Section 1

TASK MP.7

Your seventh task is to count the number of keypoints on the preceding vehicle for all 10 images and take note of the distribution of their neighborhood size.
Do this for all the detectors you have implemented.

Note: In my conclusions I will pay more attention to the detectors we will likely to use for TTC system due to their low execution time.

1. SHI-TOMASI detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	16.5894	1370	125
2	11.8486	1301	118
3	12.3126	1361	123
4	12.4399	1358	120
5	12.2408	1333	120
6	12.5787	1284	113
7	12.3434	1322	114
8	12.0824	1366	123
9	12.2524	1389	111
10	12.1379	1339	112
Average	12.68261	1342	117

Example:

Conclusion:

Average time of the detection is about 13ms. Shi-Tomasi detector requires gradient calculation and calculation of eigen values of the covariance matrix of gradients. It can be computationally expensive. It's not the slowest algorithm, but there are faster solution. Additionally we applied non-max suppression, min-distance filtering, overlap threshold, limited max amount of keypoints

based on min distance and image size. The Shi-Tomasi score seems to work better then Harris, actually Shi-Tomasi is an improvement of Harris detector which is based on different score calculation approach. The keypoints are evenly distributed, not very close to each other, and not forming dense clusters. The keypoint neighborhood size is fixed - 4 px. As mentioned above algorithm will not detect keypoint size automatically.
Another drawback is that the algorithm does not determine keypoint scale and orientation. The user can define the size before the detection procedure. This information is useful during matching. Without it such a keypoint will not be stable across different scaling and transformation changes.

2. Harris detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	13.6489	871	85
2	11.9468	874	85
3	12.0642	876	88
4	11.4609	859	87
5	11.8507	860	92
6	11.9592	869	85
7	11.9755	847	84
8	12.3689	871	90
9	12.9332	864	85
10	11.7966	852	86
Average	12.20049	864	86

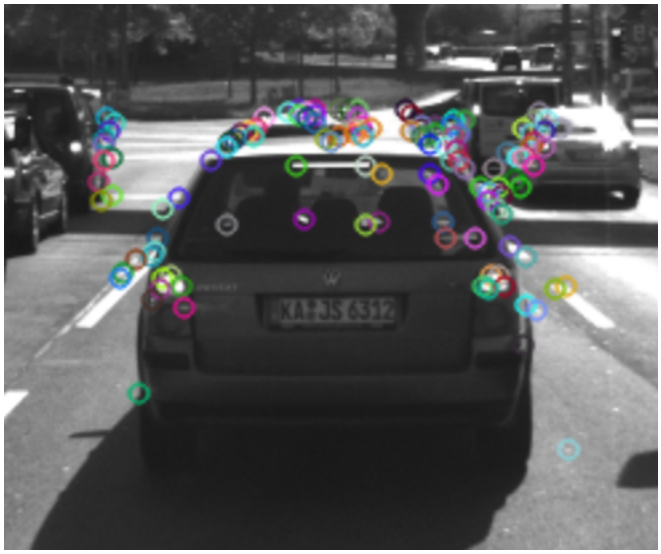
Example:

Conclusion:
Average time of the detection is about 12ms. Harris detector is similar to Shi-Tomasi. It's simple gradient based detector which different score function. The points from Shi-Tomasi are more evenly distributed, however with all the same filtering (as in previous case) the two distributions are similar. Keypoint neighborhood size is also fixed. The drawbacks are the same.

