T302: SAND-e

Semi Autonomous Navigation Debris Eliminator

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Introduction

4.5 trillion cigarette filters are littered each year, and just one is enough to kill fish in a stream. [1]

Currently, waste in the marine ecosystem is one of the largest global environmental issues. There are many beach cleaning efforts with a focus on mass collection of larger visible garbage. However, small waste is typically hidden beneath the sand and more difficult to identify.

Our stakeholders: Vancouver's Board of Parks and Recreation, AMS Sustainability, and UBC IGEN have all helped to shape the direction of our project.

Our Mission

Our goal is to reduce waste entering the ocean to improve the health of coastal ecosystems

Project SAND-e tackles the problem of small litter, focusing on collecting waste such as caps, cigarette butts, and other trash that is difficult to identify. As an autonomous solution, SAND-e enhances the work of current cleaning crews by providing a more thorough cleansing of the beach. To this end, we have created a beach crawling rover aided by GPS and an pre-generated path to sieve up to 95% of an area for small waste.

Project Components

Mechanical

- Mechanism to pick up trash in sand and deposit it into a container
- Ingress protection to withstand beach environment

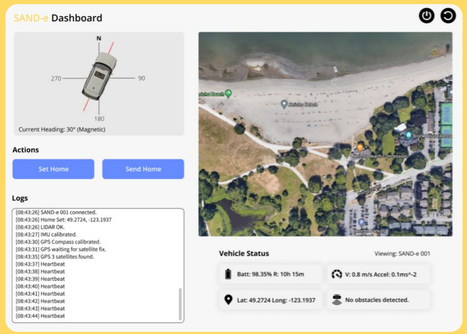
Electrical

- Drivetrain
- Integration between software devices and mechanical constraints
- Motor control for scooping mechanism
- Pure RC input

Software

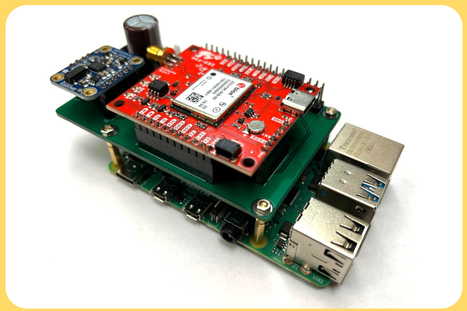
- Dashboard for data display and robot management
- Self-generated pathfinding
- GPS navigation control loop

Interactive Dashboard



- Control center for managing SAND-e remotely, from any location with a cellular or wifi connection
- Displays relevant data and information:
  - Velocity/Acceleration
  - Current Location
  - Orientation
  - Vehicle State Messages
- Actions for home location management and power systems
- Secured with password protection, hosted on a proprietary Virtual Private Server (VPS)

Controls



- Auto-generated path via onboard pathfinding algorithm that generates GPS waypoints to cover at least 95% of selected area
- Autonomous GPS waypoint navigation with RTK correction and fused IMU data on Raspberry Pi that communicates with separate Teensy 4.1 for direct motor control, all integrated on a custom sensor shield PCB
- Closed-loop control with ODrive motor controllers and encoders for accurate velocity-based control via Teensy 4.1
- Six motor and wheel differential steering system

Debris Collection

Scoop

- Digs 4cm into the sand
- 5 mm sieve diameter to collect small waste
- "Dragger" configuration, decreasing force experienced by the scoop
- Can carry up to 5kg of debris in scoop

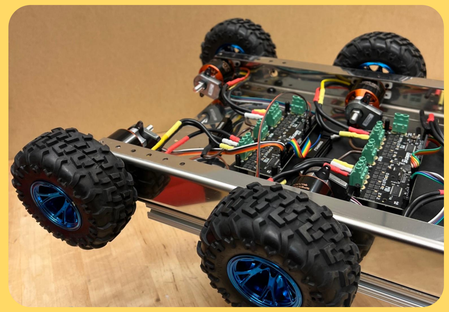
Collecting and Dumping Mechanism

- Scoop rotates by the servo motor located at the side of the scoop
- The arm moves the scoop up and down to dump trash in container
- A handle on the front plate is used to empty the waste collected in the robot manually

Drivetrain

Motors Selected:

- Avian 4260-480Kv Outrunner Brushless Motor
- Maximum capacity: 25kg
- Powered by 6S 50C LiPo, 88.8Wh



Future Work

- Solar power
- Home charging station
- Autonomous waste dumping
- Optimized waste collection mechanism
- On-board autonomous pathfinding
- Machine learning based obstacle detection/avoidance
- Tracked propulsion system