

# CS 4476 Project 3

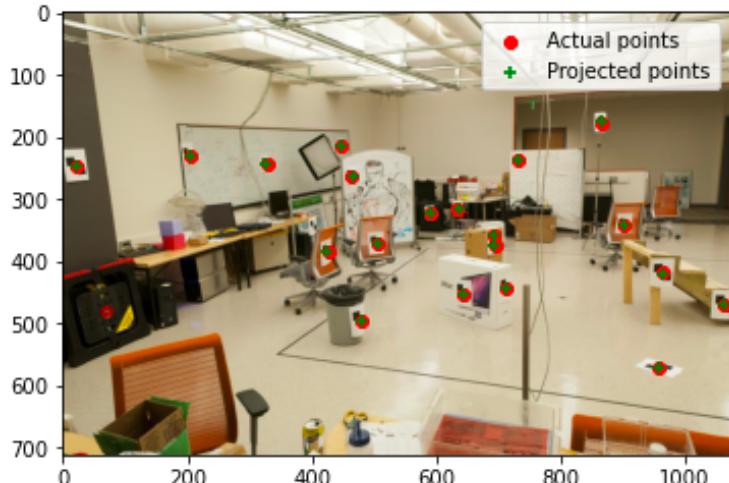
Devanshi Gupta

dgupta94@gatech.edu

903536448

# Part 1.5: Projection Matrix for provided image

<insert visualization of projected 3D points and actual 2D points for image provided by us here [1]>

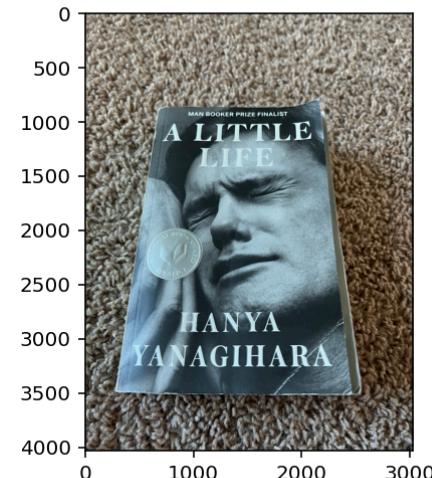
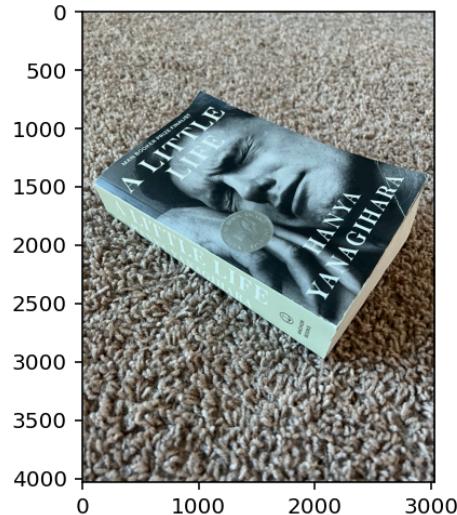


<What is the minimum number of 3D-2D point correspondences needed to estimate the projection matrix? Why? [2]>

The minimum number of 3D-2D point correspondences needed to estimate the projection matrix are 6 because you can solve for X, Y and Z using them in a system of equations.

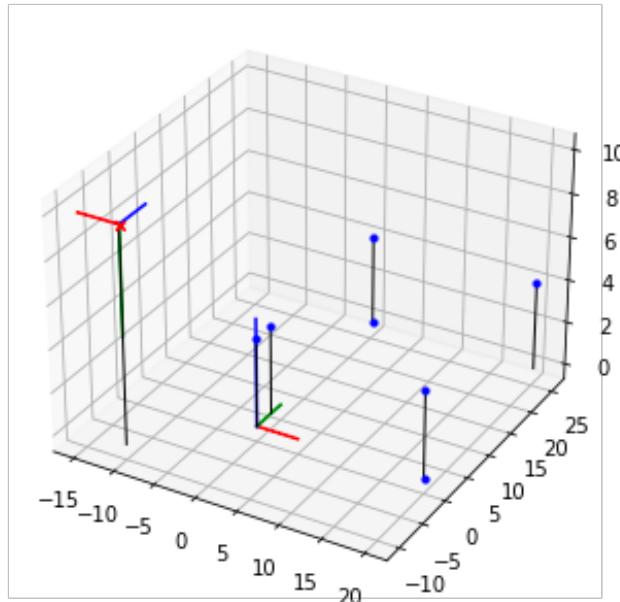
# Part 2.1: Projection Matrix for custom images

