3D Object Detection

Setup of Code

The URL of all the code and associated document (Including this one) is:

https://github.com/HarisAshraf/Project_2

The repository includes the following structure:

```
├ loop_over_dataset.py
├ student
|  ├ objdet_detect.py
|  ├ objdet_eval.py
|  ├ objdet_pcl.py
```

The analysis will follow the following steps (It is assumed that classroom workspace is provided)

Section 1 : Compute Lidar Point-Cloud from Range Image

Visualize range image channels (ID_S1_EX1).

The Range Image (truncated for ±90°) is given in Figure 1. The intensity image in Figure 2, and the Stacked Image in Figure 3. All images are converted to 8bits.

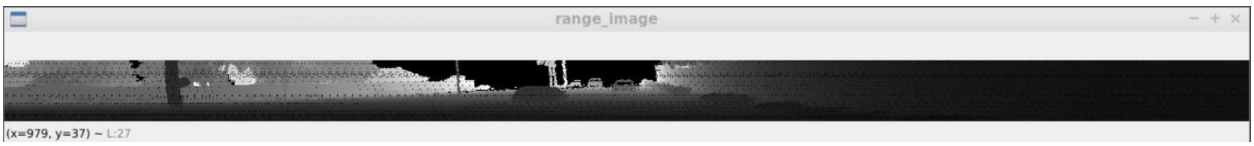

Figure 1: Range Image, ±90° view

Figure 2: Intensity Image, ±90° view

Figure 3: Stacked Image

Visualize lidar point-cloud (ID_S1_EX2)

The Point Cloud of a representative image is shown in Figure 4. The boxes contain the vehicles that can be identified. Vehicles1-6 are oncoming whereas 5-10 are in the same direction of the ego. Nos 7&9 are barely visible as they are quite far and do not have a lot of line thru them. No. 8 is a tractor trailer. No 10 is a pickup truck with a trailer. No 10 and 2 are the closest.

