FP.1 Match 3D Objects

Line238-295 in camFusion_Student.cpp file.

As suggested, I used a counts[prevSize][currSize] to track pairs of bounding box IDs and then counted the keypoint correspondences per box pair to determine the best matches between frames.

FP.2 Compute Lidar-based TTC

Line224-235 in camFusion_Student.cpp file.

I applied the median x-distance as the chosen distance to avoid work with outlier for TTC calculation. With the constant velocity model, the TTC was calculated as:

TTC = d1 * (1.0 / frameRate) / (d0 - d1)

FP.3 Associate Keypoint Correspondences with Bounding Boxes

Line139-169 in camFusion_Student.cpp file.

Outlier matches have been removed based on the euclidean distance between them. If the distance is greater than the mean of all the matches in the bounding box, the corresponding match will be removed.

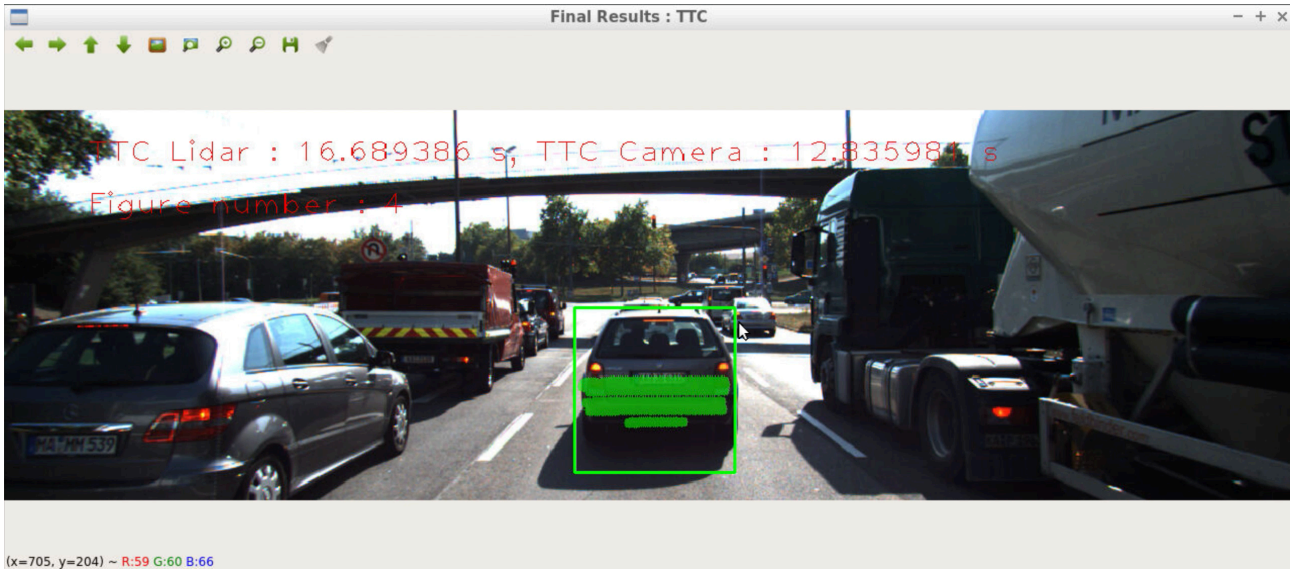
FP.4 Compute Camera-based TTC

Line173-221 in camFusion_Student.cpp file. I computed distance ratios between all matched keypoints and chose the median distance ratio to avoid the impact of outliers.

