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Laboratory 2: Feature Matching: Comparison and Applications

1.1 SIFT + RANSAC

1. For the first task we implemented a Matlab function (see file `func.m`) that takes two images and the ground truth file as an input and returns their estimated homography (`H` as a 3x3 matrix) and the error matrix with respect to ground truth (`error` as a 3x3). The function first imports the images and calculates the keypoint descriptors for each image, then sets the matching of the images with the help of provided `match` function. We then utilize the provided function `get_matching_pts` to visualize the results. Finally, the `ransacfithomography` function is applied to the images to perform RANSAC and return the estimated homography. We set the parameter `t` according to the function description in `ransacfithomography.m`. The function then calculates the error with respect to the ground truth. The result that the function delivers can be seen below:

2. For the second task we implemented a function (see file `script1.m`) that loops through the files in each subfolder and applies the previously implemented function `func` function to the pictures in the subfolder. Then, the function `imTrans` is applied to the first image with the estimated and ground truth homography pairwise for each pair of images in the subfolder. The results for the `graf` subfolder are presented pairwise for comparison below:

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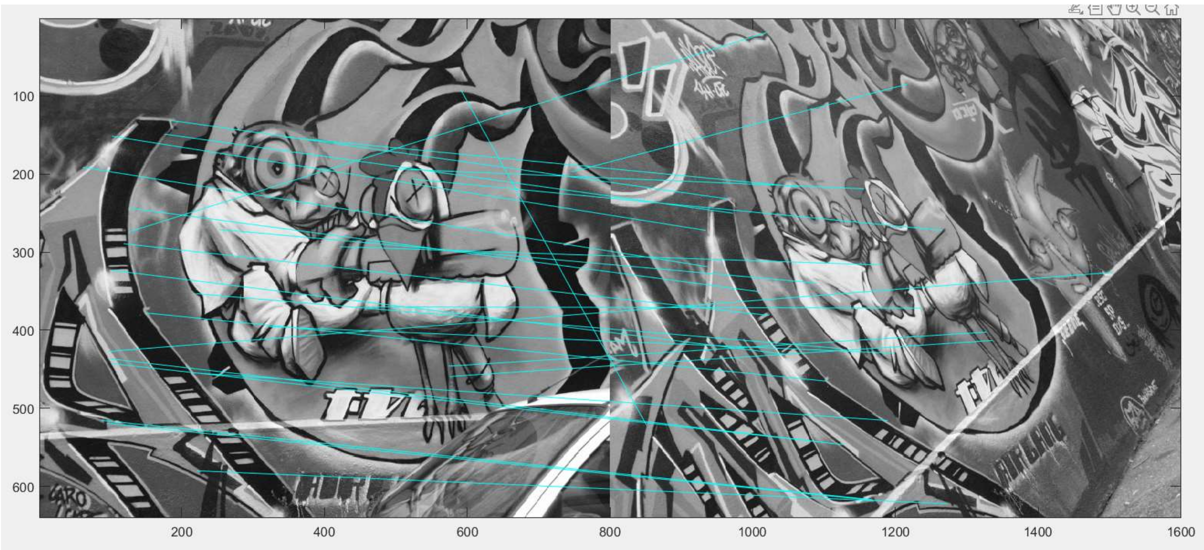

