CV: Assignment 1 – Jannik Wirtz (i6292051)

Implementation

This implementation uses Harris corner detection to extract keypoints from the two given images independently of each other. After which SIFT descriptors are determined to allow for distinctive description of the found keypoints and the matching step performed next. In order to match the most similar keypoints from the source and the target image, a BFMatcher from the CV lib is used. This approach finds the closest matching keypoint in the target image for every keypoint in the source, according to the euclidean norm of their descriptors. Thresholding of keypoint pairs is done via a ratio-test (see code and below).

RANSAC parameters include the number of points used to estimate the affine transformation. While higher numbers like 4/5 tend to yield transformations with better accuracy, they were found to be less reliable than using 3 as the minimum number of points. The residual threshold parameter of the RANSAC algorithm was crucial for finding accurate transformations.

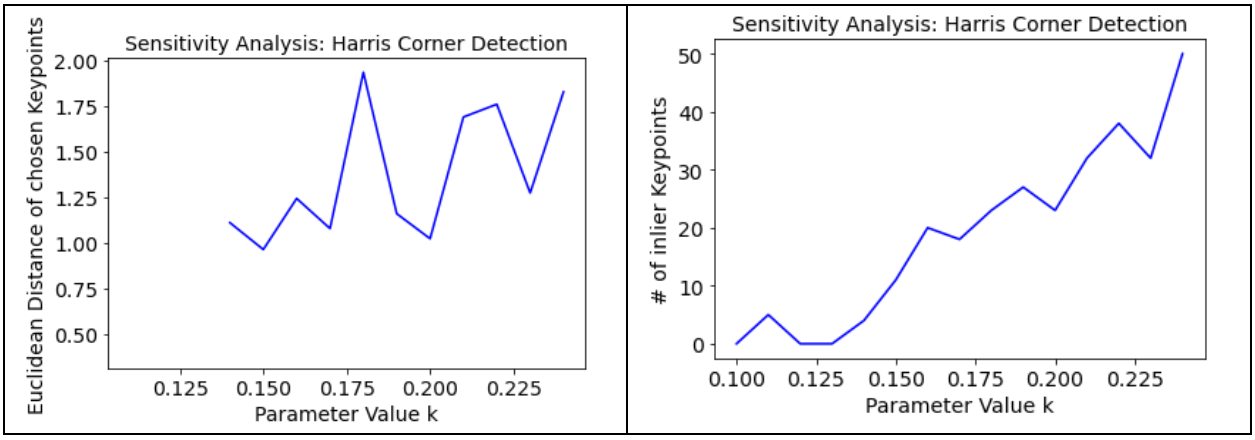
Experimental Results

Initial Parameters:

Harris Corner Detection	**SIFT Descriptor**	**RANSAC**
blockSize = 5	keyPointDiameter=13	min_points=4
ksize = 3	**Thresholding (matching)**	threshold_residual=1
k = 0.2	Ratio = 0.75	(iterations=2000)

Harrison Corner Detection Parameters

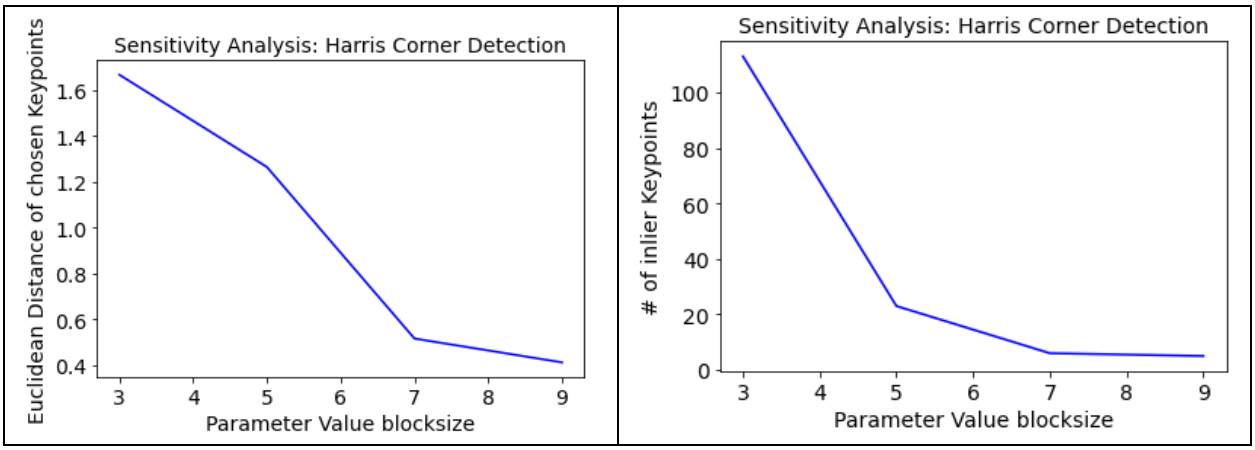
1. **k: Sensitivity factor to separate corners from edges, typically in range [0, 0.2]. Small values of k result in detection of sharp corners. (blocksize=5, ksize=3)**



