Project 5 - CMPT412 Date: Dec.11th.2020
Name: Parsa Alamzadeh Computer ID: palamzad

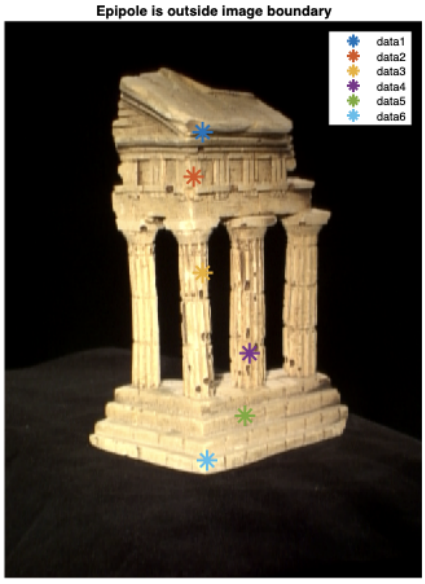
3.1.1 Eightpoint algorithm

After processing the data points from pts1 and pts2 my recovered F matrix is:

F =

0.0000	-0.0000	0.0000
-0.0000	0.0000	0.0114
0.0002	-0.0109	-0.0455

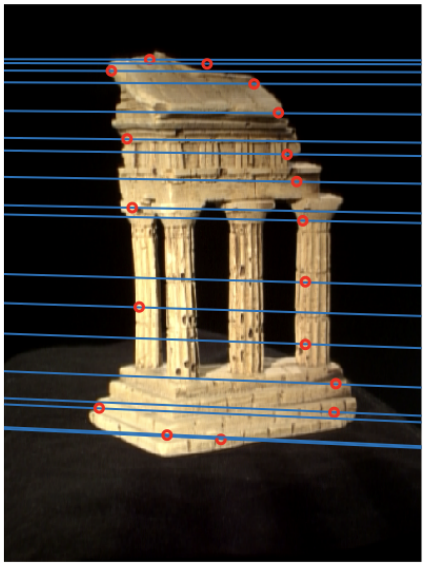
And my epipolar lines are as follows:



3.1.2 Epipolar Correspondences

To choose my candidate points, I first converted the line equation to the slope-intercept format. I then searched within 20 pixels to the left and right of the x coordinates of the original point and calculated the y coordinate of each point accordingly. I then compared the pixel values of a window 3x3 for each of those candidates with the original point and chose the one that had the shortest euclidean distance from the original point. I originally had my threshold set to 50 for searching for a candidate and it failed where there were pixels with similar neighbouring pixel values. As I made the threshold smaller the accuracy increased but there were still instances (when choosing a point from the background) where the algorithm failed to make a good prediction but since the window for choosing a candidate was small enough the results were within our degree of error. It also failed at the edges of the columns, since the other edge of the column was within the threshold and had similar neighbouring pixels (quite a lot of black pixels from the background). Here is how it performed:

Select a point in this image
(Right-click when finished)