3. FAST detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	0.672111	1359	119
2	0.697225	1337	115
3	0.568667	1324	123
4	0.56966	1331	120
5	0.561422	1291	118
6	0.916513	1309	124
7	0.564081	1307	110
8	0.551529	1242	114
9	0.590027	1270	116
10	0.547701	1248	105
Average	0.6238936	1301	116

Example:

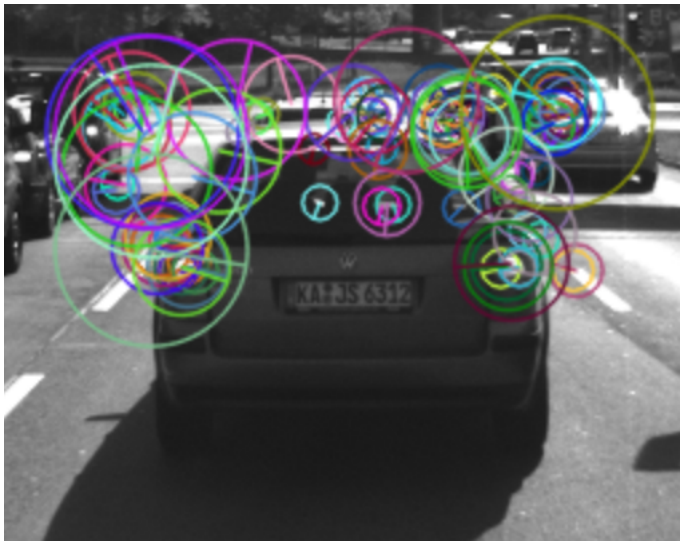


Conclusion:
As the name suggests, the algorithm is very fast. Its idea is based on intensity difference calculation and does not require computationally expensive gradients. However the quality of the detection is lower. We have dense clusters of points very close to each other. The situation was even worse with the default intensity threshold and ti has been increased to 40.
Also the algorithm does not calculate the scale of the point and its orientation. If some additional processing is applied this algorithm however could be a good candidate for our tasks because of its speed. However its keypoints does not have scale and orientation information which is very important in changing environment for robust matching. Keypoint neighborhood size is fixed. There are three choices of neighborhood size with DetectorType flag.

4. BRISK detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	15.2608	909	113
2	13.8141	914	106
3	13.8292	900	104
4	13.3665	871	118
5	13.1378	846	112
6	13.0431	844	113
7	13.1166	845	111
8	13.3271	843	114
9	13.1254	849	116
10	13.1342	844	102
Average	13.51548	866	110

Example:



Conclusion:
Brisk is more advanced detector, than the rest that was tested before. It uses FAST method for keypoint detection (AGAST, which is an evolution of FAST to be more specitic), however significantly enhances it. Brisk determines keypoint scale and orientation. When this information is used for descriptor extraction and matching it will be more robust and invulnerable to scaling or rotations. However we pay for it with computation time. I've picked up the intensity threshold (80) to reduce the amount of keypoints which with default value (30) was huge. This reduced computation time as well. The distribution of keypoints is somewhat similar to FAST, because it's a base algorithm for BRISK. However keypoint scale and orientation are also displayed. Neighborhood size is calculated by the algorithm. The larger the neighborhood the more regional information will be used to describe the keypoint.

5. ORB detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	39.5305	500	92
2	5.85159	500	102
3	6.16629	500	106
4	5.93644	500	113
5	5.97321	500	109
6	5.98172	500	125
7	6.01532	500	130
8	6.25197	500	129
9	6.04368	500	127
10	6.2978	500	128
Average	9.404852	500	116

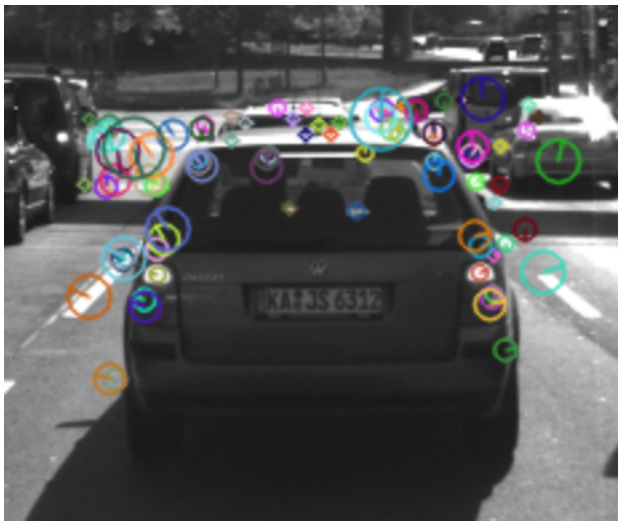
Example:

Conclusion:
ORB is an attempt to utilize the benefits of FAST point detection algorithm, enhancing it with keypoint scale and orientation. As a result we've obtained a powerful tool. The scaling approach is somewhat similar to BRISK (using pyramid), however not the same. Orientation is determined using patch intensity centroid, where the centre of the patch is the analyzed corner. The orientation vector will be a vector between corner point and centroid. This algorithm appears to be faster than BRISK in general. I would assume the orientation computation is a bit faster and scaling procedure is not as complicated. The keypoints distribution is similar to BRISK, however scaling is different. Meaningful keypoint neighborhood is much bigger here. A lot of points intersects which harden the matching.
Note: The first launch is always slow (8 times slower than intermediate). I've made up to 10 attempts, the result is the same. I would try to study this behavior.

6. AKAZE detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	78.1461	727	99
2	73.5137	709	91
3	76.2677	701	89
4	71.8619	704	95
5	74.7398	704	99
6	74.0709	711	99
7	97.4276	703	106
8	72.7411	698	109
9	71.421	719	109
10	74.621	721	108
Average	76.48108	709	100

Example:



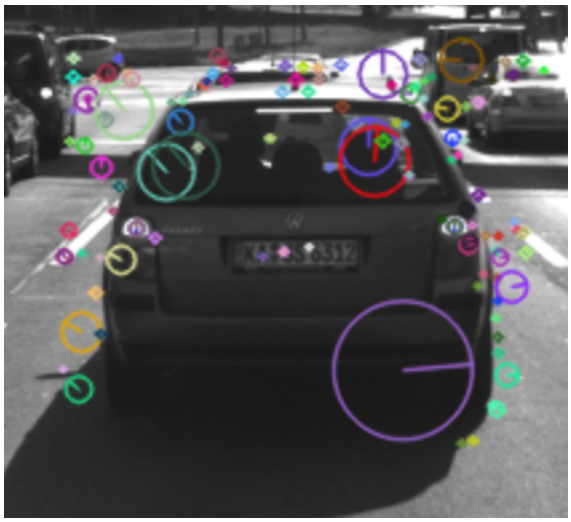
Conclusion:

AKAZE feature detector computes scale and orientation aware keypoints. They are more evenly distributed then BRISK or ORB features, however this detector is very slow for our purposes. Neighbourhoods are much smaller here. Much less points intersect. I would expect much more accurate and robust keypoint matching here.

7. SIFT detector

Frame#	Time (ms)	All keypoins count	Preceding vehicle kypoins count
1	122.142	1437	138
2	82.1473	1371	132
3	85.7365	1381	124
4	82.1355	1336	138
5	81.487	1303	134
6	79.3214	1370	140
7	80.3353	1396	137
8	83.3394	1382	148
9	80.3281	1462	159
10	92.0622	1422	137
Average	86.90347	1386	138

Example:



Conclusion:
At last, SIFT, very powerful and robust feature detector. The keypoints have scale and orientation. This detector with SIFT descriptors shows great results in keypoint matching. The keypoints are evenly distributed, much smaller number of overlaps than with BRISK or ORB detectors. Keypoints neighbourhood seem to be tight and accurately calculated.
However it has lacks which make it unusable for our purposes. The biggest issue is that the detector is very slow, the descriptors are float vectors which require additional computational effort to be compared. Another problem with it - it is patented and non free to use.

Section 2

TASK MP.8

Your eighth task is to count the number of matched keypoints for all 10 images using all possible combinations of detectors and descriptors. In the matching step, use the BF approach with the descriptor distance ratio set to 0.8.

SHI-TOMASI detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.3995	0.495631	84
2	1.43996	0.450922	80
3	1.41702	0.454796	73
4	1.45875	0.439354	77
5	1.34103	0.425872	74
6	1.44934	0.39396	70
7	1.44527	0.432599	79
8	1.3243	0.428055	81
9	1.35191	0.393705	72
Avg	1.403	0.43498	76

BRIEF Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	0.822473	0.678849	86
2	0.907647	0.254	84
3	0.775653	0.256295	87
4	0.778864	0.255176	91
5	0.83527	0.240797	87
6	0.771025	0.231273	76
7	0.783436	0.250322	81
8	0.855377	0.257174	88
9	0.810406	0.228699	88
Avg	0.81557	0.29473	85

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	0.942569	0.638678	86
2	0.888609	0.266432	84
3	0.79436	0.284952	87
4	0.795427	0.253781	91
5	0.773743	0.254729	87
6	0.774466	0.232764	76
7	0.782438	0.24185	81
8	0.772053	0.243964	88
9	0.774565	0.22357	88
Avg	0.81091	0.29341	85

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	18.4876	0.50438	66
2	18.2235	0.429512	66
3	18.196	0.419714	64
4	18.2064	0.424179	63
5	18.5277	0.397152	62
6	19.0086	0.599585	64
7	18.7857	0.40024	61
8	18.2393	0.397156	6
9	18.4876	0.50438	66
Avg	18.46248	0.45292	57

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	13.3789	0.360684	112
2	16.3917	0.290317	109
3	13.4515	0.288712	104
4	14.1808	0.289567	103
5	13.9186	0.297497	99
6	13.5072	0.252646	101
7	15.84	0.246969	96
8	13.6622	0.264566	106
9	14.2794	0.248864	97
Avg	14.29003	0.2822	103

Conclusion: BRIEF and ORB descriptors give the same amount of matches for SHI-TOMASI keypoints. ORB actually utilizes BRIEF approach (ORB = oriented FAST and rotated BRIEF). Brisk gives less matches and its descriptors are a little bit more computationally expensive. However we should take into account that orientation is not computed for these keypoints. The situation may change when orientation comes into play. FREAK descriptors are computationally inefficient, same about SIFT descriptors, however SIFT descriptors produced the biggest amount of matches.

Please, note that AKAZE descriptors can only be used with KAZE or AKAZE keypoints.

Harris detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.14585	0.296056	58
2	1.22186	0.253916	61
3	1.26057	0.258074	62
4	1.19123	0.252953	60
5	1.13888	0.262244	58
6	1.14298	0.249395	55
7	1.19413	0.357426	63
8	1.14545	0.25962	61
9	1.14941	0.291525	58
Avg	1.1767	0.27568	59

BRIEF Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	0.82888	0.564577	64
2	0.829484	0.16315	64
3	0.82159	0.161558	64
4	0.824847	0.163992	64
5	0.816893	0.166395	66
6	0.810877	0.153997	63
7	0.826108	0.170134	63
8	0.89514	0.216646	70
9	0.828839	0.201872	66
Avg	0.8314	0.21803	64

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	0.843488	0.493393	64
2	0.840085	0.17767	64
3	0.828317	0.160051	64
4	0.802683	0.164684	64
5	0.840036	0.166228	66
6	0.824467	0.152541	63
7	0.794435	0.161409	63
8	0.865121	0.31056	70
9	0.796613	0.155812	66
Avg	0.82613	0.21581	64

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	18.2569	0.588948	51
2	20.3794	0.258158	51
3	21.6442	0.250672	47
4	21.2897	0.260134	50
5	22.0734	0.252713	49
6	21.8314	0.23866	54
7	21.5219	0.254784	50
8	22.4491	0.247644	49
9	21.6894	0.409285	51
Avg	21.23726	0.30677	50

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	12.4226	0.536377	73
2	17.3167	0.169612	76
3	16.4722	0.164625	79
4	15.5119	0.208908	82
5	16.2099	0.406611	78
6	17.2293	0.171333	70
7	18.331	0.226429	78
8	15.5226	0.19185	85
9	17.305	0.18891	78
Avg	16.25791	0.25162	77

Conclusion: The conclusion here is pretty similar to the previous case.

Please, note that AKAZE descriptors can only be used with KAZE or AKAZE keypoints.

FAST detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.22416	0.449877	62
2	1.19857	0.426557	75
3	1.21096	0.437784	71
4	1.37181	0.406523	81
5	1.41592	0.745102	57
6	1.11627	0.469355	72
7	1.12119	0.390727	69
8	1.13706	0.405476	65
9	1.06861	0.378696	77
Avg	1.20717	0.45667	69

BRIEF Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	0.999692	0.292313	81
2	1.98731	0.49875	80
3	0.763779	0.254343	74
4	1.00057	0.296317	75
5	0.776361	0.265419	74
6	0.991065	0.316405	83
7	0.844482	0.230191	73
8	0.877409	0.238937	74
9	0.851624	0.227572	84
Avg	1.01025	0.29113	77

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.06837	0.295886	81
2	1.53265	0.605361	80
3	0.765054	0.256637	74
4	1.82802	0.430182	75
5	1.96695	0.31563	74
6	1.56657	0.749751	83
7	0.874705	0.315567	73
8	1.45975	0.222076	74
9	0.84428	0.233783	84
Avg	1.32292	0.38054	77

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	19.7145	0.555228	52
2	20.9629	0.422692	62
3	19.9655	0.442672	56
4	21.0313	0.428963	63
5	21.9088	0.807594	44
6	21.2435	0.569772	63
7	20.2681	0.447837	63
8	21.0886	0.417234	56
9	22.2529	0.460513	72
Avg	20.93734	0.50583	59

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	15.2005	0.695439	93
2	19.4523	0.294326	96
3	18.1123	0.678115	97
4	16.6678	0.86506	94
5	22.3421	0.336876	92
6	19.4454	0.415064	100
7	19.2524	0.226793	88
8	16.7792	0.302111	89
9	19.3644	0.270036	91
Avg	18.51293	0.45375	93

Conclusion: BRIEF and ORB descriptors give the same amount of matches as for SHI-TOMASI and Harris keypoints. Looking at the pictures it seems like FAST + ORB (or BRIEF) with 0.8 distance ration filtering gives quite good results in matching.

Please, note that AKAZE descriptors can only be used with KAZE or AKAZE keypoints.

BRISK detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.15423	0.438866	60
2	1.11048	0.364695	62
3	1.2095	0.384248	62
4	1.82392	0.405264	60
5	1.17242	0.414243	52
6	1.19799	0.373926	61
7	1.33176	0.483171	56
8	1.20769	0.384771	58
9	1.10638	0.375018	78
Avg	1.25715	0.40268	61

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	3.15854	0.262849	45
2	3.15202	0.208113	50
3	3.12707	0.213737	37
4	3.12546	0.226049	41
5	3.74564	0.228813	33
6	3.18419	0.239591	51
7	3.14786	0.220785	51
8	3.4004	0.268004	50
9	3.13359	0.210822	59
Avg	3.24164	0.23097	46

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	17.9613	0.400256	57
2	18.8108	0.390046	58
3	18.3408	0.327228	45
4	18.1373	0.349936	54
5	17.8986	0.338668	42
6	18.0149	0.340212	59
7	17.9712	0.352958	55
8	17.9118	0.356454	56
9	17.9222	0.346861	66
Avg	18.10765	0.35584	54

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	30.0896	0.670491	80
2	29.2712	0.236263	78
3	30.1829	0.249489	71
4	30.5608	0.256139	81
5	35.0109	0.275971	72
6	29.3608	0.252147	80
7	29.5236	0.26082	75
8	33.433	0.271449	78
9	30.4119	0.255584	85
Avg	30.87163	0.30315	77

Conclusion: BRISK + BRISK descriptor is the best here as a combination of speed and amount of matches. BRIEF descriptor is not orientation aware thus is not compatible with brisk.
ORB descriptors does not seem to work well with BRISK keypoints. The computation is slower, and we've got less amount of matches with BRISK + ORB descriptor then with BRISK + BRISK. When orientation came into play the ORB descriptor is slower to be computed.
SIFT descriptors are good with BRISK keypoints in terms of matching but very slow.
AKAZE descriptors can only be used with KAZE or AKAZE keypoints.

ORB detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	1.0564	0.304643	60
2	1.07901	0.303775	65
3	1.12991	0.331082	65
4	1.17595	0.316355	76
5	1.32375	0.345562	72
6	1.28437	0.416485	83
7	1.27265	0.426219	83
8	1.26953	0.422161	73
9	1.29051	0.411263	72
Avg	1.20912	0.36417	72

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	4.89016	0.232596	40
2	3.4916	0.205822	57
3	3.63736	0.217563	49
4	3.48543	0.230157	54
5	3.60833	0.290192	57
6	3.57737	0.313244	68
7	4.01727	0.293056	71
8	3.51376	0.264625	62
9	3.51889	0.33535	72
Avg	3.7489	0.26473	58

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	17.6314	0.26724	39
2	20.0352	0.137741	33
3	25.5372	0.158653	37
4	21.3649	0.147849	40
5	21.7512	0.149282	33
6	20.4011	0.205909	40
7	22.9012	0.474524	41
8	23.8922	0.215808	39
9	22.6054	0.213164	44
Avg	21.79108	0.2189	38

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	42.3606	1.60751	67
2	40.296	0.234957	79
3	41.7295	0.242783	78
4	38.9984	0.25473	79
5	40.076	0.250395	82
6	45.2688	0.295889	95
7	46.3496	0.309662	95
8	48.8021	0.332539	94
9	48.9395	0.346414	94
Avg	43.64672	0.43054	84

Conclusion: ORB + BRISK give descent performance here.
ORB descriptors does not seem to work well with BRISK keypoints. The computation is slower with ORB+ORB descriptor combination, and we've got less amount of matches.
SIFT descriptors are the slowest. Freak descriptors give a small amount of matches being slow also.
AKAZE descriptors can only be used with KAZE or AKAZE keypoints.

AKAZE detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	2.90015	0.341518	72
2	1.21945	0.279872	65
3	1.21848	0.292849	69
4	1.26664	0.31727	72
5	1.30306	0.933945	72
6	1.99557	10.6136	76
7	1.34255	0.348019	82
8	1.37805	0.356038	91
9	1.37111	0.553429	84
Avg	1.555	1.55961	75

ORB Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	2.81437	0.220654	54
2	2.45546	0.16908	56
3	2.49843	0.165298	52
4	2.44241	0.178076	49
5	2.48019	0.184253	57
6	2.4594	0.19462 7	4
7	2.54841	0.239719	61
8	2.52103	0.215841	70
9	2.60904	0.212162	73
Avg	2.53652	0.19813	52

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	21.509	0.325566	60
2	22.1012	0.263871	58
3	21.4934	0.2688	57
4	22.5462	0.30124	60
5	22.623	0.417779	58
6	21.9348	0.414061	73
7	22.9433	0.371404	79
8	21.0892	0.34273	81
9	20.9169	0.356697	72
Avg	21.90633	0.34023	66

AKAZE Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	66.9835	0.60445	69
2	78.7245	0.376527	72
3	67.8543	0.262253	73
4	70.4368	0.281864	70
5	71.6553	0.286226	69
6	63.4273	0.31238	78
7	75.9721	0.363309	83
8	63.6144	0.342516	85
9	63.9981	0.355171	88
Avg	69.18514	0.35385	76

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	63.0897	0.352599	69
2	61.4415	0.262174	72
3	63.1075	0.264974	73
4	63.0312	0.276637	70
5	63.3006	0.306531	69
6	61.6456	0.299512	78
7	62.7544	0.362887	83
8	66.8431	0.340827	85
9	61.9417	0.356329	88
Avg	63.01725	0.3136	76

Conclusion: With AKAZE BRISK descriptors give a good performance in terms of time and matches. The best are AKAZE and SIFT descriptors but showing 69ms and 63ms computation time respectively against 1.5ms for BRISK.