The optimal value for k was found to be 0.15. (minimal average distance of keypoints: 0.9623)

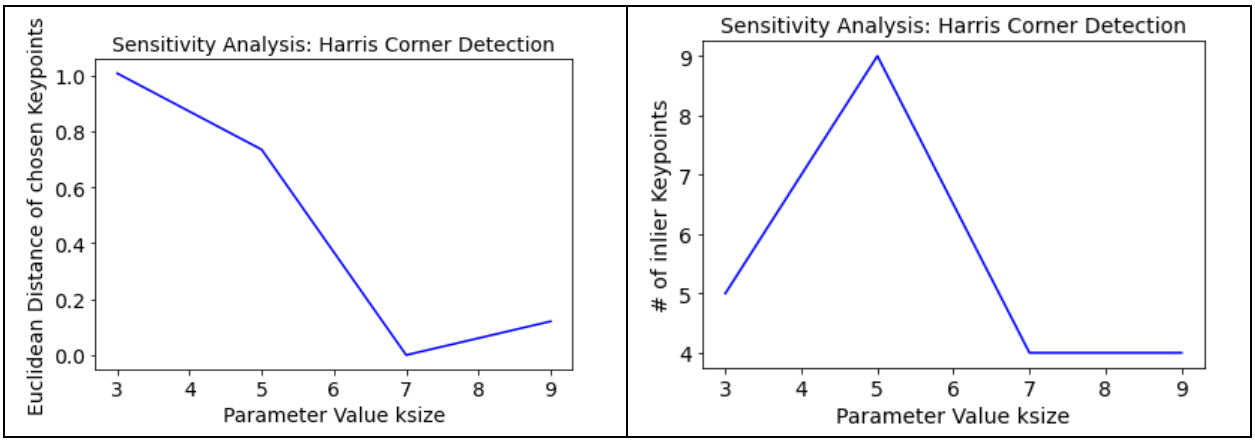
2. **BlockSize: BlockSize Neighborhood size. (blocksize=5, k = 0.2)**

   K=0.2 was chosen here because it yielded comparable results in the above result, k=0.15 would not allow the method to find enough keypoints for this test of blocksizes. Blocksizes of 11 and larger would not yield enough keypoints to estimate an affine transformation.



The best values found for blocksize were 7 and 9. (minimal average distance of keypoints: 0.4121)

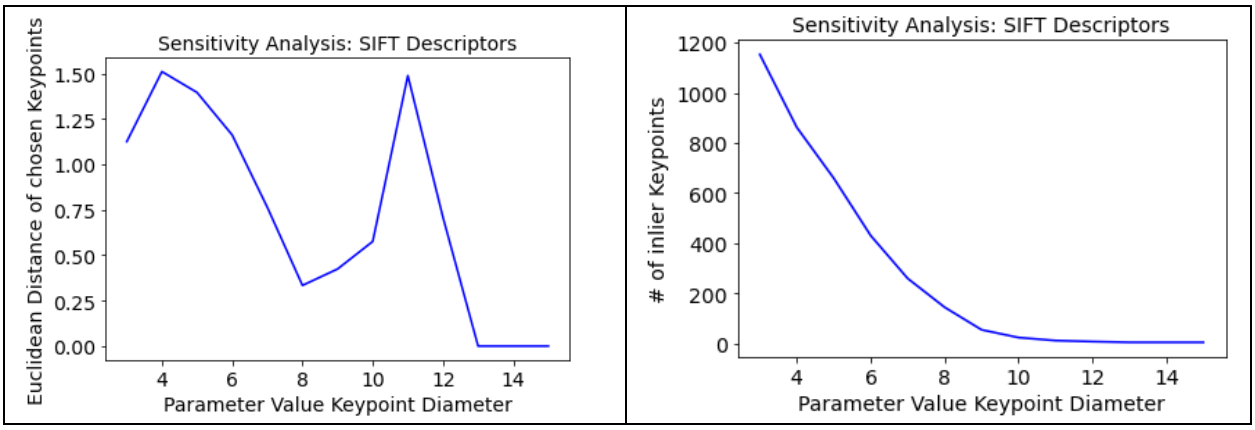
3. **ksize: Aperture parameter for the cv.Sobel operator**



The optimal value for ksize was found to be 7. (minimal average distance of keypoints: 3.478 e-12)