Verify that the corresponding point
is on the epipolar line in this image

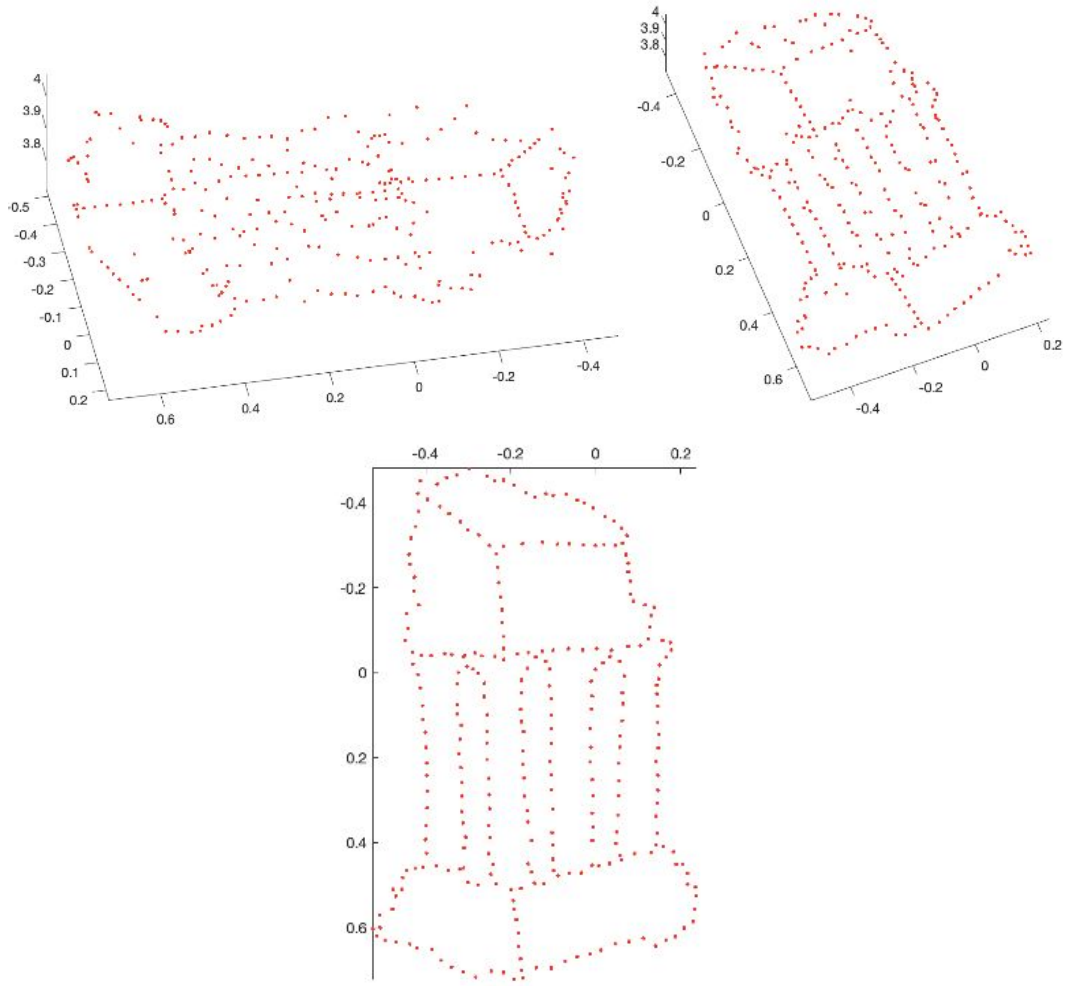
3.1.3 Essential Matrix

Here is my essential matrix calculated from the F, K1 and K2:

$$E = \begin{bmatrix} 0.0303 & -2.5787 & -0.3530 \\ -1.8614 & 0.0103 & 16.9652 \\ -0.0540 & -17.1786 & -0.0195 \end{bmatrix}$$

