Final Project Sensor Fusion and Object Detection

RECAP

The task in final sensor fusion and object detection project was to add together all the steps learned in the lessons before in order to get a running detection and tracking system. Lidar and Camera were used as sensors and fused together in a later stage.

In the filter class itself the actual Kalman filter equations from the lessons are implemented. The state transistion matrix F defining the movment of the detected object from timestep t-1 to timestep t. The process noise Q to account for the deviation of the transition model and the actual transistion. The prediction step from time step t-1 to t and the update step to update the state x and its covariance

In the track management module for each detected object a new track is initialized and confirmed if the object is present in adjacent frames, e.g. a certain threshold. If the object is not present in a frame, the score is decreased and the track will be deleted if the score drops under a threshold. Tracks with a score between the deletion and confirmation threshold will get displayed as tentative.

The data association module calculates the Mahalanobis distance between each track and measurement and takes the pair with the smallest distance in order to associate the measurement to a track and update the track accordingly.

When commenting in the camera measurements the tracks first get updated by the lidar measurements and then by the camera measurements.

RESULTS

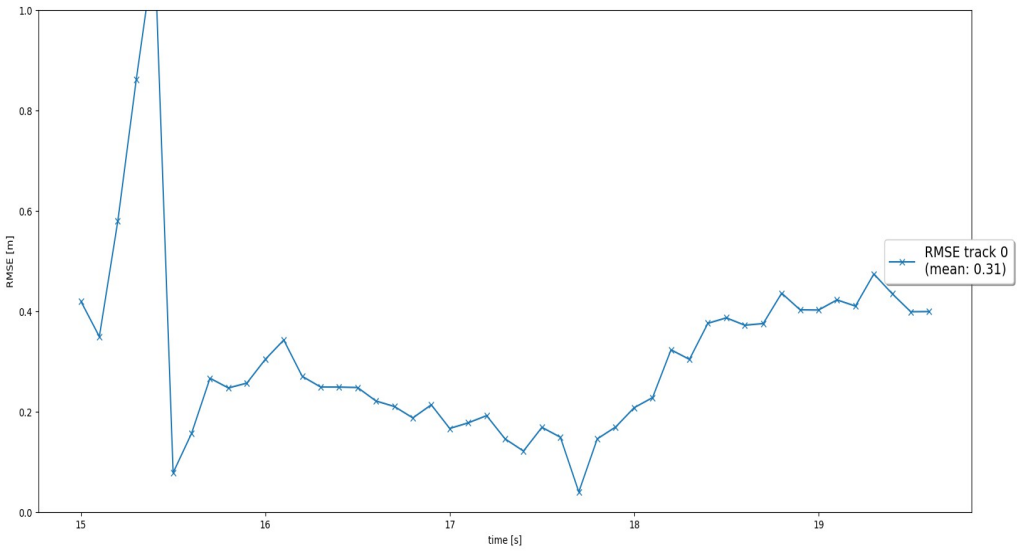

Illustration 1: RMSE plot for Step1

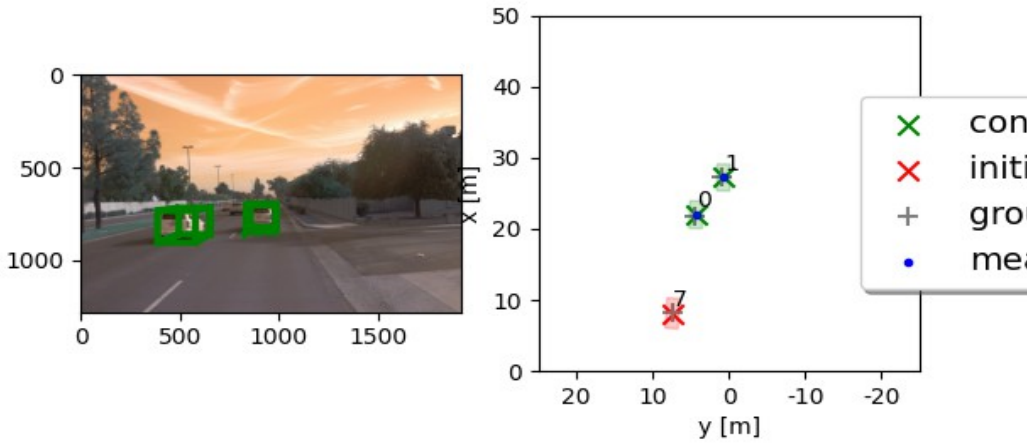

Illustration 2: Visualization Step4

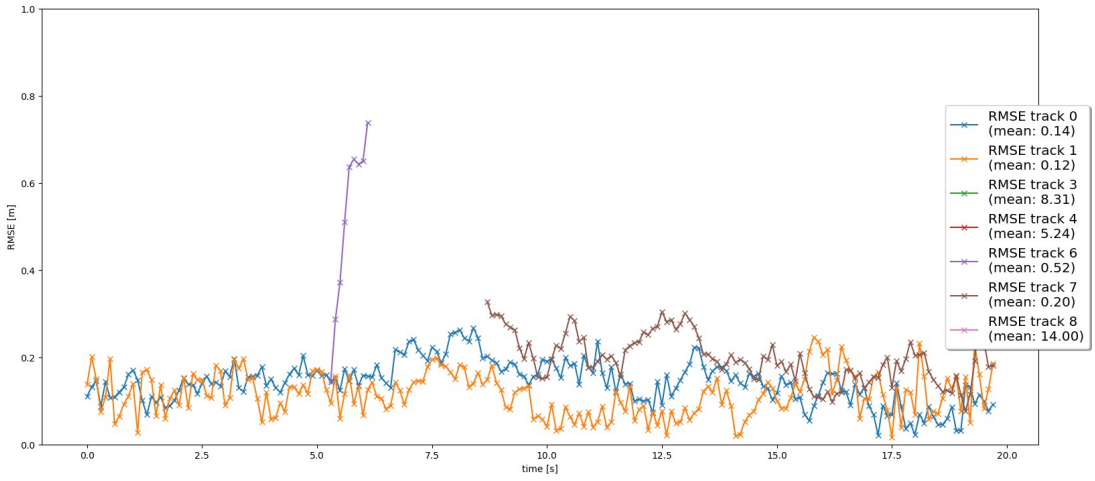

Illustration 3: RMSE plot for Step4

As can be seen in the RMSE plot for Step4, there are still ghost objects detected (track 3, 4, 6, 8). It seems liked that somethhing is still wrong with the score update to confirmed, as the ghost ojects somehow are confirmed. Illustartion 2 shows an instant where track 7 gets initialized by a lidar measurement but is not visible yet in the camera's fov. The most difficult part to implement was confiremd and tentative part.

BENEFITS OF CAMERA-LIDAR FUSION

One of the benefits of camera-lidar fusion is that both sensor complement each other. The weaknesses of one sensor can be cancelled out by the other. Also, using two sensors brings redundancy to the tracking system as there might be objects which get detected by only one of the two sensors. In addition, updating a predicted track with two measurement updates at the same time makes the prediction/update step more certain about the actual position of the object.

CHALLENGES IN REAL WORLD

A challenge in real world scenarios is the presence of ghost objects due to false positives in the detection part. Also the camera measurement model is a very rough estimation of the x,y and z coordinates, which does is not beneficial for the enhancement of the tracking.

POSSIBLE IMPROVEMENTS

Reworking the camera model can help to improve the traccking performance. Also fine-tuing the parameters in the params.py file can improve the tracking performence.