

CS 537: Assignment 3:

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1 FIVE F_0 FOR IMAGE PAIRS

The matrices are as follows:

1) **Image pair 1:**

$$F_{0_1} = \begin{bmatrix} -4.962494653175132e-07 & 3.301223512445214e-05 & -0.019922991018644795 \\ -3.356088171877492e-05 & -1.8222194790099214e-06 & 0.005779463130841968 \\ 0.020718279167212944 & -0.00329936588727165 & -0.9995646737996371 \end{bmatrix}$$

2) **Image pair 2:**

$$F_{0_2} = \begin{bmatrix} 2.9655961191016597e-06 & 0.00019896838515981306 & -0.027910119560255894 \\ -0.0001982930883607509 & -1.567282494001564e-05 & 0.07053376508573994 \\ 0.026466170974895238 & -0.060247358277798944 & -0.9949450897715092 \end{bmatrix}$$

3) **Image pair 3:**

$$F_{0_3} = \begin{bmatrix} 5.904515066560396e-06 & 0.00012319999394478742 & -0.02183456033569342 \\ -0.00012719527229635788 & 1.596393711361715e-05 & 0.032612435025010704 \\ 0.01964217230478546 & -0.03998837592870051 & 0.9982358259789288 \end{bmatrix}$$

4) **Image pair 4:**

$$F_{0_4} = \begin{bmatrix} 5.964798041453543e-06 & 9.406198607046751e-05 & -0.08375026888961629 \\ -9.824996473715781e-05 & -8.326680760845944e-07 & 0.013658773139991158 \\ 0.07355027743300471 & -0.012660411034743971 & 0.9935941739574571 \end{bmatrix}$$

5) **Image pair 5:**

$$F_{0_5} = \begin{bmatrix} -7.36313651330862e-07 & 4.599010104354609e-05 & -0.010692403294236184 \\ -4.432727741028653e-05 & -8.974858194467495e-07 & 0.055235564257176 \\ 0.01155696502385097 & -0.053012574448398166 & -0.9969407226016155 \end{bmatrix}$$

2 FIVE F_1 FOR IMAGE PAIRS

The matrices are as follows:

1) **Image pair 1:**

$$F_{1_1} = \begin{bmatrix} -1.7087134551729832e - 07 & -5.270844849292189e - 05 & 0.013249864801764488 \\ 5.177247658139095e - 05 & 7.188198196672602e - 06 & -0.0052689616568386555 \\ -0.012464740313589573 & -0.0010093499440699816 & 0.9998201131820679 \end{bmatrix}$$

2) **Image pair 2:**

$$F_{1_2} = \begin{bmatrix} 2.473680922321364e - 07 & 4.465976599021815e - 05 & -0.006127991713583469 \\ -4.603386696544476e - 05 & -1.1270852155575994e - 05 & 0.020879309624433517 \\ 0.006383892614394426 & -0.01293302234262228 & -0.9996591806411743 \end{bmatrix}$$

3) **Image pair 3:**

$$F_{1_3} = \begin{bmatrix} 3.826075953838881e - 06 & 4.971079033566639e - 05 & -0.00969251524657011 \\ -4.019236075691879e - 05 & 1.076536955224583e - 05 & 0.009022972546517849 \\ 0.006203419528901577 & -0.015558239072561264 & 0.9997720122337341 \end{bmatrix}$$

4) **Image pair 4:**

$$F_{1_4} = \begin{bmatrix} 6.628048936363484e - 07 & 1.8658527096704347e - 06 & -0.0010869280667975545 \\ 1.3832321883455734e - 06 & 2.398950073256856e - 06 & -0.0013700026320293546 \\ -0.0007316921837627888 & -0.00207100179977715 & 0.9999960660934448 \end{bmatrix}$$

5) **Image pair 5:**

$$F_{1_5} = \begin{bmatrix} -6.266088234951894e - 07 & -6.131832378741819e - 06 & -0.00297536700963974 \\ 5.250498816167237e - 06 & -3.557525189989974e - 07 & -0.0048201968893408775 \\ 0.004286502953618765 & 0.0056900521740317345 & -0.9999585747718811 \end{bmatrix}$$

3 FIGURES DEPICTING EPIPOLAR LINES, x_1 AND x_2

Here are the requested figures:

3.1 For F_0

1) Pair 1: Look at Figure 1

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 849 \\ 505 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 858 \\ 509 \\ 1 \end{bmatrix} l_2 = \begin{bmatrix} -3.67312808e - 03 \\ -2.36339463e - 02 \\ 1.49240746e + 01 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 107 \\ 59 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 149 \\ 68 \\ 1 \end{bmatrix} l_1 = \begin{bmatrix} -1.77521002e - 02 \\ 6.54980830e - 04 \\ 1.86310204e + 00 \end{bmatrix}$$

2) Pair 2: Look at Figure 3

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 21 \\ 184 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 55 \\ 184 \\ 1 \end{bmatrix} l_2 = \begin{bmatrix} 8.76234083e - 03 \\ 6.34858104e - 02 \\ -1.15246694e + 01 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 88 \\ 239 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 113 \\ 238 \\ 1 \end{bmatrix} l_1 = \begin{bmatrix} 0.01977947 \\ 0.04439651 \\ -12.34313904 \end{bmatrix}$$

3) Pair 3: Look at Figure 5

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 29 \\ 222 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 55 \\ 217 \\ 1 \end{bmatrix} l_2 = \begin{bmatrix} 5.68706926e - 03 \\ 3.24677662e - 02 \\ -7.30956063e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 116 \\ 36 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 80 \\ 36 \\ 1 \end{bmatrix} l_1 = \begin{bmatrix} -0.016927 \\ 0.02301151 \\ 1.13002808 \end{bmatrix}$$

4) Pair 4: Look at Figure 7

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 140 \\ 125 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 145 \\ 115 \\ 1 \end{bmatrix} l_2 = \begin{bmatrix} -7.11574489e - 02 \\ -2.00305433e - 04 \\ 9.70808164e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 24 \\ 154 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 11 \\ 165 \\ 1 \end{bmatrix} l_1 = \begin{bmatrix} -0.06816443 \\ 0.01244063 \\ -0.2863206 \end{bmatrix}$$

5) Pair 5: Look at Figure 9

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 916 \\ 257 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 989 \\ 260 \\ 1 \end{bmatrix} l_2 = \begin{bmatrix} 4.52589369e - 04 \\ 1.44011243e - 02 \\ -4.03499239e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 701 \\ 94 \\ 1 \end{bmatrix} x_2 = \begin{bmatrix} 777 \\ 98 \\ 1 \end{bmatrix} l_1 = \begin{bmatrix} -0.00675749 \\ 0.02070532 \\ 2.7875888 \end{bmatrix}$$

3.2 For \mathbf{F}_1

1) Pair 1: Look at Figure 2

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 849. \\ 505. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 858. \\ 509. \\ 1. \end{bmatrix} l_2 = \begin{bmatrix} -0.01351297 \\ 0.04231591 \\ -10.09246613 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 107. \\ 59. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 149. \\ 68. \\ 1. \end{bmatrix} l_1 = \begin{bmatrix} -1.77521002e - 02 \\ 6.54980830e - 04 \\ 1.86310204e + 00 \end{bmatrix}$$

2) Pair 2: Look at Figure 4

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 21. \\ 184. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 55. \\ 184. \\ 1. \end{bmatrix} l_2 = \begin{bmatrix} 2.09459996e - 03 \\ 1.78387616e - 02 \\ -3.24527355e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 88. \\ 239. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 113. \\ 238. \\ 1. \end{bmatrix} l_1 = \begin{bmatrix} 0.01977947 \\ 0.04439651 \\ -12.34313904 \end{bmatrix}$$

3) Pair 3: Look at Figure 6

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 29. \\ 222. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 55. \\ 217. \\ 1. \end{bmatrix} l_2 = \begin{bmatrix} 1.45423641e - 03 \\ 1.02473061e - 02 \\ -2.27425790e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 116. \\ 36. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 80. \\ 36. \\ 1. \end{bmatrix} l_1 = \begin{bmatrix} -0.016927 \\ 0.02301151 \\ 1.13002808 \end{bmatrix}$$

