CV Homework 5

Eric Feuvrier Danziger

1.1

$p' = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

$p^T = [001]$ $F = \begin{bmatrix} F_{21} F_{22} F_{23} \\ F_{31} F_{32} F_{33} \end{bmatrix}$ The equation for converting points in two cameras based on the fundamental matrix is $p^T * F * p^{'} = 0$
This means
$p^T * F = [F_{31} F_{32} F_{33}]$
This times $p^{'}$ is $[F_{31} F_{32} F_{33}] * \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$
The result is $F_{33} = 0$

1.2

$l = E * p$
$l = R * [t_x] * p$

Since there is no rotation, the R matrix is identity.
$R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
And the matrix t is:
$[t_x] = \begin{bmatrix} 0 & -t_3 & t_2 \\ t_3 & 0 & -t_1 \\ -t_2 & t_1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -t_z & t_y \\ t_z & 0 & -t_x \\ -t_y & t_x & 0 \end{bmatrix}$
Since y and z translation in this example are 0, we get:
$t = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -t_x \\ 0 & t_x & 0 \end{bmatrix}$ Thus $R * [t_x]$ is: $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -t_x \\ 0 & t_x & 0 \end{bmatrix}$

The epipolar line is then given by: $l = \begin{bmatrix} 0 \\ -t_x * z \\ t_x * y \end{bmatrix}$

Since it is of the form $\begin{bmatrix} a \\ b \\ c \end{bmatrix}$ where the line is given by $ax + by + c = 0$, this means the line is $(-t_x * z)y' + t_x * y = 0$. This describes a line that is totally dependent on the constant, since a is zero meaning ax will always be zero. This is a horizontal line.

1.3 Reflection

The image reflected in the mirror represents a different image plane of the object, similar to a camera that looked at the object from a different rotation.

The rays of the image first pass through the mirror, which translate them to a different coordinate frame and also translate them in the ultimate single image.

Essentially the mirror is acting as the second camera, showing the image in a different rotation and translating it to a different location as well.

2.1 Eightpoint

The F matrix I got was:

```
-0.0000    0.0000   -0.0019
 0.0000   -0.0000   -0.0000
 0.0019   -0.0000    0.0075
```

The epipolar lines looked like:

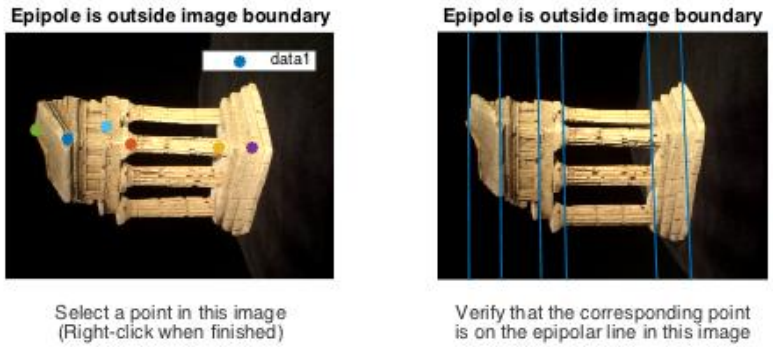

Figure 1: Epipoles from Eightpoint

2.2 Seven Point

The best F matrix I got was my third result:

```
-0.0000   -0.0000    0.0008
 0.0000    0.0000   -0.0000
-0.0008    0.0000    0.0044
```

The epipolar lines of the best one looked like:

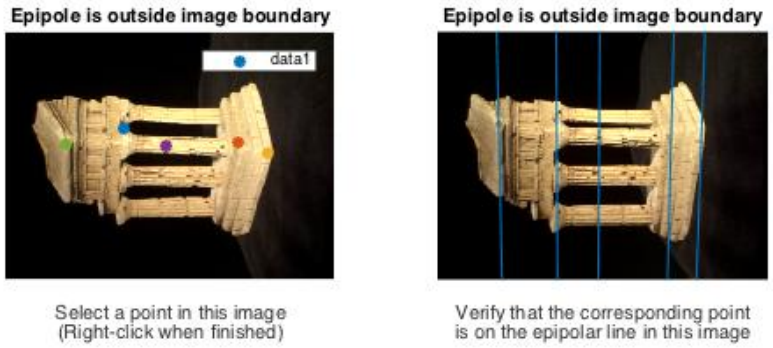

Figure 2: First F Matrix

2.X EC- Ransac

Using the noisy parameters, I get an F matrix using eightpoint of:

```
-0.0028    0.0276   -4.4297
-0.0327   -0.0022   11.3939
 6.9070   -8.4946 -664.8650
```

I run RANSAC with the minimum number of points (eightpoint just runs on all the points you give it, so when calculating the F matrix above I used all the noisy points). Then I calculate error (for deciding inliers) using the fact that $p'^T Fp = 0$ I square the result and normalize the result by the sum of the values of the points, with each value for each point squared. This made points that were close to 0 closer, and I used a threshold of 1e-12 to decide if a point was an inlier. After 100 iterations, I got a result that was substantially better than just giving all the noisy points to eightpoint. The

resultant F matrix was:

```
-0.0000   -0.0000   -0.0011
 0.0000    0.0000   -0.0001
 0.0011    0.0000    0.0008
```

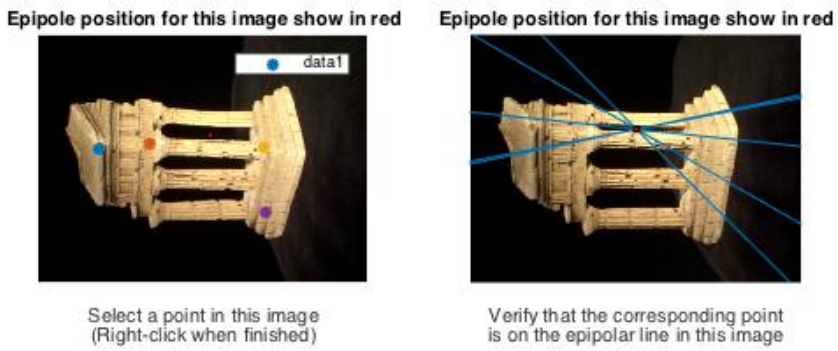

Figure 3: Eightpoint with Noisy Points

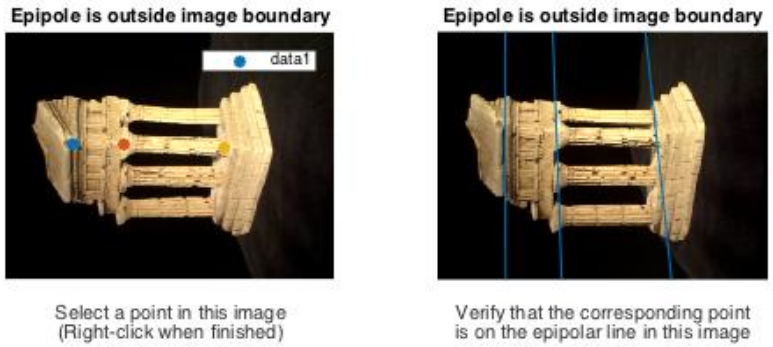

Figure 4: RANSAC

2.3 E

```
-0.0108    0.3387   -2.8773
 0.4151   -0.0060    0.0762
 2.8856    0.0206    0.0011
```

2.6 Epipolar Correspondence

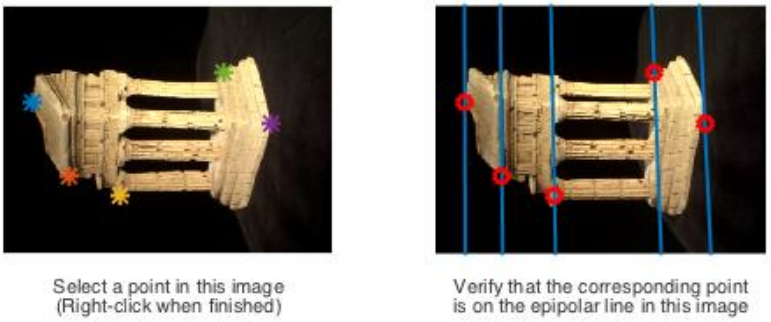

Figure 5: Matched points

2.6 Reconstruction

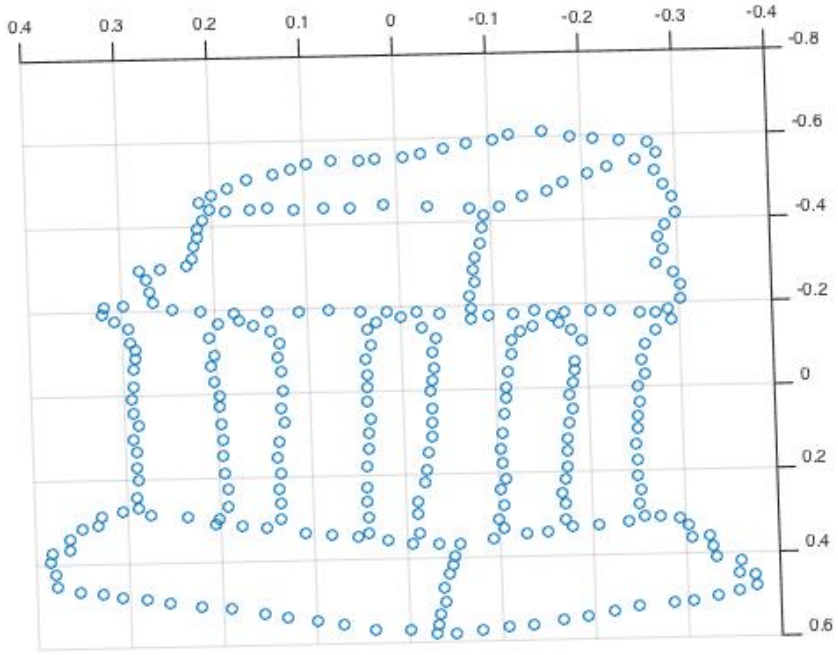

Figure 6: Reconstruction 1st View

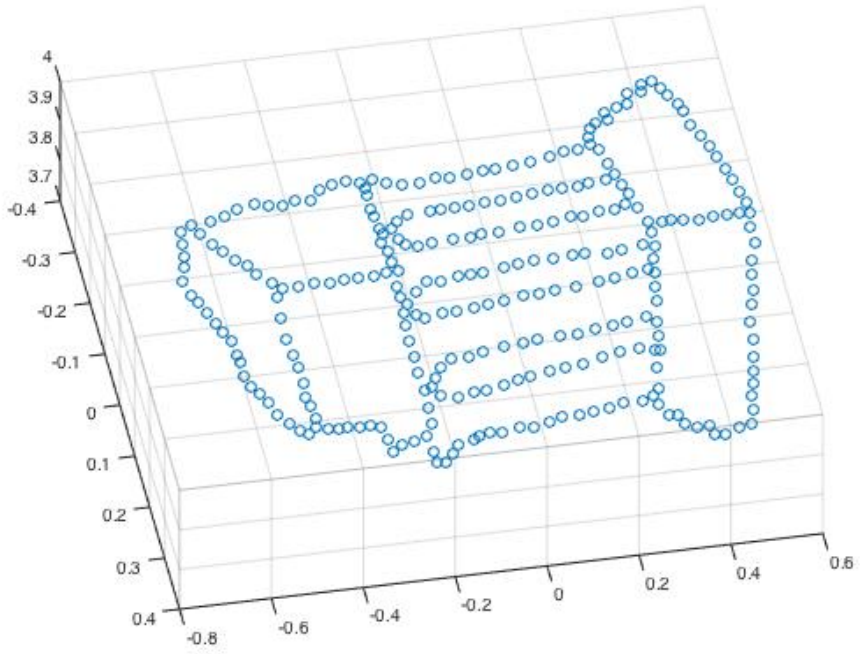

Figure 7: Reconstruction 2nd View

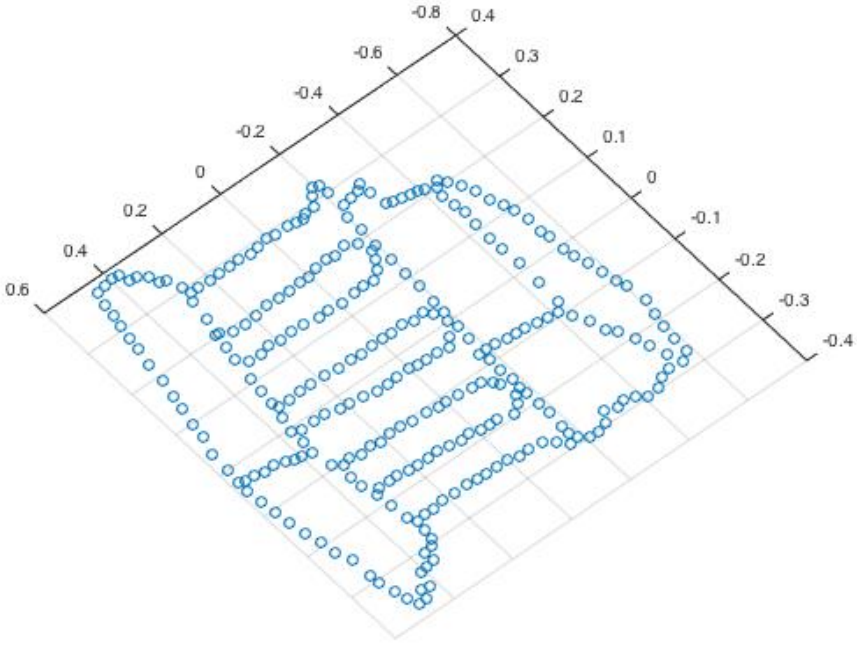

Figure 8: Reconstruction 3rd View