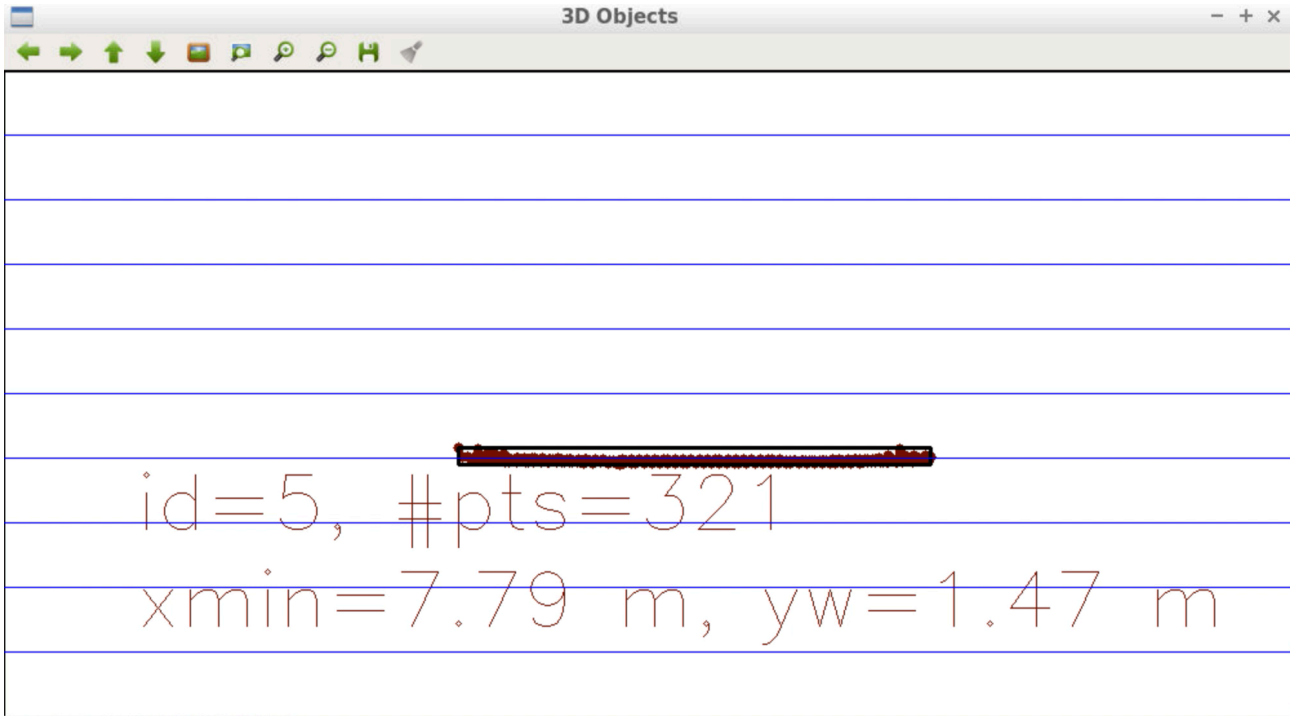
FP.5 Performance Evaluation 1

The lidar-based TTC ranges from 8-16s, the corresponding figures are shown below. Because I applied the median x-distance as the chosen distance to avoid work with outlier for TTC calculation. It is hard to estimate which TTC of frame is off. The top view of some examples are also given below.