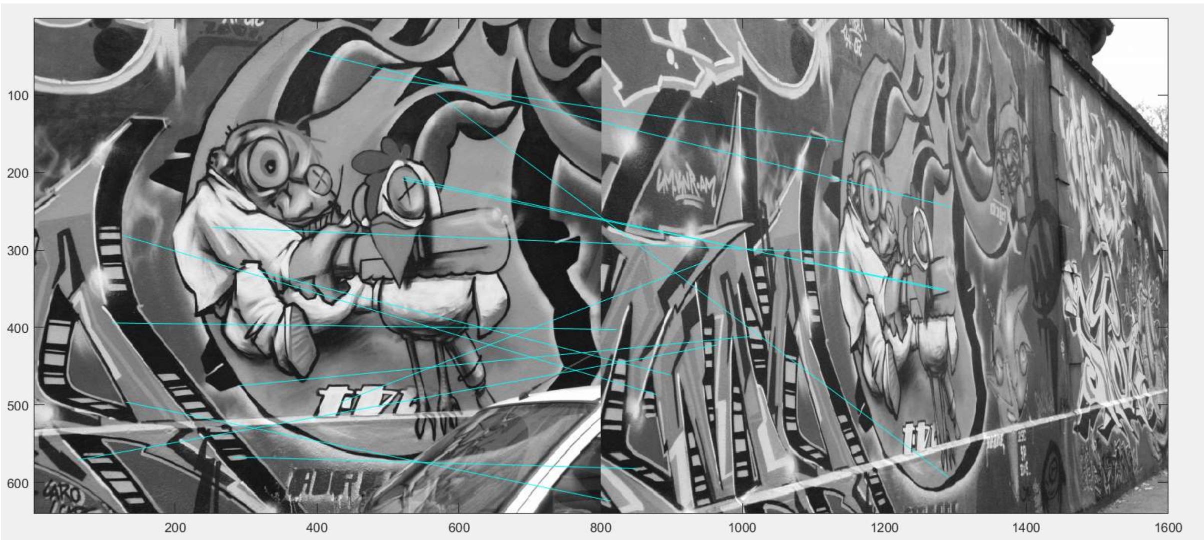

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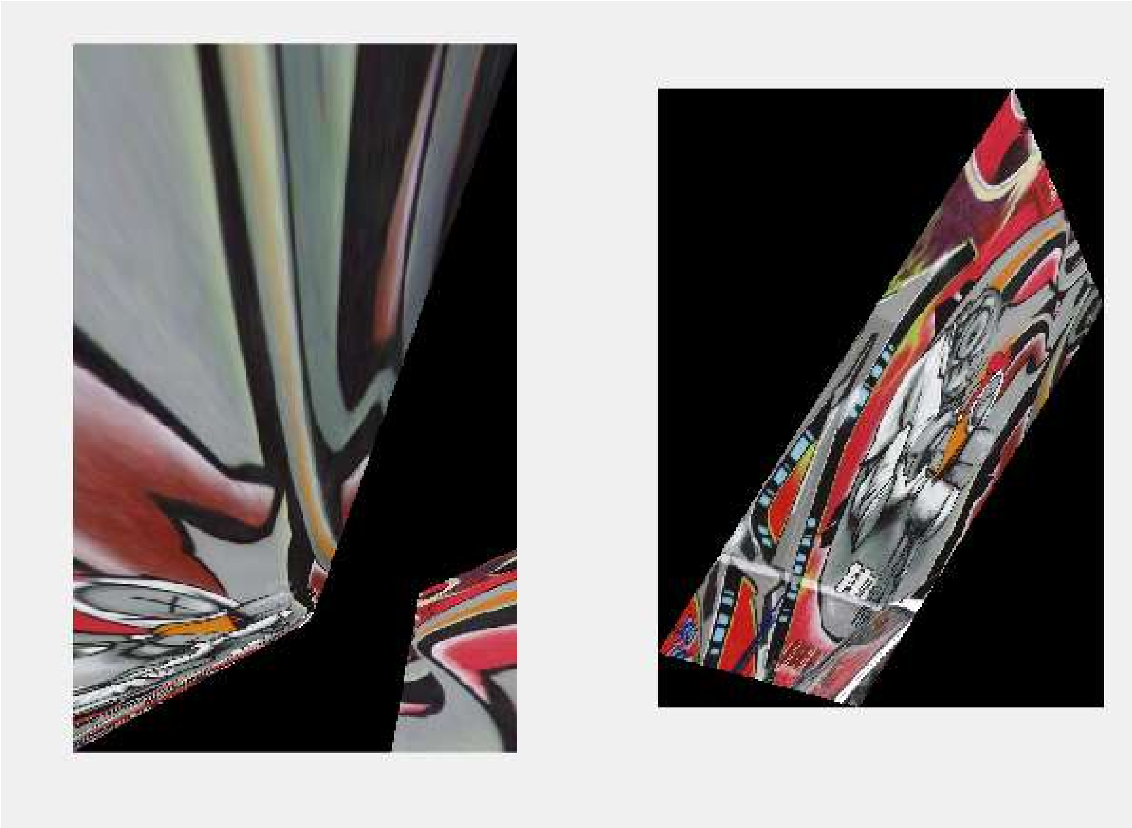


The errors:

For dataset bikes:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-0.0020	0	0.9750	-0.0010	0	2.0340	-0.0020	0	2.0660	-0.0020	0	2.0700	-0.0020	0	0.0300
2	0	-0.0020	0.0640	0	-0.0010	0.0360	0	-0.0020	1.1220	0	-0.0020	1.1220	0	-0.0020	6.2960
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For dataset boat:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-0.0080	0	-7.1790	-0.1250	0	30.7940	-0.4370	0	217.6630	-0.5760	0	235.7040	-0.5880	0	244.4400
2	0	-0.0080	-47.9840	0	-0.1250	-81.9270	0	-0.4370	61.3970	0	-0.5760	224.2680	0	-0.5880	171.7680
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For dataset graf:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-0.0025	0	1.0900	-0.0012	0	-5.5900	0	0	0	0.5125	0	-113.9287	-54.4850	0	4.3859e+04
2	0	-0.0025	-2	0	-0.0012	0.1025	0	0	0.9400	0	0.5125	-228.2387	0	-54.4850	1.0374e+04
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

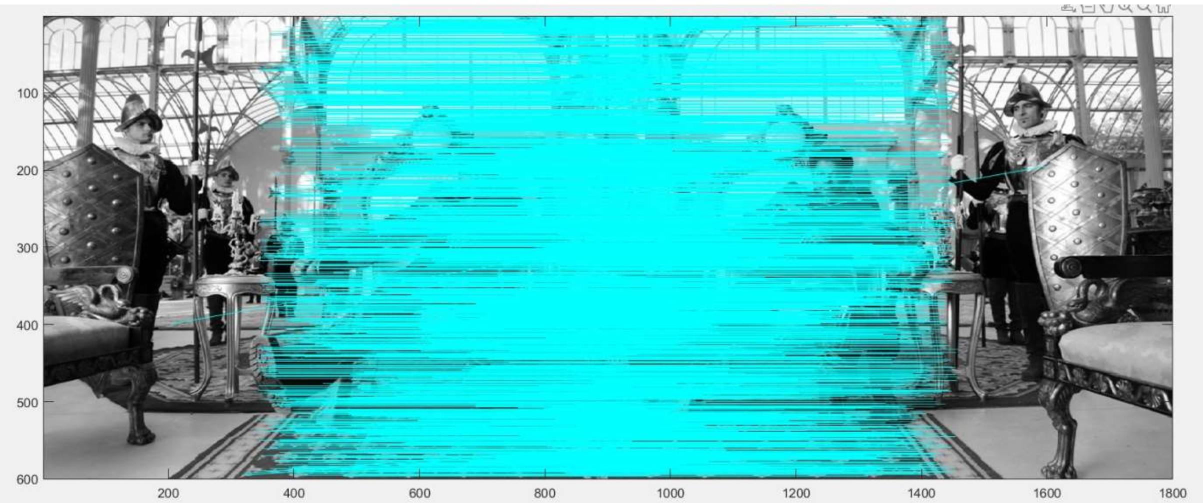
For dataset leuvren:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	-0.0011	0	-0.0033
2	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0011	0.0167
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Boat dataset has the biggest error matrix, second biggest is graf, third biggest is bikes and smallest one is leuvren. This is due to the fact that the scale, rotation and the perspective differences between the first image and the other images positively influences how large the error is.

1.1.1 Real Applications: Mosaics

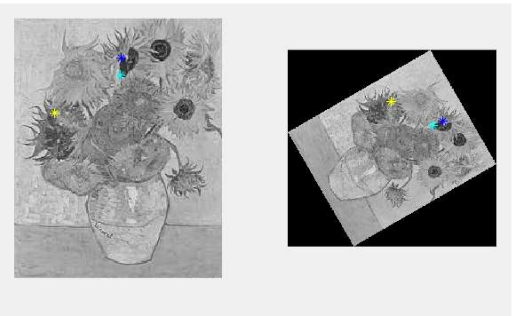
For this task we completed the code provided in `main.m` in order to compute the SIFT descriptors and the homography of the images. The result produced by the code is presented below:



1.2 Comparison of descriptors

For this task we perform the comparison of different descriptor methods: `FAST`, `SIFT`, `SURF`, `KAZE`, `BRISK`, `ORB`, `HARRIS` and `MSER`:

- `scale: 1.2 rotation: -60 FAST, MATCHES:3      COMPUTATION TIME:0.18392`



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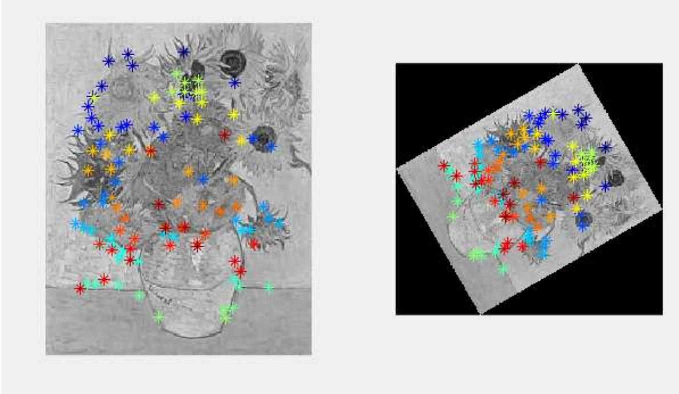
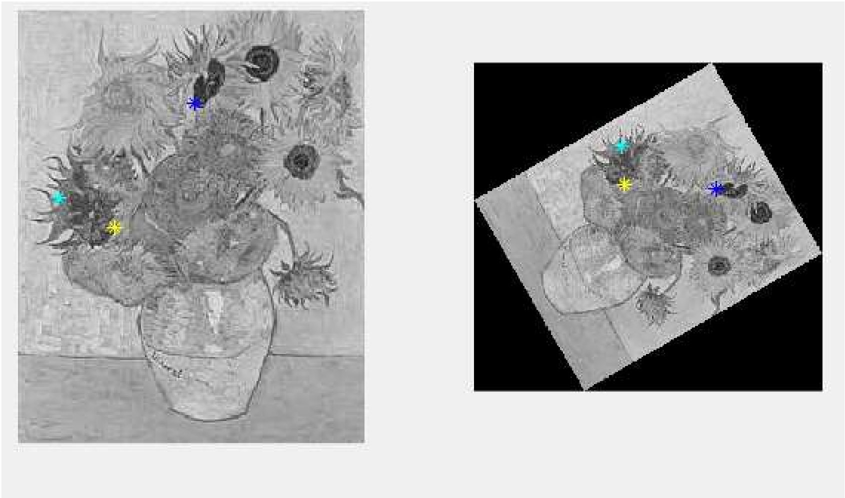
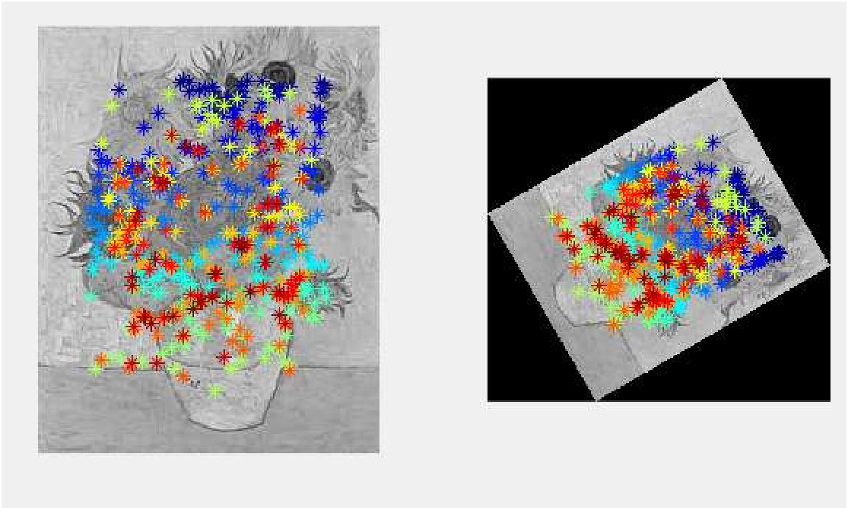
- scale: 1.2 rotation: -60 KAZE, MATCHES:109 COMPUTATION TIME: 0.21034



- scale: 1.2 rotation: -60 BRISK, MATCHES:3 COMPUTATION TIME: 0.16982



- scale: 1.2 rotation: -60 ORB, MATCHES:499 COMPUTATION TIME: 0.21292



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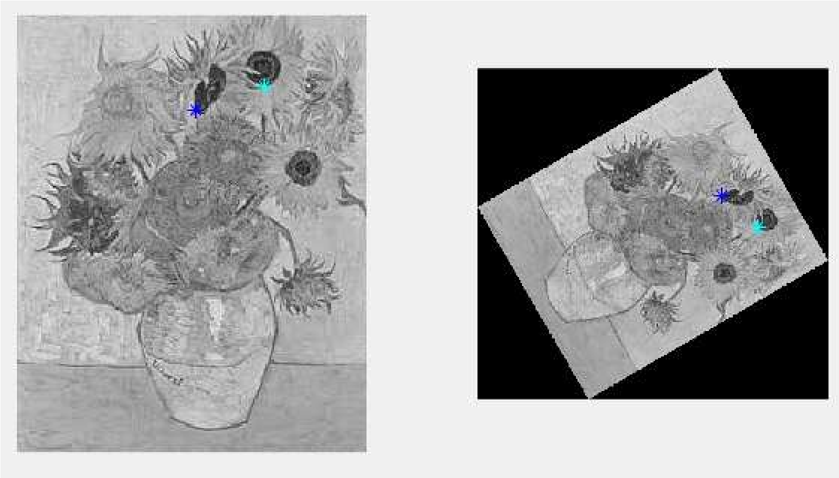
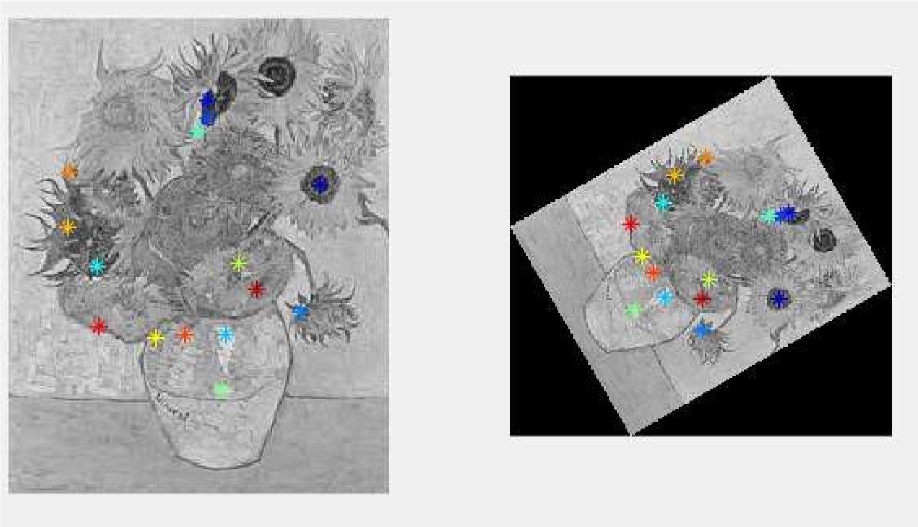
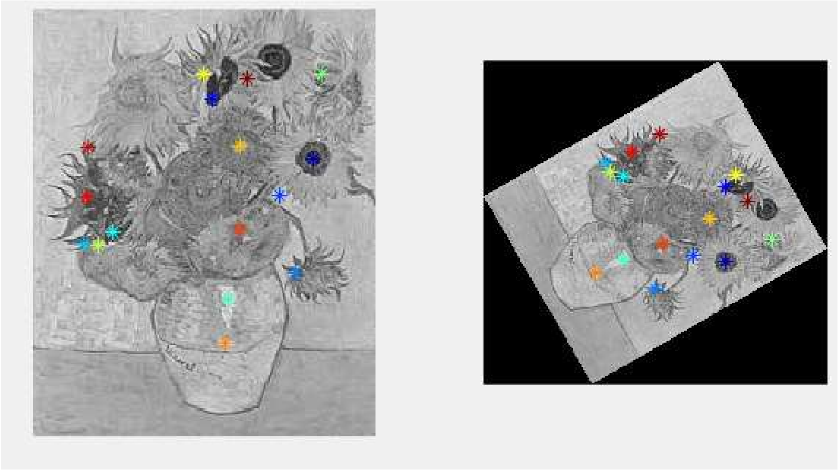
- scale: 1.2 rotation: -60 HARRIS, MATCHES:2 COMPUTATION TIME: 0.17084



