Introduction/Background

In searching problems a robot is looking for a target in a potentially unknown domain. To locate the target it is important that the robot traverses the map efficiently. My searching algorithm for locating the stationary target, focused on creating a frontier between explored and unexplored regions. The robot iteratively chooses the best position on the frontier which maximizes frontier coverage.

Robot and sensor hardware

The robots we use are Videre ERA-MOBI model. Each contains an on board Linux computer and a laser distance sensor. More details are listed below.

Robot specs:
- Size: 40cm(L) x 41cm(W) x 15 cm (H)
- Batteries: 4-5 Hours with normal movement.
- Encoder accuracy: 500 counts/rev
- Speed: up to 2 m/s
- Capacity 20kg (44lbs)

Laser specs:
- Model: Hokuyo URG laser Rangefinder
- Range: 5 meters
- Scan rate: 10 Hz
- Resolution 0.36 degrees

Player/Stage interface

Player/Stage is an interface which we use to test and simulate our robot algorithms. Stage simulates mobile robots in a two dimensional environment. Using Player/Stage is convenient especially because our algorithms can be tested on either the simulated environment or the real robots and can easily move from one to the other to make improvements.

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Properties of Algorithm

This search algorithm is complete meaning that it will find a target when one exists, or determine there is no target after exploring the entire environment. This claim holds with appropriate assumptions on the topology of the environment.

Some of the limitations on the algorithm could come from the accuracy of the sensor data, and the problem of odometry could effect how the robot navigates the environment.

The Algorithm:

The flowchart below explains the steps of the searching algorithm.

Efficiency

By weighting the best next position based on the lengths of the frontier segments covered, we believe that the algorithm maximizes the expected exposure of unexplored area. By max exposure on each iteration the algorithm minimizes the expected time to detection.

In addition, depth-first traversal of the position graph helps minimize worst-case time by relating the amount of time the robot spends traversing already explored regions.

Future Research

This algorithm is also a foundation for solving more complex variation on this search problem. For example, this algorithm can be extended to multiple searchers or a moving target.