MTRN4010 – Lab Task #2

Basic Data Fusion

In this task we begin processing data from multiple sensors, simultaneously. We do it in a simple way, deterministically. These are preliminary steps, necessary for solving the localization problem through stochastic Sensor Data Fusion, what will be applied in subsequent projects, in MTRN4010.
This task involves processing multiple sensing capabilities: laser scanner, wheel encoder and gyroscope.
All the modules implemented in this task will be used in subsequent projects. Properly solving this task does not only give you marks in this task, but also facilitates the solution of the subsequent projects.
One of the purposes of the task is for understanding and implementing localization by applying "dead-reckoning". The second purpose is getting used to using different coordinate frames and for implementing a Data Association process. All of them are necessary for future projects, during this session.

Part A.

Implement a function for estimating the attitude of the platform, based on the measurements of the IMU's gyroscopes. You may assume that the platform is always operating in a 2D context; consequently you can assume that pitch and roll are always =0; what allows processing the integration by simply integrating the angular rate ω_z. For verifying the performance of your implementation, you will plot the estimated attitude, for the full duration of the test. You will compare it (by simply inspection) with a solution provided by the lecturer.

Part B.

You are required to implement a "dead-reckoning" process, based on the kinematic model of the platform and the measurements provided by sensors. The kinematic model was explained in the document "[AAS_2015s1]_KinematicModels.pdf" (released for Lecture 1). The way for implementing it, in a discrete time fashion, is also explained in that document.
The inputs of the process model are the angular rate ω_z and the speed encoder measurements. All the measurements have associated timestamps. The necessary data is contained in the Matlab data files "IMU_data.mat" and "speed_data.mat". These files do also include useful comments (in addition to the necessary data) for explaining the data format.
You will compare the estimated path (by simply inspection) with a solution provided by the lecturer.
Additional validation of these results will be done in Part C.

Part C

At each time, when a laser scanner measurement is available, you will perform the following processing:

1) Obtain an estimate of the position and orientation of the platform at that time (provided by B).
2) Perform feature extraction, for detecting the OOIs (as implemented in Task1)
3) Express the currently detected OOIs' positions in a global coordinate frame (using the results obtained in (1) and (2))

We assume as "global coordinate frame" the one aligned with the platform at time t_0. I.e. we say that the platform's position and heading at time t_0 are (0 m, 0 m) and (90 degrees) respectively (based on the coordinate frame convention, shown in figure 1).
For proper processing, you must consider the position of the laser scanner (on the platform), as it is shown in figure 1. The displacement, ***d***, is 46 cm (approximately), longitudinally.

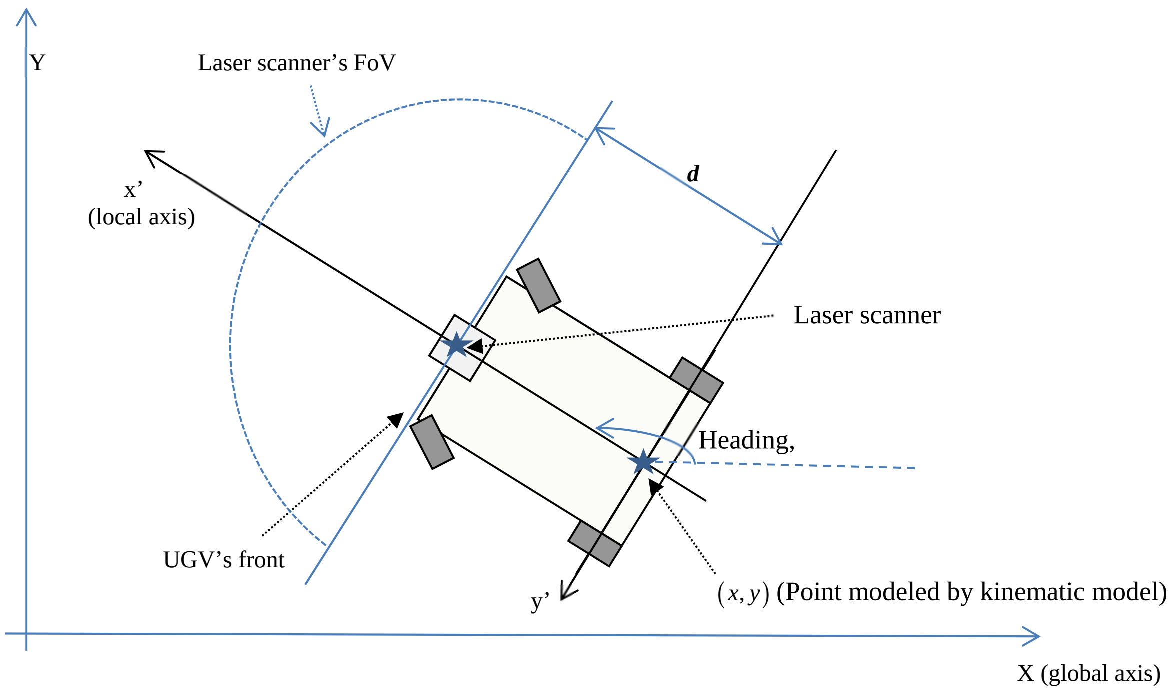

Figure 1

Expected result: When the currently detected OOIs are shown in the global coordinate frame, they would appear near the original OOIs, detected at the initial time. The discrepancy will be increasing as the platform travels, due to the cumulated error in the platform's pose estimates (that usually grows with the time).
Visualization of results: For showing the performance of this process, your program will plot (dynamically, as you have done in previous tasks), the OOIs detected at the initial time and the OOIs currently being detected. Both sets of OOIs are shown, in the global coordinate frame. Use different colors and/or symbols for each set of OOIs.

Part D

Implement a Data Association process.
Based on the previous parts of this task; implement a Data Association (DA) process. The DA concept is discussed in class (week 5).
The DA process would be able to identify (and keep identifying) the OOI that are detected at each scan.
The operation of the module is expected to be the following one:

1) At scan #0, the scanner's data is processed for inferring the OOIs that are present in the image. Those are given identities, i.e. a unique number for each of them.

2) Each subsequent scan is also processed for extracting the OOIs occurring in it. The DA process will infer the identity of each currently detected OOI, based on the positions of the OOIs obtained in the first scan and on the estimated global positions of the currently detected OOIs. A tolerance of 50 cm will be considered for the matching process.

For visualizing the performance of the approach, you will use Part C, adding text nearby each currently detected OOI, for indicating its inferred ID.

Deadline: Demonstration of this task will be on Week 7, during your lab session. In the demonstration, you will briefly show (to the evaluator) your program working (or the parts of the task that are working). You may need to explain parts of your program, and answer questions, as part of the demonstration.

Quiz: A short quiz, about this task, may take place during your lab session (the day of the demonstration). It will be announced in week 6; consequently, you will know about it, in advance. If the quiz is announced to take place, you must attend the quiz of your session. If you are not able to attend your quiz, you will need to apply for SC.

Report: There is no report associated to this task.

Exam: Questions related to this task may be part of the final exam.

Questions: Via Moodle Forum or email to lecturer (j.guivant@unsw.edu.au)

Note: you do not need to print this document, on paper.