- scale: 1.2 rotation: -60 SURF, MATCHES:15 COMPUTATION TIME: 0.15048



- scale: 2 rotation: -60 SURF, MATCHES:16 COMPUTATION TIME: 0.14525



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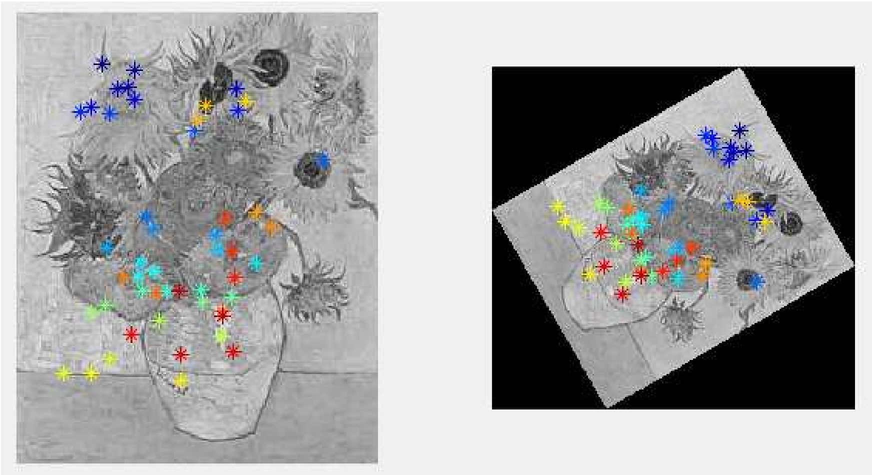
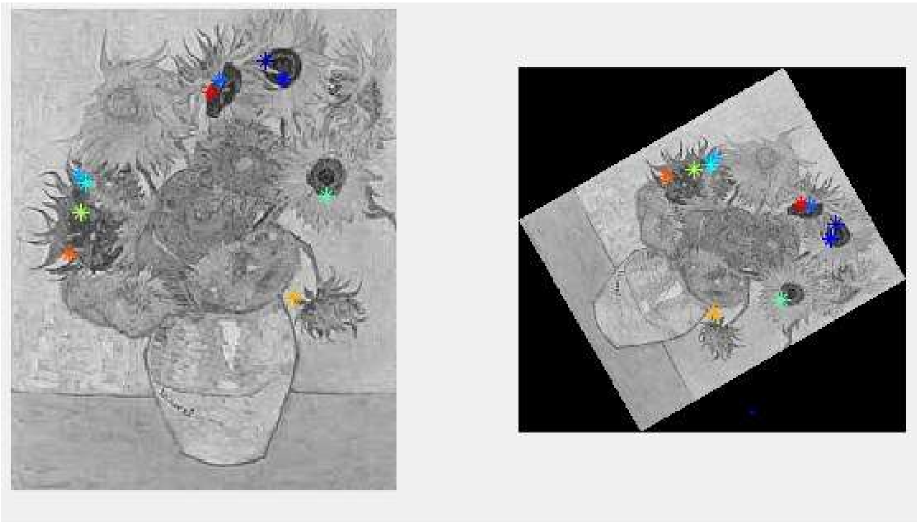
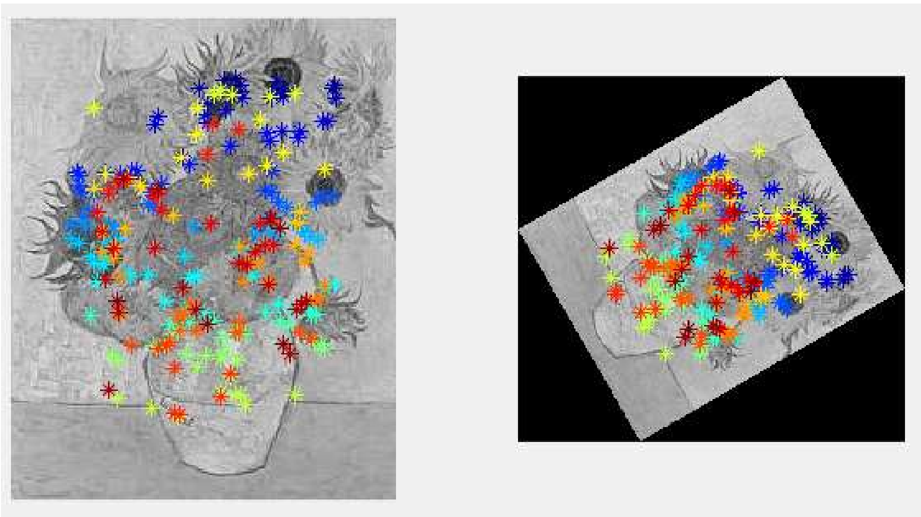
- scale: 2 rotation: -60 KAZE, MATCHES:50 COMPUTATION TIME: 0.32653