<Copy two images of your fiducial object here [2]>

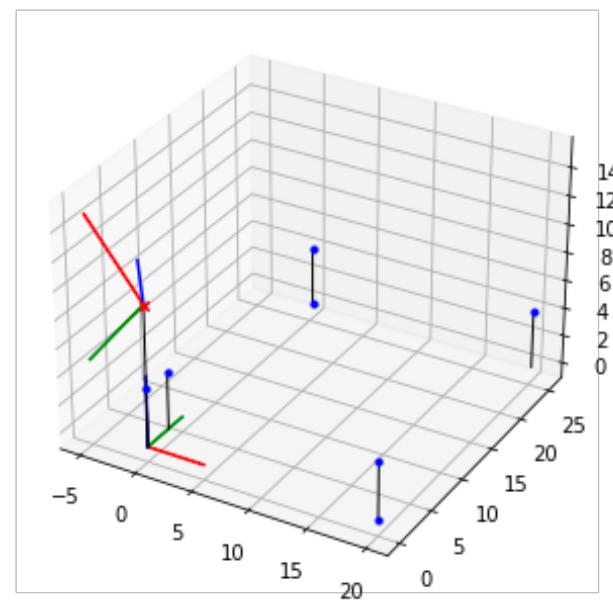


## Part 2.2: Pose init for custom images

<Insert visualization for the initialized camera pose for 1st image> [1]

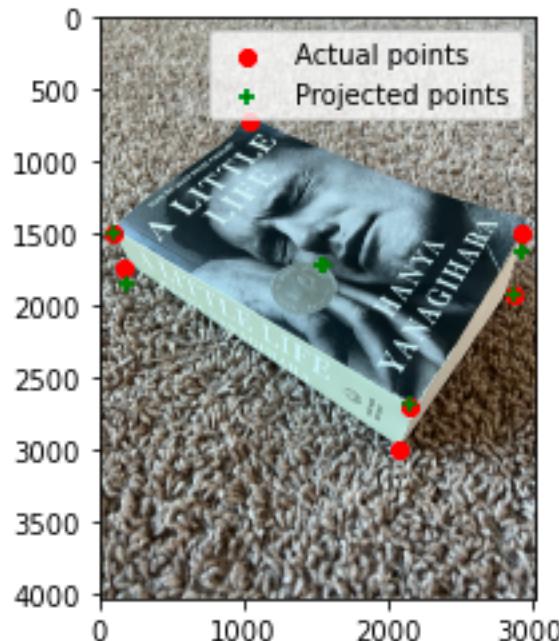


<Insert visualization for the initialized camera pose for 2nd image> [1]

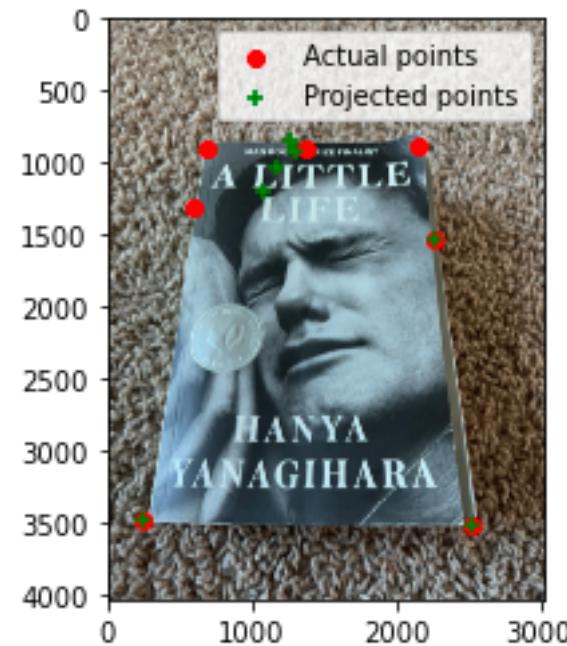


## Part 2.2: Optimized results for custom images

<Insert visualization for projected 3D points and actual 2D points for 1st image> [1.5]