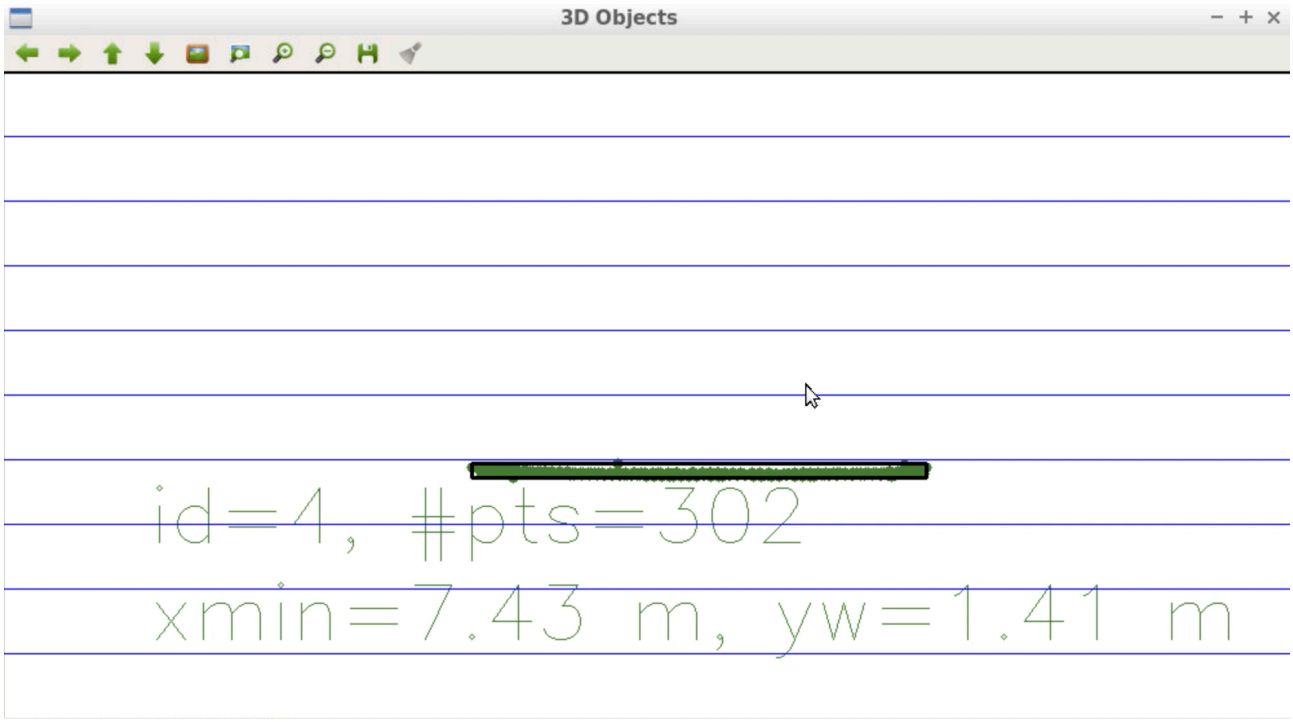
Minimum lidar-based TTC



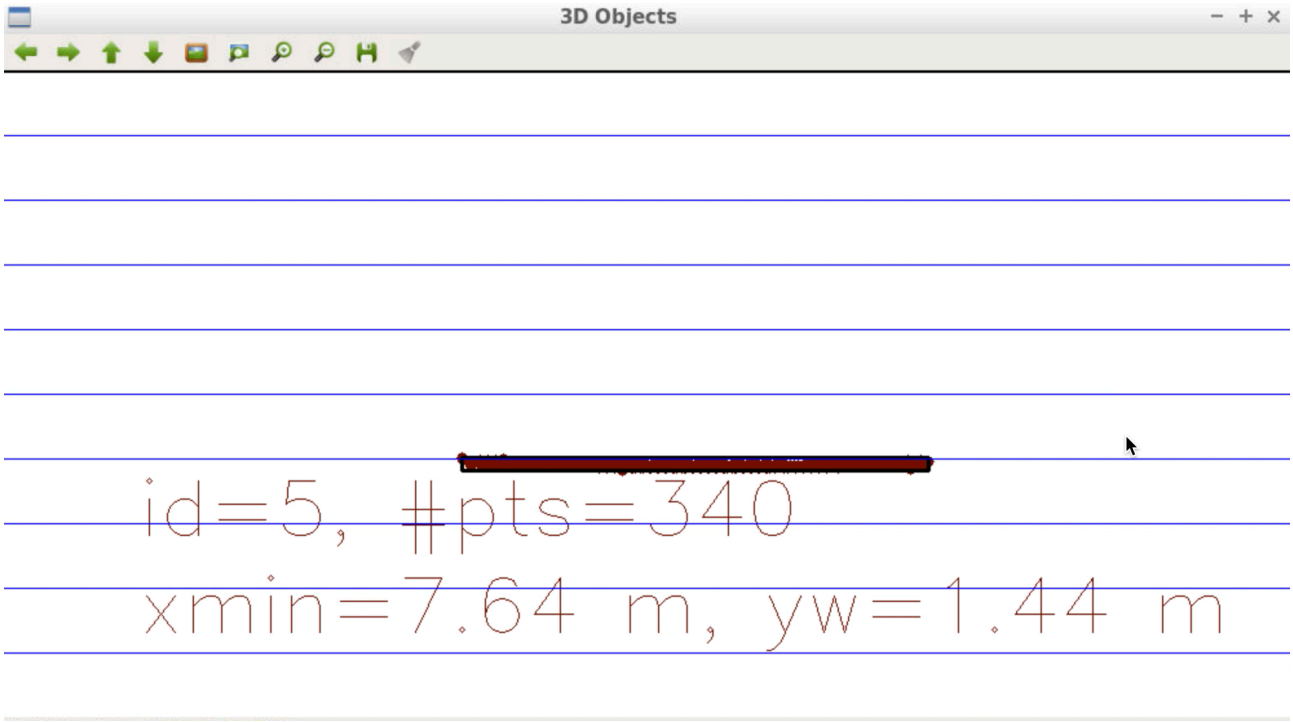
Maximum lidar-based TTC



Far-outlier



Near-outlier



Tight-group

FP.6 Performance Evaluation 2

I evaluated all the detector/descriptor combinations and the results are given in File all_combinations.txt. From the results, it was found that detectors HARRIS and ORB resulted in unreliable camera based TTC. The other detectors can produce reliable TTC estimations. The camera based TTC estimations may be unreliable, the potential reason is that the outlier matches removing during the task of Associate Keypoint Correspondences with Bounding Boxes works not so well.

Following is an example of the comparison results:

Detector	Descriptor	ImageID	lidarTTC	cameraTTC	TTC_Difference
SHITOMASI	BRISK	1	12.5156	15.0726	-2.55698
SHITOMASI	BRISK	2	12.6142	13.2121	-0.59783
SHITOMASI	BRISK	3	14.091	14.3921	-0.30106
SHITOMASI	BRISK	4	16.6894	12.836	3.8534
SHITOMASI	BRISK	5	15.9082	12.8285	3.07977
SHITOMASI	BRISK	6	12.6787	11.3009	1.37783
SHITOMASI	BRISK	7	11.9844	12.1538	-0.169444
SHITOMASI	BRISK	8	13.1241	13.6508	-0.526638
SHITOMASI	BRISK	9	13.0241	10.8823	2.14179
SHITOMASI	BRISK	10	11.1746	35.585	-24.4103
SHITOMASI	BRISK	11	12.8086	12.8	0.00860114
SHITOMASI	BRISK	12	8.95978	11.5836	-2.62381
SHITOMASI	BRISK	13	9.96439	11.1144	-1.14996