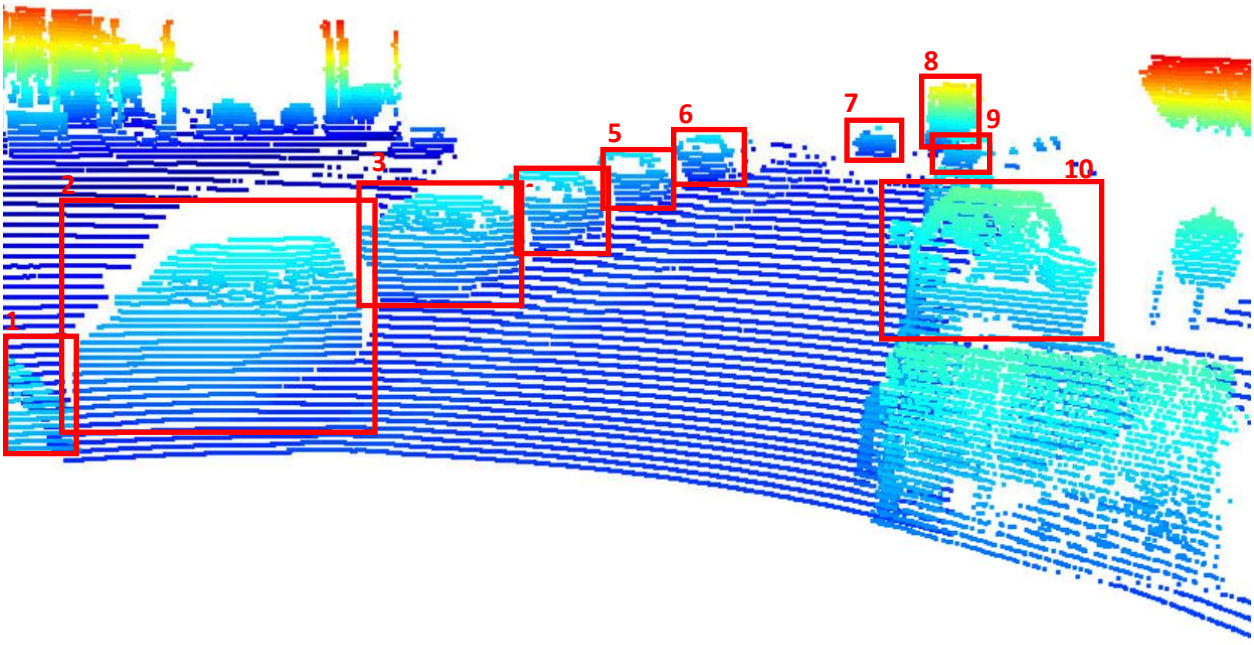

Figure 4: Point cloud visualization

By rotating around the point cloud, some features that can be identifies are: type of vehicle (truck, cars and a semi); side view mirrors and wheels can be seen from most cars. Form side view, tires can also be identified.

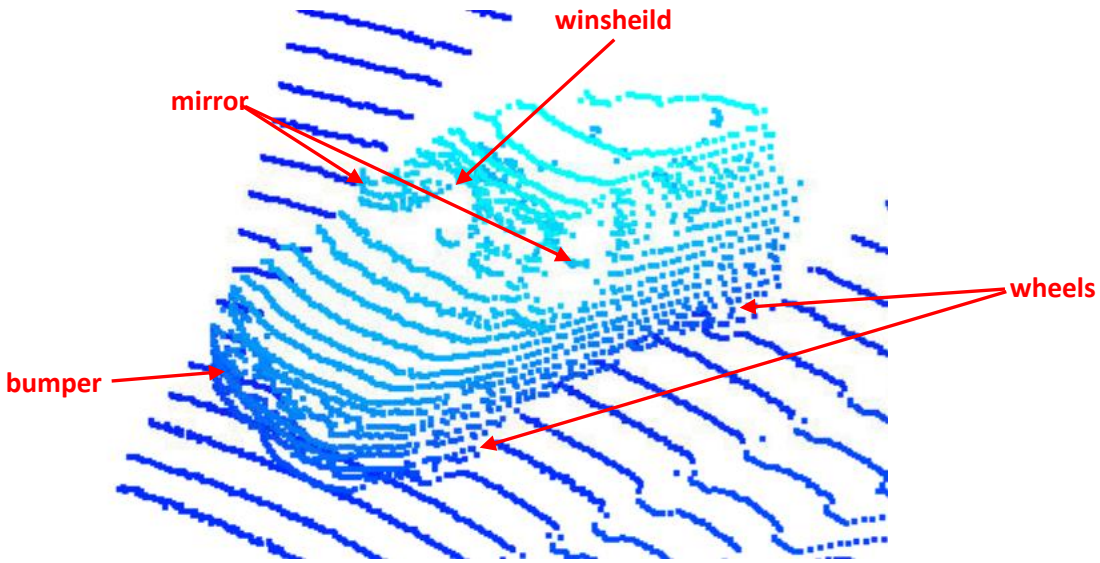

Figure 5: Features identification

Section 2 : Create Birds-Eye View from Lidar PCL

A BEV map of a point cloud is given in Figure 6.

