入力 [14]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from IPython.display import Image
from os import listdir
from os.path import isfile, join
```

入力 [43]:

```
df = pd.read_csv("data/results.csv", sep=";")
df.drop("Unnamed: 9", axis=1,inplace=True)

###### CONSTANTS
MAX_YLIM = [0,100]
```

Matched Points - Neighborhood Evaluation

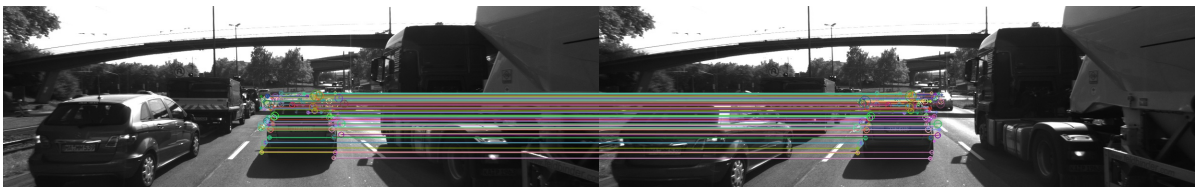
Some observations:

- AKAZE, BRISK, ORB and SIFT provide keypoints in different dimensions due to their multilevel keypoint detection.
  - ORB create the biggest radius keypoints while AKAZE create the smallest keypoint size variation.
- By using BF Matching + KNN + Ratio Test, the matched points showed a really good result, *i.e.*, there almost no diagonal maching points between sequences of images
- Points seems to be uniformly distributed over the edges of the car's laterals and the car's plate.

入力 [38]:

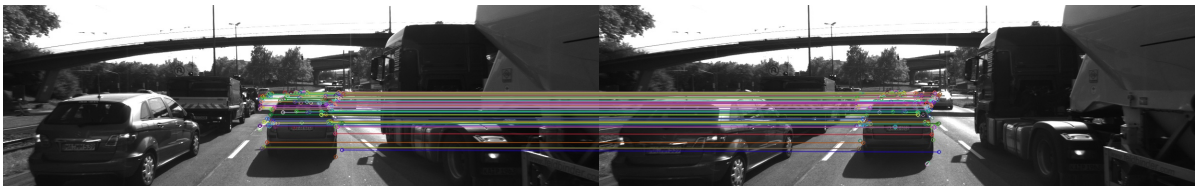
```
# show images
# take 1 photo (that ends with "1") for each combination detector/descriptor

onlyfiles = np.array([f for f in listdir(images_dir) if isfile(join(images_dir, f))])
filter_str = "1"
chosen_files = [ix for ix, elem in enumerate(onlyfiles) if filter_str in elem]
chosen_files = sorted(onlyfiles[chosen_files])

