MTRN4010 / ADVANCED AUTONOMOUS SYSTEMS T1.2022

Week 2 tutorial problems.

Aim of this tutorial / Hands on tutorial: By working on these problems, we understand how to implement certain kinematic models. We use those models, in this tutorial, for predicting the trajectory of a wheeled platform.

This type of processing will be well useful, later, when we need to exploit kinematic models, for helping in the estimation of the platform state, or for Control purposes, or used in simulations for testing those estimation and control processes.

Question 1.

What would be the approximate heading rate that you would measure, if, when driving your car, you applied a steering angle of 20 degrees, when its speed was 20km/h?

(if you do not have a car, just choose the one you prefer).

Why do we need to know which car?

Question 2.

What would occur if you, when driving a vehicle, during an interval of time, kept the steering angle constant?

(do a brief simulation, for a small car, and for a large one, using a reasonable steering angle).

What do you appreciate? (from your simulations, no need to burn fuel doing it with your car!)

Question 3.

Assuming that you have a kinematic model (of a platform), which is not perfect, but which is realistic enough; would you use it for a short-term prediction (few seconds)?, in the following situation:

You know your current steering angle and your longitudinal velocity, and you have an available LiDAR scan (which has been taken right now) which gives you a good idea about the surrounding obstacles now.

You also know, well, how is that LiDAR installed in the platform (position and orientation in the platform's chassis)

Assuming that the platform's driver will keep the current steering angle and current speed, during that horizon of few seconds, and that the obstacles are stationary (trees, walls, stopped cars, etc.), and that the LiDAR's FoV allowed us to see those obstacles of interest.

Could you infer (predict) if there are chances if a collision?

Hint/Simplification: Although your platform's shape should be approximated by a rectangular shape, you may, in this problem, assume it has circular shape (which a reasonable radius). Students who want to dedicate more time, can assume a rectangular shape.

Other approaches you may propose may be feasible, as well.

Question 4.

We have the following information about a trip which was performed by a slow platform, which behaves according to an Ackermann kinematic model.

a) Initial platform's pose, at time t0.
b) Sequence of measurements, from speed sand heading rate sensors, having a sampling rate of at least 40ms.
c) LiDAR scans (frequent, every ~ 160ms)
All the measurements include "timestamps" with accuracy of fraction of millisecond.

4.1) Use a proper kinematic model, for predicting the trajectory of the platform.

4.2) Think about a way of appreciating prediction accuracy, of your kinematic model, by exploiting LiDAR scans

Hint: scanned infrastructure should appear static/stationary in a global (and stationary) coordinate frame

Use the simulated measurements contained in file "Data_Tu02Q4.mat"
(The file includes comments which describe the data and the data format)

Questions/doubts: ask the lecturer, via Moodle or via email (j.guivant@unsw.edu.au), or consult your demonstrators during tutorial time.

Appendix: Structure of data, used in Q4.

The data is organized, to be accessed chronologically. This is convenient as your processing is oriented to process those measurements "as they occur", which is usual in processes that perform in real-time (That will happen, later, in the term, when we operate in that way.)

Now, we perform our processing, in an off-line fashion, but, still, we want to organize our implementations in a way which would be easier to adapt to those "real-time" constraints.

Our processing does not use future samples, it just uses current and past measurements.

Sensors measurements may also be asynchronous, which means that they do not occur at common sampling times.

For that reason, we provide the data to be accessed via a table of events.

Each row of that table is associated to an event (i.e. a measurement from a specific sensor). Each individual row does specifies the time (timestamp of the measurement), an ID to indicate the sensor which generated that measurement, and an index, to read the actual measurement of that sensor (from a set of many records of that particular sensor.)

So, that the full dataset contains a table of events and a set of individual arrays of records, each of them associated to a sensor.

In our case, those will be:

One array of measurements of LiDAR scans (associated to a LiDAR)

One array of measurements of dead reckoning sensors (couples of Gyro and speed measurements)

Read the program “**ExampleUsingData01.m**” to see how to read the data.

The Lecturer will show his solution, during the lecture on week 2. Details about how to implement the processing will be shown and discussed.

(End of tutorial)