Final Project: Writeup

- **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?**

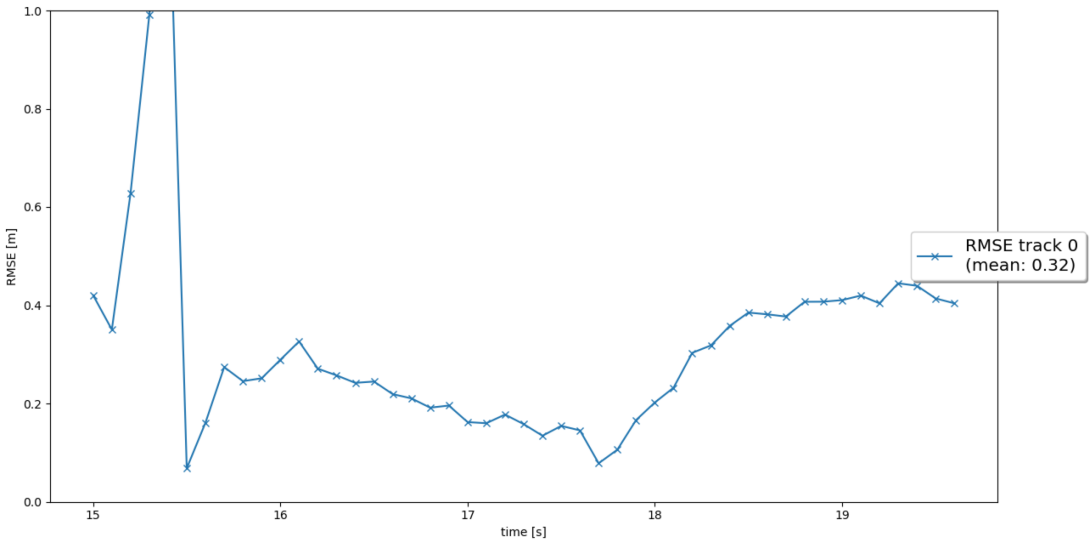
  Throughout the final project I implemented the different algorithms that are necessary to successfully perceive the environment using two different sensors and track their position. It is interesting the way how the project was setup. If I would have to tackle the project all alone, I would chosen a slightly different approach:

  - started with the track initialization.
  - used the kalman filter for the prediction using only LiDAR
  - implemented the track management and association algorithm
  - integrated the sensor fusion using the video measurements

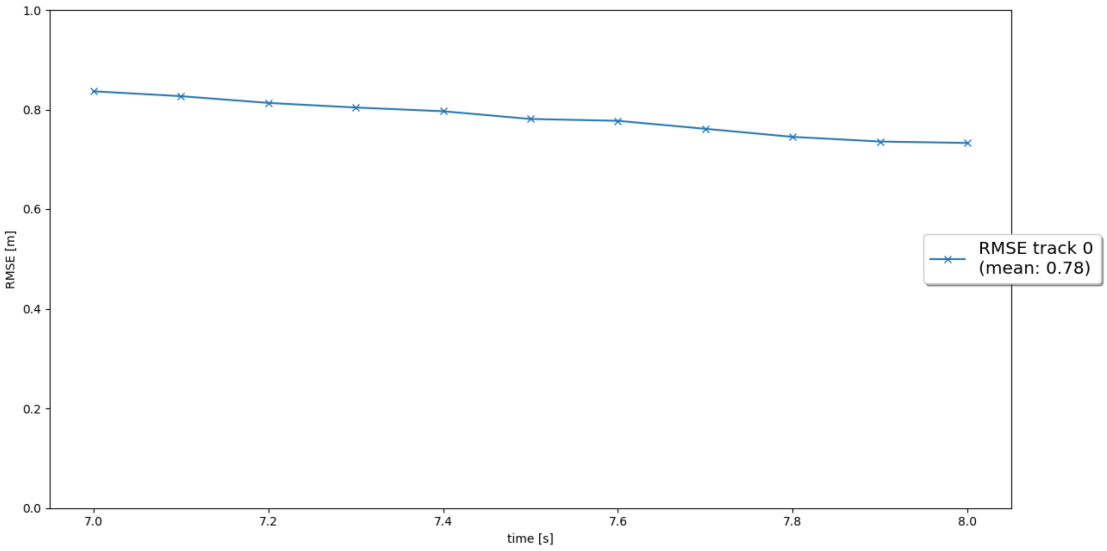
  To me the most difficult part was probably the track management part. In my implementation it worked correctly for LiDAR but when I introduced the camera results some weird results were shown, which made me realize that I had a bug.