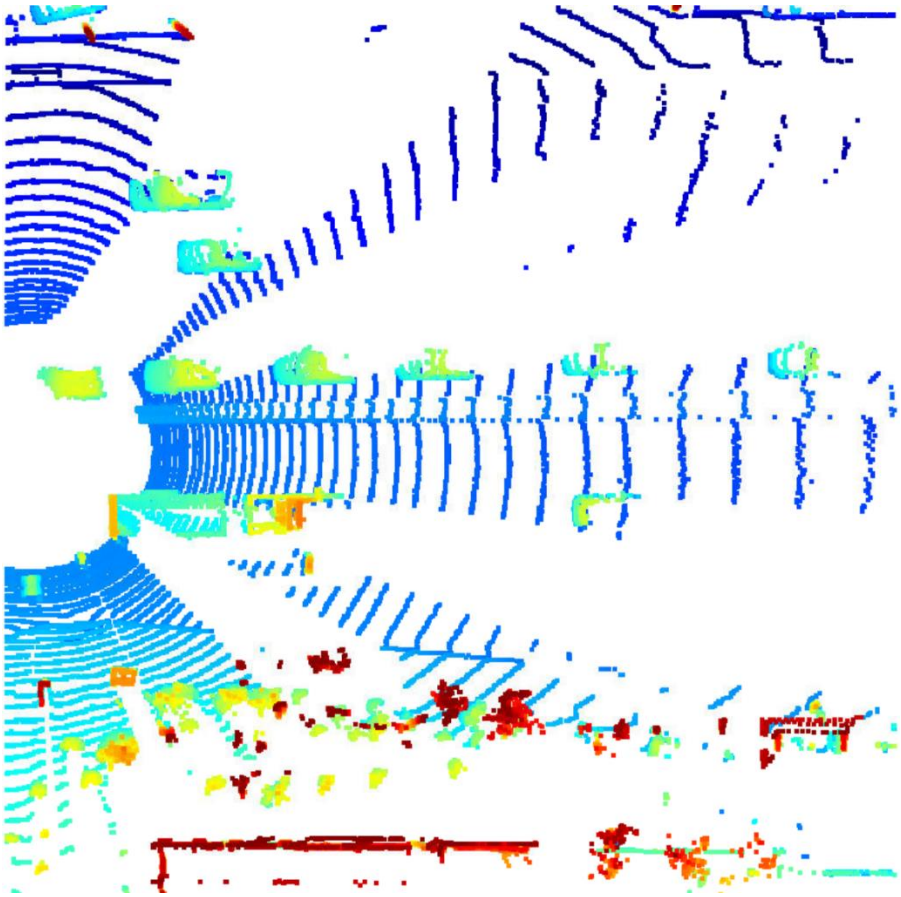

Figure 6: Visualization into BEV map coordinates

Compute intensity layer of the BEV map (ID_S2_EX2)

Intensity layer of a BEV map is shown in Figure 7.

