AAS - MTRN4010 – Project 2 (aka Task 4)

FINAL PROJECT

All the parts of this project involve developing versions of the EKF localizer, intended to operate in Real-time. You will use the API and play data back, as you did in the RT module in the previous project (P1.Part3).
In order to proceed solving this project you must have solved the previous project (P1). If you have not solved P1, you will first proceed completing it. You need to demonstrate P1 before demonstrating P2.

Part 1:

Implement an EKF localizer, for operating in an ON-LINE fashion. You should reuse many of the modules you have implemented in previous tasks.
The EKF localizer must consider all the available observations (range and bearing).
The measurements from the gyro should be preprocessed by simply subtracting the bias (previously estimated, via an off-line approach); consequently, the measurements are polluted by noise which can be considered to be approximately white.
In order to validate the convergence of this estimation process, we consider an indirect approach. The accuracy of the expected values of (x, y, Phi) is verified by comparison of the observed OOIs, expressed globally (whose transformation is based on the estimates of (x, y, Phi)) and the given map (landmarks).
If the estimates of position and heading are accurate, the OOIs would usually appear near known landmarks.
Note: The discrepancy between those sets of points should be lower than the one appreciated in Project1.Part3.

Part 2:

This part requires the ON-LINE estimation of the gyroscope's bias, in addition to the pose of the platform. You can modify Part 1 for including estimates of the gyroscope's bias. Only if your solution for Part 1 is working, you can extend it for solving this part.
In this case, the measurements from the gyro are NOT preprocessed (we do NOT subtract the bias, estimated off-line). The bias is to be estimated ON-LINE, assuming that there was no opportunity to perform an OFF-LINE estimation of it.
For validating the convergence of this estimation process, we apply the following:

a) For estimates of (x, y, Phi), as in Part 1, i.e. indirectly by comparison of OOI expressed globally.
b) Bias' estimates: by comparison with the OFF-LINE version of the estimate.
   Its visualization should be in a separate figure; like an oscilloscope, for showing the two variables: the estimated bias and the off-line one whose value is constant. Alternatively, you can print the value, at low frequency (e.g ~1Hz). In any case, the bias should be shown in units whose angular component is in degrees.

Assumptions: We assume that the bias is constant, whose value is limited to be inside the range [-1, +1] degrees/second. A more realistic assumption would be considering that it is "almost constant", i.e. it is time varying, but bounded to drift less than 1 degree/second during 1 hour. However, for the short experiment we perform, we can assume it is constant.

Recommendation: You could/should implement that capability in the fully simulated localizer, implemented in parts 1 and 2 of Project 1; before trying it in the real time version. However, you are only evaluated for the real-time version, which is the objective of this part of P2.

Expected result: OOI's (globally expressed) should appear close to landmarks (as in Part 1). Expected value of gyroscope's bias should converge, in short term, to a value close to the OFF-LINE estimates (e.g. less than 5% of it).

Part 3:

Implement the version of localizer for the case where the longitudinal component of the velocity (speed) is not provided by a sensor but it is estimated.
For verifying the convergence of the estimation, we compare the estimated speed with the one measured by the speed sensor (however, the sensor's measurements are not used by the EKF).
In order to validate the convergence of this estimation process:

a) For estimates of (x, y, Phi), as in Part 1.
b) Speed: We use the speed measurements just for verifying the accuracy of the speed estimates. This can be shown in a separate figure (e.g. as an oscilloscope showing the two signals: the measured speed and the estimated one.) In any case, the speed should be expressed in meters/second.

Note: The gyroscope's measurements should be preprocessed (bias removal, as in Part 1). You are not required to simultaneously estimate the gyroscope's bias.

Assumptions: We assume that the platform is never able to accelerate (or deaccelerate) or exposed to longitudinal accelerations higher than 1.5m/s^2. Consequently we assume that $|a(t)| < 1.5\ m/s^2$.
Note: You can verify it (approximately), by numerically deriving the measured speed data.

Expected result: OOI's (globally expressed) should appear close to landmarks (as in Part 1). Speed's expected value should be close to the measured speed. Estimated speed will appear constant during prediction times, only being modified at the update times.

Before solving this project

Trying to implement this full program, involves integrating many modules which were previously solved in Project 1 (P1). Before you try P2, you need to complete relevant parts of Project 1 (P1).

Relevance of the project's parts:

Demonstration Part 1: 27%
Demonstration Part 2: 27%
Demonstration Part 3: 28%
Report: Total 18% (6%,6%,6%, for each of the parts, respectively)

Those marks will be affected by your result in the Quiz.
The Quiz will include five (5) questions, having each of them 20 marks, totalizing 100 marks.
The final mark for Project 2 is evaluated according to the following formula:

Final mark of Project2= MIN(total mark of demonstration and report, 25+75(**Quiz_mark**/100))*

* Demonstration: On week 13 (during your session time).

* Submission of programs: On Friday, Week 13, before 23:59. Electronically, via Moodle site. Details, about how to organize the files, will be given during this week. Submission site will be open from Wednesday, week 13.

* Submission of report: At any time between Wednesday (Week 13) and the following Tuesday ("Week 14"), time=11:59AM. Electronically, via Moodle site. Details about the required format will be given during this week.

There will be no extension time for submissions and demonstrations, except in cases where you apply (and get approved) Special Consideration.

Quiz: The Quiz will take place in week 13, in your lab session, before demonstration time. It will run from minute 20 till minute 35. You are expected to attend it, even if you give your demonstration in a different week or day.
If you are not able to attend, contact the lecturer or apply for Special Consideration.

Questions: Via Moodle's Forum or by asking the lecturer by email (j.guivant@unsw.edu.au)

Thinking about some additional work during your free time, in July? (not part of this project!)

1) Estimating the bias and the speed, simultaneously (as in certain projects in previous years).
2) Estimating the parameter "L" (location displacement of laser scanner), as it was done in certain project in previous years.

➔ Contact the lecturer, via Moodle, if you want to try.