Coursework assignment
Probabilistic Robotics UFMFNF-15-3

Hand-in date: 4th April, 2019

Overview

Using the simulated robot platform and environment provided on the blackboard site complete each of the following tasks and submit an individual report (single pdf) that documents your solutions using the guidelines provided.

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Task 1: Robot controller (15%)

Use MATLAB and ROS to implement a closed loop controller that generates appropriate motor commands for the simulated robot to explore at least 50% the environment whilst avoiding collisions with walls.

Document your solution by providing clearly commented MATLAB code of the controller **(10 marks)** and a figure that shows an example plot of the path taken by the robot as it explores the environment **(5 marks)**.

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Task 2: Motion model (15%)

Generate a noisy estimate of pose from your robot using a velocity motion model that accepts the same velocity commands sent to the simulated robot platform. Use the following parameters in your motion model:

[$\alpha1=0.1$, $\alpha2=0.02$, $\alpha3=0.2$, $\alpha4=0.01$, $\alpha5=0.001$, $\alpha6=0.01$]

Document your solution by providing clearly commented MATLAB code of the motion model **(5 marks)** and a figure that overlays an example of the ground truth path taken by the robot with the subsequent noisy path generated by your motion model **(10 marks)**.

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Task 3: Observation model (10%)

Place some fiducial landmarks into the environment. Convert the readings from your fiducial detector on board the robot into range and bearing measurements when a fiducial is observed. Add noise to the observations made by the fiducial detector to better represent uncertainty in the sensor measurements. Chose appropriate parameters for uncertainty in range and bearing.

Document your solution by providing clearly commented MATLAB code of your observation model **(5 marks)**, a figure showing landmark locations in the environment **(2 marks)**, and an appropriately formatted map of your landmarks **(3 marks)**.

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Task 4: Mapping (10%)

Gather a data set from the robot as it autonomously explores the environment. Include: ground truth pose from clean odometry, noisy pose estimate from your motion model, clean range and bearing measurements from your fiducial detector, noisy range and bearings from your observation model, and noise free range measurements from your laser range finders.

Document your data set by generating an occupancy grid map of the environment using the ground truth pose and the noise free laser range finder measurements. Include a figure of the occupancy map generated using MATLAB **(10 marks)** [do not include MATLAB code for this task]

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Task 5: Extended Kalman Filter based localisation (30%)

Implement an Extended Kalman Filter (EKF) based localisation algorithm using MATLAB.

Document your EKF algorithm using clearly commented MATLAB code **(20 marks)**. Demonstrate performance of your EKF using the data set collected in task 4 by including a figure that overlays ground truth pose, noisy pose estimate and best estimated pose generated by your EKF for each data point in the set **(5 marks)**. In a second figure, overlay a plot of the Mean Squared Error (MSE) between ground truth pose and noisy estimated pose against the MSE between ground truth pose and EKF best estimated pose for each data point in the set **(5 marks)**.

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Task 6: Particle Filter based localisation (20%)

Implement a Particle Filter (PF) based localisation algorithm using MATLAB.

Document your PF algorithm using clearly commented MATLAB code **(15 marks)**. Demonstrate performance of your PF using the data set collected in task 4 by including a figure that overlays ground truth pose, noisy pose estimate and best estimated pose generated from PF for each of the data points in the set **(3 marks)**. In a second figure, overlay a plot of the Mean Squared Error (MSE) between ground truth pose and noisy estimated pose against the MSE between ground truth pose and PF best estimated pose for each data point **(2 marks)**.