The Design and Development of a Modular Robotic Control Board for Multiple Applications

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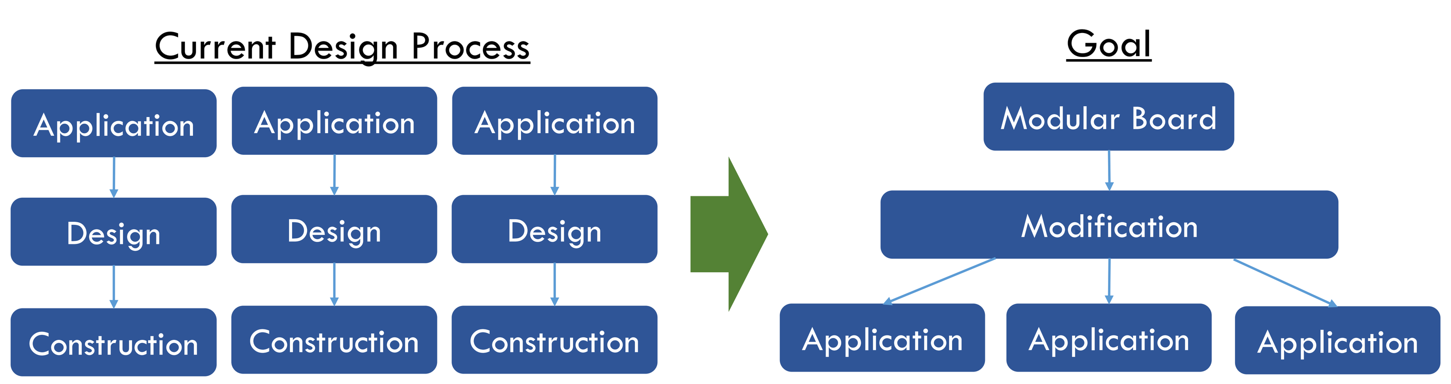
Introduction

What is Modularity? Modularity is defined as the degree to which a system's components may be separated and recombined.

The Problem:
- Robots are generally custom-designed for specific applications
- Designing complex mobile robots "from the ground up" can be difficult and expensive
- Modularity between different robots is almost nonexistent

The Goal: To design an electrical board that can be used on different robotic platforms to increase the flexibility of the board, allow for easier robotic design development, as well as lower cost.

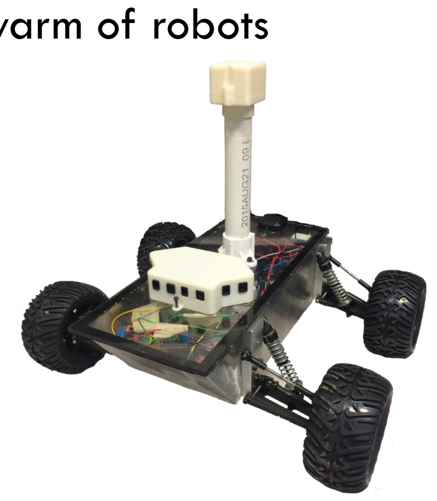


This will be accomplished by:
- Assessing the design constraints of various robotic applications
  - Within the subsystems as well as overall robotic constraints
- Subdividing the board into four main components
  - Main processing unit, sensors, actuators, and power

Main Platforms

For this project, 4 robotic platforms were used for design constraints and application of the designed board:

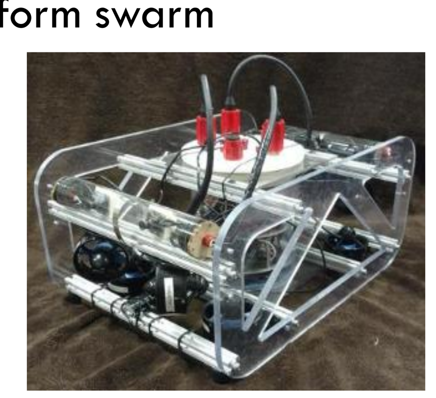
- **ET-NavSwarm**
  A proof of concept Extraterrestrial Rover to test Particle Swarm Optimization on a swarm of robots