SIFT Descriptor Parameters

1. **KeypointDiameter: The diameter of keypoints used for SIFT descriptors**

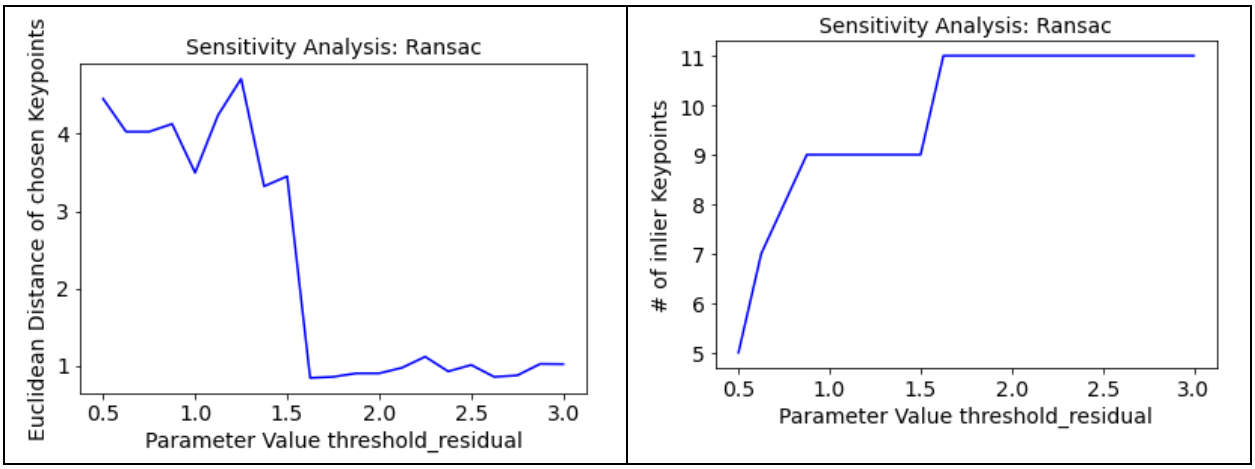


The optimal diameter around the keypoints for the SIFT descriptor was found to be 13. (minimal average distance of keypoints: 3.90e-12)

Thresholding Parameter

Ransac Parameters

1. **Residual-threshold: used to determine inliers and outliers for a transformation**



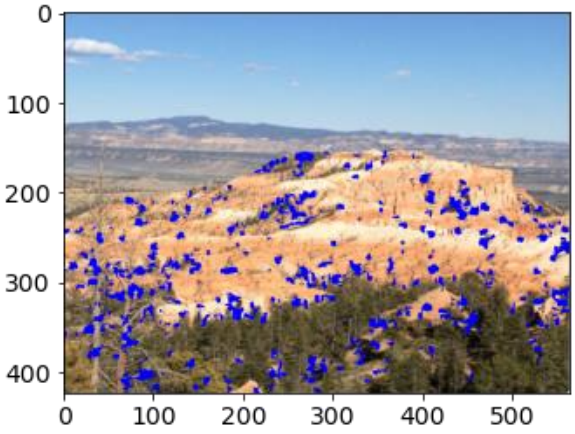
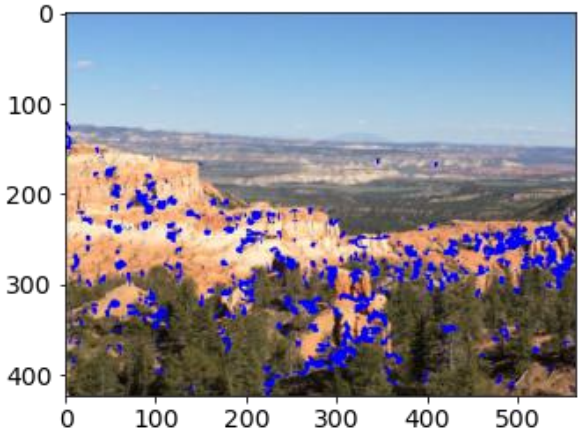
The optimal range for the ratio used in the ratio-test for thresholding was found to be between 1.625-2 (minimal average distance of keypoints: 0.8575)