4) Pair 4: Look at Figure 8

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 140. \\ 125. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 145. \\ 115. \\ 1. \end{bmatrix} l_2 = \begin{bmatrix} -0.0007609 \\ -0.00087648 \\ 0.63868394 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 24. \\ 154. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 11. \\ 165. \\ 1. \end{bmatrix} l_1 = \begin{bmatrix} -0.06816443 \\ 0.01244063 \\ -0.2863206 \end{bmatrix}$$

5) Pair 5: Look at Figure 10

- Point 1: Selected on left image

$$x_1 = \begin{bmatrix} 916. \\ 257. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 989. \\ 260. \\ 1. \end{bmatrix} l_2 = \begin{bmatrix} -5.12522161e - 03 \\ -1.02168371e - 04 \\ 4.38882154e + 00 \end{bmatrix}$$

- Point 2: Selected on right image

$$x_1 = \begin{bmatrix} 701. \\ 94. \\ 1. \end{bmatrix} x_2 = \begin{bmatrix} 777. \\ 98. \\ 1. \end{bmatrix} l_1 = \begin{bmatrix} -0.00675749 \\ 0.02070532 \\ 2.7875888 \end{bmatrix}$$

3.3 Figures



Figure 1. for pair 1 with F_0 . Due to lack of space, the coordinates are specified in previous subsections "for F_0 ". The line appears to closely pass (in this case over) the dots.

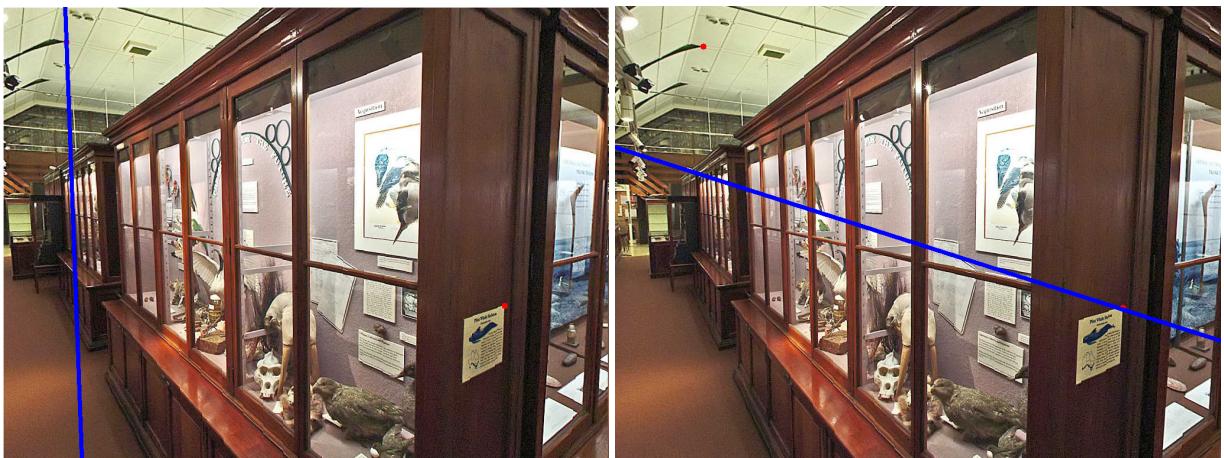


Figure 2. for pair 1 with F_1 . Due to lack of space, the coordinates are specified in previous subsections "for F_1 ". The line appears to closely pass (in this case over) the dots.



Figure 3. for pair 2 with F_0 . Due to lack of space, the coordinates are specified in previous subsections "for F_0 ". The line appears to closely pass (in this case over) the dots.



Figure 4. for pair 2 with F_1 . Due to lack of space, the coordinates are specified in previous subsections "for F_1 ". The line appears to closely pass (in this case over) the dots.



Figure 5. for pair 3 with F_0 . Due to lack of space, the coordinates are specified in previous subsections "for F_0 ". The line appears to closely pass (in this case over) the dots.

