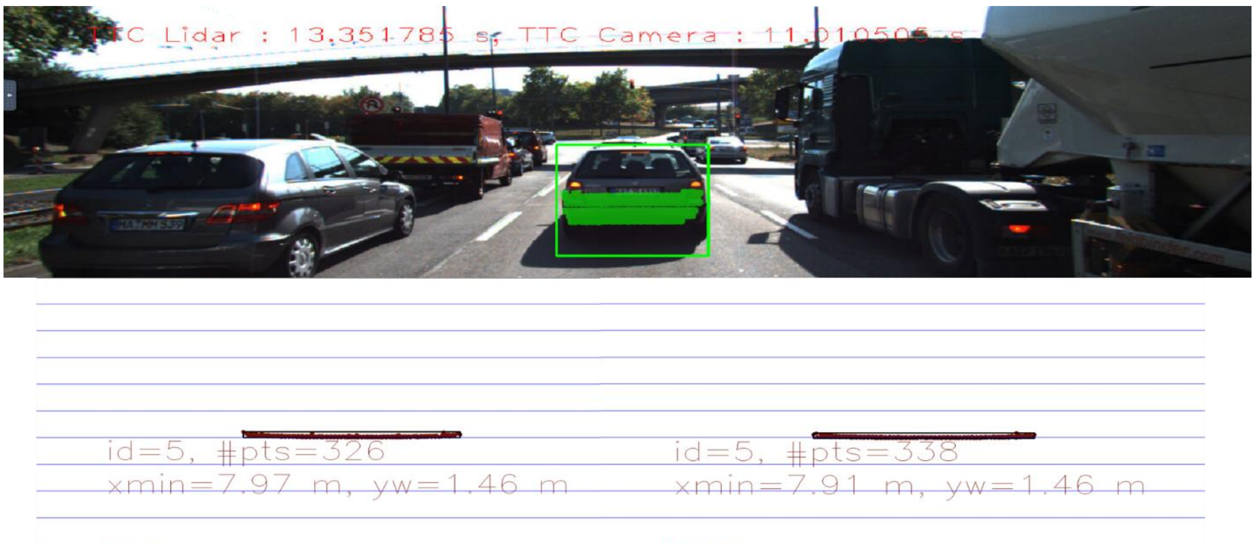
Udacity

Camera Final Project

FP.5: Performance Evaluation 1

This exercise is about conducting tests with the final project code, especially with regard to the Lidar part. Look for several examples where you have the impression that the Lidar-based TTC estimate is way off. Once you have found those, describe your observations and provide a sound argumentation why you think this happened.

The following are four successive frames, you can notice that the TTC estimation from the lidar goes from 12.62 sec. to 31.55 sec. then drops back to 14.56 sec.



