

Assignment 5 Writeup

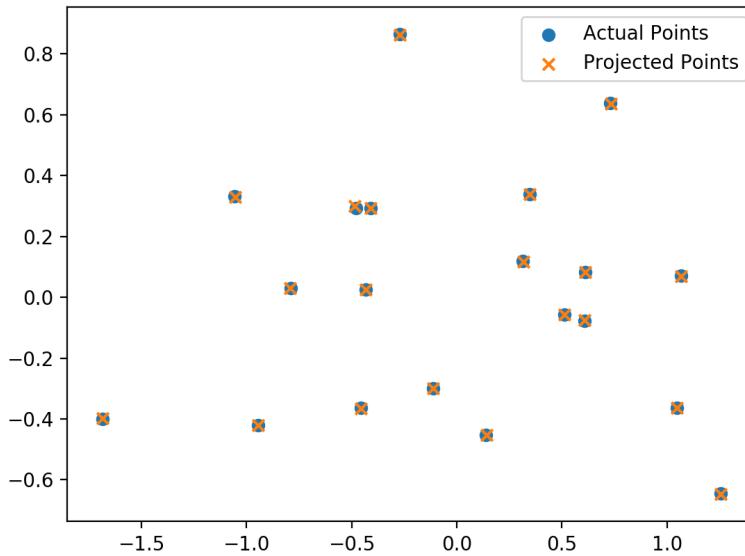
Pascale Walters

Part 1

In this part, the camera projection matrix and camera location are estimated. The camera projection matrix is found by setting up the equation as described in the notes for the question and solving with a least squares solver. This makes the assumption that the bottom right value in the calibration matrix is one. The code for this part can be found in the method calculate_projection_matrix in student.py. The estimated camera projection matrix is

```
[[ 0.76785834 -0.49384797 -0.02339781  0.00674445]
 [ -0.0852134 -0.09146818 -0.90652332 -0.08775678]
 [ 0.18265016  0.29882917 -0.07419242  1.      ]]
```

Visualization of the projection can be seen in the following figure:

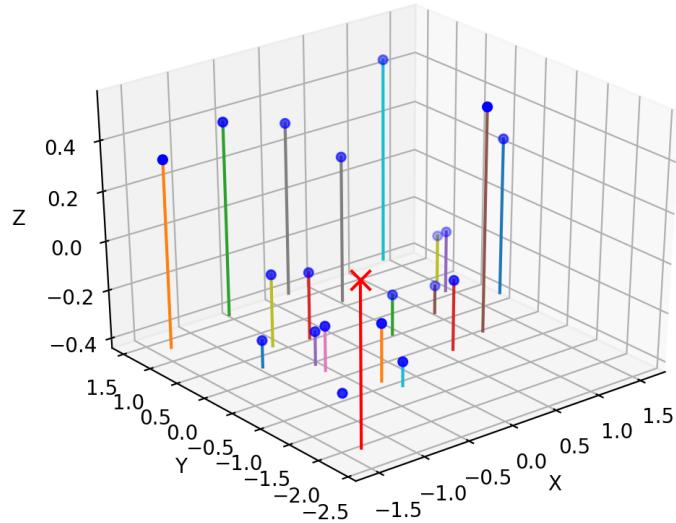


The total residual is 0.044534993949316135.

The camera centre C was found from the camera projection matrix M by implementing the following equations:

$$M = (Q|m_4)$$
$$C = -Q^{-1}m_4$$

The estimated camera location is [-1.51263977 -2.35165965 0.28266502]. Visualization of the camera location can be seen in the following figure:



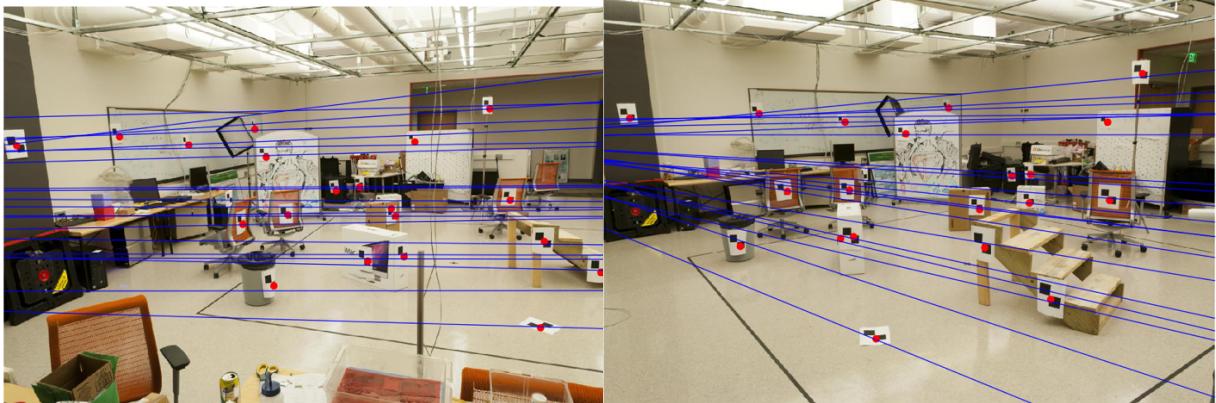
Part 2

Your estimate of the fundamental matrix for the base image pair (pic_a.jpg and pic_b.jpg)