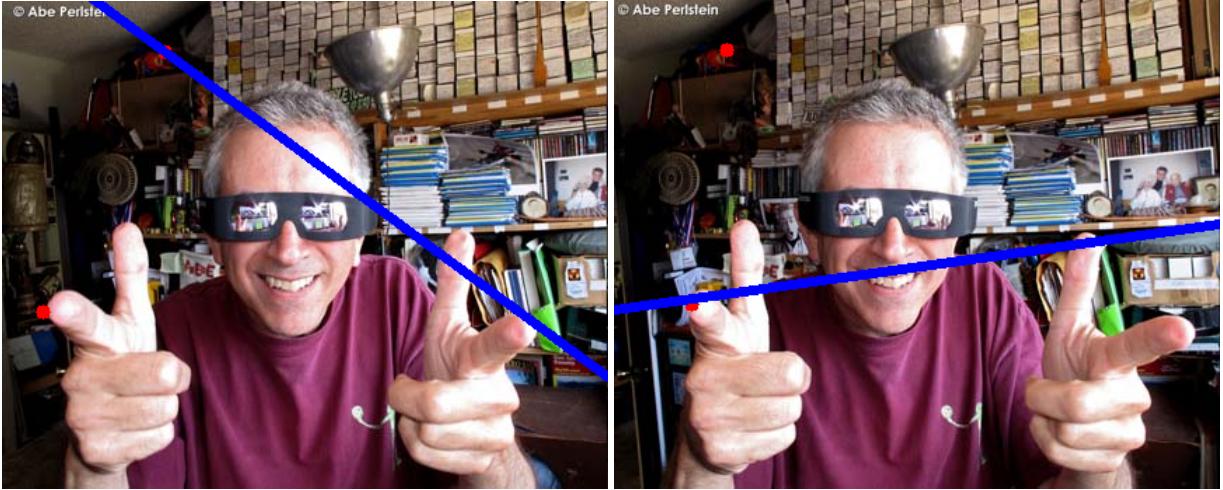


Figure 6. for pair 3 with F_1 . Due to lack of space, the coordinates are specified in previous subsections "for F_1 ". The line appears to closely pass (in this case over) the dots.



Figure 7. for pair 4 with F_0 . Due to lack of space, the coordinates are specified in previous subsections "for F_0 ". The line appears to closely pass (in this case over) the dots.



Figure 8. for pair 4 with F_1 . Due to lack of space, the coordinates are specified in previous subsections "for F_1 ". The line appears to pass only one of the lines. This is a very good result for this particular example. The reason to this is because the shapes used in this image are very repetitive and makes it very difficult for our descriptor to differentiate. When we try to compute best matching, this causes a lot of issues.

