Sensor Fusion Final Project

Write a short recap of the four tracking steps and what you implemented there (EKF, track management, data association, camera-lidar sensor fusion). Which results did you achieve? Which part of the project was most difficult for you to complete, and why?

The first tracking step involved implementing various components of the extended Kalman filter, including the system matrix, F, and the time-dependent process noise covariance, Q. The prediction and update steps were also implemented. A final mean RMSE of 0.32 was achieved.

The second step required the initialisation of the tracking state, x, and position error covariance, P, as well as the reduction or increase of scores, transition of tracking state, and deletion of tracks, all as part of track management. A final mean RMSE of 0.77 was obtained.

Step 3 dealt with data association and required the implementation of an association matrix that depended on the Mahalanobis distance. Gating was employed to ensure that a high percentage (99.5 in our case) of correct measurements are retained. Simple Nearest Neighbour was achieved by the successive trimming of the association matrix after each track-measurement pair was found. Three vehicles were confirmed, at different time points, and all the mean RMSEs fell under 0.20.

The last step involved the actual fusion of lidar and camera sensor data, which included the initialisation of the measurement vector, z, and measurement noise covariance, R. In addition, the nonlinear camera measurement function, h, as well as the means of determining whether the input state vector, x, of an object fell within the field of view of a sensor. Two vehicles were confirmed at the outset, and the third later on, with mean RMSEs that were lower than the corresponding values in step 3. This last aspect of the project proved the most difficult to complete because of an error in the calculation of the initial tracking state, x, from step 2 that retarded the confirmation of one of the tracks.

Do you see any benefits in camera-lidar fusion compared to lidar-only tracking (in theory and in your concrete results)?

In theory, the fusion should help to detect actual objects faster and reject erroneous detections more readily., The results bore this out: the objects were tracked and confirmed much earlier. In addition, the performance measure, in terms of RMSE, was improved over that of step 3, where only the lidar was used.

Which challenges will a sensor fusion system face in real-life scenarios? Did you see any of these challenges in the project?

A challenge may be that, owing to a weakness in one or more of the sensors (e.g. weather conditions), the sensors are in conflict. This may slow down or impede the tracking performance of the system. Such a issue was not encounter in this project.

Can you think of ways to improve your tracking results in the future?

The tracking results may be improved by the inclusion of more sensors or the implementation of a more robust association algorithm such as Probabilistic Data Association (PDA).