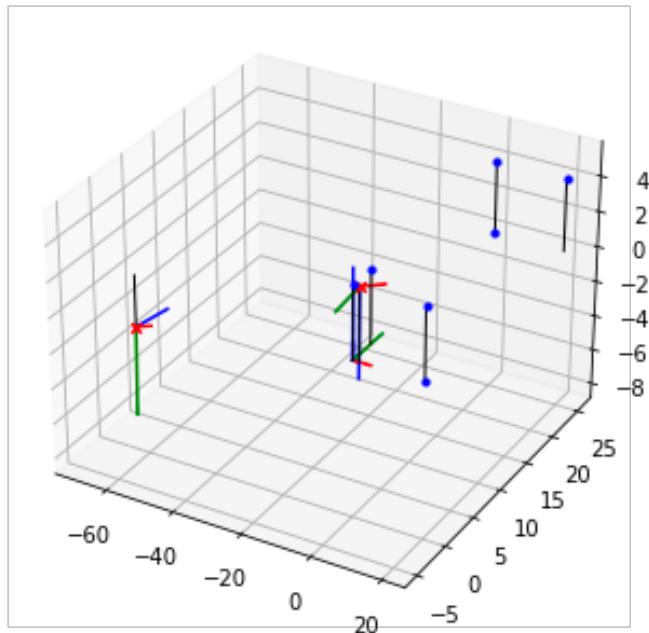


<Insert visualization for projected 3D points and actual 2D points for 2nd image> [1.5]



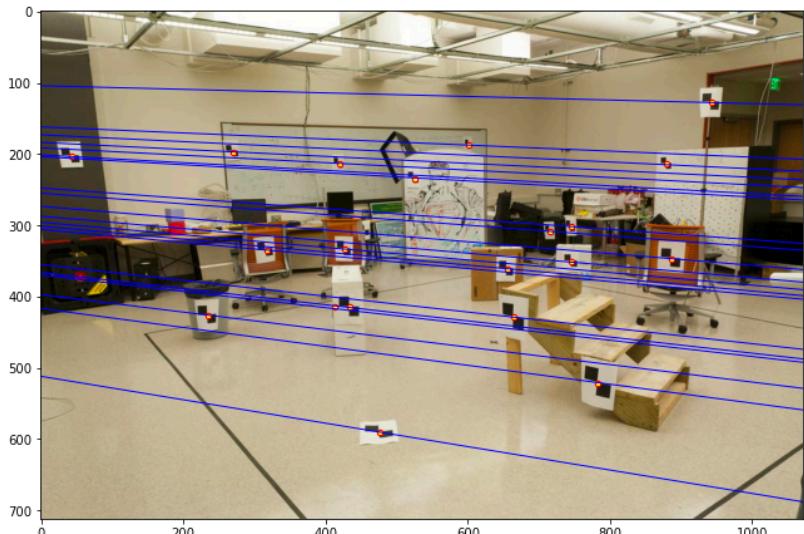
# Part 2.3: Optimized Camera Poses

<Insert pose with world and optimized camera's coordinate systems [1]>

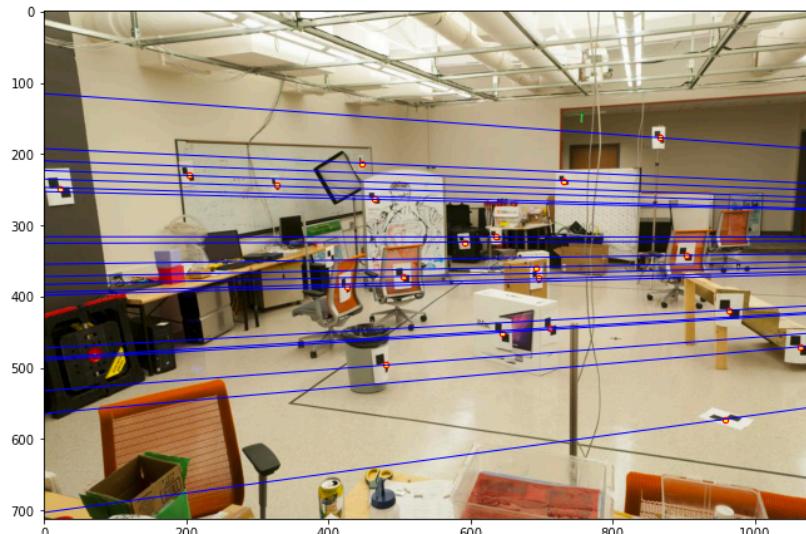


# Part 3.2: Optimized Epipolar Lines (given images)

<Insert left image with epipolar lines> [1]

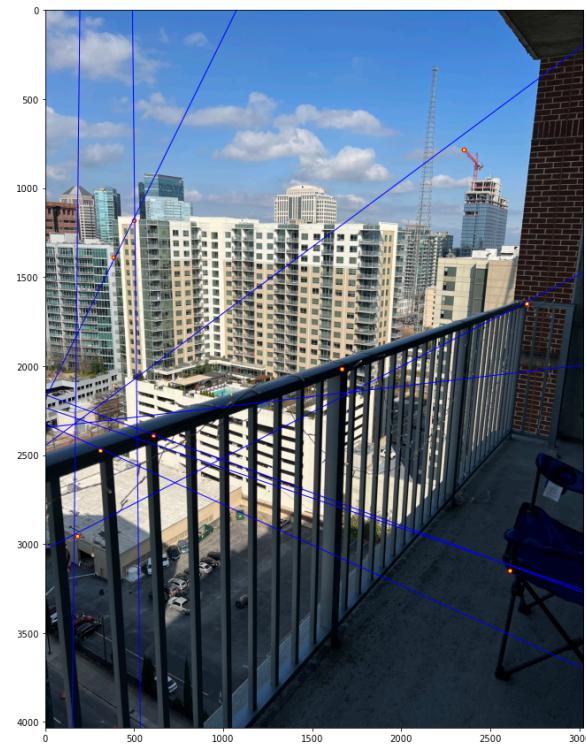


<Insert right image with epipolar lines> [1]

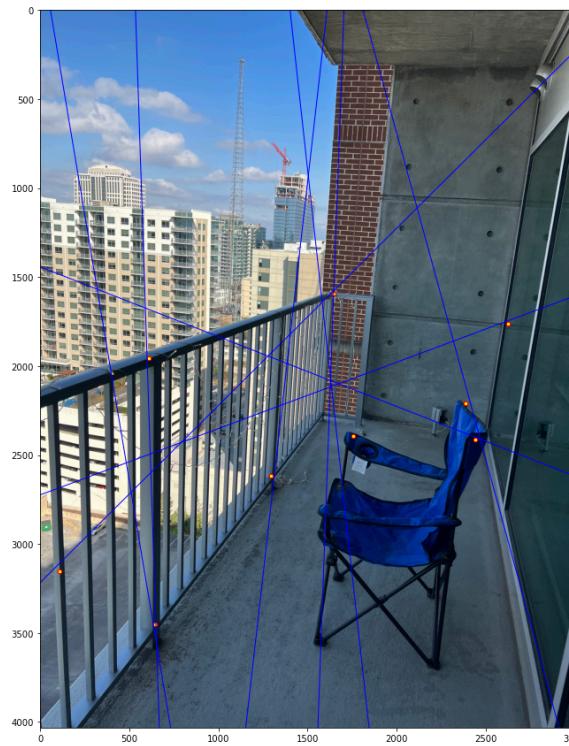


# Part 3.3: Optimized Epipolar Lines (custom images)

<Insert left image with epipolar lines> [1.5]



<Insert right image with epipolar lines> [1.5]



## Part 3.4: Reflection Questions [1x3]

1. Because you have to keep the focal length and the principal point the same in each scene hence you can't rotate/zoom because it would change those two aspects.
2. Because the points you select are such that they will translate to epipolar lines through the fundamental matrix and are thus constrained.
3. The epipoles become the camera centers and the lines get reduced to the epipoles.

## Part 3.4: Reflection Questions [1x3]

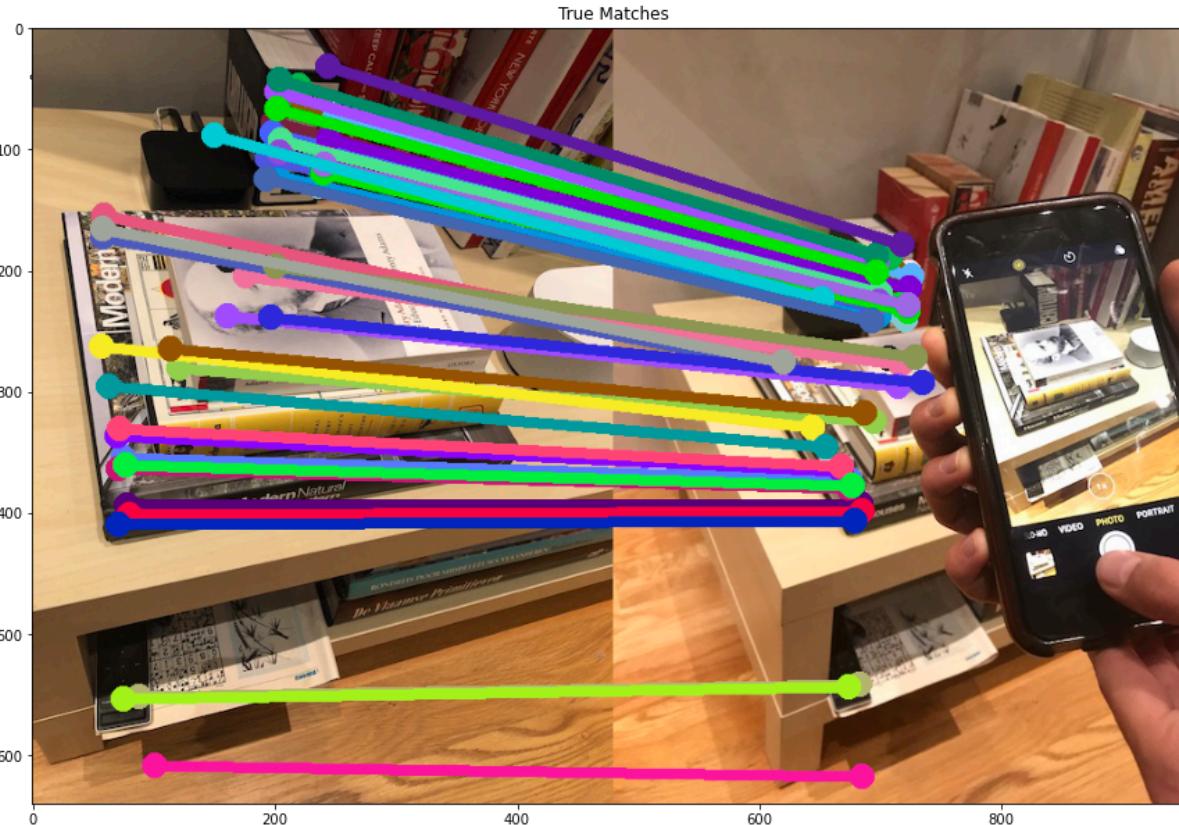
4. The images are parallel if epipolar lines are all horizontal across the two images.
5. Because the equation used to define the fundamental matrix is  $x'Fx = 0$ . Once you have the solution for the equation, you can multiply it by any scalar  $a$  and it will still give you the same solution hence you have to define it up to a scale to get up to that many solutions.
6. We know that epipoles lie on the epipolar lines and  $eF = 0$  for epipoles  $e$ . Hence,  $F$  is not equal to the zero vector so it is not a full rank matrix and since it is a  $3 \times 3$  matrix, the rank must be 2.

## Part 4.2: RANSAC Iterations Questions [1x3]

Type your answers to the three RANSAC Iterations questions from the jupyter notebook below:

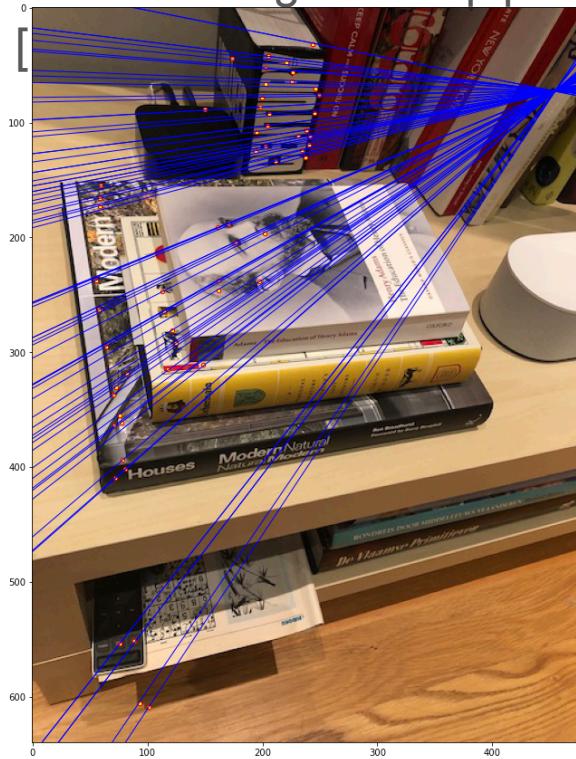
1.  $15 \rightarrow S = 15$
2. 43
3. 168

# Part 4.4: RANSAC Inlier Matches

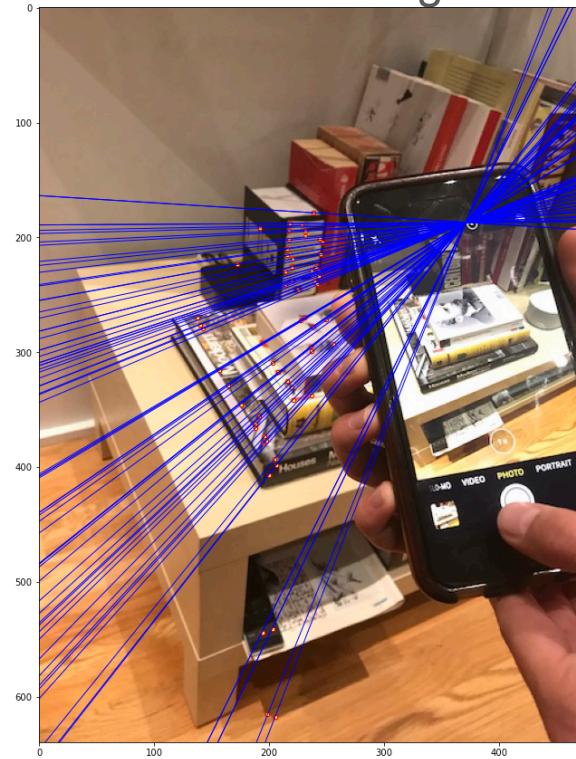


# Part 4.4: RANSAC Epipolar Lines

<Paste the left image with epipolar lines> [



<Paste the right image with epipolar lines>



## Local Unit tests results

<Paste the screenshot when you run all provided unit tests using `pytest`> [1]

```
(cs4476_proj3) devanshi_gupta@Devanshis-MacBook-Pro proj3_code % cd ~  
~/desktop/proj3_release  
(cs4476_proj3) devanshi_gupta@Devanshis-MacBook-Pro proj3_release % cd proj3_unit_tests  
(cs4476_proj3) devanshi_gupta@Devanshis-MacBook-Pro proj3_unit_tests % pytest ./  
===== test session starts =====  
platform darwin -- Python 3.6.13, pytest-6.2.4, py-1.11.0, pluggy-0.13.1  
rootdir: /Users/devanshi_gupta/Desktop/proj3_release  
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 =====  
proj3_unit_tests/test_ransac.py::test_ransac_find_inliers  
/Users/devanshi_gupta/Desktop/proj3_release/proj3_unit_tests/test_ransac.py:46: DeprecationWarning: elementwise comparison failed; this will raise an error in the future.  
    assert outliers not in inliers  
  
-- Docs: https://docs.pytest.org/en/stable/warnings.html  
===== 20 passed, 1 warning in 1.40s =====  
(cs4476_proj3) devanshi_gupta@Devanshis-MacBook-Pro proj3_unit_tests %
```

# Conclusions

<Describe what you have learned in this project. Feel free to include any challenges you ran into.> [2]

I learned how to find camera locations within two scenes and how to use familiar linear algebra to help me with finding different matrices.

Some of the challenges I ran into were purely based on making sure that I was keeping matrix dimensions right and different ways to manipulate them.