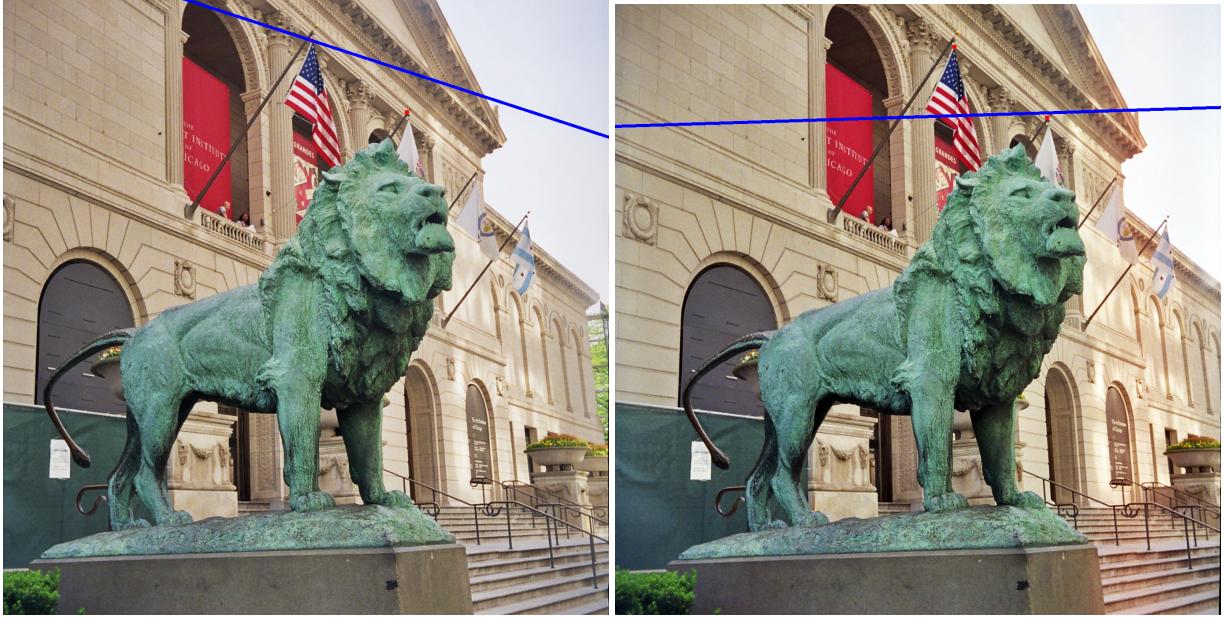


Figure 9. for pair 5 with F_0 . Due to lack of space, the coordinates are specified in previous subsections "for F_0 ". The line appears to closely pass (in this case over) the dots.

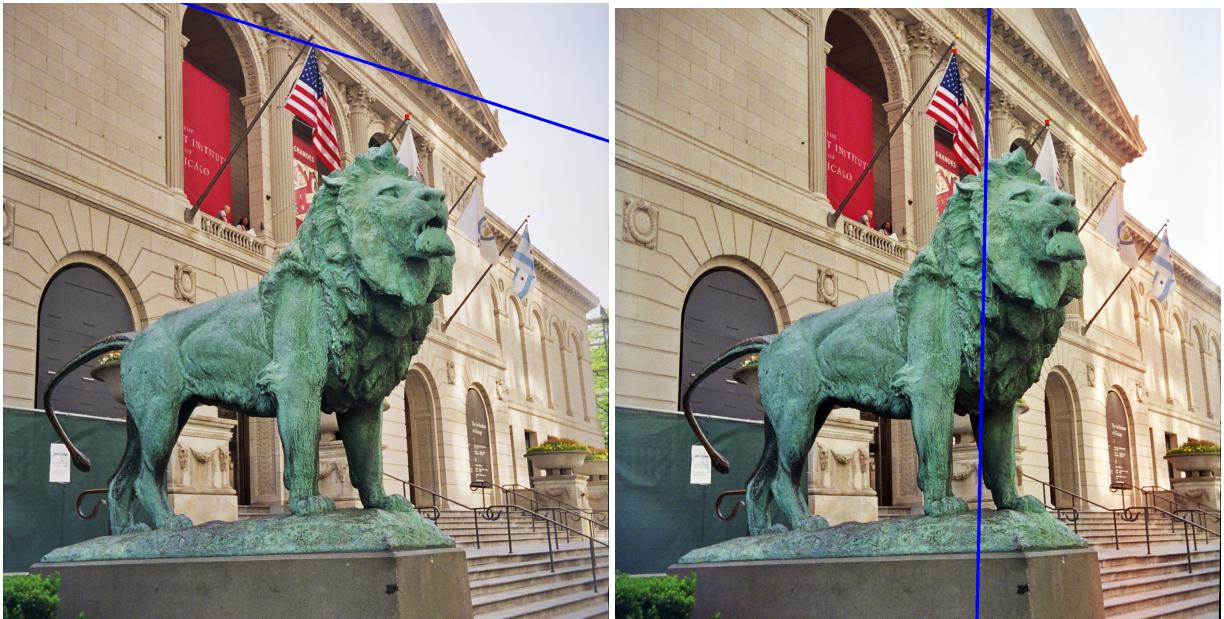


Figure 10. for pair 5 with F_1 . Due to lack of space, the coordinates are specified in previous subsections "for F_1 ". One of the lines appears to closely pass (in this case over) the dots, but the other was not very good.

4 EPIPOLES AND THEIR COORDINATES

4.1 Coordinates

Here is the list:

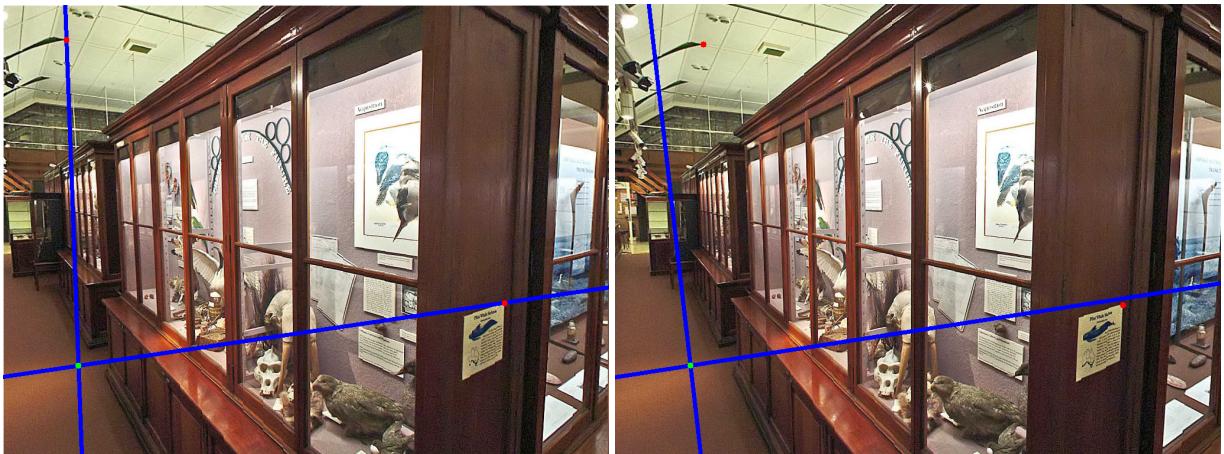


Figure 11. for pair 1 with F_0 $e_1 = \begin{bmatrix} 127 \\ 611 \end{bmatrix}$, $e_2 = \begin{bmatrix} 127 \\ 611 \end{bmatrix}$



Figure 12. for pair 1 with F_1 $e_1 = \begin{bmatrix} 21 \\ 245 \end{bmatrix}$, $e_2 = \begin{bmatrix} 22 \\ 245 \end{bmatrix}$



Figure 13. for pair 2 with F_0 $e_1 = \begin{bmatrix} 315 \\ 138 \end{bmatrix}$, $e_2 = \begin{bmatrix} 315 \\ 138 \end{bmatrix}$



Figure 14. for pair 2 with F_1 $e_1 = \begin{bmatrix} 329 \\ 143 \end{bmatrix}$, $e_2 = \begin{bmatrix} 330 \\ 142 \end{bmatrix}$

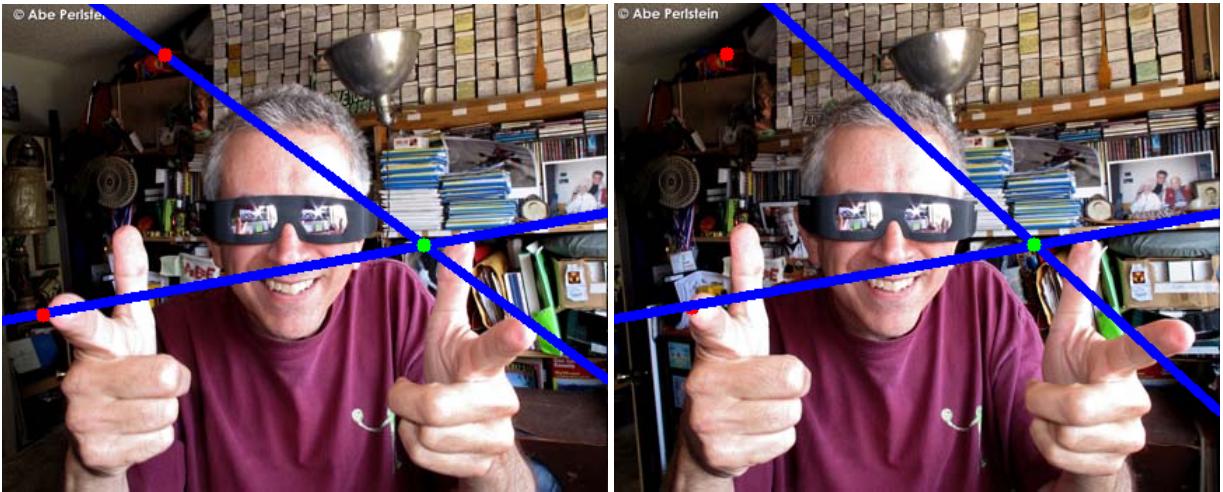


Figure 15. for pair 3 with F_0 $e_1 = \begin{bmatrix} 301 \\ 172 \end{bmatrix}$, $e_2 = \begin{bmatrix} 299 \\ 172 \end{bmatrix}$

