MTRN4010 – Project #2

Applying EKF for map-based robot localization

Project 2 involves applying the EKF, for solving a robot localization problem, based on maps. We intend to use it with the real data which was used in Project 1. For achieving it, we solve this problem incrementally, so we are able to secure that its many parts are working well, before we try the full solution under real data conditions. The first part of the project asks the student to adapt the EKF to solve the map-based localization, in a purely synthetic simulation context. The second part aims to use it dealing with real data, but still in an off-line fashion. Real time conditions, such as receiving and processing the data in real-time, as it was usually performed in previous years, is not required in 2020.

Part 1)
Modify the provided example "DemoEKF_2020.m" for
a) Processing bearing (angle) observations (in addition to the range ones which are already implemented in the example.)
b) Using a proper Q matrix, based on the assumed noise in the inputs of the process model.
Note: for solving item (a) you need to also modify certain parts of the simulator components, for simulating the bearing measurements; you should see, as an example, the source code for implementing the simulated ranges.

Part 2) Use parts of the solution developed for Part (1), for implementing the EKF based on the data and code used in Project1.
This program is based on the data used in Project 1. It is OFF-LINE but using real data, in the same way we solved Project 1. You are requested to adapt your solution for Project1, adding the EKF component. The estimates should be more accurate than those obtained in project 1, which were based on simple dead-reckoning.
Assume the following realistic conditions:

Noise in angular rate measurements:	standard deviation = 1.5 degrees/second.
Noise in speed sensor:	standard deviation = 0.4m/s.
Noise in range measurements:	standard deviation = 0.2m.
Noise in bearing measurements:	standard deviation = 1.5 degrees

You need also to consider that the LIDAR sensor is located at the front of the platform. There is a PDF document (included in this project release), which describes how to treat that matter.

Note: you must remove the bias which is present in the angular rate measurements (as you have done in Project 1)

Note/Recommendation: You may use the simplified version for the dataset ("unified dataset"). An example program, which uses the unified dataset, is implemented in the file "ExampleUsingUnifiedDatasetMTRN4010.m". The datafile is named "All01.mat". Both files were provided during week 5, for helping in solving Project 1; however, you can still use the original files, which were originally released for Project 1 (those files can still be used for both projects, if preferred by the student).

Showing results

For Part 1, you will plot the result at the end of the process. The style of the plots may be as the ones produced by the provided example program ("DemoEKF_2020.m").

For Part2, you will include dynamic plots, as you have already done in Project 1. You may (this is not mandatory) simultaneously run the pure dead-reckoning solution, for comparing the performances of both approaches. The lecturer showed a solution, in class, in which both estimation processes were performed simultaneously, and their estimates compared.

For visualizing that the pose estimates are consistent with the real ones, we will infer it by inspecting the expected global position of the detected OOIs. Those will appear close enough to the map landmarks. This visualization is the same you had implemented for solving Project1.

Relevance of project parts

Part 1: 45% (of the whole project mark)
Part 2: 55%

Submission details

You will submit your program, uploading your files via Moodle; the deadline will be Week 9, Saturday 25/April,09:00PM.
The specifications, about how the files must be submitted, will be given via Moodle, during week 8.

Late submissions: We will apply the penalties according to the course outline.

Quiz
There will be a unified brief quiz about the Projects 1 and 2; it will take place via Moodle, on week 9.
The final marks for project 1 and 2 will be affected by your result in that quiz, according to a formula which will be given before that week.
The questions included in the quiz are fully related to basic concepts which you apply for solving the projects.

Questions: Ask the lecturer, via Moodle or via email (j.guivant@unsw.edu.au)