Collaborative Distributed Sensing Rovers

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Abstract

Goal: Build a collaborative and inexpensive network of mobile sensing platforms for developing cooperative navigation and sensing algorithms.

Currently testing: Mapping soil magnetic signatures

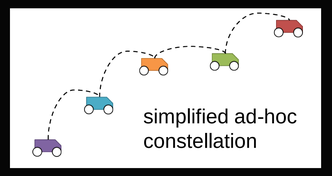
1) Model

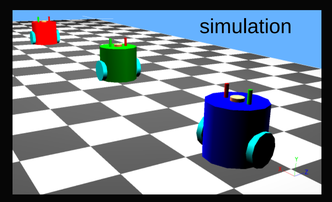
- Simulate multiple robots operating in a mobile ad-hoc network (MANET)
- Gain insight about the software tool's limitations and its relevance for real-world hardware
- CAD models capture the key components of the system: cylindrical body, differential wheels, transceiver and GPS.

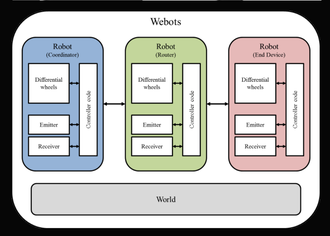
Early simulations implement 3 robot roles: Coordinator, Router, and End Device. This follows standard ZigBee network protocol.

The control software is written in C.

The functional diagram represents the overall system.







Functional diagram

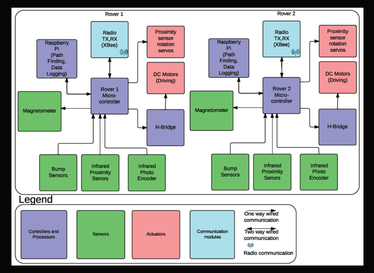
2) Small scale platforms (on-going)

- Rover to rover communication
- Real-time obstacle avoidance
- Heuristic navigation
- Magnetic mapping

Collaborative Navigation and Mapping: The D* lite path finding algorithm.

- Rovers sense obstacles using IR proximity sensors.
- Magnetometer measures the magnetic field intensity and outputs it as a corresponding frequency.

- Obstacles and sensor readings are appended to the map of each rover.
- Obstacles and sensor readings are transmitted to the other rover for updating it's map.
- Transmission is done using XBee modules.
- Raspberry Pi sends direction commands to the microcontroller, updates the map by input from the microcontroller, and logs the data.



3) Large scale platforms (future)

Deploy the mobile sensing technology on two mini All Terrain Vehicles (ATV) as part of on going collaborations with NASA Ames and the U.S. Geological Survey (USGS). The research environment is expected to be on large flat empty dry lake beds. These areas are ideal area for autonomous testing of sensor collaborative technologies as Areas of Interest can be 10's of square miles.

The USGS utilizes Geometrics cesium vapor magnetometers for geophysical research on magnetic anomalies. These highly sensitive magnetometers measure the geomagnetic field to nanotesla (10^{-5} Gauss) levels. Integrating these magnetometers into our mobile sensing platform, we hope to develop collaborative system mapping algorithms that will enable efficient surveying of large areas with autonomous vehicles.