- **QuadSat**
  A quadcopter design intended to test Particle Swarm Optimization in an Aerial Fleet

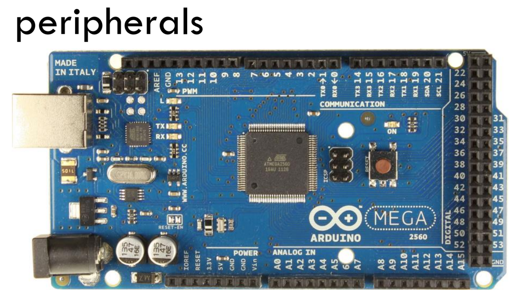
- **ASV**
  Autonomous Surface Vehicle to test collaborative multi-platform swarm

- **ROV**
  Underwater Remotely Operated Vehicle to test collaborative multi-platform swarm



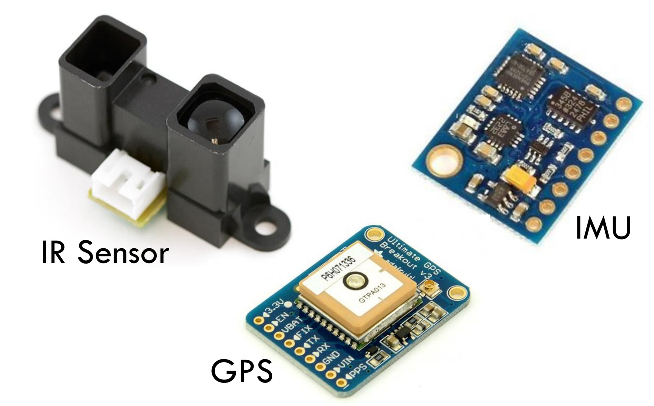
Subsections of the Electrical System

- **Main Processing Unit**
  Microcontroller
  A small computer on a single integrated circuit that contains a processor core, memory, and programmable input/output peripherals

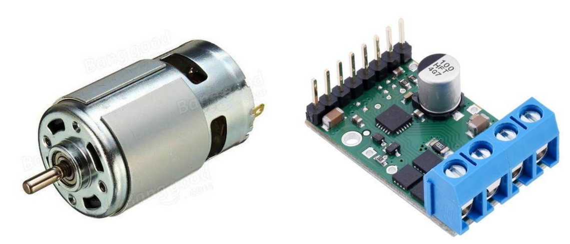


Arduino Mega Microcontroller

- **Sensors**
  Include Infrared (IR) Sensors, pressure sensors, Inertial Measurement Units (IMUs), and GPS, etc.



- **Actuators**
  Responsible for moving and controlling the robot
  - Consists of parts such as motors and Electronic Speed Controllers (ESCs)



- **Power**
  A basic power unit consists of a power supply and voltage regulation (to step down the voltage)

Design Constraints

	ET-NavSwarm	QuadSat	ASV	ROV
Width	6.5"	20"	19"	8.5"
Length	15"	20"	32"	8.5"
Height	4.5"	2.5"	16"	13"
Actuators:				
Type of Motor	Brushed DC Motor	Brushless DC Motor	Brushless Thruster	Brushless Thruster
Number of Motors	4	4	2	6
Number of ESCs	2	4	2	6
Power Requirements	12V	11V	12V	12V
Sensors:	GPS, 5V	Gyroscope, 5V	GPS, 5V	Pressure Sensor, 5V
	IMU, 3.3V	Radio Receiver, 6V	IMU, 3.3V	Pixhawk 4, 5V
	IR, 5V		Lidar, 5V	
Processor Unit:	Arduino Mega; Raspberry Pi	Arduino Uno	Arduino Mega; Raspberry Pi	Fathom-X Tether Interface Boards
Current Battery:				
Voltage	16V	11.1V	5V	14.8V
Amp Hours	16Ah	2.2Ah	10Ah	18Ah
Size	3"x7"x2"	4"x1"x1.25"	5"x3"x0.5"	5.5"x3"x2"

