

Computer Vision Assignment Four @ ETH Zurich

Model Fitting

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November 1, 2018

1 Line fitting with RANSAC

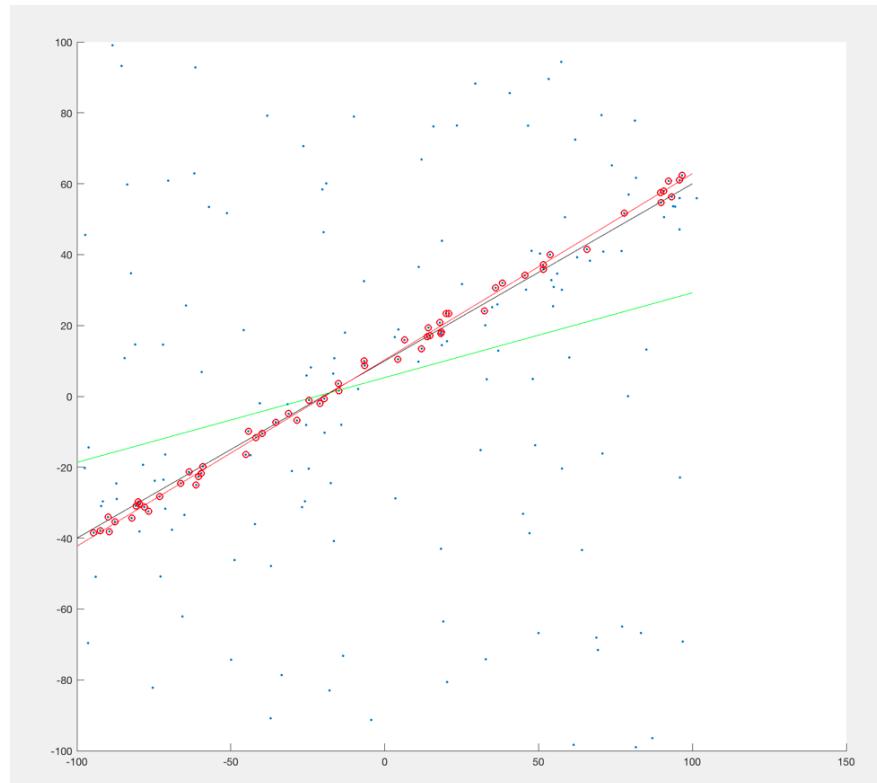


Figure 1

Applying the Ransac algorithm gives an error close to the real model as expected and much better than the least squares model. The resulting following errors are as follows:

$$err_{least_squares} = 182.7807$$

$$err_{RANSAC} = 41.6691$$

$$err_{Real} = 39.7104$$

The number of inliers detected are as follows:

$$inliers_{RANSAC} = 60/100$$

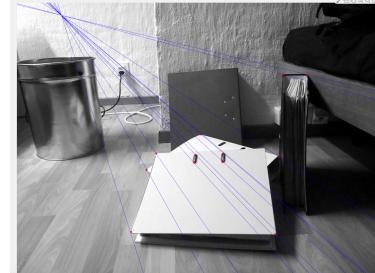
2 Fundamental Matrix

Following the slides, the 8 point algorithm was implemented and ran on each of the pair images. One example is shown below, as evident applying the singularity provides convergence of the epipolar lines at a specific epipole. However, if singularity was not enforced the lines fail to converge at a specific epipole. The fundamental matrix caculated for this pair of images is :

$$F = \begin{bmatrix} 0.0000 & 0.0000 & -0.0004 \\ 0.0000 & 0.0000 & -0.0003 \\ -0.0001 & -0.0039 & 0.3104 \end{bmatrix}$$



(a) epipolar lines on the first image.



(b) epipolar lines on the second image.

Figure 2: Calculation of the fundamental matrix with singularity enforced.