To calculate the fundamental matrix, the equation described in the notes was set up and solved with singular value decomposition. The estimate of the fundamental matrix for the base image pair is

$$[[-3.01066255e-07 \quad -3.46836736e-07 \quad 3.27438995e-04 \\ 6.48600100e-06 \quad 6.14215853e-06 \quad 2.00115788e-03 \\ -1.45213757e-03 \quad -8.88267695e-03 \quad 9.99957438e-01]]$$

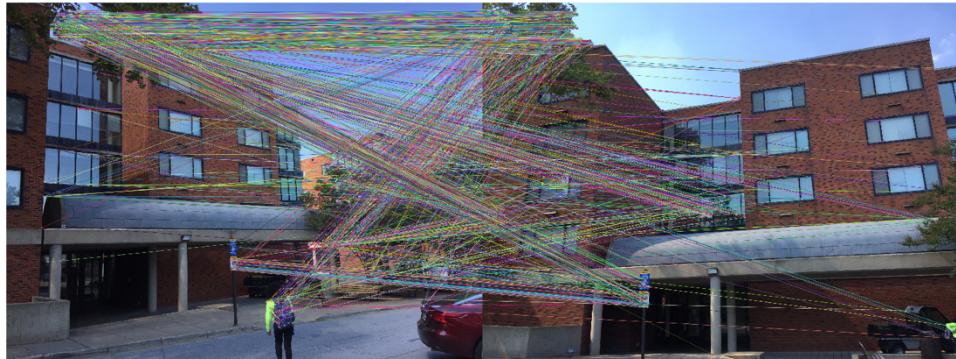
The fundamental matrix can be visualized with the epipolar lines in the following figures:



Part 3

In this part, correct matches between points extracted with the ORB feature extractor are calculated between two images. This part relies on calculating a fundamental matrix with the RANSAC algorithm that best represents matches between the two images. For this part, I randomly selected 9 points for an initial matrix calculation. I had an inlier threshold of 0.05 and required 20% of all points to be inliers for the fundamental matrix to be selected as correct.

The ORB matches are shown in the figure below. It can be seen that there is a significant number of incorrect matches, especially around the windows in the image on the right. I found that there were significantly more incorrect ORB matches than correct matches in all pairs of images based on visual inspection. This pair seemed to have the fewest.



The following figure shows the first 30 matches between the pair of images based on the RANSAC algorithm.



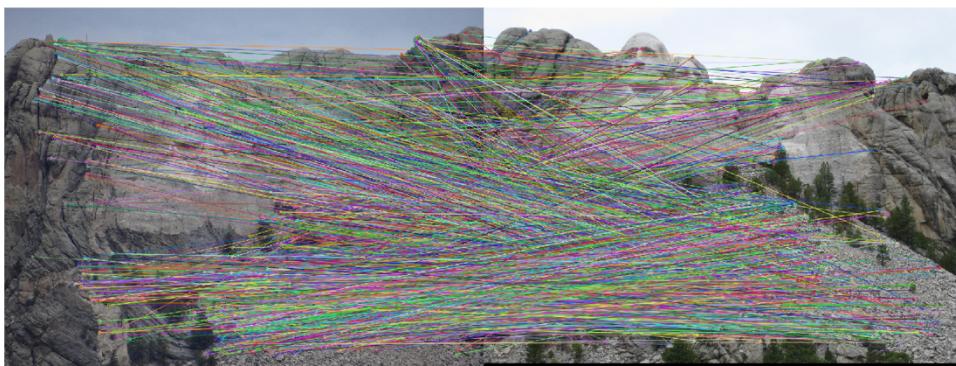
The following two figures show the matching points along with their epipolar lines.



Adding normalization improved the performance of the algorithm. It did not converge in a reasonable time without normalization and the parameters used. The estimated fundamental matrix for this pair of images is

$$\begin{bmatrix} [& 2.21294570e-06 & -7.31189435e-06 & 1.17461954e-04] \\ [& -1.64173787e-06 & 8.53219827e-06 & -3.03166181e-04] \\ [& -9.37294635e-04 & 2.30461579e-03 & 5.32723800e-03] \end{bmatrix}$$

A less successful matching can be seen with the Mount Rushmore image pair.



The figure above shows the poor quality of image matches from the ORB algorithm.