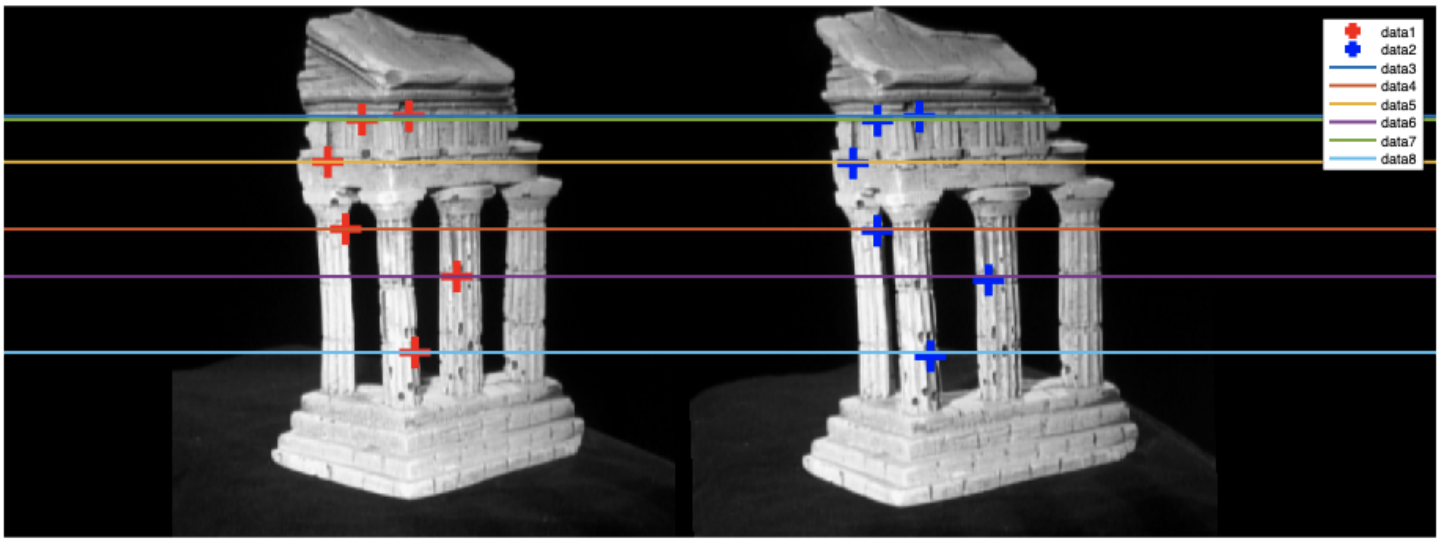
3.1.4 and 3.1.5

To evaluate the correctness of the extrinsic matrices, I first had my intrinsic matrix multiplied by the extracted extrinsic matrix to get my projection matrix. Then I projected the 2d points into 3d and checked which ones generated negative z-values. This meant that these points were behind the camera which means that our extrinsic matrix is wrong. I also checked for the determinant of R matrix, and if it equaled to 1 then the candidate was a viable choice. As for the projection errors I got 0.1461 for pts1 and 0.1439 for pts2.



