NAVSWARM

University of New Hampshire

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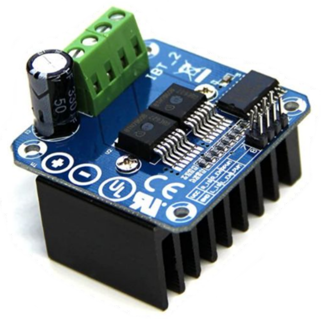
Electronics



Electronic Speed Controller (ESC)

- Uses pulse width modulation from Pixhawk to power motors
- One ESC powers two motors, one for each side of the rover
- Controls motors

Raspberry Pi

- Runs PSO code and communicates goal position to the rest of the rover
- The brains of the rover

Pixhawk Flight Controller with Global Positioning System (GPS)

- Enables us to collab with ASV and Quad X Swarm teams
- Tracks current and future locations of rovers
- Controls positioning and movement

XBee and Shield

- 2.2 GHz transmitter/receiver
- Allows for swarm data communication
- Communication device

Battery

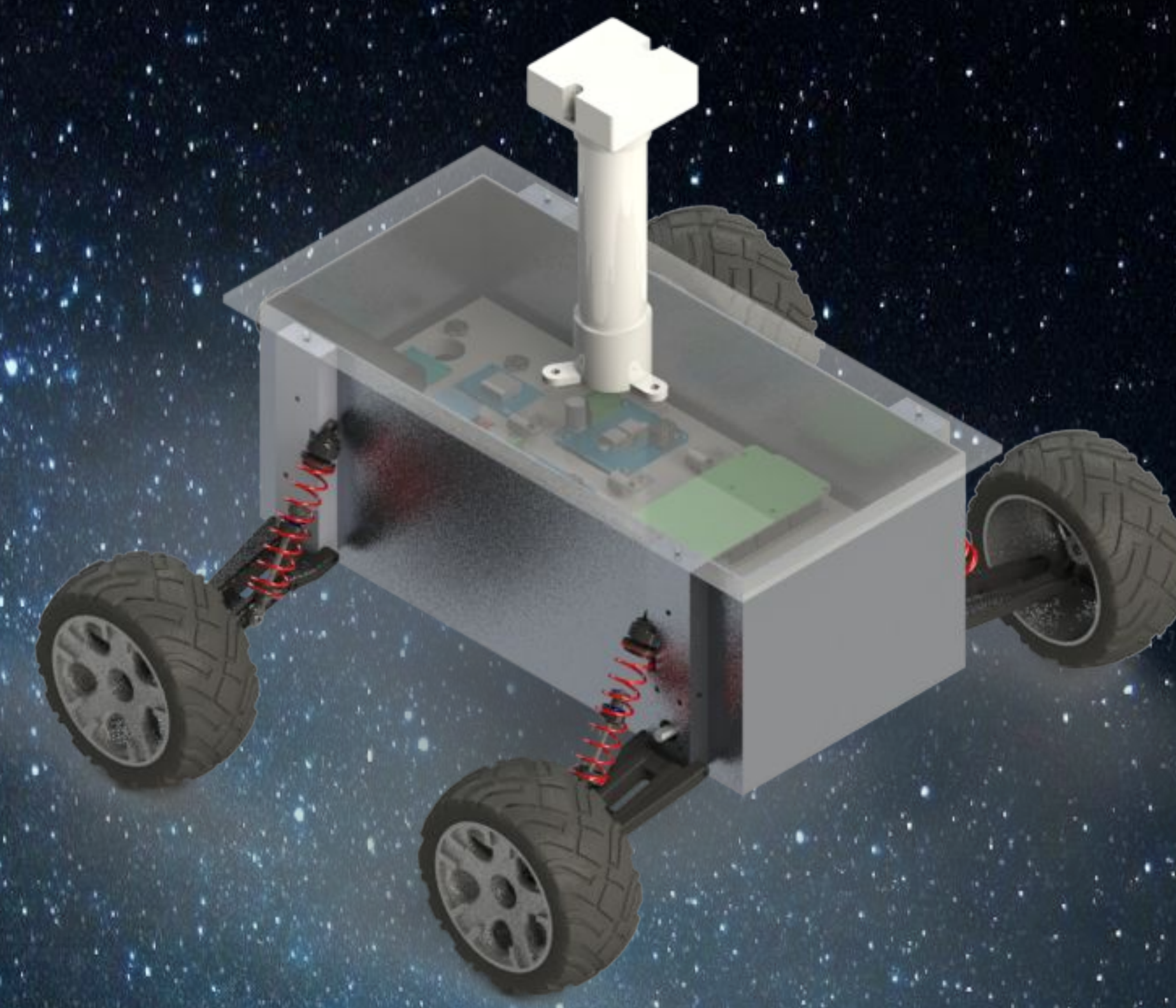
- 10,000 mAh capacity LiPo pack
- Provides overall power to the rover