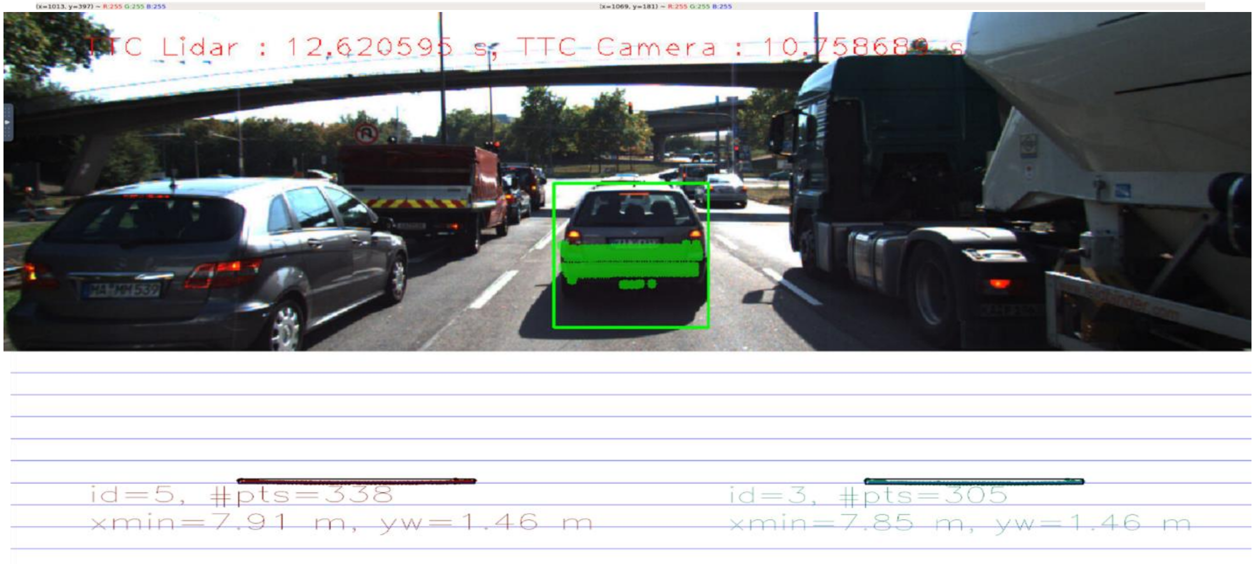


Figure 1: 4 consecutive frames with corresponding TTC

Explanation:

Since the equation used to measure the TTC depends on the relative distance between two successive frames, as shown in the following fig.:

$$TTC = \frac{d_1}{V_0} = \frac{d_1 \cdot \Delta t}{d_0 - d_1}$$

Figure 2 TTC for Lidar measurement

In addition, there is red light in the front of the ego car, which means that the ego car moves slowly. My intuition is that small moving distances incurs big fluctuation as denominator depends on the difference between two consecutive distance readings.

FP.6: Performance Evaluation 2

This last exercise is about running the different detector / descriptor combinations and looking at the differences in TTC estimation. Find out which methods perform best and also include several examples where camera-based TTC estimation is way off. As with Lidar, describe your observations again and also look into potential reasons.

The task is complete once all detector / descriptor combinations implemented in previous chapters have been compared with regard to the TTC estimate on a frame-by-frame basis. To facilitate the comparison, a spreadsheet and graph should be used to represent the different TTCs.

Building a reliable collision avoidance system is heavily dependent on the execution time. Choosing the top three combinations of detector/descriptor will depend to the execution time in the first place. In addition, we will take into consideration having a sufficient number of points in order to detect the preceding vehicle reliably in different conditions.

The top three detector/descriptor combinations according to the midterm project are:

- Detector: FAST + Descriptor: ORB
- Detector: FAST + Descriptor: BRIEF
- Detector: FAST + Descriptor: BRISK

Table 1 Top three detector/descriptor combination

Detector	Descriptor	Execution time (ms)	#Points
FAST	ORB	28	1071
FAST	BRIEF	33.1	1099
FAST	BRISK	36.4	776

The TTC estimation results are shown in the table below:

Table 2 TTC estimation for lidar and camera using different detector/descriptor combinations

Frame #	Lidar	FAST + ORB	FAST + BRIEF	FAST + BRISK
1	13.35	11.01	10.80	12.33
2	12.62	10.75	11	12.53
3	31.55	11.41	14.15	14.36
4	14.56	12.84	14.38	12.6
5	10.27	17.81	19.95	34.7
6	14.06	12.99	13.29	12.43
7	11.45	11.60	12.21	18.92
8	14.92	11.16	12.75	11.3
9	13.26	12.11	12.6	13.2
10	15.31	13.34	13.46	12.52
11	12.02	13.78	13.67	14.25
12	9.72	10.89	10.9	11.4
13	9.03	12.04	12.37	12.24
14	9.64	10.73	11.24	12.13
15	7.78	11.2	11.87	12.08
16	9.30	11.19	1183	12.17
17	11.85	7.86	7.92	8.51
18	10.5	10.60	11.55	11.54

There are matched points in the ground or in other cars which violates the assumption that each matched point has same distance to the ego car. The camera TTC is much unstable compared with lidar TTC.