ACoRNS

Autonomous Collaborative Rover Navigation System

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Motivation and Objective

Project done for the KU Aerospace Engineering Department

To design an collaborative system for guiding a vehicle through a terrain mapped by a UAV

Optimal path takes into account the performance metrics of the vehicle

Simulate navigating an unknown area safely and quickly

Rover can do surveying or data collection while driving

Real World System

A UAV would have a LIDAR (Light Detection and Ranging) sensor to measure terrain depths

This drone would scan an area and generate a map of the terrain

Based on the rover's performance metrics, a maximum gradient is generated

Using this and max gradient, a path finding algorithm would determine the most optimal route

The aerial system connects to a rover or automated car via radio frequencies

Navigation commands are sent to the rover and the path is traveled

Small Scale Solution

UAV is simulated by an overhead rail system similar to a 3D printer

8ft x 8ft grid with artificial “terrain”

Small rover

Bluetooth connection

Process and Design

Broken into 4 components

1. Aerial Mapping
2. Vehicle Performance Metrics Equation
3. Pathfinding Algorithm
4. Vehicle Movement

Aerial Component

UAV simulated with an overhead rail system like a 3D printer, to make accurate and consistent tests

Sampled depths with a LIDAR sensor

Iterated over the entire area to get a high resolution image of the terrain

Vehicle Performance Metrics

Takes in vehicle information like dimensions, torque (horsepower), and coefficient of friction

Determines at each point whether the terrain is traversable based on the gradient

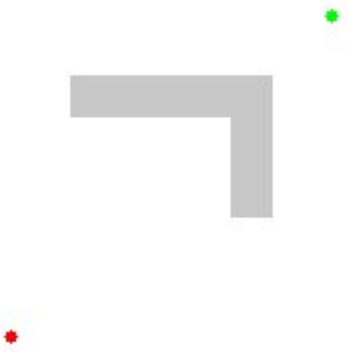
Essentially determines maximum slope

Pathfinding Component

Modification of the A* algorithm

Transform path into directions for the rover to follow

Connect via bluetooth to the rover and send commands



https://en.wikipedia.org/wiki/A*_search_algorithm#/media/File:Astar_progress_animation.gif

Rover Component

Receive commands from the UAV

Navigate precisely to those positions

Provide real-time sensor readings

Unified System

Arduino for controlling scanning connected to scanning apparatus via UART

Pathfinding and mapping done on the same raspberry pi

Connected via Bluetooth to vehicle for sending directions

Video

https://youtu.be/nHMl7G0eS0A

Future Work

Move from small scale to full scale with UAV and actual vehicle

Error correcting path, automatic feedback system

Integration of GPS for more precision (small scale, GPS couldn’t work)

Have the rover moving and attempting to navigate while thee UAV is sampling commands

Demo