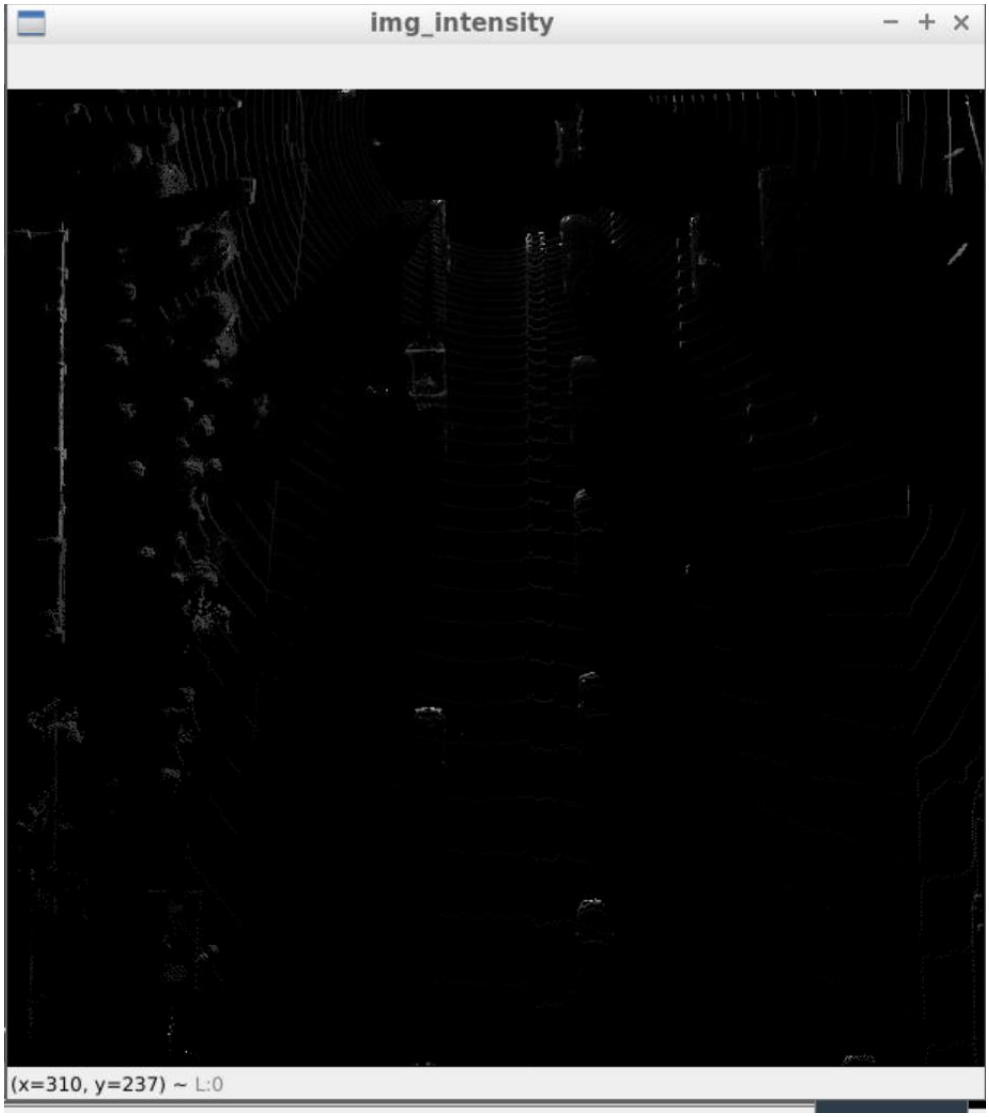

Figure 7: Intensity layer from the BEV map

Compute height layer of the BEV map

Height layer of a BEV map is shown in Figure 8.

