EE 6900
"Simultaneous Localization and Mapping (SLAM) for Robotics"

Spring 2015

Project # 2
(due Thursday February 26th, 2015 at midnight via e-mail)

Part 1:

The goal of this part of the project is to generate an **Occupancy Grid** map for a set of downtown Athens LMS SICK 360 laser scanner data. Develop Matlab code that reads the SICK data and user truth reference data to generate 2D maps for occupancy grid resolutions of 1m, 0.5m, 0.2cm, 0.1m and 0.05cm.

The SICK laser scanner data is given in data file: 'laserdata.mat.' The laser scanner data (ranges and angles) have been converted for you to point cloud points expressed in a local East-North-Up (ENU) navigation frame using the following equation:

$$\mathbf{p}_n^i(t_i) = \mathbf{x}_n(t_i) + \mathbf{C}_b^n(t_i)\left[\mathbf{l}_b + \mathbf{C}_l^b(t_i)\mathbf{p}_l^i(t_i)\right]$$

where:

i is the i[th] laser range scanner point,
t_i is the time at which the i[th] point was measured,
$\mathbf{C}_l^b(t_i)$ is the transformation matrix from the 'laser frame' to the vehicle body frame,
$\mathbf{l}_b$ is the lever arm between the laser range scanner and the vehicle reference point,
$\mathbf{C}_b^n(t_i)$ is the transformation matrix from the vehicle body frame to the navigation frame,
$\mathbf{x}_n(t_i)$ is vehicle position in the navigation frame at t_i,

Loading the 'laserdata.mat' file in Matlab will provide you with the following:

tSICK - 1-by-N vector of reference time tags for each of the scans
peastSICK - M-by-N matrix whose columns are the East coordinates of each point of the laser scan.
pnorthSICK - M-by-N matrix whose columns are the North coordinates of each point of the laser scan.
pxSICK - M-by-N matrix whose columns are the body x-coordinates of each point of the laser scan.
pySICK - M-by-N matrix whose columns are the body x-coordinates of each point of the laser scan.

In the files M = 1440 and corresponds to a full 360 degree scan. N=399 and represents about 80 seconds of data collected with an SICK LMS 360 laser scanner in uptown Athens, OH.

Tasks:

- Write the Matlab code to make the occupancy grid maps for resolutions of 1, 0.5, 0.2, 0.1, and 0.05m, respectively;
- The laser scanner data includes reflections from moving targets such as cars and pedestrians. When setting a grid cell's occupancy to 1 if only 1 laser point is detected within a grid cell, the effect of these non-stationary objects may be significant, thus, evaluate if we can remove some of their effects by setting a threshold for the number of points within with grid cell that would make it "occupied" (i.e. if more than K points are detected within the cell, it is considered occupied);
- Visualize these maps using an appropriate method in Matlab;
- Discuss the results.

Note: make sure to break your code as much as possible into subroutines that can be used in later projects.

Part 2:

The goal of this part of the project is to generate a Gaussian likelihood field for the map you generated under part 1. Visualize the likelihood field for portions of the 'map' and indicate high probability areas by lighter colors (i.e. white) and low probability areas by darker colors (i.e. black).

Tasks:

- Write the Matlab code to generate a likelihood function given a map you are generating. You code must include a function that would output the likelihood of a measurement **z** given a position **x** and a map **m**. This 'likelihood function' can be used in later projects;
- Visualize these maps using an appropriate method in Matlab;
- Discuss the results.

Note: make sure to break your code as much as possible into subroutines that can be used in later projects.