- scale: 2 rotation: -60 BRISK, MATCHES:11 COMPUTATION TIME: 0.172



- scale: 2 rotation: -60 ORB, MATCHES:244 COMPUTATION TIME: 0.27544



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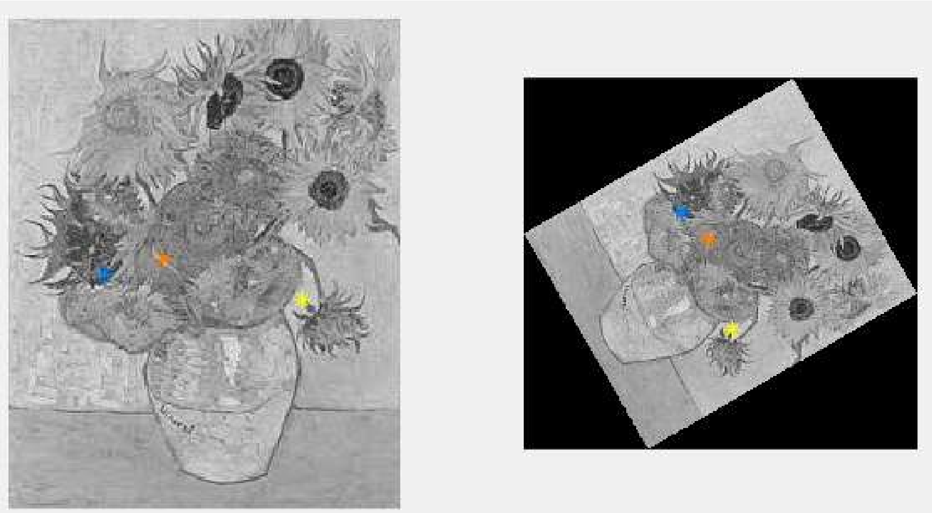
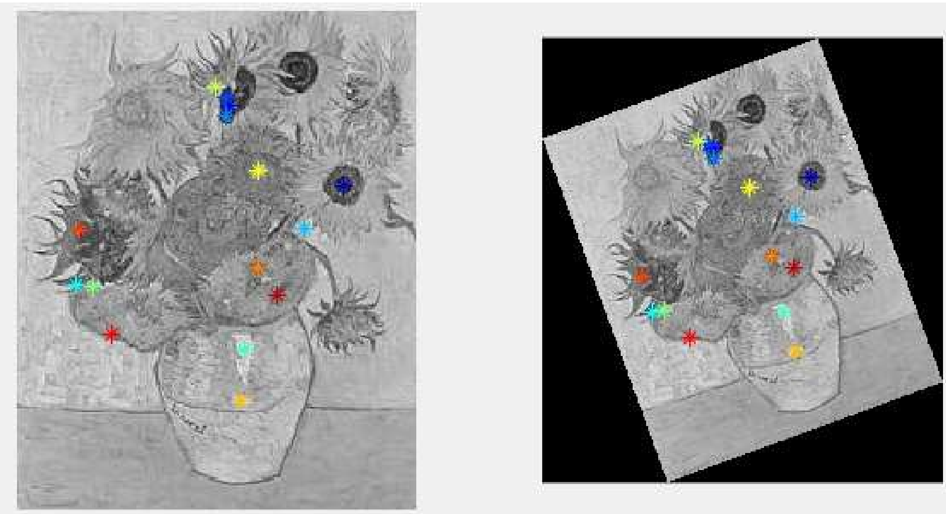
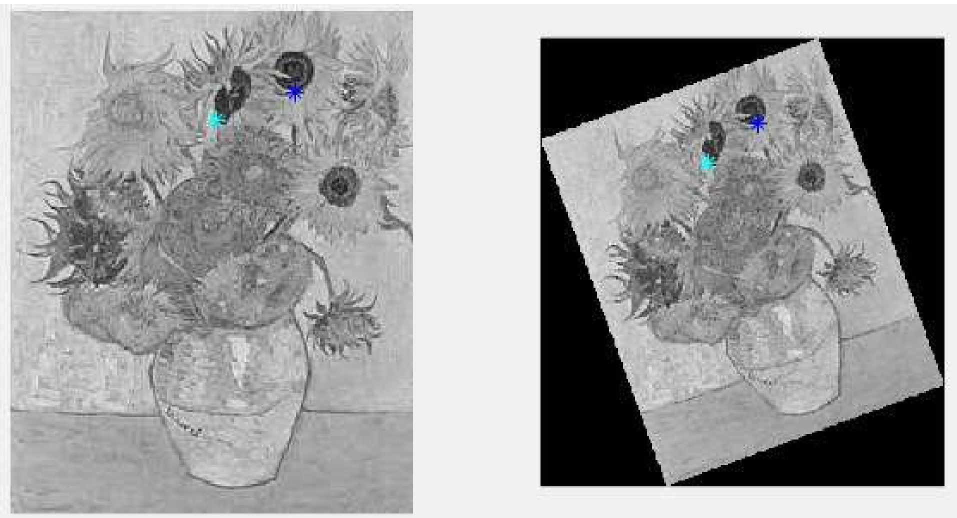
- scale: 2 rotation: -60 MSER, MATCHES:6 COMPUTATION TIME: 0.16643



