Sensor Fusion and Tracking

Ashwin Vaidya

October 2021

1 Point Cloud Visualization

Figure 1 shows point cloud visualizations for different vehicles with varying degrees of Lidar visibilities. Figure 1a shows a vehicle partially occluded possibly due to the autonomous vehicle's ego. In Figure 1b we can see the most common type of point cloud densities visible. While the vehicle does not have high density but the vehicle is almost completely visible. Figure 1c shows the effect of different surfaces on the Lidar visibility. The side of the trailer facing the sensor does not have a raised enclosure but the one on the other side of the vehicle has. This is more visible in the intensity image. Figure 1d shows two vehicles in the shadow of the Lidar but their front/back trunks are visible in the point cloud. This can also be seen in the intensity maps in Figure 2a and Figure 2b. Figure 1e shows a few point clouds which are hard to predict as belonging to the vehicle class. These might pose a challenge for humans but based on their location on the road and by guessing the features, humans might be able to make a correct prediction. Figure 1f shows a vehicle that is turning and is represented by a sparse point cloud. Such scenarios might be fewer in the dataset as most of the time vehicles move parallel to the road. Such instances might be a challenge for the detector.

The intensity images and the point clouds show that any feature directly facing (at 90°) the sensor is picked up by the sensor. The identified stable features share this trait and are listed below.

- Rear-bumper
- Front trunk
- Side-view mirrors
- Roof edges around the front and back glass.
- License plate

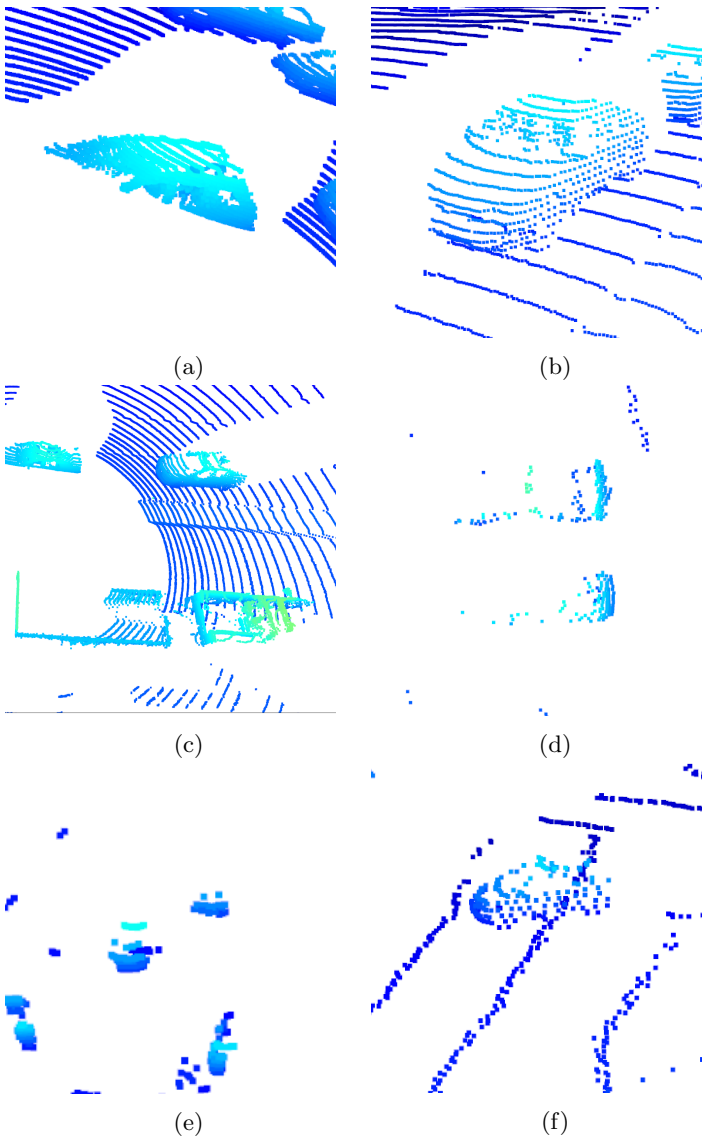
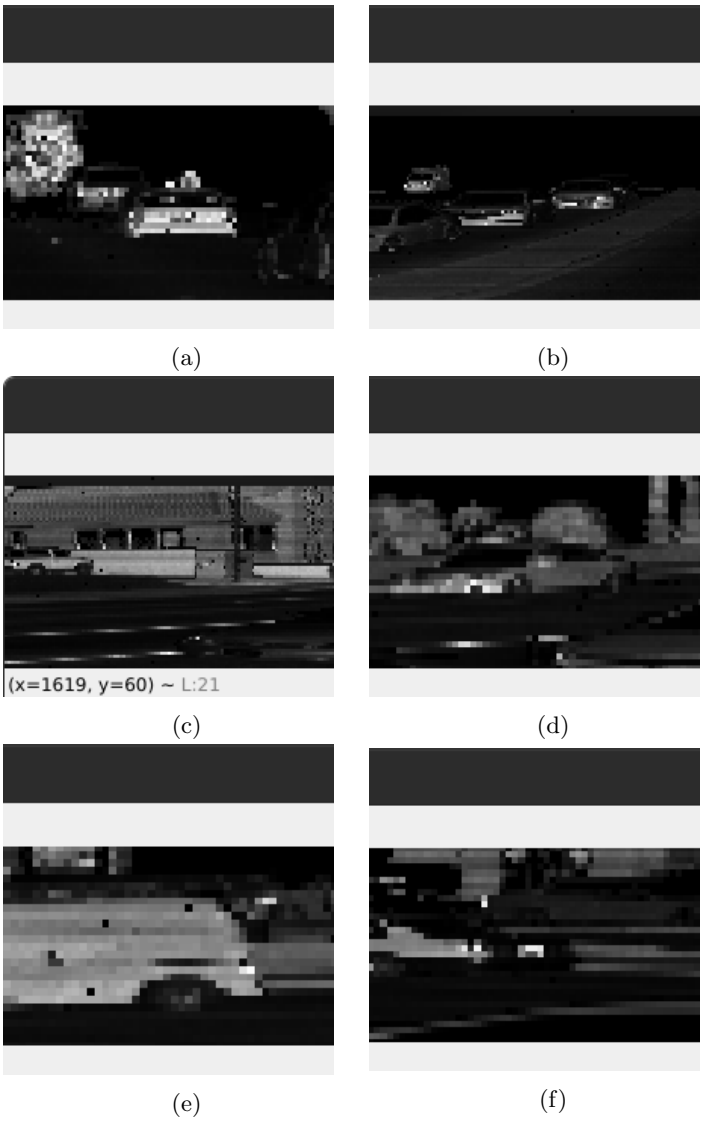