for im in chosen_files:
    print(im)
    display(Image(filename=images_dir + "/" + im, width = 1000, height = 800))
```

AKAZE_AKAZE_1.jpg

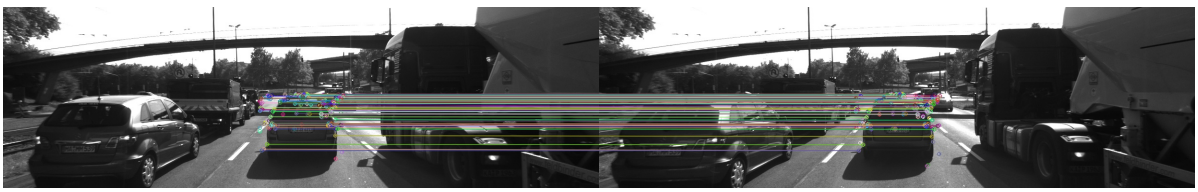


BRISK_BRISK_1.jpg

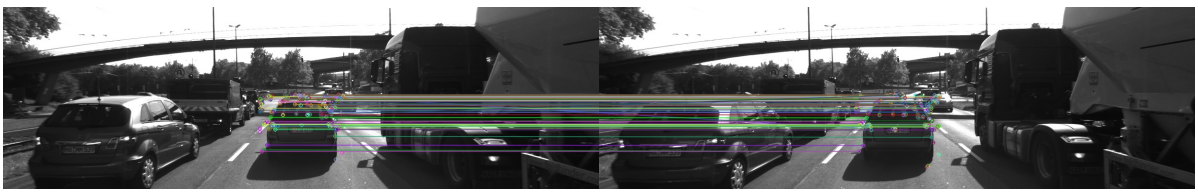
FAST_BRIEF_1.jpg



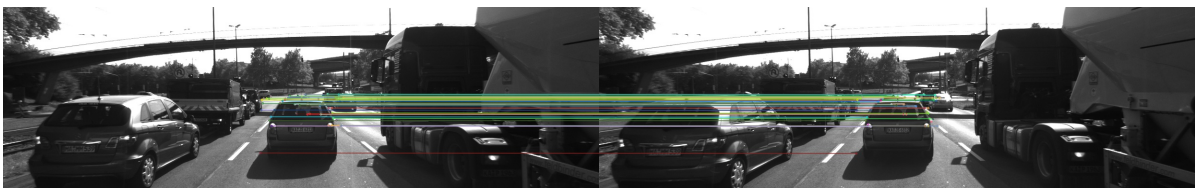
FAST_BRISK_1.jpg



FAST_FREAK_1.jpg

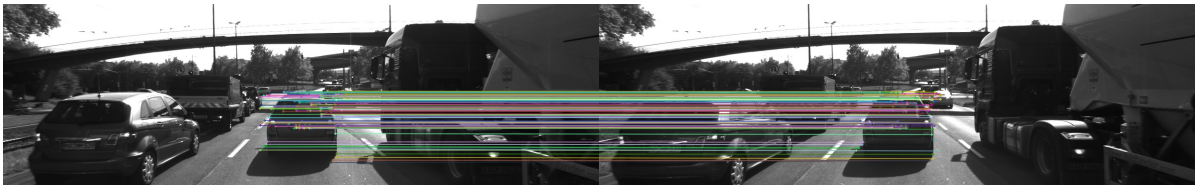


HARRIS_SIFT_1.jpg

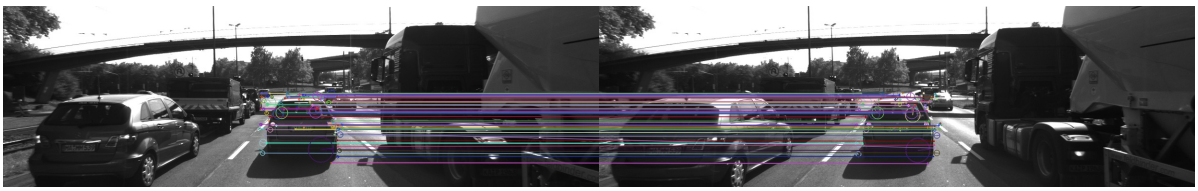


ORB_ORB_1.jpg

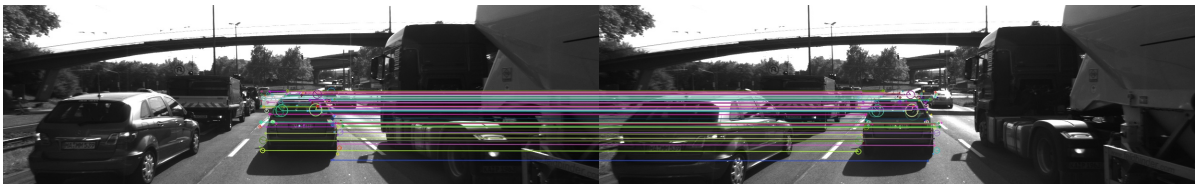
SHITOMASI_SIFT_1.jpg



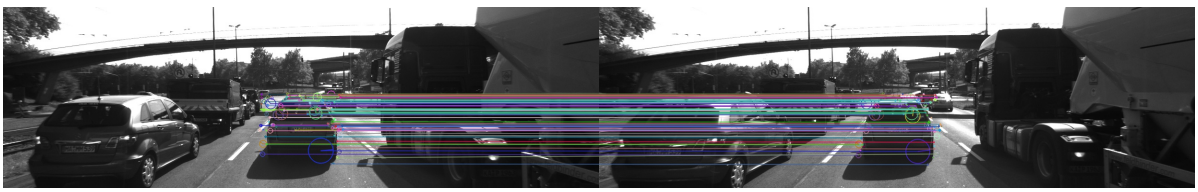
SIFT_BRIEF_1.jpg



SIFT_FREAK_1.jpg



SIFT_SIFT_1.jpg



Statistics on Execution Time

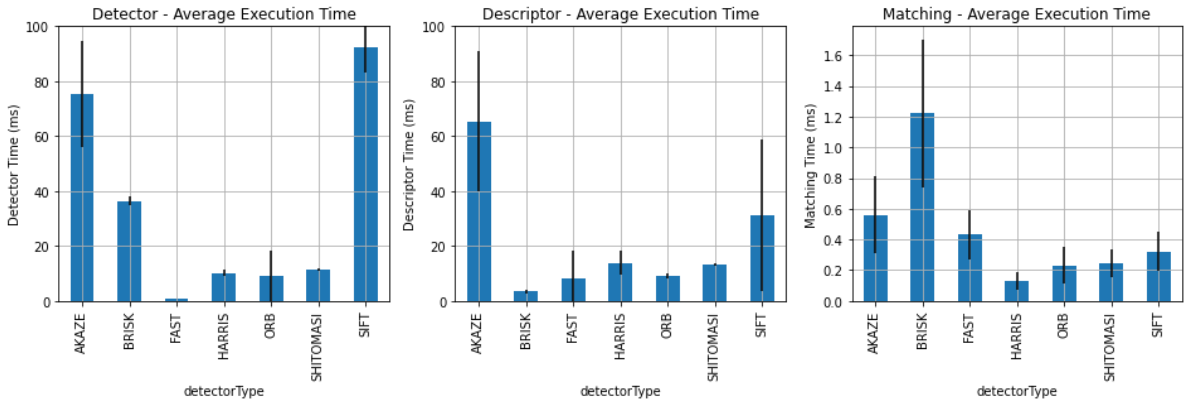
Detector, Descriptor and Matcher Average Execution Time

- **Detectors** AKAZE and SIFT were the slowest, while FAST was distinctively the fastest
- **Descriptors** AKAZE and SIFT again were the slowest while BRISK was the fastest. However, among the fastest descriptors, no significant difference is perceived.
- **Matchers** When Maching with BRISK, the BF Matcher + KNN + Ratio Test takes the longest while HARRIS is the fastest, but also with no big difference among the faster results.

入力 [61]:

