Computer Vision
Fall 2016
Problem Set #4

Yonathan Halim
yonathan@gatech.edu

1a: Solve Least Squares

- Matrix M recovered from normalized points
  - `[[ 0.76785834 -0.49384797 -0.02339781  0.00674445]`
    `[-0.0852134  -0.09146818 -0.90652332 -0.08775678]`
    `[ 0.18265016  0.29882917 -0.07419242  1.        ]]`
- <u,v> projection of the last point given in M Matrix
  - `[ 0.14190586 -0.45183985]`

1a: Solve Least Squares

- Residual between projected location and actual one
  - [[0.00265589, 0.00272786, 0.00117601, 0.00176557,
    0.00088366, 0.00162143, 0.00124975, 0.00220188,
    0.00238704, 0.00186283, 0.00422666, 0.00216373,
    0.00318443, 0.00096588, 0.00944   , 0.00135103,
    0.00061994, 0.00161859, 0.00086915, 0.00156369]]

  (Original shape is (20, 1) and reshape to (1, 20)

2a: Camera Calibration

- Average Residuals for each trial of each K (list of 10 x 3 residuals)
  - Average Residuals k = 8: 0.838523745293
  - Average Residuals k = 12: 0.719463172923
  - Average Residuals k = 16: 0.623147242743

2a: Camera Calibration

- Explanation of difference seen between the results for the different k’s
  - We need at least 6 points to solve the projection matrix. Usually the more points were used to calculate the projection matrix, the lower the error and the residual would be. In some cases, this were not the case and it would depend on how similar the k points used to calculate M and the 4 points used to calculate the residual. In general, however, when I took 100 runs and averaged the error and residual, it showed that the error and residual were lower for k=16 points.

2a: Camera Calibration

- The best M matrix (3x4)
  - [[-2.04652402e+00 1.18667291e+00 3.85961862e-01 2.44027695e+02]
    [-4.57560988e-01 -3.01499053e-01 2.14685411e+00 1.65993723e+02]
    [-2.24804704e-03 -1.09240761e-03 5.57378769e-04 1.00000000e+00]]

2b: Real Coordinates

- Location of the camera in real 3D world coordinates
  - `[[ 303.09947993  307.18768462   30.42105659]]`

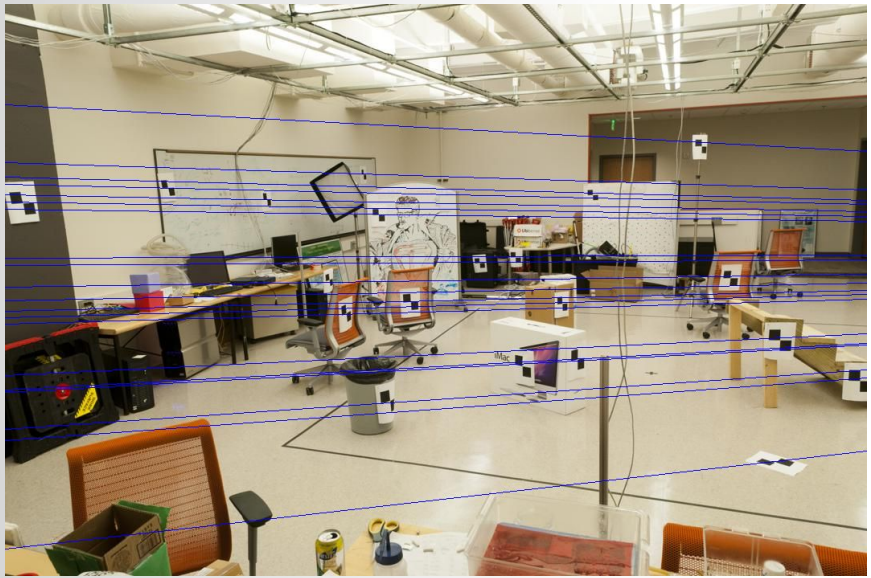
3a: F Matrix (Full Rank)

- The Matrix F-tilda generated from Least Squares function
  - [[-6.60675944e-07 7.90642197e-06 -1.88480992e-03]
    [8.82674944e-06 1.21863596e-06 1.72276843e-02]
    [-9.08539064e-04 -2.64201801e-02 1.00000000e+00]]