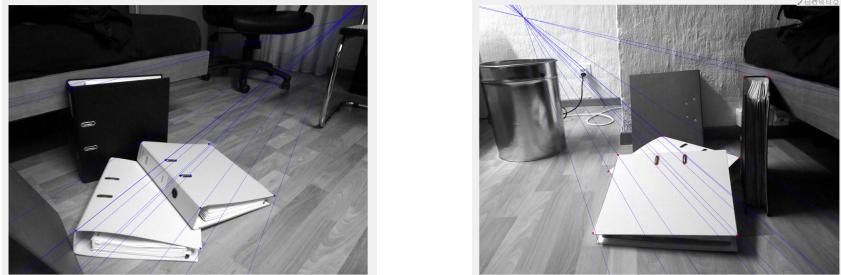
3 Essential matrix

When provided with a known camera calibration parameters, I ran the 8 point algorithm with the calibrated points provided by $\hat{x} = K^{-1}x$. Singularity is also enforced but in this case the first two values are equal and the third one is zero. The results obtained are as follows:



(a) epipolar lines on the first image. (b) epipolar lines on the second image.

Figure 3: Calculation of the fundamental matrix without singularity enforced.



(a) epipolar lines on the first image. (b) epipolar lines on the second image.

Figure 4: Calculation of the essential matrix.

$$E = \begin{bmatrix} 0.0886 & 5.4757 & 2.2044 \\ 5.8914 & 0.1308 & 2.6671 \\ 2.2352 & -2.8864 & -0.1490 \end{bmatrix}$$

and

$$F = \begin{bmatrix} 0.0000 & 0.0000 & -0.0001 \\ 0.0000 & 0.0000 & -0.0005 \\ -0.0002 & -0.0037 & 0.3255 \end{bmatrix}$$

As we can see the results are much more accurate and the epipolar lines are more aligned.

4 Camera matrix

The camera matrix is obtained by decomposing the essential matrix and assembling 4 candidates using different R and t. After checking for the correct solution

where all the 3D points in front of the camera, the correct solution is chosen.

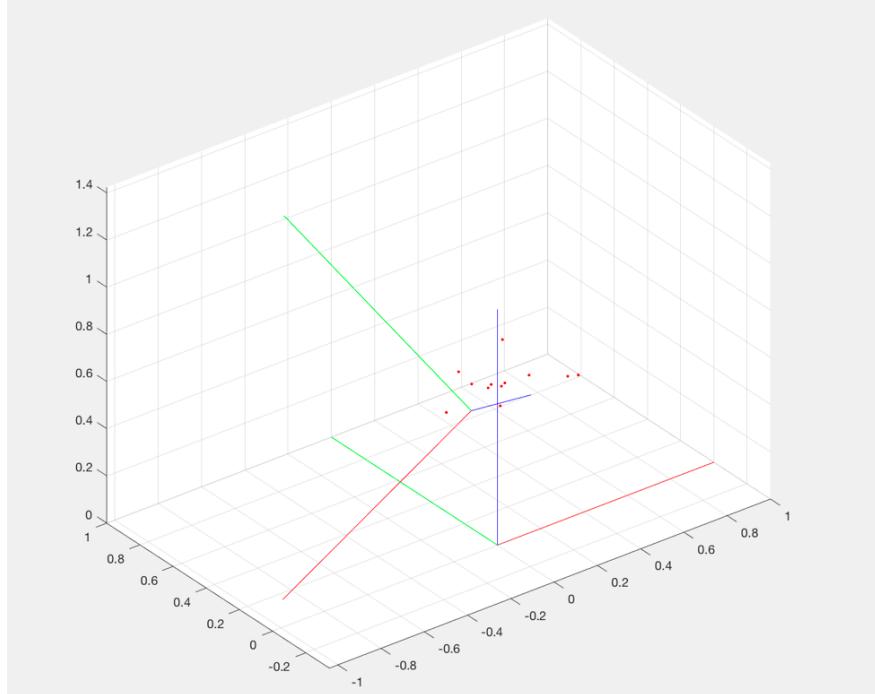


Figure 5: The camera matrix after choosing the candidate that makes all the 3D points in front of the camera