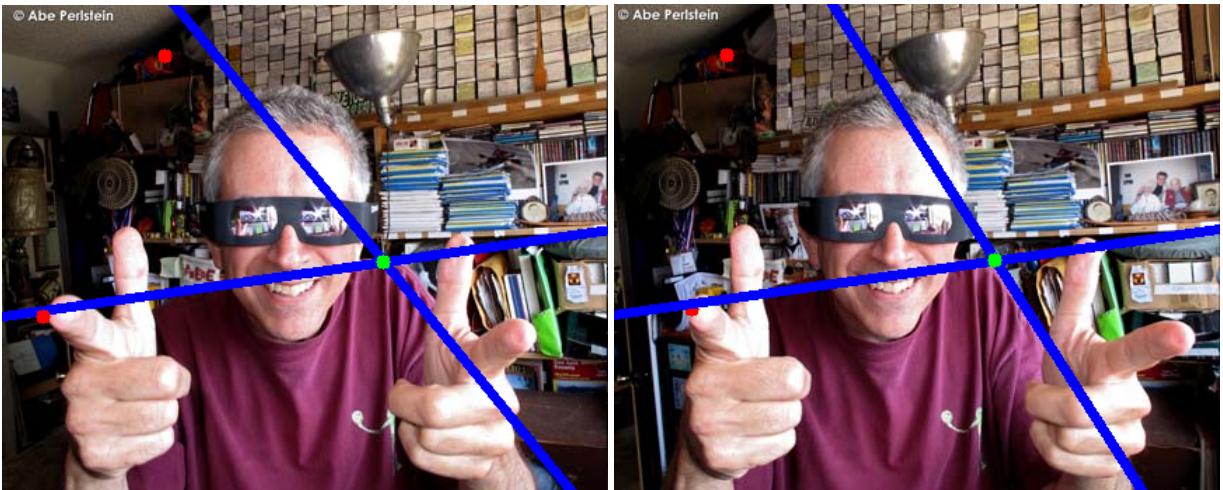


Figure 16. for pair 3 with F_1 $e_1 = \begin{bmatrix} 273 \\ 183 \end{bmatrix}$, $e_2 = \begin{bmatrix} 272 \\ 183 \end{bmatrix}$



Figure 17. for pair 4 with F_0 $e_1 = \begin{bmatrix} 134 \\ 756 \end{bmatrix}$, $e_2 = \begin{bmatrix} 134 \\ 757 \end{bmatrix}$



Figure 18. for pair 4 with F_1 $e_1 = \begin{bmatrix} 496 \\ 302 \end{bmatrix}$, $e_2 = \begin{bmatrix} 494 \\ 299 \end{bmatrix}$