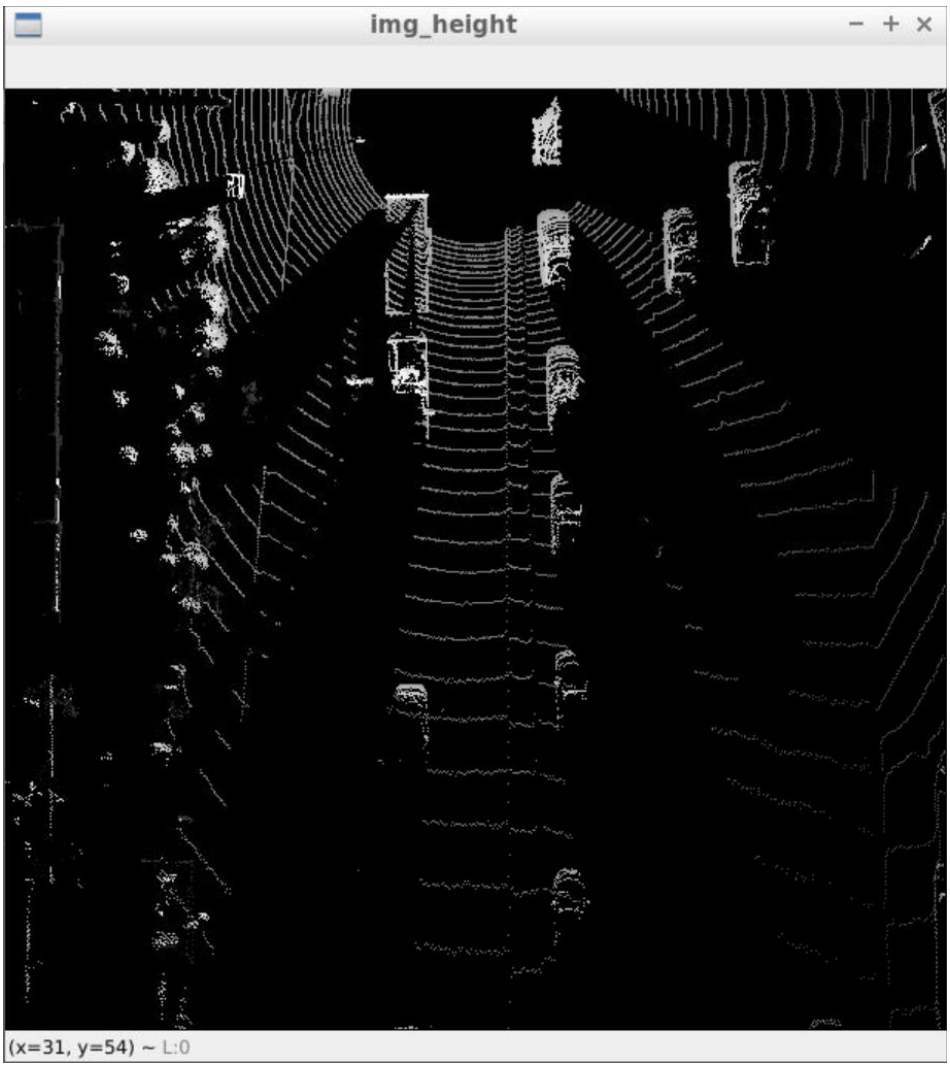

Figure 8:height layer from the BEV map

Section 3 : Model-based Object Detection in BEV Image

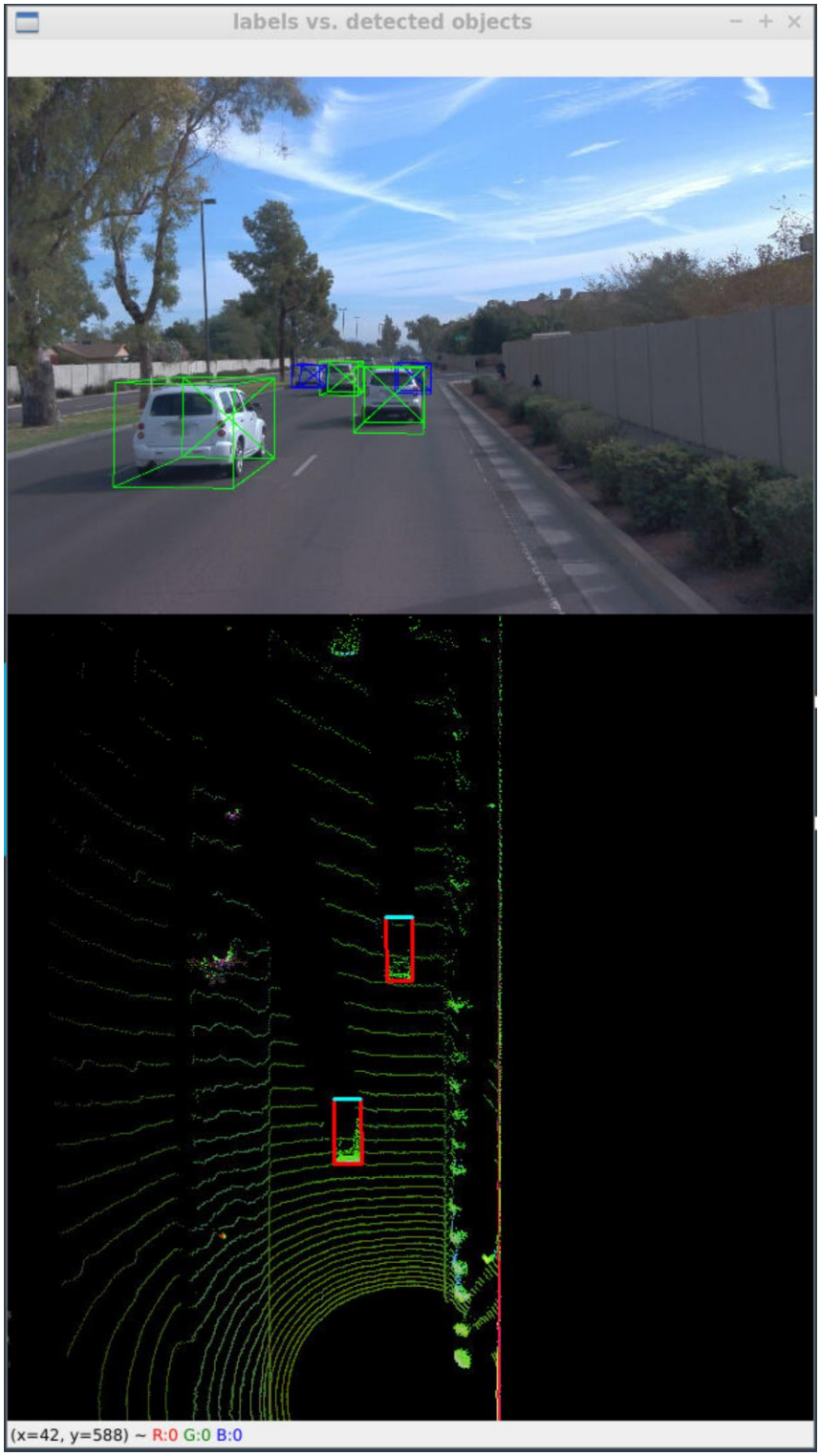

Figure 9: Bounding Boxes added to images

Section 4 : Performance Evaluation for Object Detection

Precision and recall of the first image in data set is given in Fig 10:

```
------------------------------
processing frame #100
computing point-cloud from lidar range image
computing birds-eye view from lidar pointcloud
student task ID_S2_EX1