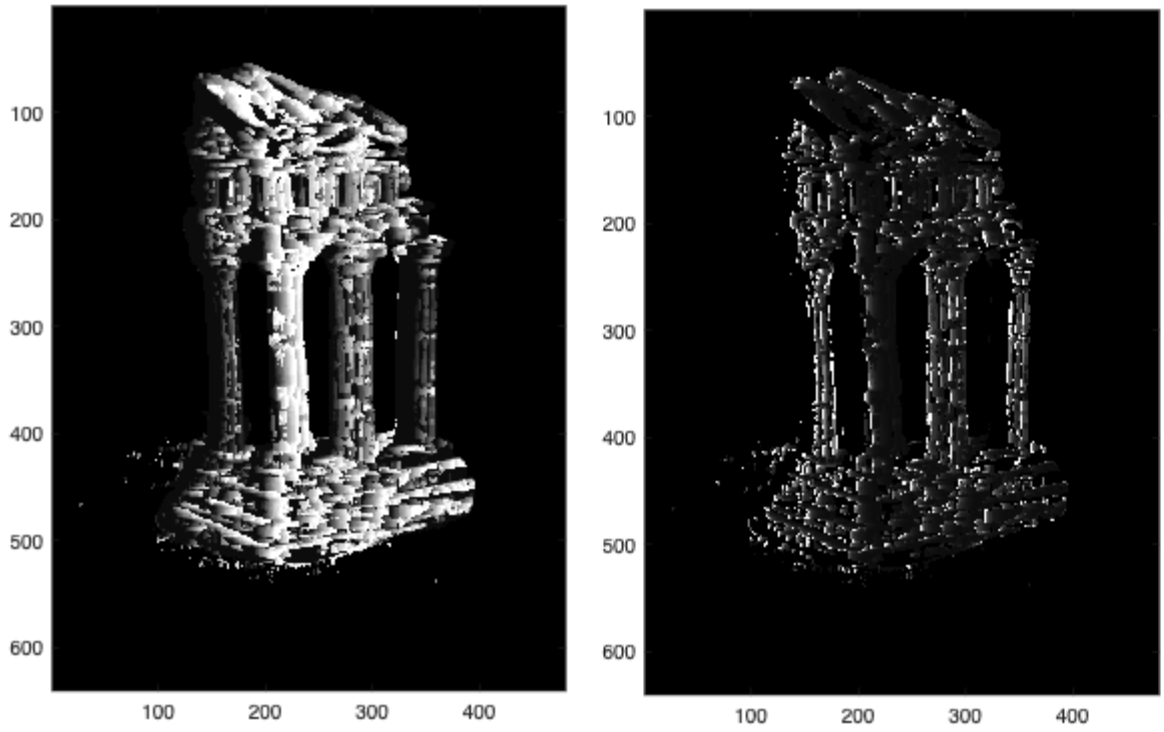
3.2.1 Image rectification

The data points from both sets seem to be on the line except a few points from the rectified image that seem to be a couple of pixels off which seem to be okay according to a comment on a piazza post. (https://piazza.com/class/kcl14hafwgk37z?cid=440)

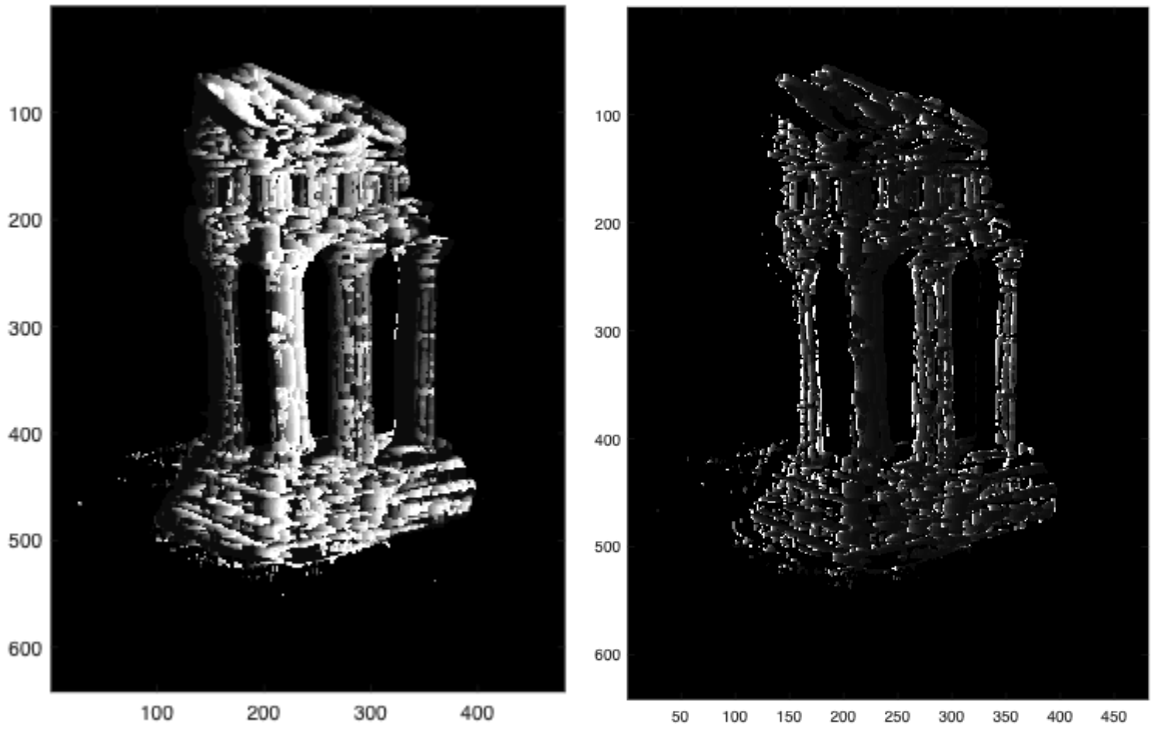


3.2.2 and 3.2.3

My outputs are as follows for the disparity map (left) and depth map (right) before rectification:



Here is the results after rectification (left for disparity and right for depth map):



3.3.1 Camera Matrix Estimation

Below is my errors from reprojection of clean and noisy data:

```
Reprojected Error with clean 2D points is 0.0000
Pose Error with clean 2D points is 0.0000
------------------------------
Reprojected Error with noisy 2D points is 2.5616
Pose Error with noisy 2D points is 2.3398
```

3.3.2 Intrinsic and Extrinsic Matrices Estimation

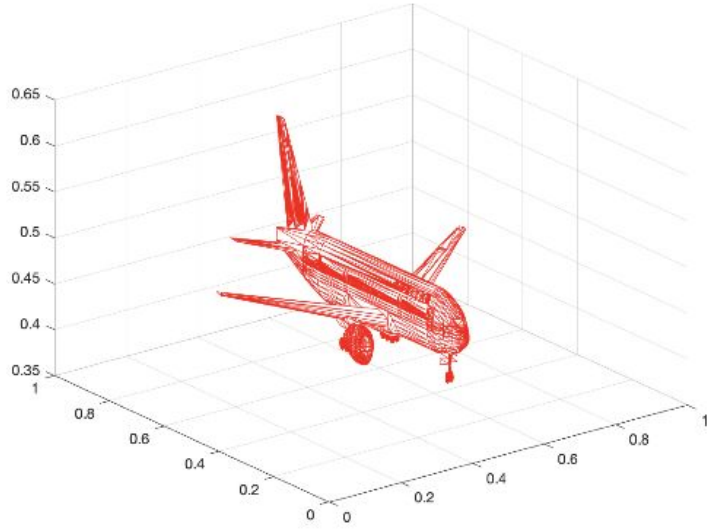
Similarly, below is my errors from reprojection of clean and noisy data:

```
>> testKRt
Intrinsic Error with clean 2D points is 0.0000
Rotation Error with clean 2D points is 0.0000
Translation Error with clean 2D points is 0.0000
------------------------------
Intrinsic Error with clean 2D points is 0.6104
Rotation Error with clean 2D points is 0.0677
Translation Error with clean 2D points is 0.2460
```

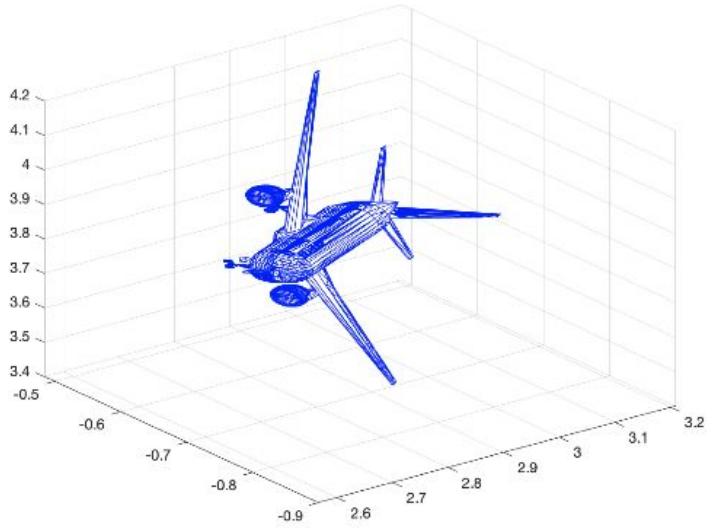
3.3.3 CAD Projection

Projection of 3D points on the image:

3D graph of the vertices:



3D graph after rotation (with translation):



Projection of vertices onto the image:

p.s. There is a bug on the mac version of matlab which the second hold on command does not work after a hold off command. If the figure does not overlap the image please uncomment the close all command which is specified in the code.