SIFT detector with:

BRISK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	2.24131	0.914301	57
2	2.02642	0.4866	63
3	2.16835	0.496524	59
4	2.08761	0.529234	62
5	2.11574	0.526059	55
6	2.10859	0.525064	52
7	2.20409	0.570455	54
8	2.27848	0.633671	63
9	2.09828	0.593252	73
Avg	2.14765	0.58612	59

FREAK Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	21.9511	0.572422	59
2	21.6366	0.480617	63
3	22.3572	0.656924	55
4	23.9334	0.508987	65
5	22.181	0.518629	51
6	22.2819	0.54401	50
7	22.7762	0.540729	47
8	23.2096	0.624821	53
9	22.1589	0.588292	65
Avg	22.49843	0.55949	56

SIFT Descriptor			
Frame	**Extraction time (ms)**	**Match time (ms)**	**Matches**
1	71.0978	1.69729	82
2	73.0649	0.345079	81
3	79.1031	0.348835	86
4	94.7405	0.349361	94
5	71.2129	0.340893	90
6	71.6165	0.315829	81
7	70.5774	0.367391	82
8	73.0489	0.439851	102
9	72.0573	0.361594	104
Avg	75.16881	0.50734	89

Conclusion: SIFT + SIFT is a beast. Slow but powerful. ORB descriptor is not compatible with SIFT, other performed worse in terms of the amount of matches.

Section 3

TASK MP.9

Your ninth task is to log the time it takes for keypoint detection and descriptor extraction. The results must be entered into a spreadsheet and based on this information you will then suggest the TOP3 detector / descriptor combinations as the best choice for our purpose of detecting keypoints on vehicles. Finally, in a short text, please justify your recommendation based on your observations and on the data you collected.

Conclusion:
During tasked 7 and 8 I've logged time for both, keypoint detection and matching. The information can be found in the tables above.
Let's choose the best 3 combinations now, basing on this information.

1. The fastest combination is **FAST detector + BRIEF descriptor - 1.92 ms** for keypoint detection, descriptor generation and matching with 0.8 distance ration filtering. This is amazingly fast combination and seems suitable for realtime tasks. However keypoints and descriptors (in this combination) are not scale and orientation aware. This means that such system can be vulnerable to rotations or scale changes. It requires further quality analysis to make more robust conclusions about such combination performance in terms of keypoints detection/matching quality.
2. The second candidate would be **ORB + BRISK - 10.98 ms** for keypoint detection, descriptor generation and matching with 0.8 distance ration filtering. Taking into account that such combination is scale and orientation aware 11ms is not bad. ORB detector seems to be faster than BRISK detector. This is (IMHO) because it uses more simple scale detection procedure. However brisk descriptor seems to be faster to be calculated and gives more matches.
   I would note however, that ORB gives a lot of overlapping points which may lead to errors during matching. ORB may be replaced this BRISK detector, but this combination will work for 15.2 ms. That is significantly slower.
3. It's a hard decision however I would consider **SHI-TOMASI + BRIEF - 13.5 ms** as a third candidate. SHI-TOMASI gives evenly distributed keypoints, in some approximation they can be matched reliably if the scale change is not huge, for example if we take frames fast enough. On the test frame sequence this combination seems to work. However it's not enough tests to make a conclusion if this combination can be reliable enough for TTC system.

Of course it would be great to use SIFT or AKAZE combination, however up to 100ms (almost 50 times slower than the first candidate) seems too slow.