student task ID_S2_EX2
student task ID_S2_EX3
detecting objects in lidar pointcloud
student task ID_S3_EX2
validating object labels
measuring detection performance
student task ID_S4_EX1
student task ID_S4_EX1
student task ID_S4_EX1
student task ID_S4_EX2
reached end of selected frames
student task ID_S4_EX3
precision = 0.9423076923076923, recall = 0.9040590405904059
```

Figure 10:Precision and Recall

Histograms are shown in Fig 11

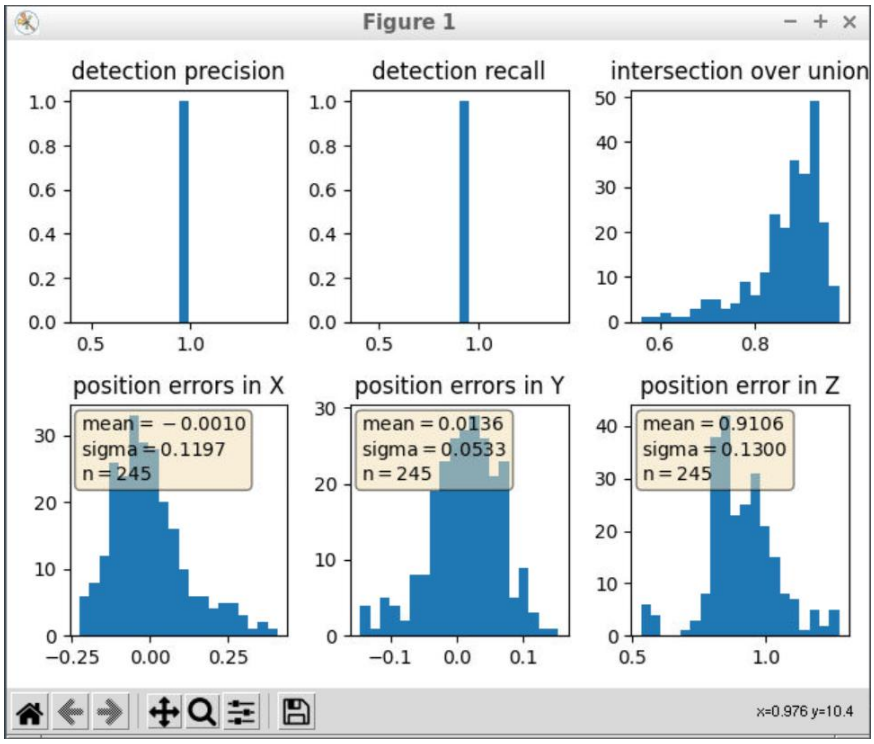

Figure 11: Histograms of error, precision and recall