```
fig, ax = plt.subplots(1,3, figsize=[16,4])
df_agg = df.groupby("detectorType")[["detectorTime(ms)", "descriptorTime(ms)", "match_time(ms)"]].ag
display(df_agg)

df_agg["detectorTime(ms)"]["mean"].plot.bar(yerr=df_agg["detectorTime(ms)"]["std"], ax=ax[0])
ax[0].set_title("Detector - Average Execution Time")
ax[0].set_ylabel("Detector Time (ms)")
ax[0].set_ylim(MAX_YLIM)
ax[0].grid()

df_agg["descriptorTime(ms)"]["mean"].plot.bar(yerr=df_agg["descriptorTime(ms)"]["std"], ax=ax[1])
ax[1].set_title("Descriptor - Average Execution Time")
ax[1].set_ylabel("Descriptor Time (ms)")
ax[1].set_ylim(MAX_YLIM)
ax[1].grid()

df_agg["match_time(ms)"]["mean"].plot.bar(yerr=df_agg["match_time(ms)"]["std"], ax=ax[2])
ax[2].set_title("Matching - Average Execution Time")
ax[2].set_ylabel("Matching Time (ms)")
ax[2].grid();
```

	detectorTime(ms)		descriptorTime(ms)		match_time(ms)	
	mean	std	mean	std	mean	std
detectorType						
AKAZE	75.264090	19.227434	65.424850	25.549001	0.560525	0.253364
BRISK	36.443460	1.659547	3.485906	0.731275	1.222254	0.481163
FAST	0.788629	0.065972	8.324330	10.108254	0.430996	0.163387
HARRIS	10.199198	1.178375	13.864790	4.376075	0.129121	0.057987
ORB	9.301569	9.200367	9.015415	0.909257	0.232727	0.116598
SHITOMASI	11.419480	0.638433	13.140840	0.498580	0.244012	0.092640
SIFT	92.336710	9.250260	31.217990	27.680665	0.323056	0.127329



KeyPoints Statistics

- ORB noticiably produces the biggest radius but also detects and matches the smallest number of points

入力 [63]:

```
df_agg = df.groupby(["descriptorType"])[["detectectedKeypoints", "averageKPSize", "matchedKeypoints"
display(df_agg)

fig, ax = plt.subplots(1,3,figsize=[16,4])
df_agg["detectectedKeypoints"]["mean"].plot.bar(yerr=df_agg["detectectedKeypoints"]["std"], ax=ax[0]
ax[0].set_title("Matching - Average Number of Detected Points")
ax[0].set_ylabel("Average Count")
ax[0].grid()

df_agg["matchedKeypoints"]["mean"].plot.bar(yerr=df_agg["matchedKeypoints"]["std"], ax=ax[1])
ax[1].set_title("Matching - Average Number of Matched Points")
ax[1].set_ylabel("Average Count")
ax[1].grid()

df_agg["averageKPSize"]["mean"].plot.bar(yerr=df_agg["averageKPSize"]["std"], ax=ax[2])
ax[2].set_title("Matching - Average Key Point Size")
ax[2].set_ylabel("Average Size")
ax[2].grid()
```

	detectectedKeypoints		averageKPSize		matchedKeypoints	
	mean	std	mean	std	mean	std
descriptorType						
AKAZE	1343.000000	17.081504	7.482975	0.079109	117.200000	42.023274
BRIEF	1586.750000	210.275728	6.014726	1.013429	75.750000	31.950414
BRISK	2249.500000	476.267892	13.094385	6.253689	103.700000	45.927976
FREAK	1586.750000	210.275728	6.014726	1.013429	57.850000	22.873278
ORB	500.000000	0.000000	53.924600	0.000000	51.500000	20.764553
SIFT	1080.533333	409.720235	1.676484	2.412141	72.866667	33.083732