SHITOMASI	BRISK	14	9.59863	12.5836	-2.98494
SHITOMASI	BRISK	15	8.57352	10.009	-1.43543
SHITOMASI	BRISK	16	9.51617	11.414	-1.8978
SHITOMASI	BRISK	17	9.54658	10.6233	-1.07673
SHITOMASI	BRISK	18	8.3988	10.2624	-1.86364
SHITOMASI	BRIEF	1	12.5156	14.6744	-2.15879
SHITOMASI	BRIEF	2	12.6142	13.9717	-1.35744
SHITOMASI	BRIEF	3	14.091	9.73978	4.35123
SHITOMASI	BRIEF	4	16.6894	14.982	1.70737
SHITOMASI	BRIEF	5	15.9082	12.7628	3.14543
SHITOMASI	BRIEF	6	12.6787	13.2703	-0.591609
SHITOMASI	BRIEF	7	11.9844	15.2359	-3.25159
SHITOMASI	BRIEF	8	13.1241	12.0847	1.03939
SHITOMASI	BRIEF	9	13.0241	11.8703	1.15381
SHITOMASI	BRIEF	10	11.1746	12.6285	-1.45382
SHITOMASI	BRIEF	11	12.8086	11.8507	0.95793
SHITOMASI	BRIEF	12	8.95978	11.7642	-2.80445
SHITOMASI	BRIEF	13	9.96439	11.7158	-1.75137
SHITOMASI	BRIEF	14	9.59863	11.3522	-1.75357
SHITOMASI	BRIEF	15	8.57352	12.1983	-3.62474
SHITOMASI	BRIEF	16	9.51617	8.22875	1.28742
SHITOMASI	BRIEF	17	9.54658	11.1382	-1.59161
SHITOMASI	BRIEF	18	8.3988	8.43097	-0.0321632
SHITOMASI	ORB	1	12.5156	13.8654	-1.34978
SHITOMASI	ORB	2	12.6142	11.6588	0.955436
SHITOMASI	ORB	3	14.091	12.0672	2.02386
SHITOMASI	ORB	4	16.6894	13.0791	3.61029
SHITOMASI	ORB	5	15.9082	12.0934	3.81484
SHITOMASI	ORB	6	12.6787	13.2282	-0.549505
SHITOMASI	ORB	7	11.9844	12.8026	-0.818275
SHITOMASI	ORB	8	13.1241	11.8822	1.24194