  Results from the exercises:

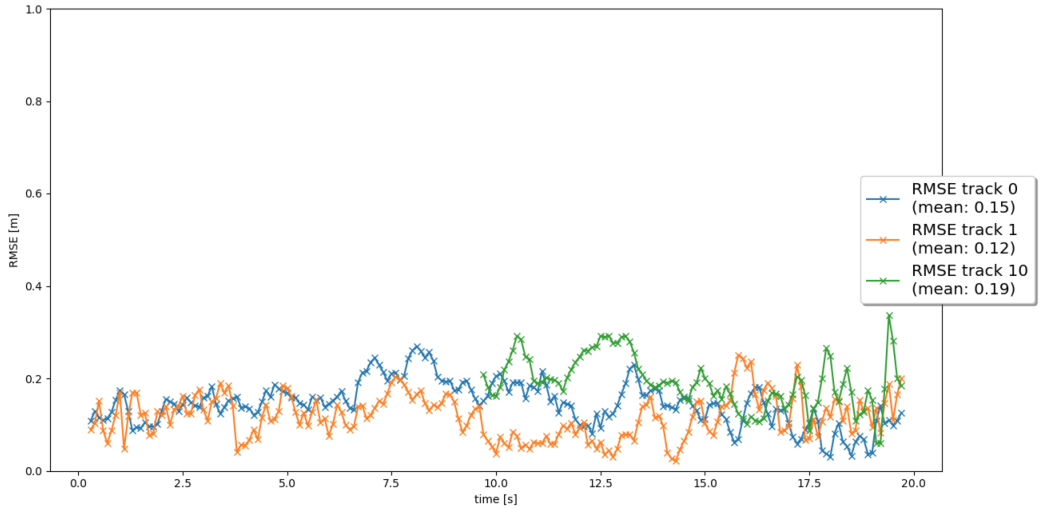
  - Exercise 1



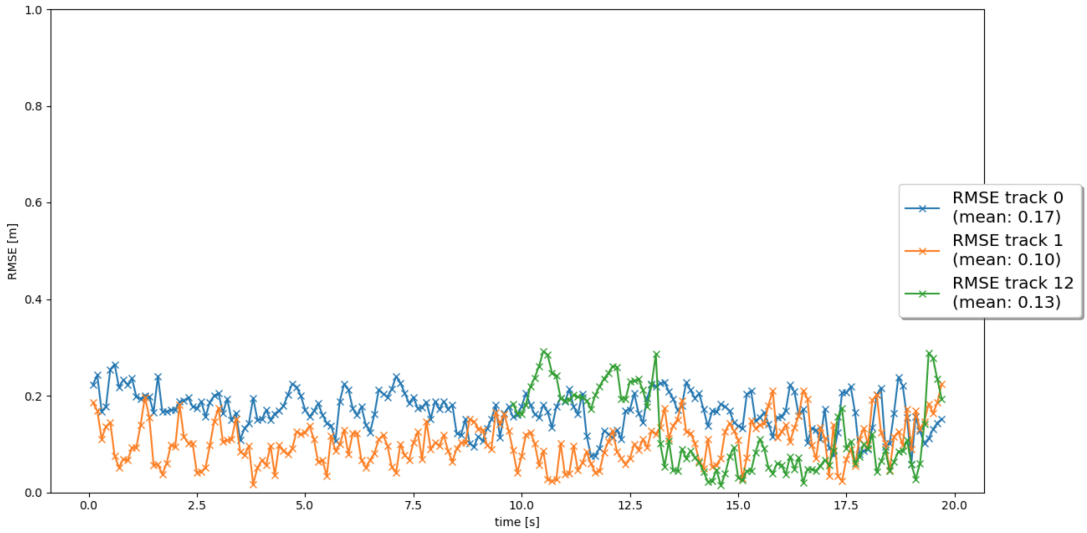
- Exercise 2



- Exercise 3



- Exercise 4



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

  As the camera does not provide any depth information it can only increase the accuracy so much. In the results obtained, the accuracy was improved for 2 out 3 tracks and worsened for the other one (the vehicle that was located the closest).

  The benefit the camera brings is the increase in robustness of the system. It can clearly be observed from the generated sequences, that there are fewer ghost

vehicles in the scene

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

  Several factors can pose a challenge to the fusion system:

  - The correct calibration of the sensors to ensure the correct fusion of the system: For prototypes / low volume production it might be an option to have a quasi-perfect calibration. For high volume this might be more difficult to meet
  - The need of a reference sensor capable of measuring depth
  - The arbitration/updates between the different sensors depending on their measurment rate. The computing power of the system increases proportional to the number of sensors that need to be fused. In the project we worked with regular time intervals, but the real world data does come at different time rates

- **Can you think of ways to improve your tracking results in the future?**
  - Implementing a more complex association algorithm
  - using a more complex physical model for the kalman filter
  - fine-tuning the thresholds in the track management system