Assignment 1: Particle Filter Localization

Intelligent Robotics/Intelligent Robotics Extended
School of Computer Science
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1 Objective

The objective of this exercise is for you to implement, analyze, and understand the working of a particle filter localization algorithm. You will be working in simulation (RosStage and Rviz). To write your localisation node, you will use the skeleton code provided for you https://github.com/IRUOB/pf_localisation; please read the README.md file in the repository for further instructions on how to compile and use the package. Use the simulated world found at *socspioneer/data/meeting.world*, and the rosbag files in *pf_localisation/data* to test your implementation. The rosbag contains data published on the following topics */base_pose_ground_truth, /odom, /tf*, and */base_scan* as the robot was being teleoperated in the simulated world. Unlike the simulated data, real robot data will not include ground truth robot pose.

2 Task

Implement a version of the particle filter (Monte Carlo Localization, MCL) algorithm for localization. You will use the map provided for the practice exercise in the *socspioneer* package. In addition to the steps of the particle filter (i.e., motion update, sensor update, and re-sampling), you will also investigate methods for obtaining a single estimate of the robot's pose at each time step. You should also be able to deal with the "kidnapped robot" problem. You are to compare the performance of your implementation with the AMCL implementation in the ROS nav-stack. You will submit (on Canvas) a report (3-5 pages, 11-point font, single-space) documenting the design choices made and the results of experimental analysis. Demos will be due in your assigned lab session. As an optional task, you may attempt (i) extensions such as adaptive MCL, i.e., varying the number of particles over time; (ii) Kalman filter-based localization.

3 Marking Scheme

The following marking scheme will be used for this exercise:

- Task performance (5 marks): how well does the robot localize in the map of the domain?
- Design choices (2.5 marks): what design choices were made during the implementation of the algorithms for automated mapping and localization? if an adaptive version of MCL was attempted, what capabilities were implemented and how?
- Pose estimation (2.5 marks): how is the single pose estimate computed during each iteration of the algorithm? how does this approach deal with multi-hypothesis tracking?
- Viva (10 marks): does each team member demonstrate a good understanding of the algorithms and related trade-offs?
- Report (10 marks): does the report discuss the design choices and results of experimental analysis? are the experiments and results presented properly?