5 Feature extraction and matching

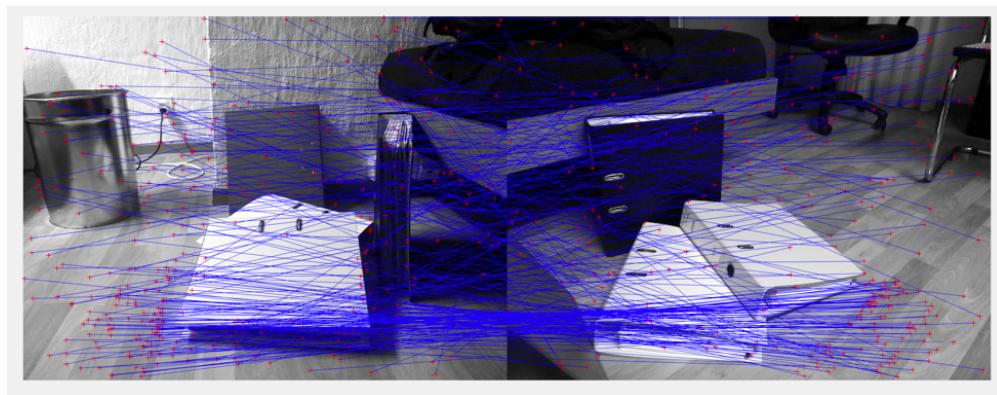


Figure 6: SIFT matches using vlsift
Applying SIFT on the following pair of images, the algorithm produces 320

matches.

6 8-Point RANSAC

Applying the RANSAC algorithm on the matches produces a "better" subset of matches decreasing the amount of noise. The results are shown below. It produces 54 inliers out of the 320 matches which is 16.8%. Increasing the threshold, increase the ratio of the inliers but we get a risk of having some outliers matching in the result.



Figure 7: RANSAC applied to the matches, the image shows the set of inliers.

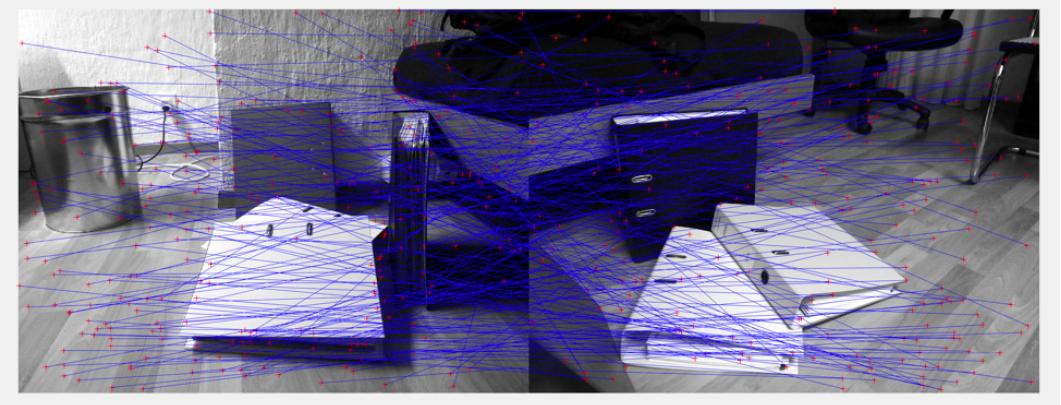


Figure 8: RANSAC applied to the matches, the image shows the set of outliers.

7 8-Point Adaptive-RANSAC

Applying the formula of the Adaptive-RANSAC showed early exit for some of the pairs of the images such like the pumpkin images but for example for the

pair of images shown it went till the maximum iterations provided. For the pumpkin pair of images, 320 iterations were needed with threshold of 5 pixels.