Figure 1: Point Cloud Visualizations for Different Vehicles

Figure 2 shows the intensities of a few features. We can see in Figure 2a, 2b and 2c that the rear and the front trunks of the vehicles show higher intensities as their surfaces are perpendicular to the Lidar sensor. Figure 2c and Figure 2e show higher intensities for the side of the vehicles for the instances where the side is facing the sensor. Figure 2f shows higher intensity from the number plate of the vehicle.

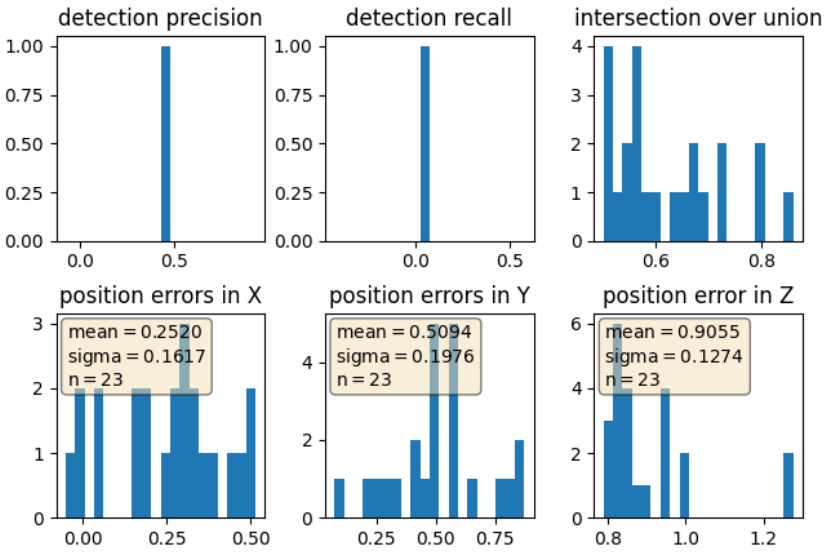


(a) (b) (c) (d) (e) (f)

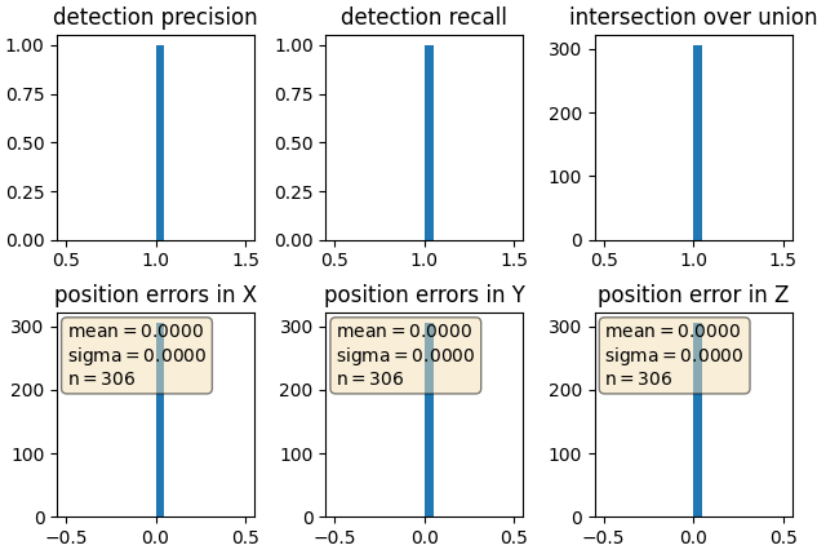
Figure 2: Intensity Visualizations

2 Performance Evaluation

Figure 3a shows the final perofrmance of DarkNet (YOLO) on the computed intensity and height map.



(a) Test Performance on Darknet



(b) Performance on Actual Labels

Figure 3: Performance Evaluation

3 Code

The code can be found here: https://github.com/ashwinvaidya17/nd013-c2-fusion-starter