CG1112 Engineering Principle and Practice II
Semester 2 2018/2019

Week of 29th March 2019
Tutorial 6 Part 2

SLAM

In studio W9S1, we used SLAM (Hector SLAM) as a black box. The following questions attempt to show you a glimpse of one aspect of a typical SLAM algorithm, namely **landmark extraction**. The main idea is to process the data points reported by sensor (e.g. LiDAR) to extract landmark(s), e.g. wall, table etc.

1. [Spike Extraction] The "`Landmark.xlsx`" excel file contains one complete 360 degree of LiDAR data, similar to those collected from the W8S1 – LiDAR studio. A X-Y scatter plot is also provided for ease of visualization.

   One simple way to find "interesting" points is to look for abrupt change in the data points. Perform the following in excel:
   - Calculate the **2D distance with the previous** point
   - Ignore those points with low quality (anything <= 128) as they usually means bad / error data
   - Find out points with a large enough distance with previous point. This is known as a "spike"

   Use the X-Y scatter plot and the identified spike points to discuss their significance. (i.e. how are these spike points useful / interesting?)

2. [Is that a wall?] It is quite cool to see Hector SLAM in action. Instead of the multiple LiDAR points we see in W8S1, solid lines representing real world obstacle are drawn instead. Let's take a look at how such "line segment" can be deduced from data points computationally.

   First, take a look at the basic idea of RANSAC (RANdom SAmple Consesus) at wikipedia https://en.wikipedia.org/wiki/Random_sample_consensus . The overview is pretty high level and sufficient for our discussion.

The Wikipedia page focus on getting a single "best fit line" through the points. However, in a typical LiDAR scan, there are multiple lines, each representing some parts of a landmark. Let us adapt the RANSAC algorithm as follows:

While

1. There are still unassociated LiDAR readings,
2. **and** the number of readings is larger than the consensus,
3. **and** we have done less than **N** trials.

Do:

- Select a random laser data reading.
- Randomly sample **S** data readings within **D** degrees of this LiDar data reading (for example, choose 5 sample readings that lie within 10 degrees of the randomly selected laser data reading).
- Using these **S** samples and the original reading calculate a least squares best fit line.
- Determine how many laser data readings lie within **X** centimeters of this best fit line.
- If the number of laser data readings on the line is above some consensus **C** do the following:
  - Calculate new least squares best fit line based on all the laser readings determined to lie on the old best fit line.
  - Add this best fit line to the lines we have extracted.
  - Remove the number of readings lying on the line from the total set of unassociated readings.

Use the X-Y scatter plot in "`Landmark.xlsx`" to see whether you can deduce a few line segments based on this idea. Note that there is no need to actually perform the calculations (as excel is not very friendly ☹), rather use the idea above to see how "wall" segment can be found and plotted.

Note: This question is really just to expose you to the idea. Don't panic as you wont be asked to implement the algorithm ☺.

Credit: The idea of the questions and algorithm are from https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412j-spring-2005/contents/projects/1aslam_blas_repo.pdf