COMPSCI 603
Assignment 2: Particle Filters For Mobile Robot Localization

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Background

The goal of this assignment is to implement a particle filter for mobile robot localization, and to demonstrate it working on real robot data. You may implement this using any programming language subject to certain constraints listed below. Any techniques discussed in class, as well as those discussed in the reading materials for the class, may be used by you for the assignment.

Your robot is operating in a formidable university building with nothing but odometry and a laser rangefinder. Fortunately, you have a map of the floor, and a deep understanding of particle filtering to help it localize.

Source Code

You may use any programming language that can be installed from standard packages on Ubuntu 16.04. Any dependencies used must also be installable from standard packages (any packages hosted on the main Ubuntu package mirror). All source code must be submitted in a single archive file, with a clear Readme text file with instructions on how to install its dependencies, and run the code. No external code may be used to implement the core algorithms of the assignment.

Data Format

The robot data log is a text file consisting of multiple rows. Each row is one of three types, denoted by the first character in the row: an initialization message (I), or a laser scan message (L), or an odometry message (O). The initialization message has the following entries:

1. X - coordinate location
2. Y - coordinate location
3. Angle

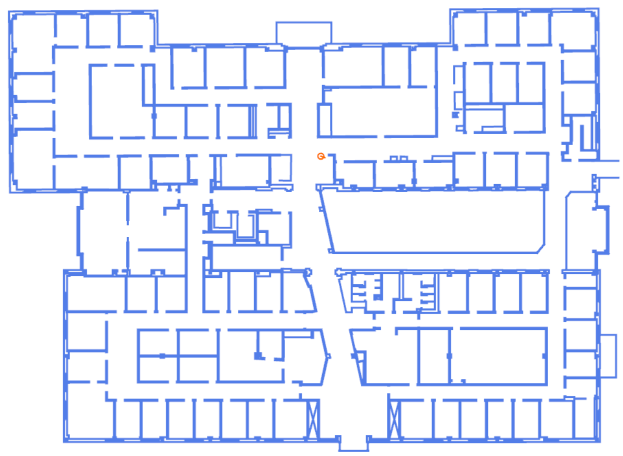

Figure 1: Map of the environment.

The laser scan message has the following entries:

1. Timestamp in epoch time
2. The number of scan rays, N
3. Min angle
4. Max angle
5. Angle increment
6. The N scan rays

The odometry message has the following entries:

1. Timestamp in epoch time
2. Odometry along x (forward) coordinate
3. Odometry along y (left) coordinate
4. Angular odometry

The map is specified in vector form, consisting of multiple line segments, one line segment per line specified in the form `x1,y1,x2,y2` where `x1,y1` is one end of the line segment and `x2,y2` the other end. Figure 1 shows a visualization of the map, and Figure 2 shows a partial trace of the robot's location as it moves around on the map. The instantaneous laser scan is shown in orange, transformed to the map coordinates using the estimated location of the robot.

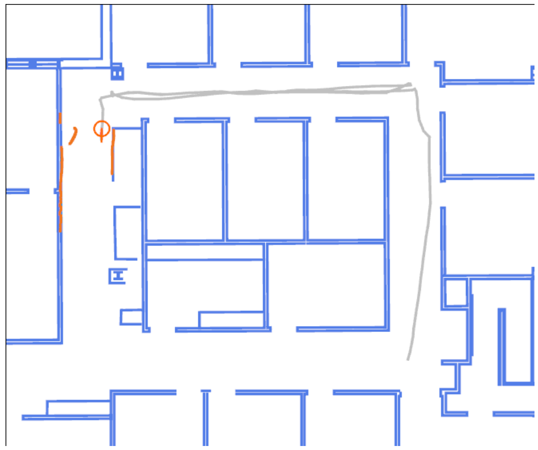

Figure 2: Partial trace of the robot's location.

What to turn in

You should generate a video of your robot localizing using the log. You should also submit a report describing your approach, implementation, and results. In particular, describe and report your

1. sampling distribution,
2. motion model,
3. laser beam model,
4. observation likelihood model,
5. resampling procedure, and
6. the parameters that you had to tune (and their values).

Include some future work/improvement ideas in your report as well.

Suggested Work Timeline

Succesful completion of this assignment will require you to implement several sub-problems. Here is a suggested timeline for you to follow, while working on this assignment.

Week 1

1. Convert map format, if desired.
2. Write code stub to read robot data, and empty loops for sensor update and odometry update.
3. Visualize robot data.
4. Write and test motion model sampling. Verify that it generates the expected banana distribution.

Week 2

1. Write observation likelihood function.
2. Write visualization of observation likelihood function in a window of regions.
3. Verify expected behaviour when in a hallway and observing a single wall.
4. Verify expected behaviour when in a rectangular room and observing a single corner.

Week 3

1. Write resampler.
2. Integrate predict, update, resample steps.
3. Debug, optimize motion model parameters, observation likelihood parameters.
4. Generate video.
5. Write report.