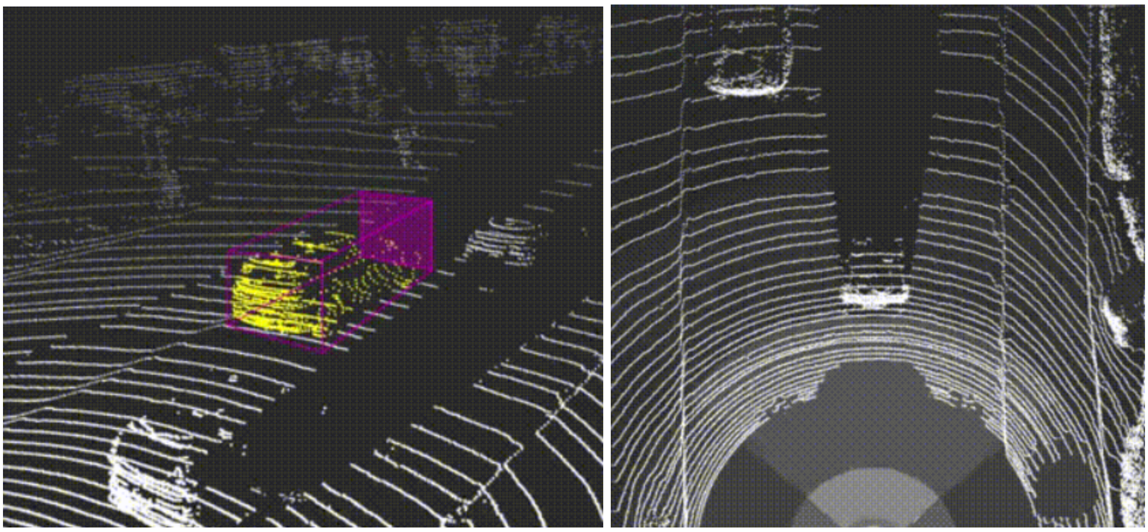
3D LIDAR Point Cloud based Intersection Recognition for Autonomous Driving

Algorithm:

Brief summary:
- First a grid map of point clouds is calculated, the cells belonging to other vehicles are cleared.
- A beam model is applied in front of autonomous vehicles, at a specified distance.
- A feature set based on the length distribution of the beam is extracted from the current frame and combined with a trained classifier to solve the road-type classification problem.

Beam based feature construction:



Data Preprocessing:
Pedestrians and vehicles are detected based on external cubes generated by adjacent cells in grid maps. Using the following steps:
- ➔ Firstly, create a grid map for a frame of data with a quadratic cell size r x r, then calculate the variance of elevation of the points in the corresponding cell.
- ➔ Then we take a threshold on the grid map, if variance of elevation> threshold, then the corresponding entry of the grid is set as 1 else it is set as 0.
- ➔ Go through all the cells of the grid map, then we assemble whose 4 connected regions are all 1 as a connected region, then we surround a cube using these connected regions.
- ➔ Finally we clear all the cells belonging to pedestrians and vehicle and use the remaining grid map for intersection recognition.

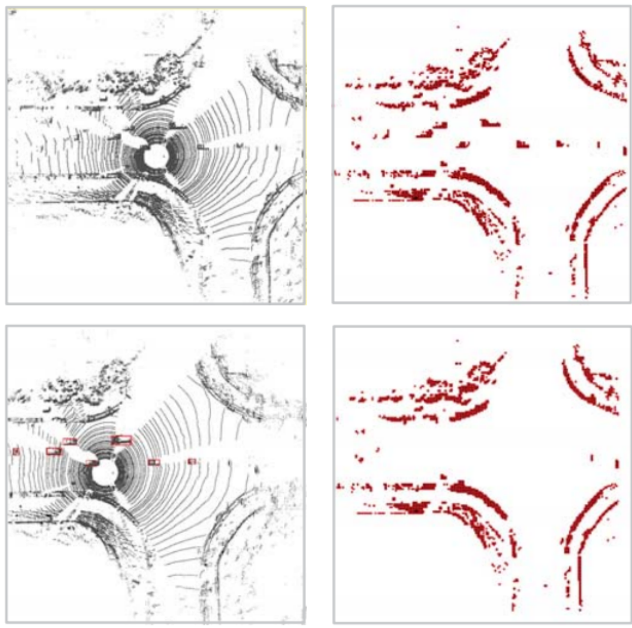


Fig. 2. Step-by-step results of preprocessing: original data; the grid map; vehicle and pedestrian detection and the remaining grid map after removing vehicles and pedestrians.

Beam model based feature construction

- ➔ A probabilistic beam model is used as a range finder.
- ➔ A sequence of beams with the same launching point with an adaptive distance in front of the autonomous vehicle (which is related to the speed of the vehicle) is used.
- ➔ There are 360 beams with 1 degree angle between 2 adjacent beams.
- ➔ Higher the speed longer is the distance between vehicle and the launch point, slower the speed slower is the distance.
- ➔ For intersection and road segments the distribution of length of each beam is different.

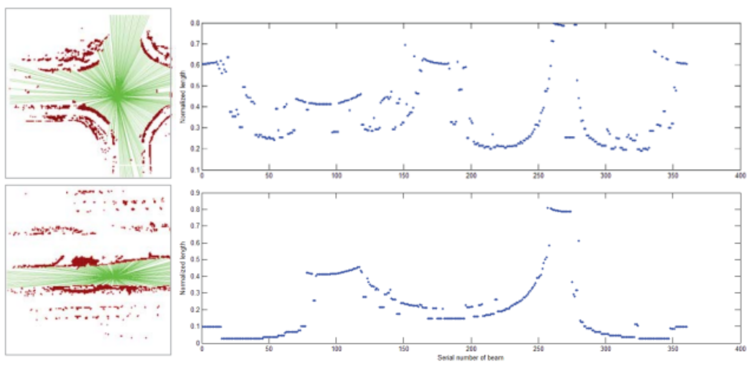


Fig. 4. Examples of beams in intersection and road segment, and corresponding histogram of length distribution. The top one is the intersection and the bottom one is the road segment.

- ➔ For road segment there will be 2 peaks in histogram of length of beam segment whereas for a '+' shaped road there will be 4 peaks.

Feature classification:

Finally a SVM (Support Vector Machine) model is used for classification , we consider 360 beams as 360 features and used SVM for analysing and learning.

RESULT + My take:

- ➔ As written in the paper, for normal dataset (for roads with fewer pedestrians and vehicles), accuracy is above 93% and for the challenging dataset (for busy roads) accuracy is between 80-85% for intersection and road segment classification. Hence I think a better and more effective preprocessing is required to increase accuracy.
- ➔ For T shape and + shape classification accuracy is almost same = 80-85% but it is not good enough for the real world scenario.
- ➔ Final take:
    - ➢ Positive aspects:
        - ★ Use of LiDAR sensors makes the input data more accurate and gives an HD 360 degree view.
        - ★ Not much affected by weather conditions.
    - ➢ Negative aspects:
        - ★ The LiDAR sensor ,laser used may make the vehicle very costly.
        - ★ The accuracy is still not high enough to make the vehicle fully autonomous.