Step-by-step Example

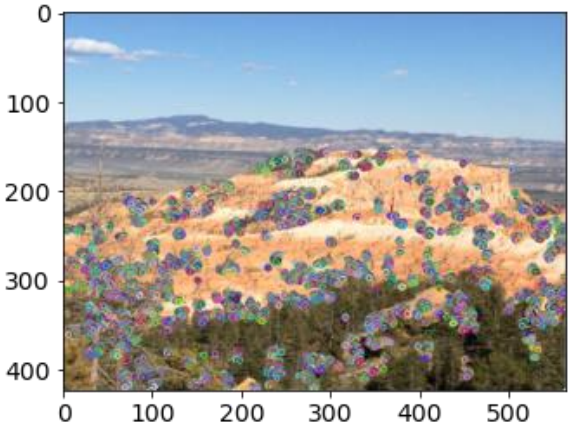
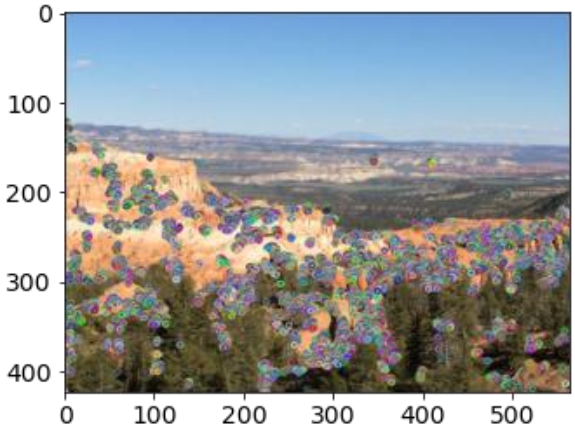
Used parameters:

blockSize = 9, ksize=7, k=0.2, peakPercent=0.01, ratio=0.85, threshold_residual=1, min_points=4

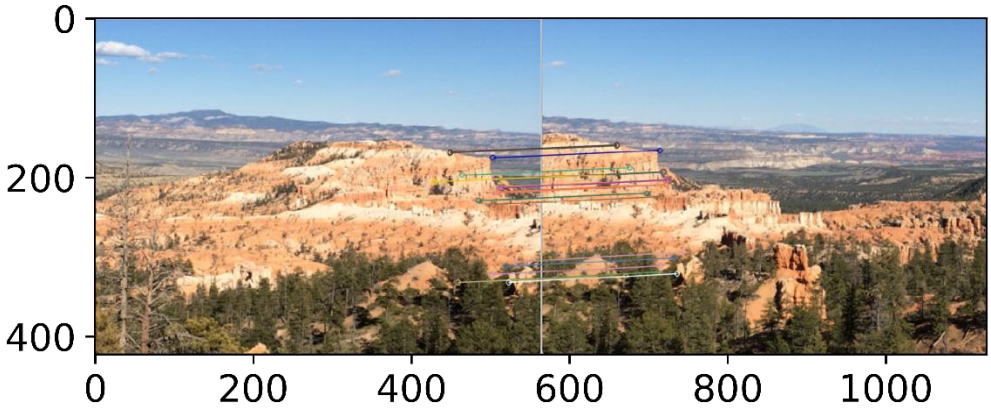
Harris Corner detection

Keypoints found in left Image: 12800	Keypoints found in right Image: 13859
	

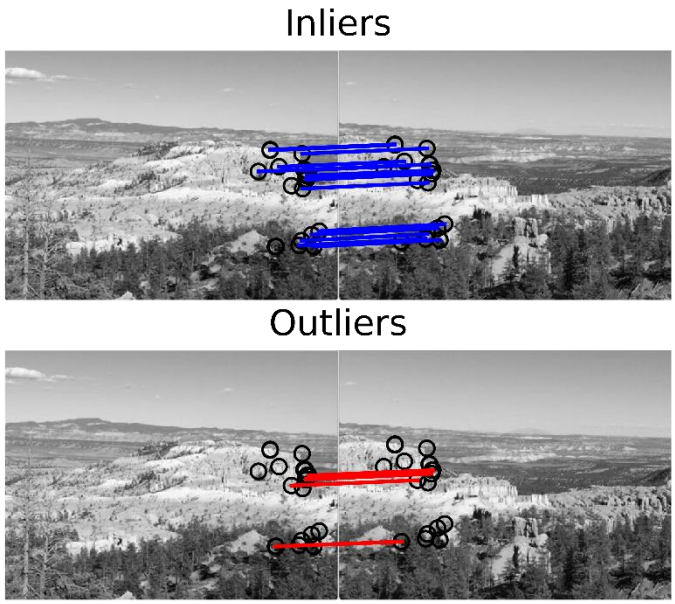
SIFT Descriptors

SIFT Descriptors of Keypoints in left Image	SIFT Descriptors of Keypoints in right Image
	

Correspondance



RANSAC Inliers & Outliers



Keypoints after Matching/Thresholding: 25

M = [[9.89021960e-01 1.25043425e-02 -3.49422731e+02]

[-1.22740748e-02 9.86975671e-01 -7.04598283e-01]]

Inlier indices [0 1 2 3 4 5 6 7 8 9 13 15 17 18 19 20 21 24]

Average keypoint distance 0.95913498162817

Stitched Image