- scale: 2 rotation: 20 SURF, MATCHES:15 COMPUTATION TIME: 0.13768



- scale: 1.2 rotation: 20 FAST,MATCHES:2 COMPUTATION TIME: 0.17905



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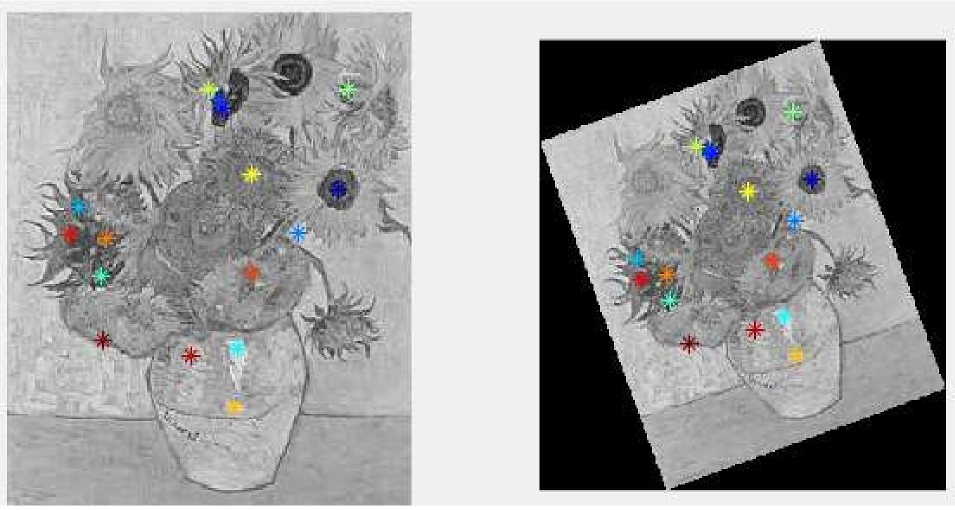
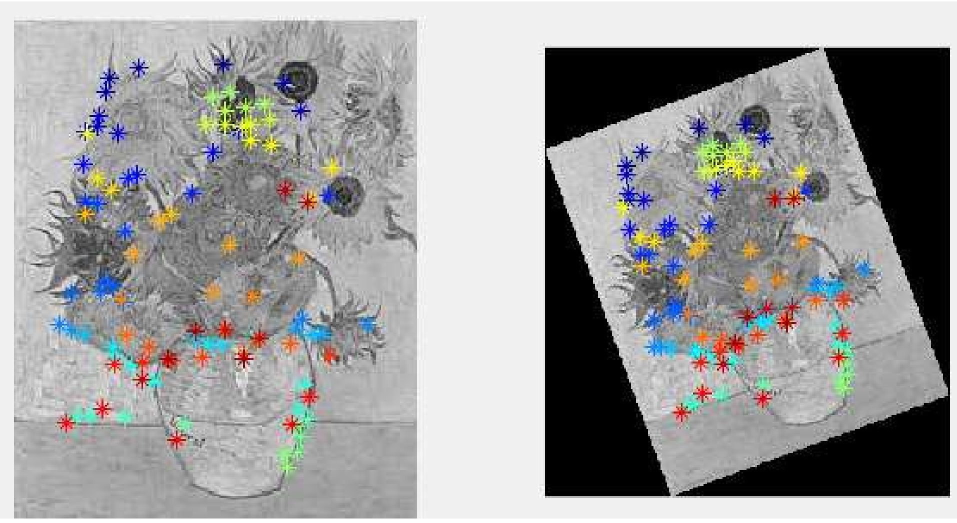
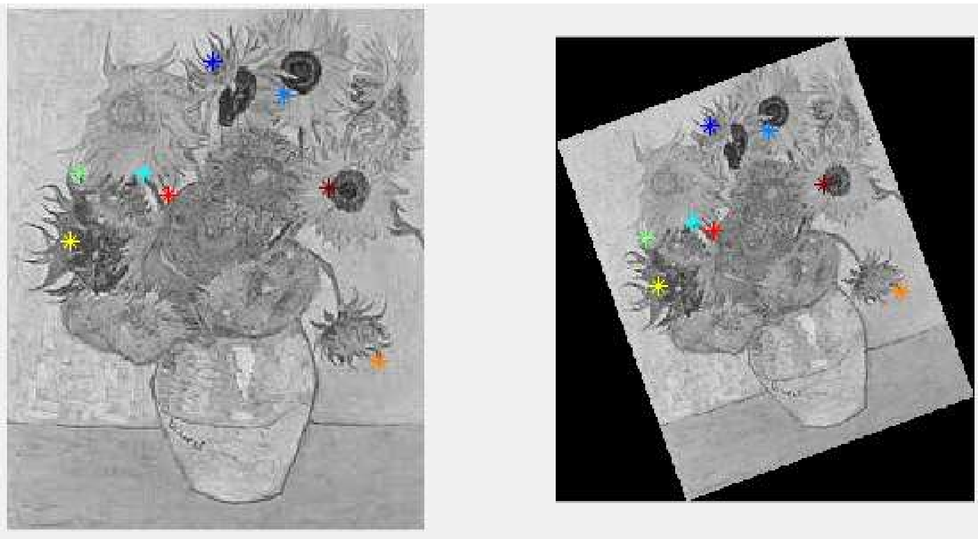
- scale: 1.2 rotation: 20 SURF,MATCHES:16 COMPUTATION TIME: 0.12827