Mission Statement

Our goal is to design and test a swarm of autonomous robots acting as a proof of concept for a particle swarm optimization (PSO) algorithm. This algorithm will then be tested on a field where the swarm of rovers will locate and travel to the highest point of elevation.

Capabilities

- 1.5 hour run time
- Robust and impact resistant
- 45 degree incline climbing
- Water resistant
- Prototyping quadcopter landing pad
- Early interoperability to run with air, land, and sea rovers



Rover Design

Chassis

- 5052 welded sheet aluminum

Drivetrain

- 4WD, tank steering
- Driven by 4 DC motors

Suspension

- Modified, independent single A-arm RC car suspension

"Unicorn Horn"

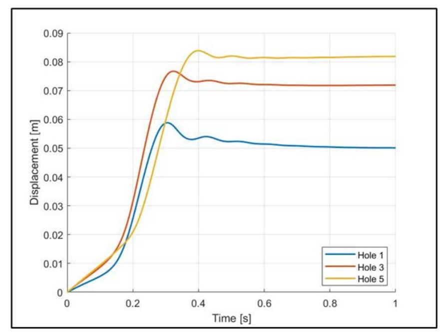
- Isolated system for IMU to prevent EMF interference
- Collapsible square tubing and 3D printed mount for Pixhawk

IR Vision System:

- Optimized field of view to reduce in-test crashing
- 3D printed, enabling rapid prototyping and repair

Suspension Overhaul

- Changed to springs with a higher spring rate
- Analyzed second order impulse response
- Tuned suspension geometry for quickest response with minimal overshoot and optimal ride height
- Designed axle guards to fix the problem of tall grass wrapping around and jamming the axles



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Particle Swarm Optimization (PSO)

- Based on biological swarms such as birds or fish
- Equation emphasizes efficient movement and common goals
- Searches for optimal parameters (such as a maximum or minimum) of a specific target
- Swarm converges on optima gradually, allowing each iteration to improve accuracy
- Requires current velocity, local (personal) best location, and global best location from the search space

$$\Delta\vec{x}(k+1) = M\Delta\vec{x}(k) + C_1\vec{r}_1(k) \otimes [\vec{L}_{best}(k) - \vec{x}(k)] + C_2\vec{r}_2(k) \otimes [\vec{G}_{best}(k) - \vec{x}(k)]$$

Software and Control

- Changed to PixHawk Flight Controller from Arduinos to improve GPS accuracy and enable interoperability with air- and sea-based robots
- Migrated to Raspberry Pi 3b's, ROS, and Python for all control and PSO calculations
- Communication between rovers facilitated over XBee using Python
- PSO algorithm outputs direction vector to reach a desired destination
- Pixhawk controller uses custom firmware file to move the rover to a set GPS position
- Incorporates obstacle avoidance in parallel with PSO control output using IR sensors
- Configured wireless access to rovers for setup and configuration through SSH
- Developed centralized command station Graphical User Interface (GUI) to interface with all the rovers within the swarm