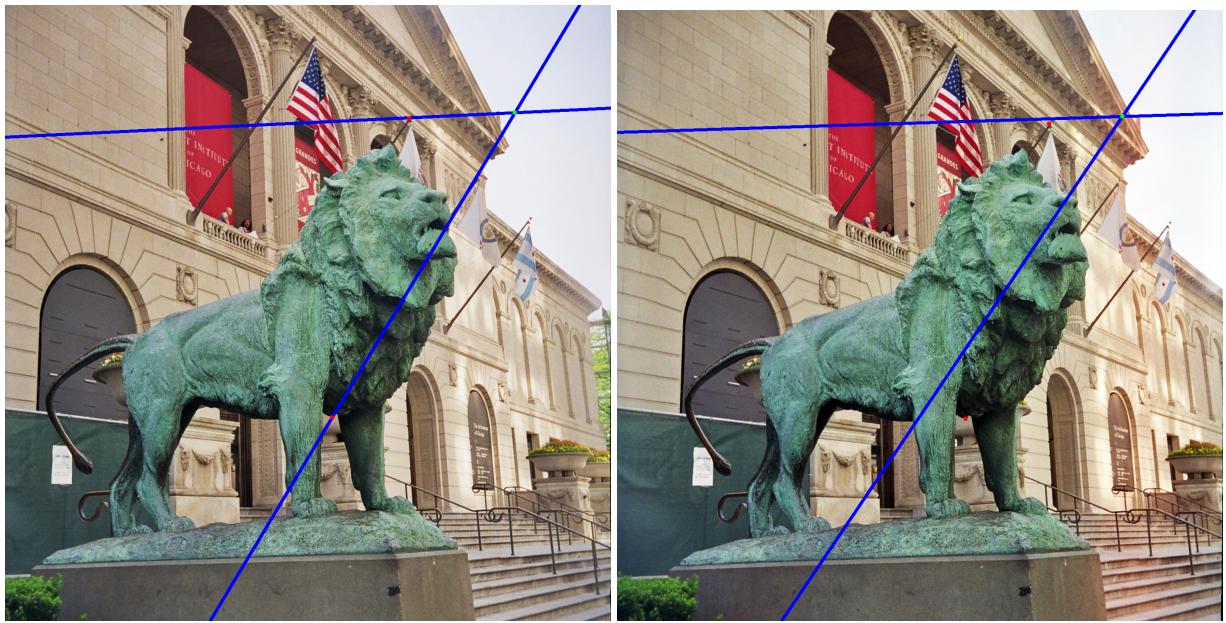


Figure 19. for pair 2 with F_0 $e_1 = \begin{bmatrix} 1157 \\ 244 \end{bmatrix}$, $e_2 = \begin{bmatrix} 1157 \\ 244 \end{bmatrix}$

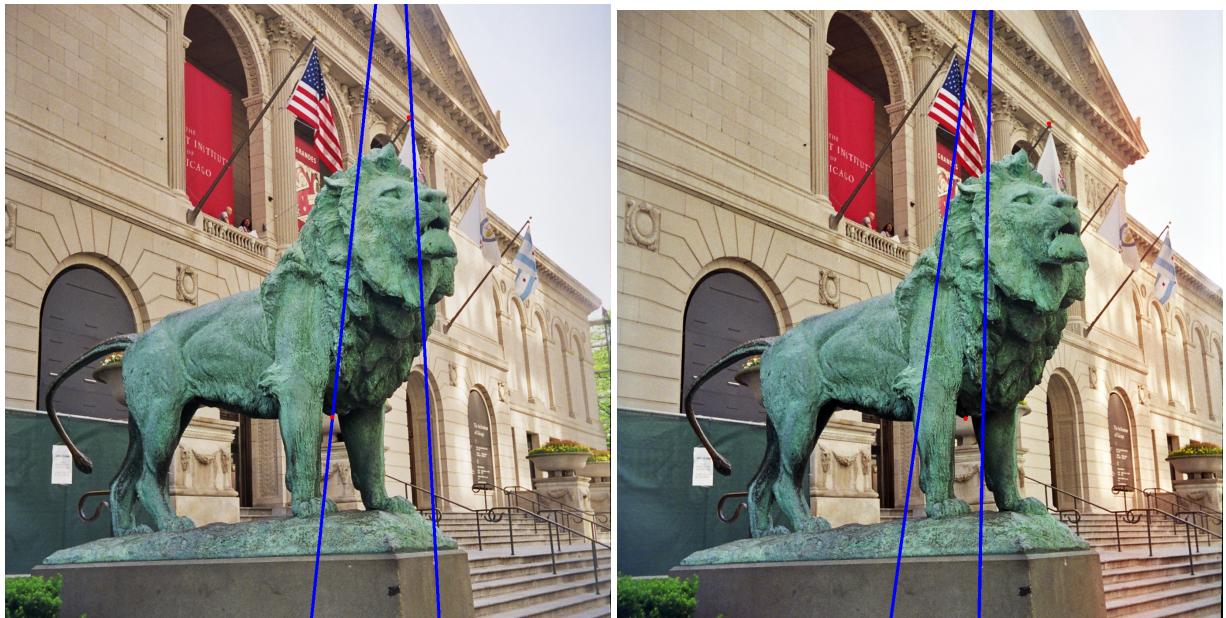


Figure 20. for pair 5 with F_1 $e_1 = \begin{bmatrix} 886 \\ -433 \end{bmatrix}$, $e_2 = \begin{bmatrix} 863 \\ -329 \end{bmatrix}$