- scale: 1.2 rotation: 20 KAZE,MATCHES:105 COMPUTATION TIME: 0.22513



- scale: 1.2 rotation: 20 BRISK,MATCHES:8 COMPUTATION TIME: 0.17033



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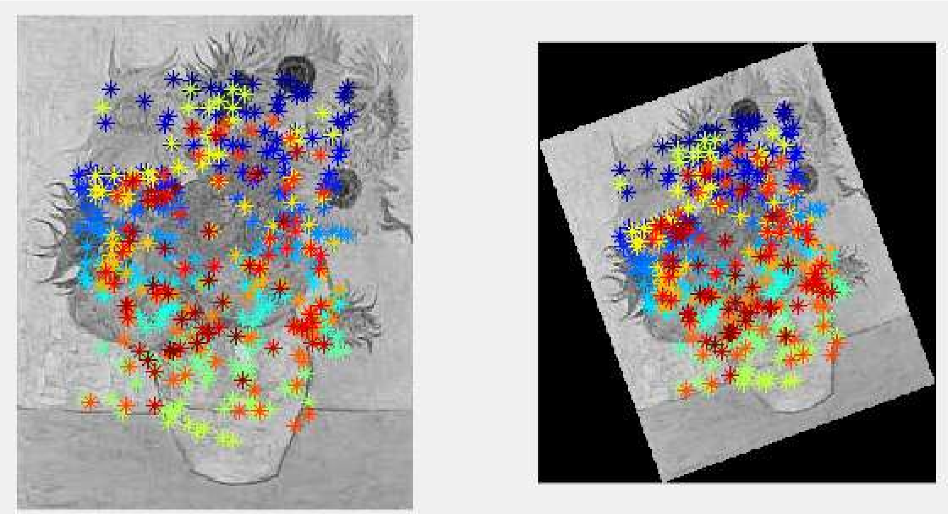
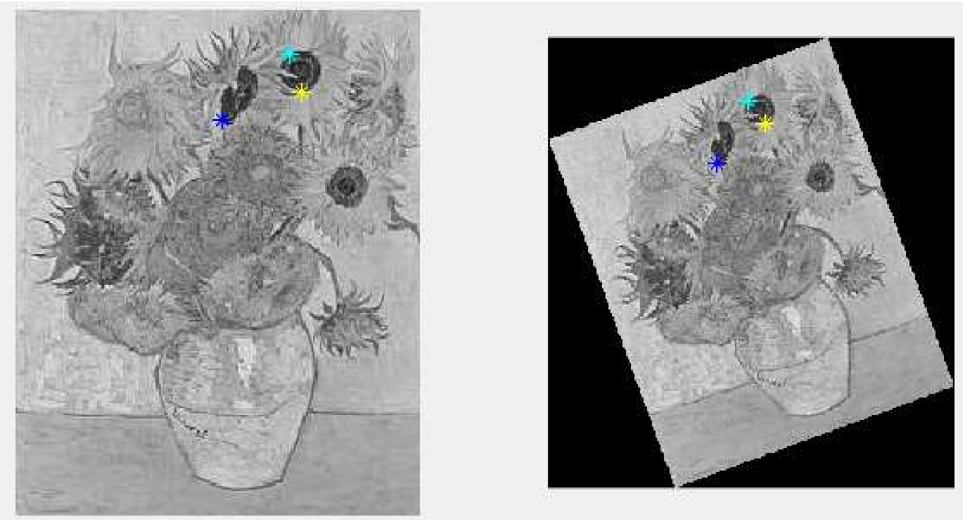
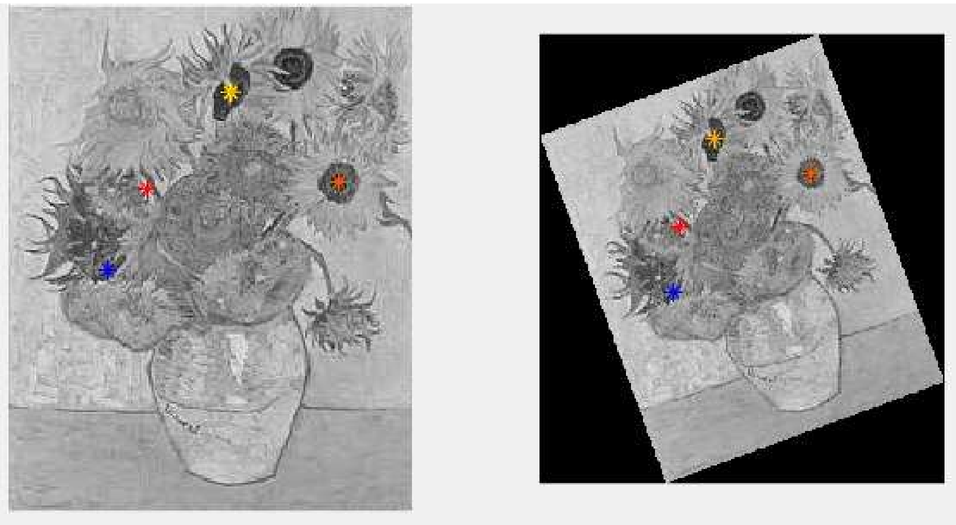
- scale: 1.2 rotation: 20 ORB,MATCHES:479 COMPUTATION TIME: 0.20484



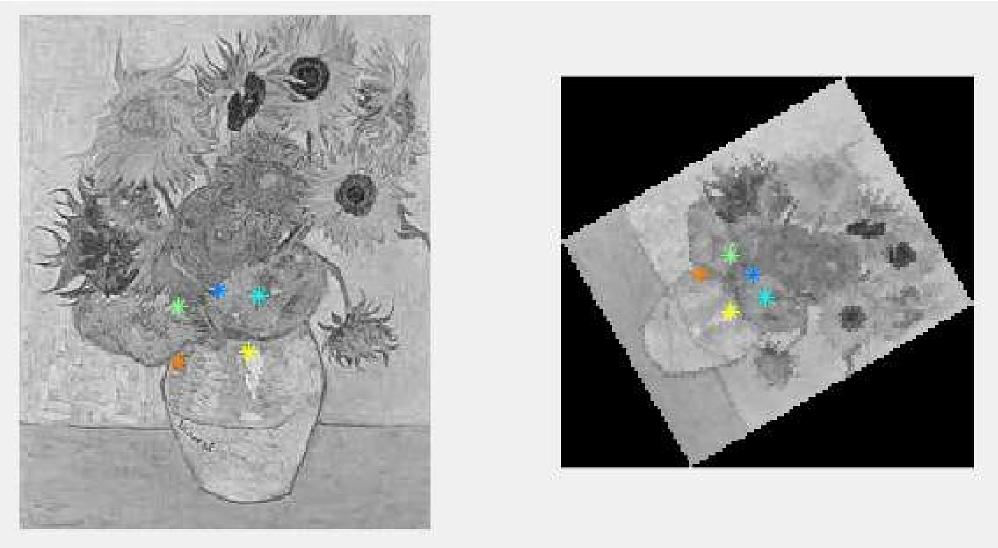
- scale: 1.2 rotation: 20 HARRIS,MATCHES:3 COMPUTATION TIME: 0.17471



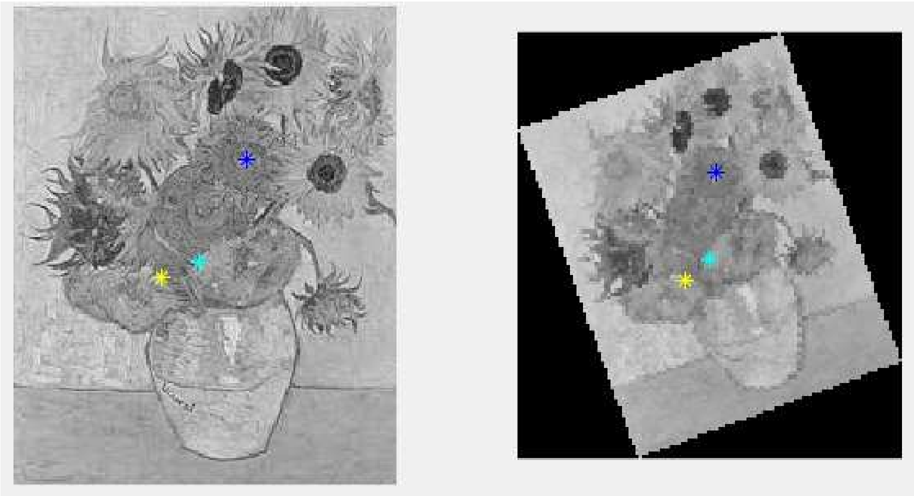
- scale: 1.2 rotation: 20 MSER,MATCHES:11 COMPUTATION TIME: 0.16943



