ET NavSwarm

Patrick Rubinas, Megan Sorette, Jilly Sticca, Adam Vogler
Computer Science, University of New Hampshire, Durham, NH 03824

Introduction

The goal of ET NavSwarm is to develop a fleet of robust, autonomous, land rovers for the use of exploring and surveying extraterrestrial terrain.

The rovers will make use of a variety of hardware and software to handle obstacle avoidance, GPS positioning, pathing, and robot-to-robot/robot-to-base-station communication.

Particle Swarm Optimization (PSO) algorithms will be utilized to organize the rovers, and a group of them will coordinate with each other to act like a herd or flock of animals.

Requirements

- At least 2 robots with all components (Arduino, Raspberry Pi, XBee, Pixhawk) connected and functioning together, with 3 additional robots capable of reaching the same functionality
- 5 robots are capable of base random navigation through LiDAR obstacle avoidance, even when GPS data is not available
- A fully functional robot can navigate to waypoints using GPS and IMU data
- A robot can run commands sent remotely from a base station
- Robots can notify other robots of obstacles to be avoided

Design

Fig. 4 (right) shows how each of our bots are configured.

- XBee receives waypoint information from a base station or other rovers and sends it to the RPi
- Pixhawk sends GPS and IMU data to RPi
- RPi acts as the brain, processing data into motor instructions that it sends to the Arduino
- LiDAR sends sensing data to Arduino
- Arduino controls the motors to make the rover move
- LiDAR data takes precedence over RPi instructions

Visuals

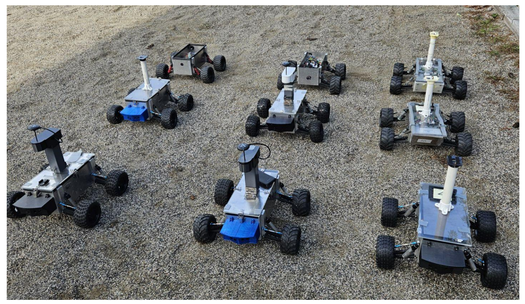

Fig. 1 Photo of rover swarm

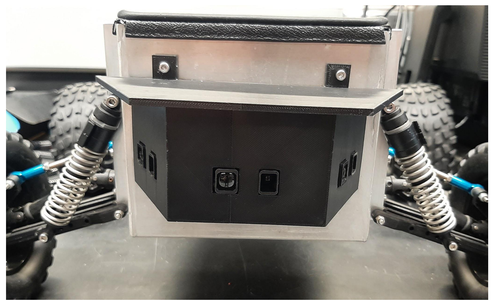

Fig. 2 Improved LiDAR Housing Unit

Navigation

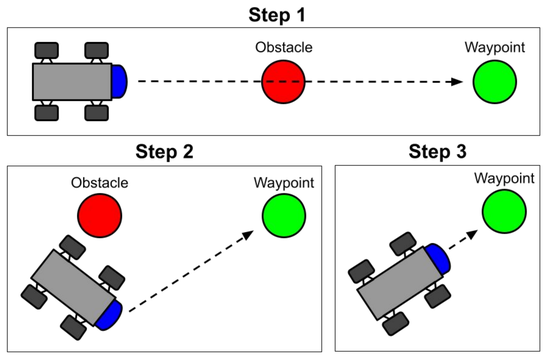

Fig. 3 Waypoint Navigation with Obstacle Avoidance

Fig. 3 (left) shows an example of how obstacle avoidance and waypoint following will work together in navigation. In step 1, the rover moves in a straight line towards the waypoint. In step 2, the rover senses an obstacle and redirects its path. Once it is out of the way of the obstacle, it redirects its path towards the waypoint and continues moving. This process will repeat again if anymore obstacles are encountered.

Design

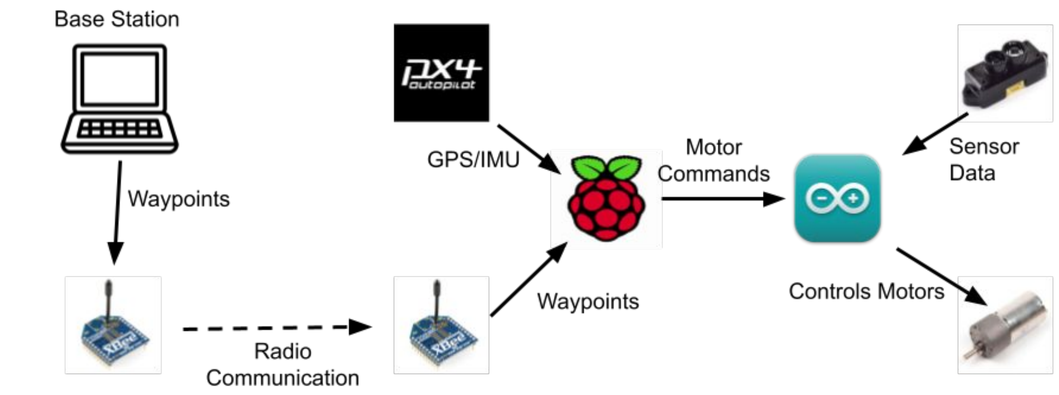

Fig. 4 Robot Component Diagram

Implementation and Testing

Arduino and LiDAR sensing

- Arduino is used to interface with and control the rover's motors
- Remote sensing and obstacle avoidance protocols
- Optimization of LiDAR code through Arduino programming
- Written in C++

XBee

- Radio communication modules made for point-to-multipoint communication
- Bot to bot communication through Raspberry Pis
- Send and receive messages/data between XBees
- Written in Python

Pixhawk

- Provides GPS and IMU data to Raspberry Pis
- Data used for waypoint following

Raspberry Pi

- Processes data from both the Pixhawk and XBee into motor instructions for the Arduino
- Will be the platform for implementing PSO algorithms in the future

Testing

- Set up indoor courses for testing obstacle avoidance using LiDAR sensors
- Created groups of waypoints for rovers to follow during outdoor tests

Evaluation and Conclusion

Obstacle avoidance code has been upgraded and made more robust. The LiDAR Housing unit has also been redesigned to give the rovers a higher FOV. This now gives us 8 rovers capable of performing basic, random navigation of terrain without GPS and with the ability to receive commands from a base station..

If we can successfully test two rovers simultaneously, both with full functionality (obstacle avoidance, waypoint following, path correction, and communication), then this project will be set up for the future implementation and testing of PSO algorithms for land exploration and surveyal.

Acknowledgements

A sincere thank you to...

- Project sponsor Professor May-Win Thein
- Project advisor Professor Craig Smith
- Cooper Montgomery
- Nate Cannon