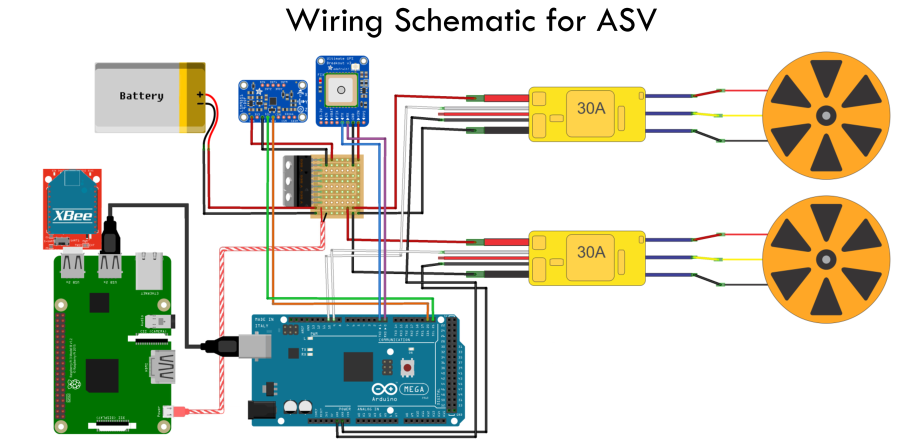
Basic Board Requirements and Specifications

- Temperature control/Heat dissipation
- Supply regulated power to actuators
- Supply regulated power to sensors
- Connect sensors to controllers
- Fuse to prevent damage
- Monitoring of battery levels
- Ease of battery recharge
- Withstand the required vibration levels

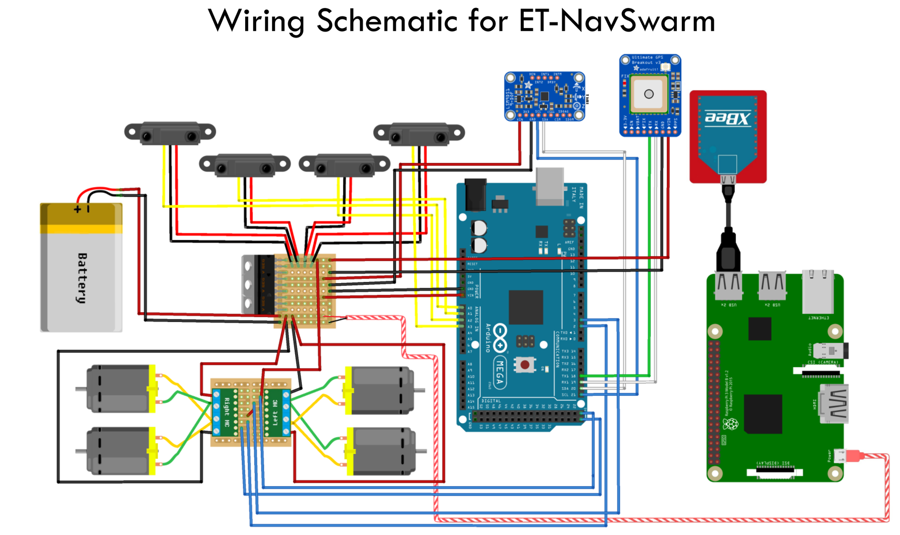
Current Work

- Modularity of the power system was found to be feasible, while modularity was not feasible for the main processing unit and sensors
- The power board is in the construction phase and will soon be tested and implemented
- Wiring schematics will be created for each of the different systems to ensure that each platform is wired in an organized and efficient manner

Wiring Schematic for ASV



Wiring Schematic for ET-NavSwarm



Future Work

- Other work to be done include further research into other potential modular groupings
- Working with the different platforms for implementation
- Once optimal design is reached, Printed Circuit Boards (PCBs) will be designed to reduce clutter, increase reproducibility, and for a more permanent and durable structure

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Acknowledgments

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NAVSWARM