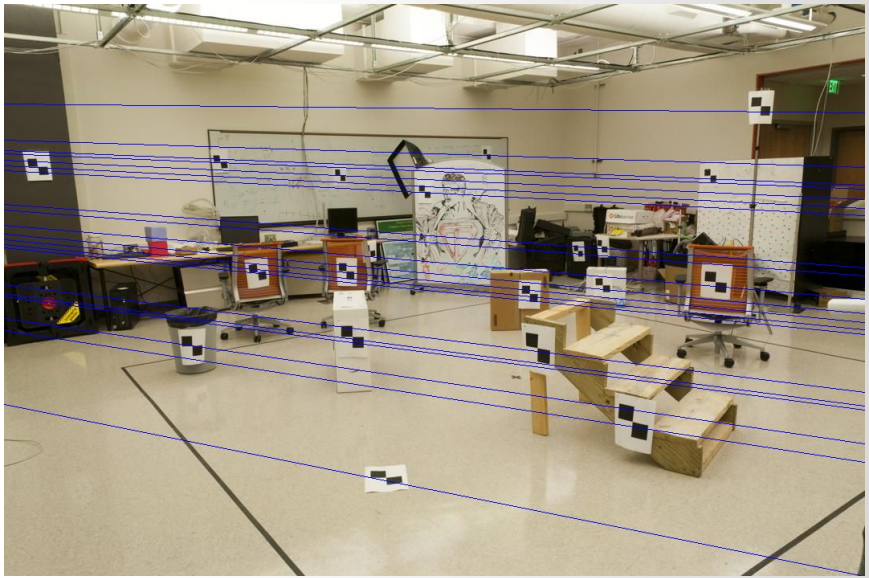
3b: Fundamental Matrix (reduced)

- The Fundamental Matrix (reduced rank) generated from Least Squares function
  - [[-5.35883058e-07 7.89972529e-06 -1.88480998e-03]
    [8.83820595e-06 1.21802118e-06 1.72276843e-02]
    [-9.08539027e-04 -2.64201801e-02 1.00000000e+00]]

3c: Images with Epipolar Lines



pic_A with epipolar lines - **ps4-3-c-1.png**



pic_B with epipolar lines - **ps4-3-c-2.png**

4a: Better Matrices

- The Matrix Ta
  - [[2.49017580e+02 0.00000000e+00 -1.39188376e+05]
    [0.00000000e+00 2.49017580e+02 -8.10801240e+04]
    [0.00000000e+00 0.00000000e+00 1.00000000e+00]]
- The Matrix Tb
  - [[2.74670839e+02 0.00000000e+00 -1.69389507e+05]
    [0.00000000e+00 2.74670839e+02 -9.52833142e+04]
    [0.00000000e+00 0.00000000e+00 1.00000000e+00]]

4a: Better Matrices

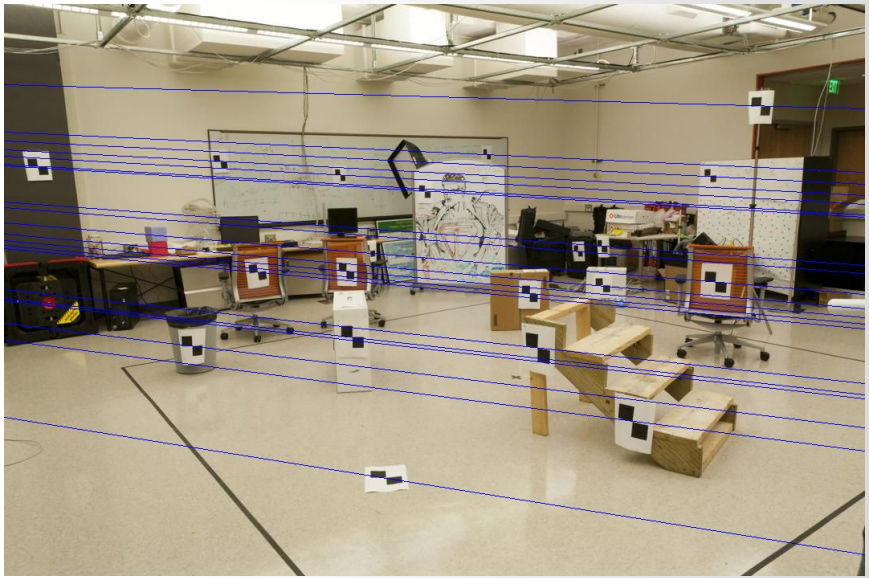
- The Matrix F-circumflex
  - [[1.07547648e-10 -1.41173365e-09 -1.08034006e-05]
    [-8.86150702e-10   2.69998620e-10 -7.98162244e-04]
    [-6.88875138e-05   8.28441480e-04   1.00000000e+00]]

4b: Fundamental Matrix (reduced)

- The new Fundamental Matrix F
  - [[7.35602976e-06 -9.65595714e-05 2.43607645e-02]
    [-6.06108184e-05 1.84673298e-05 -1.91366439e-01]
    [-6.64772590e-04 2.59438463e-01 -5.22006245e+00]]

4b: Images with Epipolar Lines (cont.)

pic_A with “better” epipolar lines - **ps4-4-b-1.png**



pic_B with “better” epipolar lines - **ps4-4-b-2.png**