CS 4476/7646 Project 2

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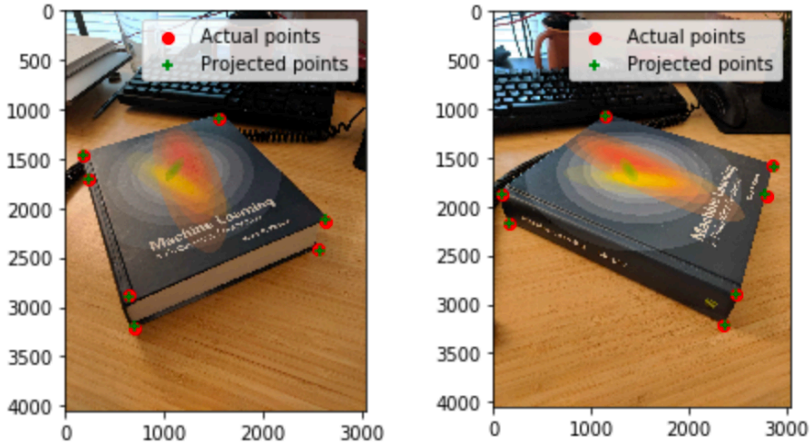
Part 1: Projection Matrix

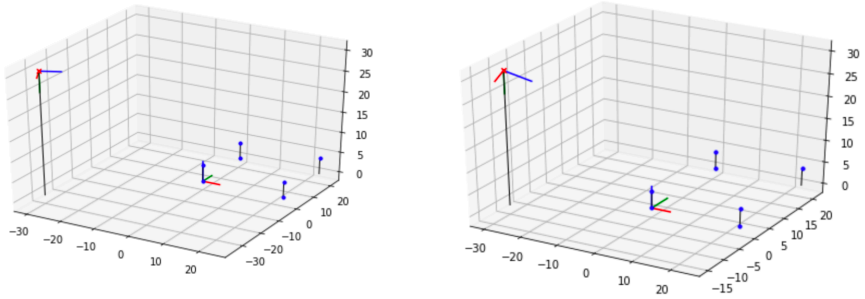
<insert visualization of projected 3D points and actual 2D points for image provided by us here>



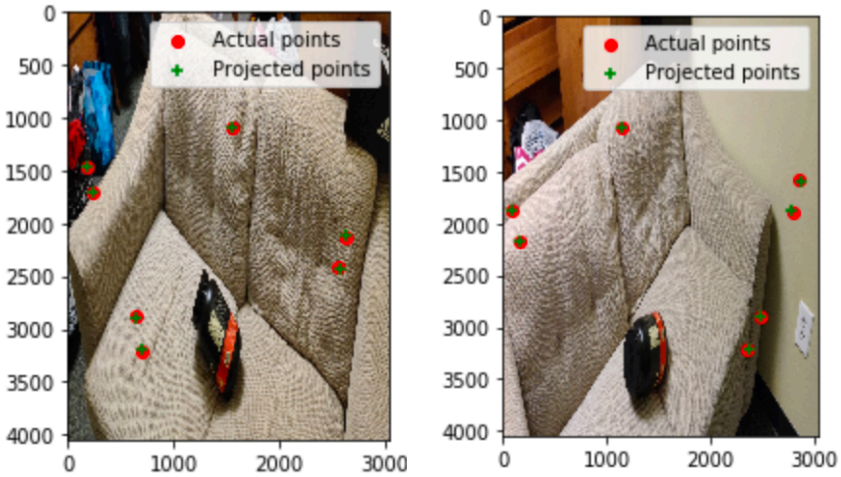
< insert the two images of your fiducial object here>

Part 1: Projection Matrix

<insert visualization the initial guesses for rotation matrix and camera center for the two images here>

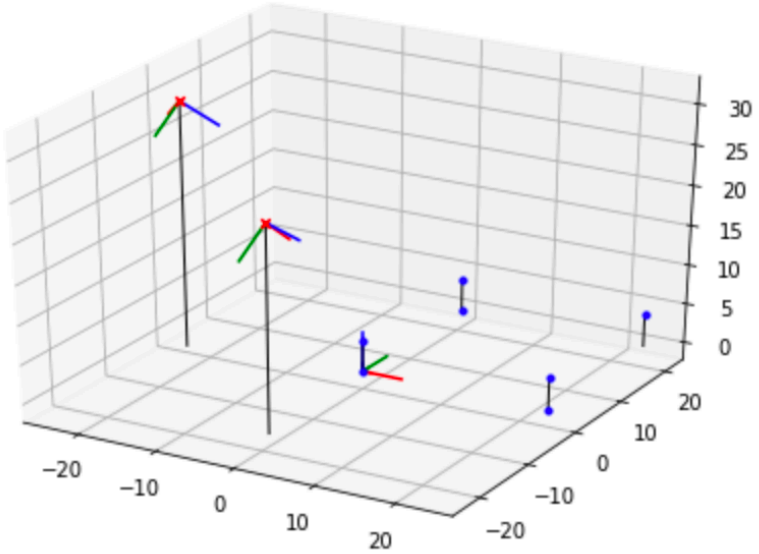


<insert visualization of projected 3D points and actual 2D points for both the images you took>



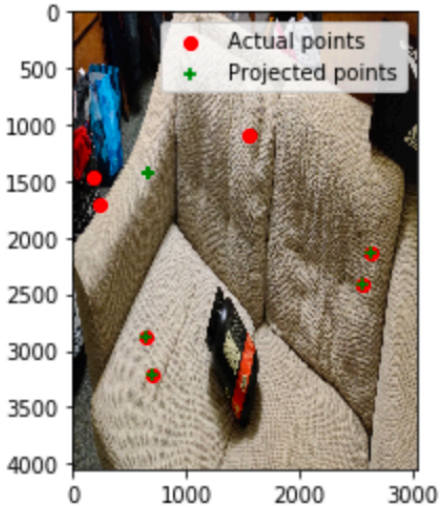
Part 1: Projection Matrix

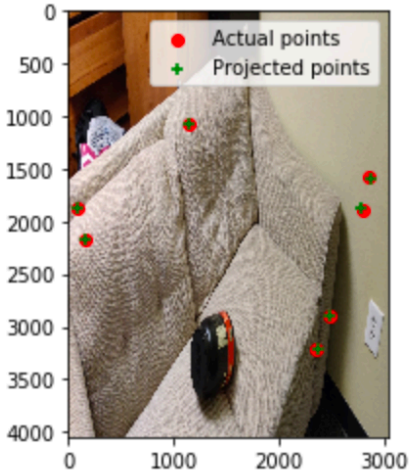
<insert visualization of both camera poses here>



Part 1: Projection Matrix

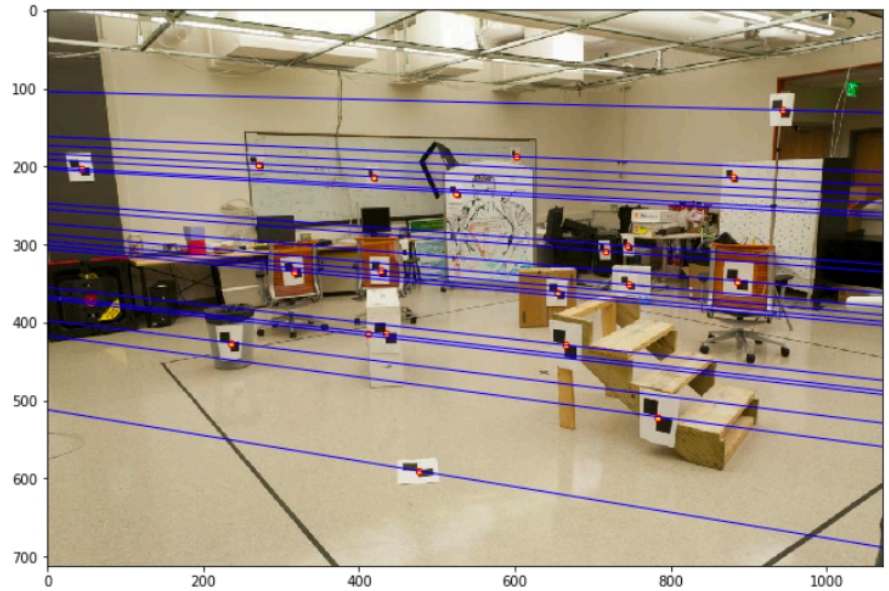
I would expect the projections to be the same as the projection matrix doesn’t depend on the camera center. As we notice most projections are still correct except a few.



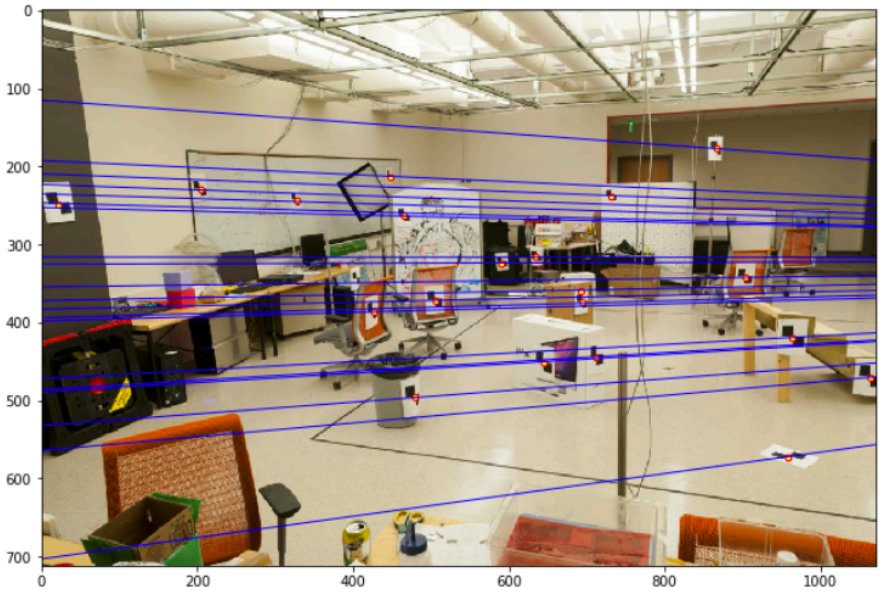


Part 2: Fundamental Matrix Estimation

Room: Left Image with Epipolar Lines



Room: Right Image with Epipolar Lines



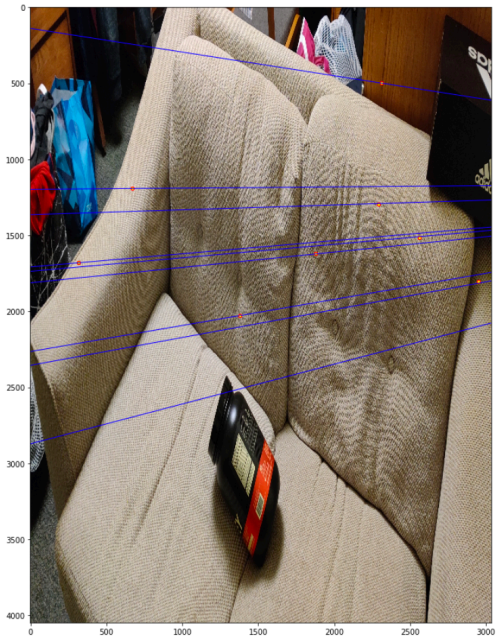
Part 2: Fundamental Matrix Estimation

Fundamental Matrix Estimation Result:

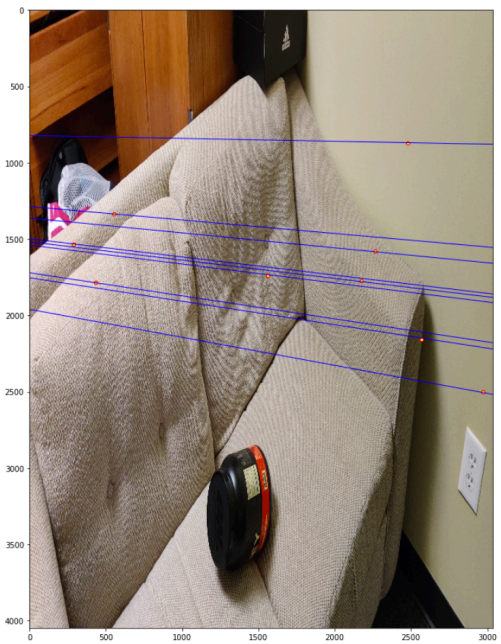
```
[[-0.00005892  0.00062327 -0.01533953]
 [ 0.00091634 -0.00016226 -2.51761268]
 [-0.23385867  1.8371397  60.01878543]]
```

Part 2: Fundamental Matrix Estimation: Your Images

Your Image: Left Image with Epipolar Lines



Your Image: Right Image with Epipolar Lines



Part 2: Fundamental Matrix Estimation: Your Image

Fundamental Matrix Estimation Result:

```
[[ 0.00000003 -0.00000039  0.00048835]
 [-0.00000017  0.0000001  -0.00120284]
 [-0.00002715  0.00241223 -1.81919145]]
```

Part 2: Reflection Questions

1. The principal point and the focal length should be the same

2. The correspondences selected to estimate the fundamental matrix are such that they are restricted to epipolar lines and therefore the relation which the fundamental matrix represents is the epipolar constraint.

3. The epipoles become the camera centres themselves and the epipolar lines are reduced to those points.

4. The images are parallel

5. The equation used to define the fundamental matrix is – $x'Fx = 0$. kF is also a solution to this equation for any k

6. As the epipoles lie on the epipolar lines themselves, $eF = 0$ for both epipoles e. Therefore the nullspace of F is not equal to the zero vector and it is rank deficient. As F is 3x3, its rank=2.

Part 2: Extra Credit: Fundamental Matrix Song

Reflect on the Fundamental Matrix Song

Link here: https://www.youtube.com/watch?v=DgGV3l82NTk

The sample set will be degenerate if we use coplanar scenes and therefore if we have three scenes, we can use the trifocal sensor. He also used the bow tip at different instances to create the fundamental matrix.

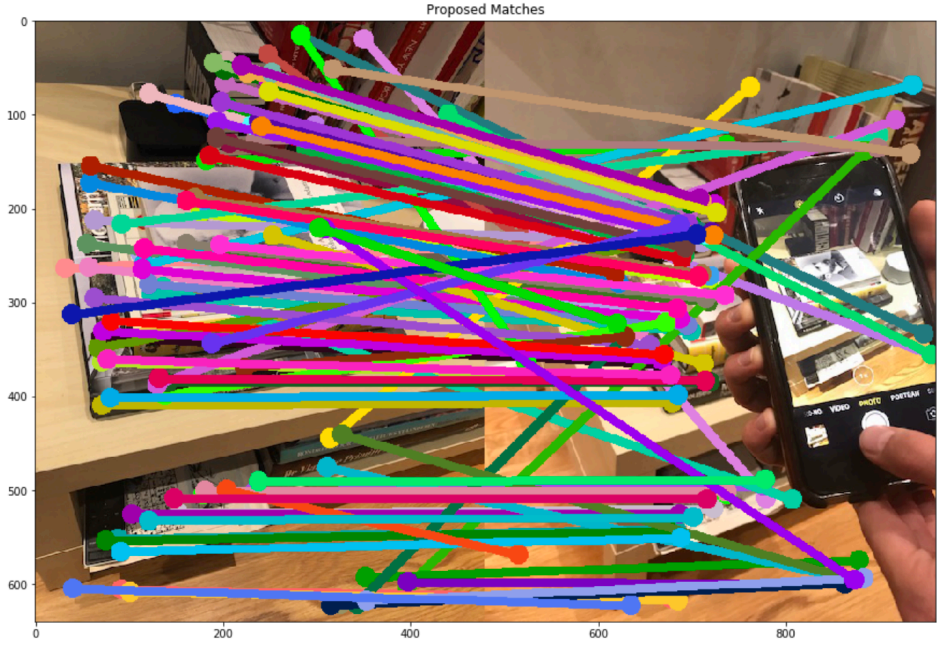
Part 3: RANSAC Iterations Questions

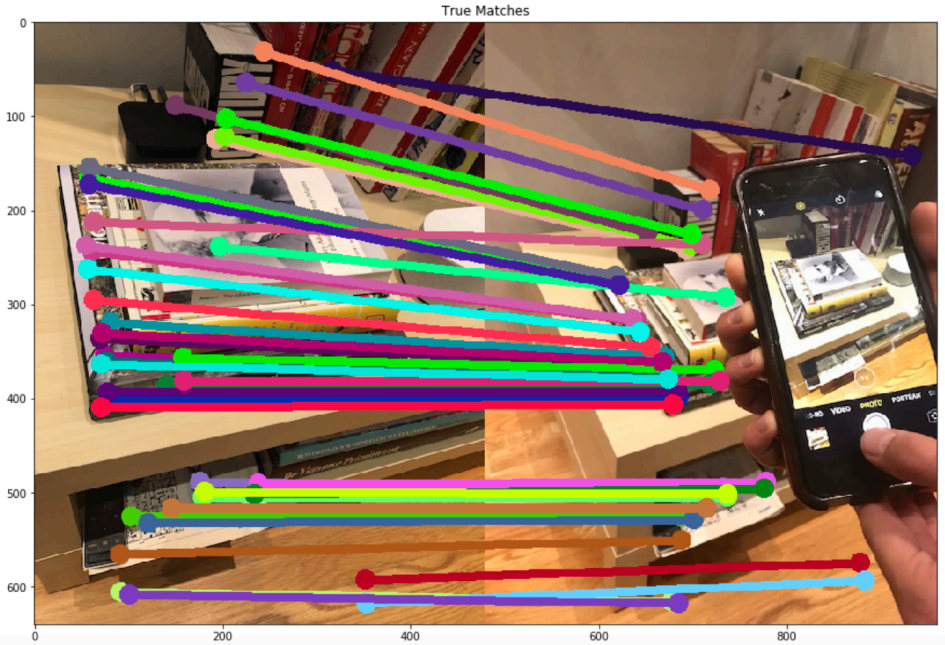
Delete the questions and type your answers to the three RANSAC Iterations questions from the jupyter notebook below:

1. 15
2. 43 – Exponential Increase
3. 168

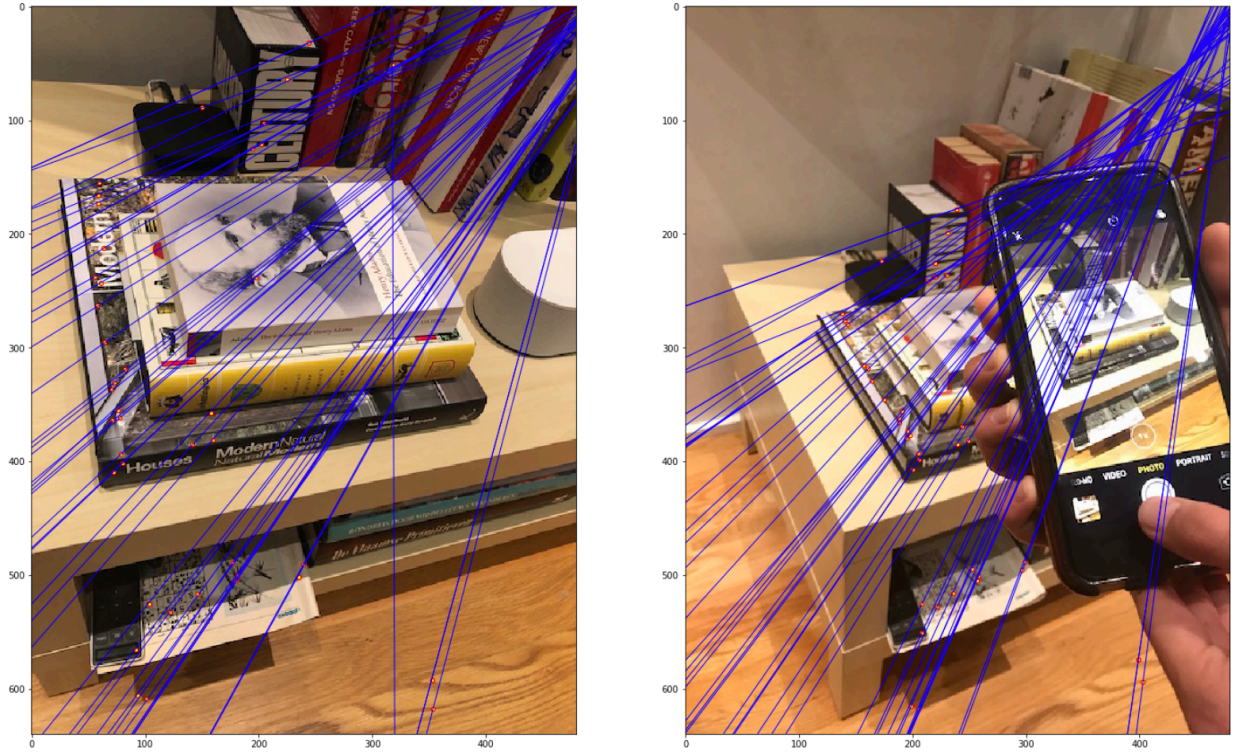
Part 3: RANSAC Inlier Matches

Paste two sets of images: displaying matches loaded from disk; and inlier matches after RANSAC





Part 3: RANSAC Implementation



Tests

```
(proj2) ssipani:proj2_unit_tests ssipani$ pytest
============================= test session starts ==============================
platform darwin -- Python 3.6.10, pytest-5.3.5, py-1.8.1, pluggy-0.13.1
rootdir: /Users/ssipani/Documents/CS4476 CV/ps2_release_v1
collected 20 items

part1_unit_test.py .....                                                 [ 25%]
test_essential_matrix_decomposition.py ..                                [ 35%]
test_fundamental_matrix.py .........                                     [ 80%]
test_ransac.py ....                                                      [100%]

============================== warnings summary ================================
proj2_unit_tests/test_ransac.py::test_ransac_find_inliers
  /Users/ssipani/Documents/CS4476 CV/ps2_release_v1/proj2_unit_tests/test_ransac
.py:46: DeprecationWarning: elementwise comparison failed; this will raise an er
ror in the future.
    assert outliers not in inliers

-- Docs: https://docs.pytest.org/en/latest/warnings.html
======================== 20 passed, 1 warning in 3.68s =========================
```

Conclusions

Image scaling was a problem which I encountered and understood how it could cause problems.
While solving part 4, one sees that the SVD does not yield accurate results due to real world data due to which I read about how we have to consider possible solutions and algorithms to bypass it.

Overall I learned how manipulate images and perform linear algebra operations in python.