- scale: 0.4 rotation: -60 ORB,MATCHES:5 COMPUTATION TIME: 0.16397



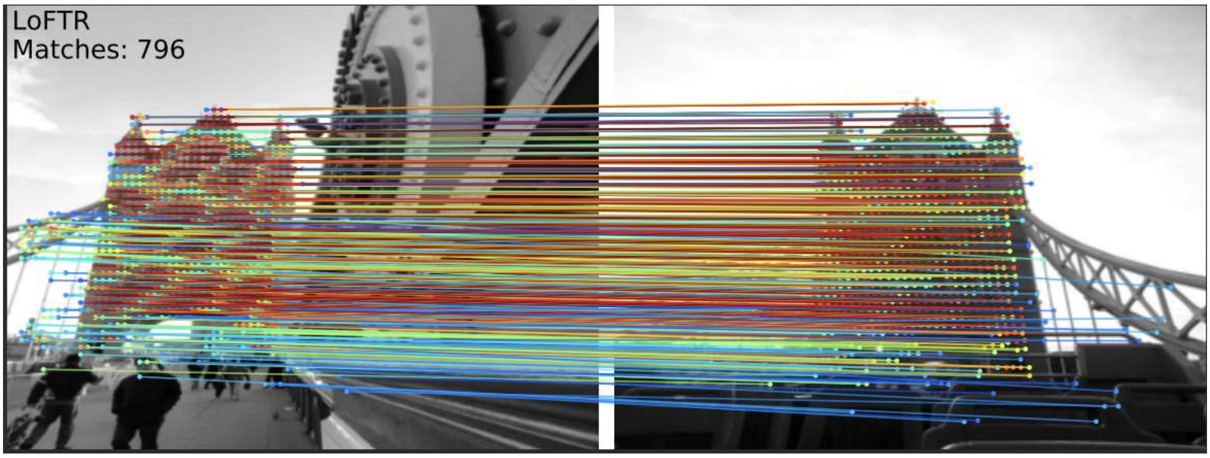
- scale: 0.4 rotation: -60 ORB,MATCHES:3 COMPUTATION TIME: 0.1635



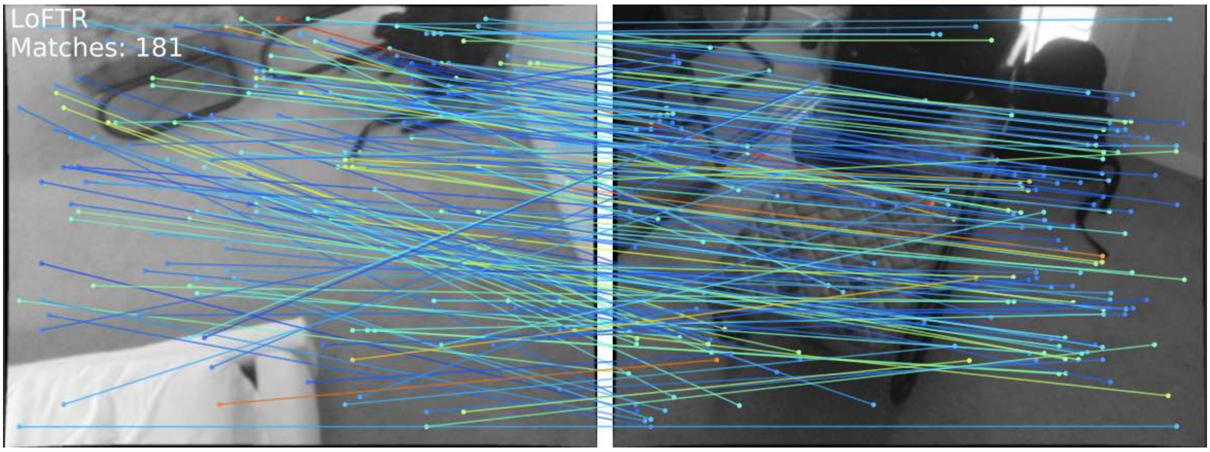
1.3 Data-driven Algorithms

The double image that we extracted was taken from sample images same LoFTR github https://github.com/zju3dv/LoFTR. We have also taken double image examples for the second task, one of them is textureless surface which has 181 LoFTR matches. Second double image one has global and well-textured scenes which has 429 LoFTR matches. Third double image is motion blur image which has 150 LoFTR matches. The most dense feature distribution belongs to global and well-textured scene whereas the sparse is motion blur one since this double image includes movement.

double image:



texture less surface:



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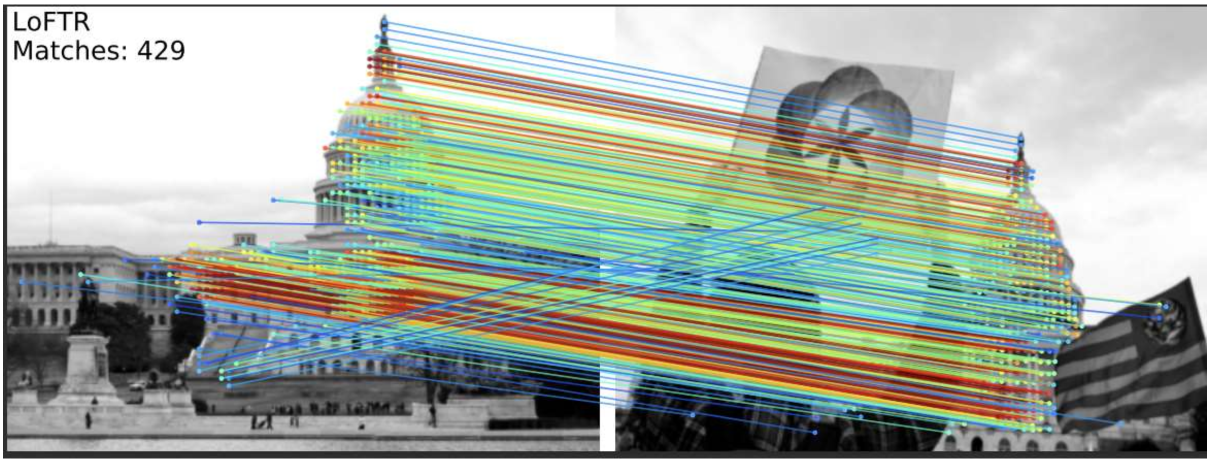
global and well-textured scenes:



motion blur image: