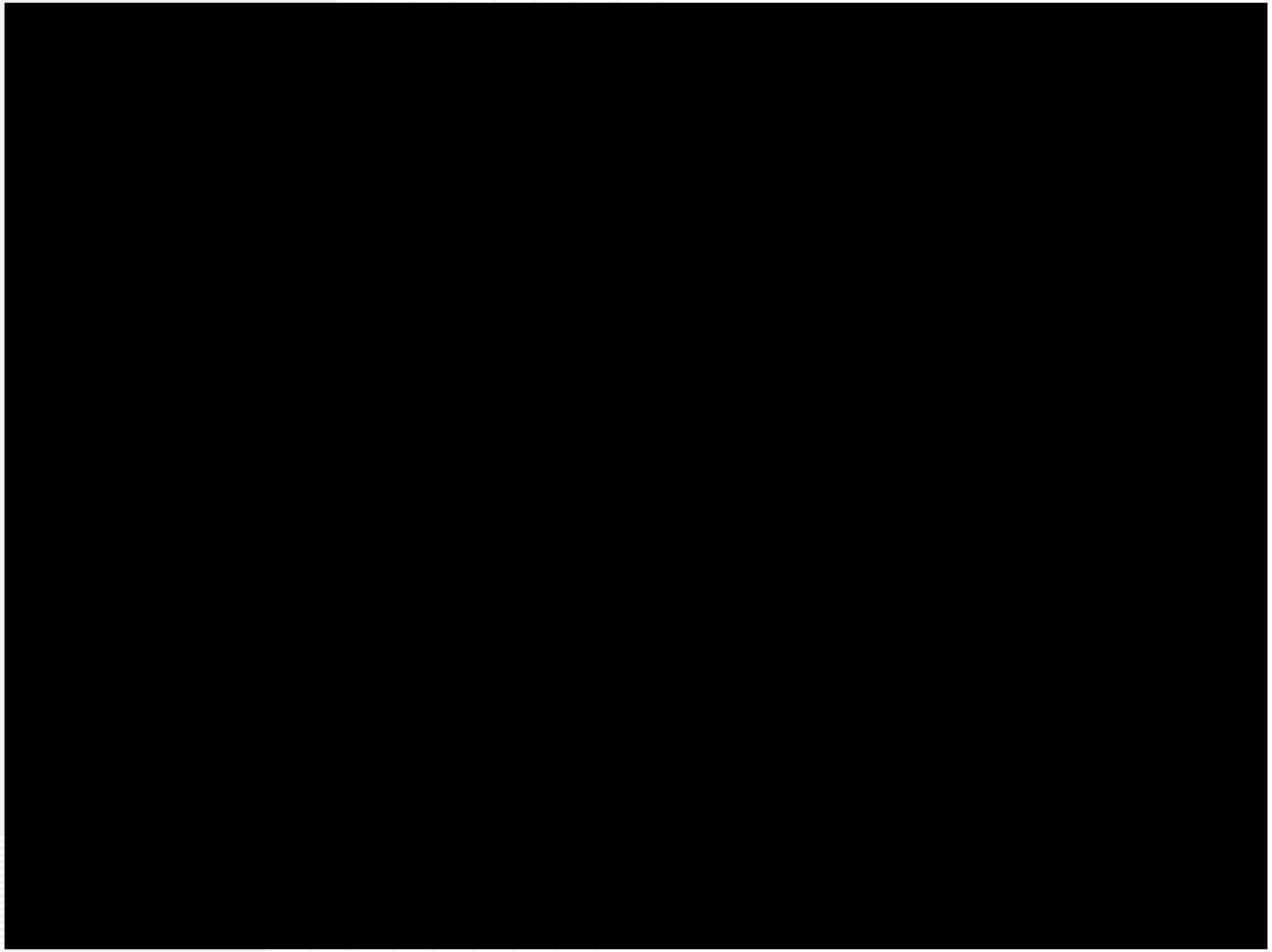
Item	Price	Quantity	Cost
Tupperware Enclosure	$7.99	6	$47.94
Underwater DC Motor	$30.00	12	$360.00
Raspberry Pi Zero	$5.00	6	$30.00
Arduino Pro Mini	$9.95	6	$59.70
Lipo Pack Battery	$7.64	6	$45.84
RGB LEDs	$1.95	24	$46.80
RGB Color Sensor	$7.95	24	$190.80
TOF Sensor	$14.95	24	$358.80
IMU	$24.95	6	$149.70
Acoustic tx/rx	$10.35	6	$62.10
Total			**$1,351.68**

SPECIFICATION: SWARMING ALGORITHM

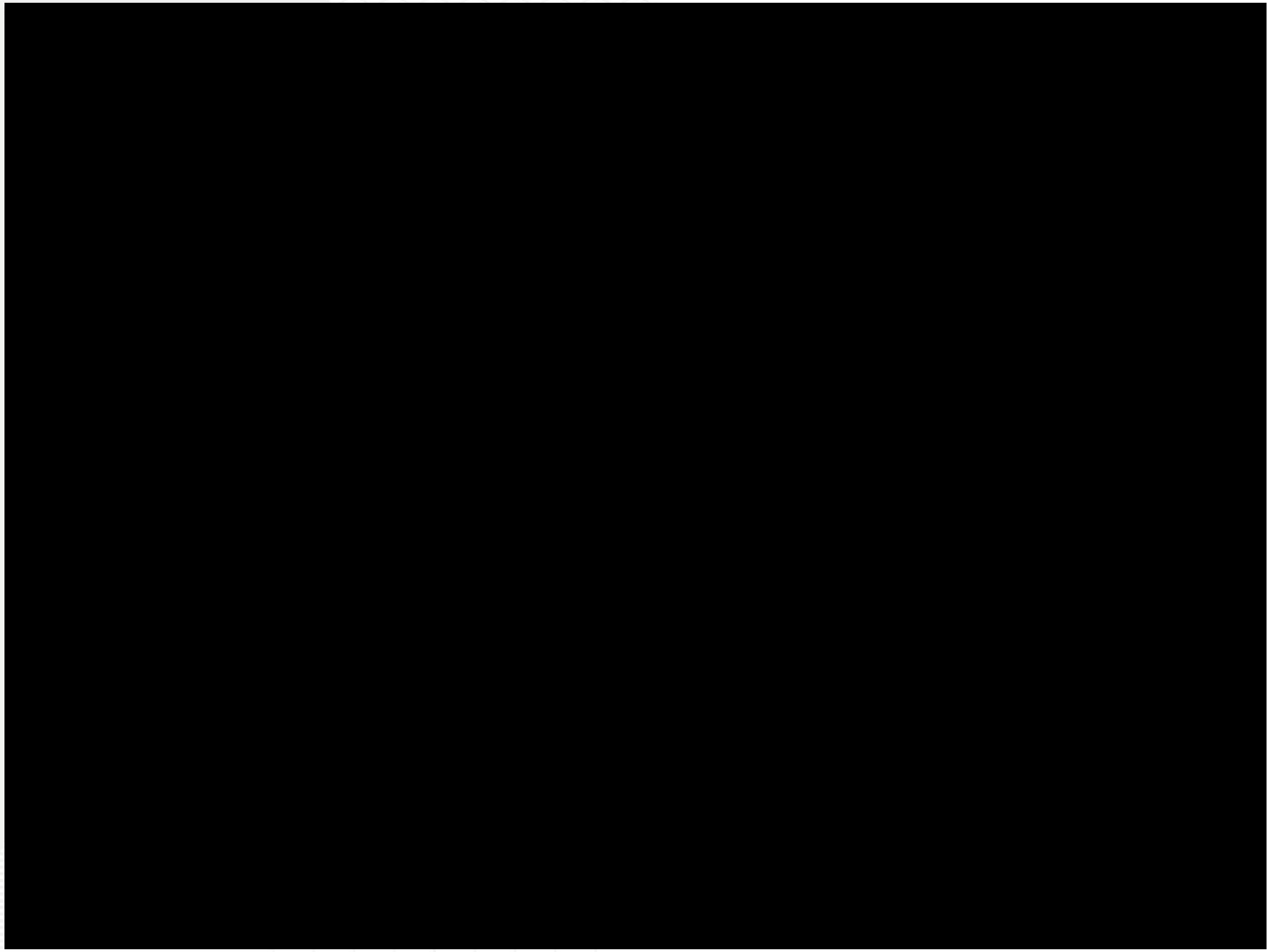
- Decentralized control algorithm
  - No central communication unit (“God’s eye view”)
  - Communication between immediate neighbors
- Maximally-spanning configuration
- Mixing formation control and leader-follower coverage control



FORMATION CONTROL

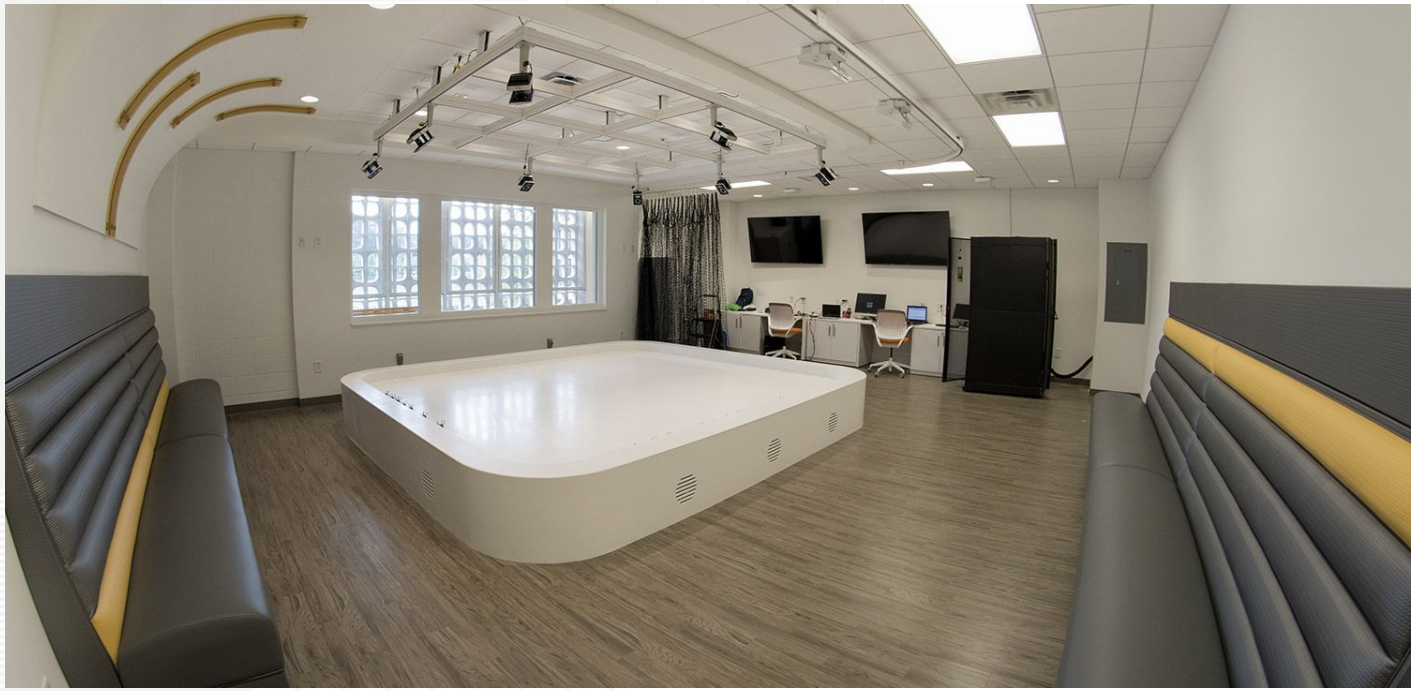


LEADER-FOLLOWER



TESTING

- Georgia Tech's Robotarium provides simulation tools and surrogate platforms to test swarming algorithm
- Completed HydraBots will be tested in a shallow children’s pool or the J. Erskine Love Building pool

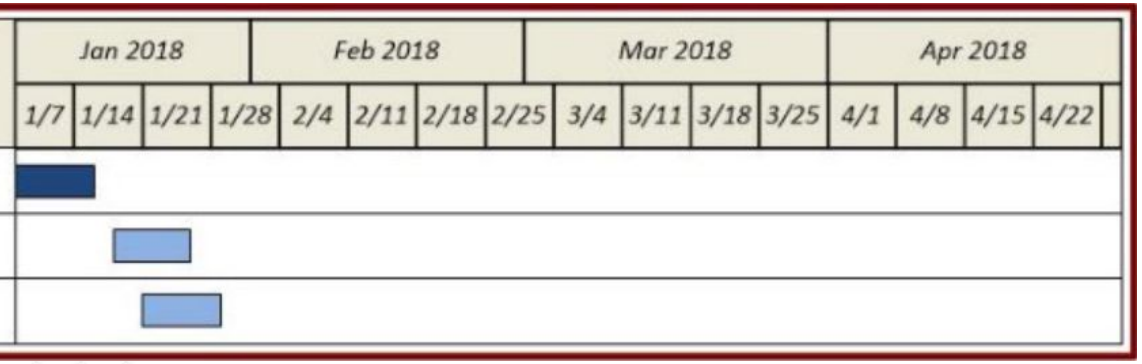


TESTING

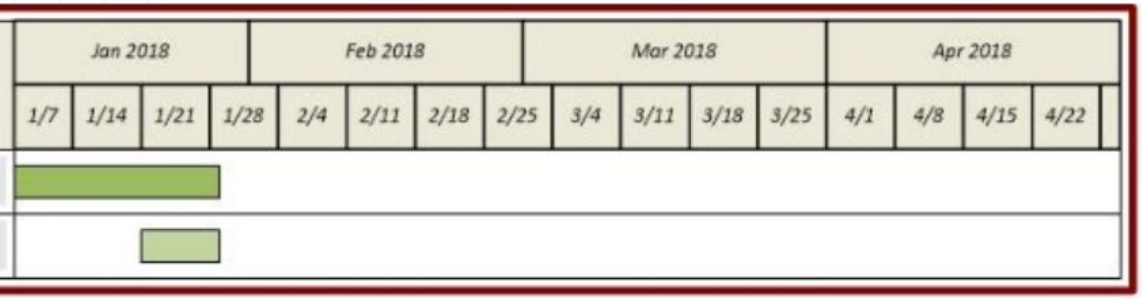
- Acoustic pinger will act as the beacon from the flight recorder
- In the process of finding an acoustic pinger to use. Potential sources:
  - Woodruff Building of Mechanical Engineering
    - Dr. Ji-Xun Zhou: Principal Research Scientist in Acoustics and Dynamics

SCHEDULE: HARDWARE SELECTION

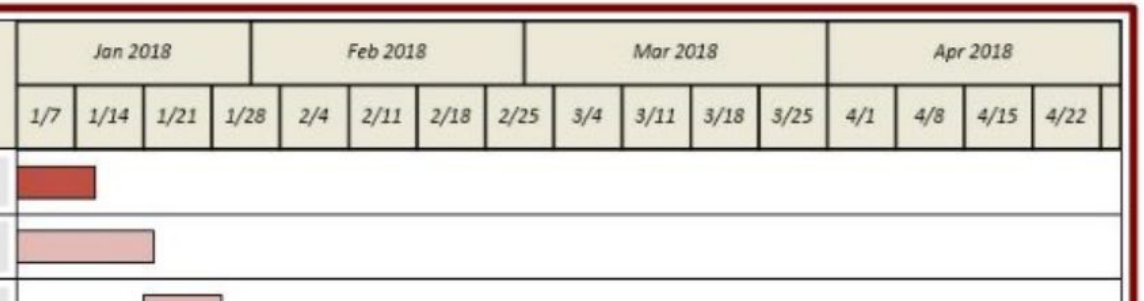
ID	Task Name	Start	Finish	Duration
1	**Select and Order Hardware Platform to Use**	1/8/2018	1/15/2018	1w 1d
2	Finalize/modify Chassis Design and Motor Control	1/18/2018	1/25/2018	1w 1d
3	Test basic hardware platform	1/21/2018	1/28/2018	1w 1d



ID	Task Name	Start	Finish	Duration
1	**Select and Order Light tx/rx**	1/8/2018	1/28/2018	3w
2	Finalize communication protocol	1/21/2018	1/28/2018	1w 1d

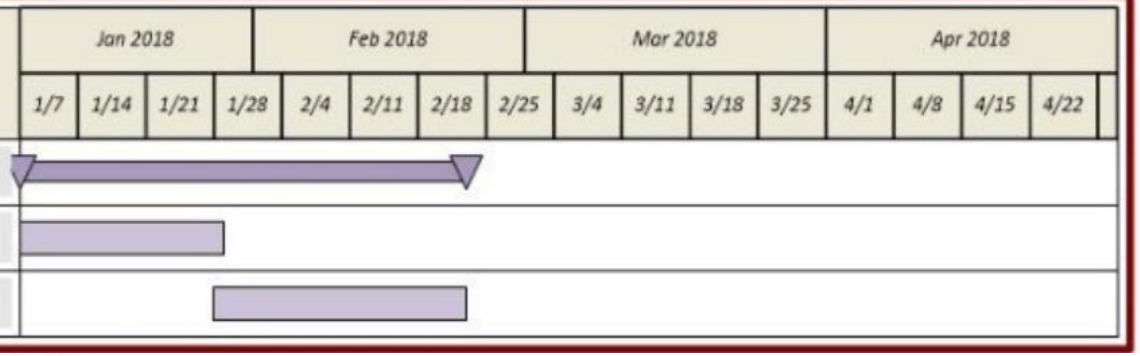


ID	Task Name	Start	Finish	Duration
1	**Finalize Microcontroller to Use**	1/8/2018	1/15/2018	1w 1d
2	Select battery	1/8/2018	1/21/2018	2w
3	Team review of microcontroller	1/21/2018	1/28/2018	1w 1d



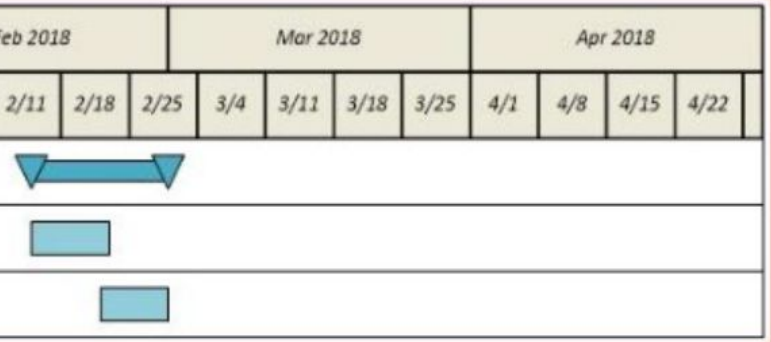
SCHEDULE: SOFTWARE

ID	Task Name	Start	Finish	Duration
1	**Software**	**1/8/2018**	**2/22/2018**	**6w 4d**
2	Determine swarm algorithm to use	1/8/2018	1/28/2018	3w
3	Simulate swarm algorithm behavior	1/28/2018	2/22/2018	3w 5d



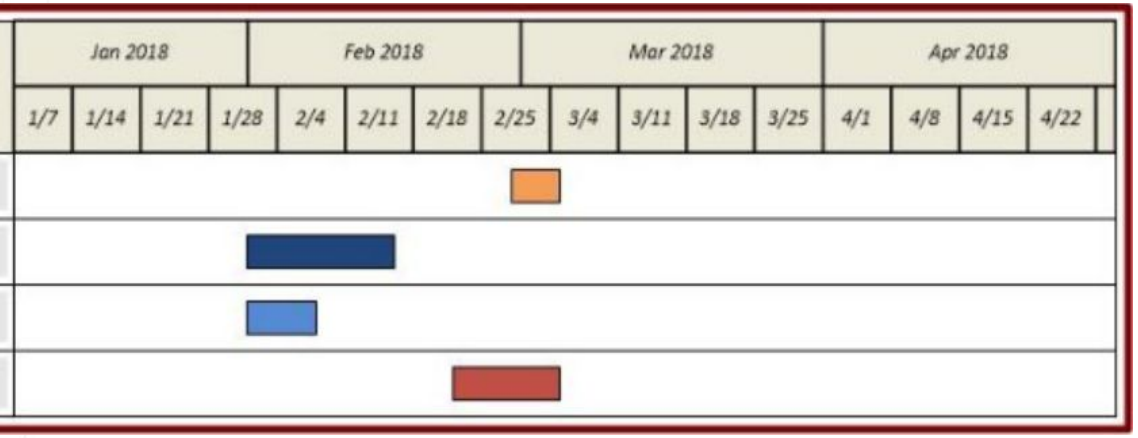
SCHEDULE: CONTROL FLOW

ID	Task Name	Start	Finish	Duration
1	**Create Control Flow**	**2/15/2018**	**2/28/2018**	**2w**
2	Integrate sensors on hardware platform	2/15/2018	2/22/2018	1w 1d
3	Software/Hardware compatibility review	2/22/2018	2/28/2018	1w



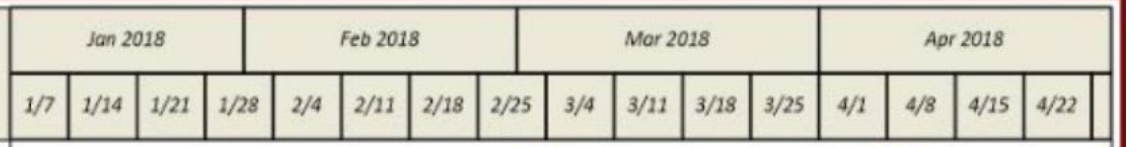
SCHEDULE: HARDWARE/SOFTWARE INTEGRATION

ID	Task Name	Start	Finish	Duration
1	Integrate Software and Hardware	2/28/2018	3/4/2018	5d
2	Design PID controller	2/1/2018	2/15/2018	2w 1d
3	Identify PID gains	2/1/2018	2/7/2018	1w
4	Test Single Robot	2/22/2018	3/4/2018	1w 4d

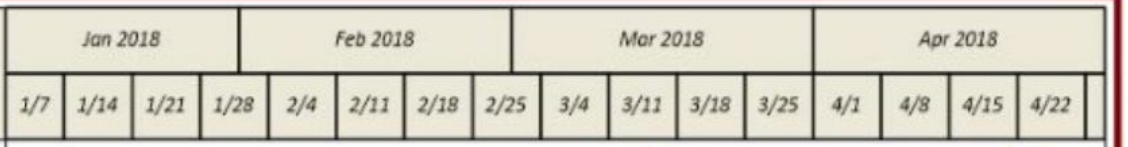


SCHEDULE: MULTIPLE ROBOTS

ID	Task Name	Start	Finish	Duration
1	**Create Multiple Robots**	**3/4/2018**	**4/8/2018**	**5w 1d**
2	Create Second Robot	3/4/2018	3/15/2018	1w 5d
3	Create Third+ Robots	3/25/2018	4/8/2018	2w 1d

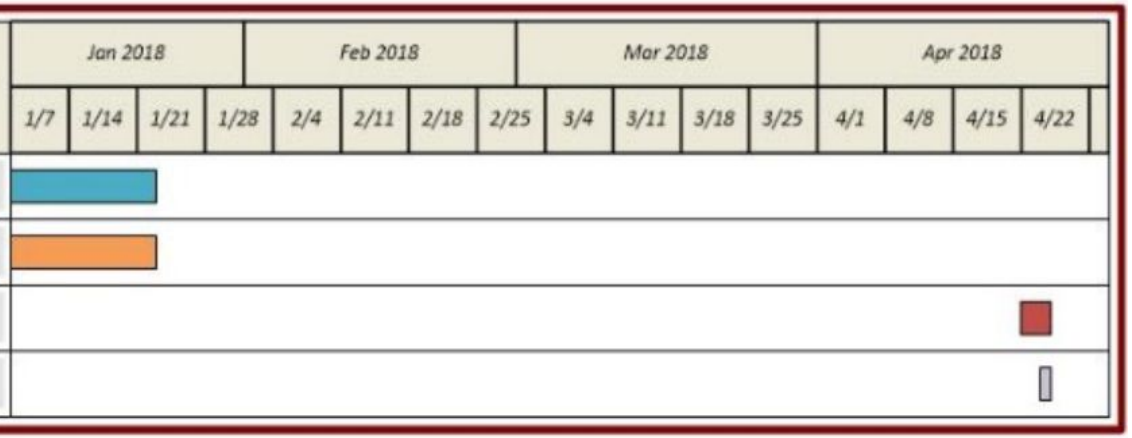


ID	Task Name	Start	Finish	Duration
1	**Test Multiple Robots**	**3/16/2018**	**4/22/2018**	**5w 3d**
2	Test communication between two robots	3/16/2018	3/25/2018	1w 3d
3	Product testing on multiple robots	4/8/2018	4/22/2018	2w 1d



SCHEDULE: DELIVERABLES

ID	Task Name	Start	Finish	Duration
1	Oral Presentation	1/8/2018	1/22/2018	2w 1d
2	Review of Design Proposal	1/8/2018	1/22/2018	2w 1d
3	Final Project Demonstration	4/22/2018	4/24/2018	3d
4	Participation in Design Expo	4/24/2018	4/24/2018	1d



CURRENT PROJECT STATUS

- Finalized all the parts, components and major design features.
- Met with Dr. Magnus Egerstedt to determine suitable coverage control algorithms for multi-agent systems used for beacon detection.
- Method to acquire distance measurements underwater and the development for underwater communication protocol still needs to be researched and tested.
- Reached out to Dr. Ji-Xun Zhou, Georgia Tech's Principal Research Scientist in Acoustics and Dynamics, for an acoustic pinger.

Thank you

QUESTIONS?

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