

Homework 4

Student Name: _____

AuE 8200: Machine Perception and Intelligence

Instructor: Dr. Bing Li, Clemson University, Department of Automotive Engineering

- * Refer to Syllabus for homework grading, submission and plagiarism policies;
- * Submission files includes (Due March. 14, 2022 11:59 pm):
 - This document file (with answers), and with your program results/visualization;
 - A .zip file of source code (and data if any) with names indicating question number;

Note: You can use any 3rd party libraries and built-in functions

Download the Apollo “Lidar Point Cloud Obstacle Detection & Classification” dataset and description (LiDAR_datasets.zip and LiDAR_datasets_description.pdf) from [this share folder](#): This Lidar dataset is collected from a 3D Velodyne HDL-64E Lidar. You will find the .bin (point cloud) files for each scanning frames. Please pay attention that in the description pdf, it says:

- The point cloud data are stored in the format of **binary** files.
- The data are arranged in the order of **X1, Y1, Z1, I1**, X2, Y2, Z2, I2... (Xi, Yi, Zi refer to the spatial 3D coordinates of each point.
- Ii represents the reflectance value of this point and the effective value of the reflectance value is from 0 to 255)
- The data in each dimension are stored as the **four-byte float type**.

Question 1) [10 pts]

Select a frame (or a few frames) of LiDAR data file, parse the file and visualize the 3D point cloud of this frame, colored by its reflectivity value.

Question 2) [10 pts]

Choose a 3-D resolution granularity, perform voxel filter (or box grid filter) to down-sample all the 3D point cloud points to the 3D voxel space points, and visualize the result points;

Question 3) [20 pts]

- Apply RANSAC algorithm (or any others you prefer) to the 3D voxel space points to find a ground plane model. Print out your plane model parameter values result, visualize the plane with the points in the 3D (10 pts);
- Analyze the computational time complexity of this algorithm (5 pts).
- Remove all the ground planes points in the 3D voxel space points, visualize all the off-ground points in the 3D (5 pts);

Question 4) [10 pts]

Perform a x-y projection to the off-ground points, and get a 2D matrix (you decide what is the element value), and visualize the 2D matrix as an image.

Question 5) [10 pts]

- Based on the raw point cloud data (Questions 1), which is in Cartesian Coordinate, represent and visualize all the point cloud in 3D of horizontal and vertical angels (converted using Polar Coordinate) and distance to the original (5 pts).
- Finally, generate the projected 2D depth image w.r.t horizontal and vertical angels, with intensity value using the distance. Visualize the 2D depth image (5 pts).

Question 6) [40 pts]

Write a 2~3 pages of survey on a particular 3D measurement related to vehicles (40 points), (such as: 3D mapping of the traffic environment, 3D model of the vehicle, 3D reconstruction of an accident, 3D pose/traj prediction of vehicle/pedestrian, et al). The grading of this question is based on the contents which the survey covers:

- The importance of measuring this target (5);
- The challenges of measuring this target (5);
- Existing approaches of measuring this target (15);
- Existing problems of these existing approaches (10);

There will be other grading factors (such as novelty, organization, et al) (10);

* You are encouraged to include any drawing/table in the report;

* Attention: use “...” [1] to cite any sentence you literally copied and use ... [1] to cite a content you referred to, with reference list in the end;