CS543 Assignment 4

DATE EXTENSION APPROVED by the professor.

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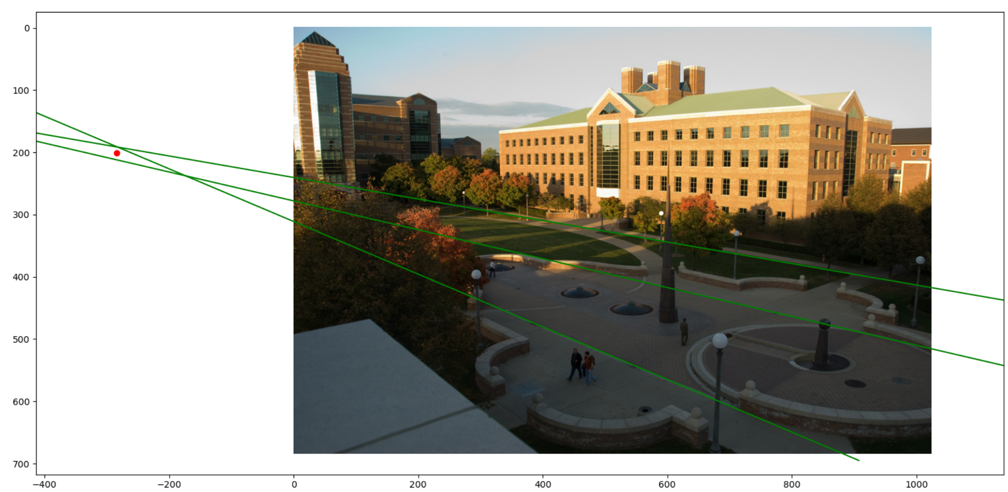
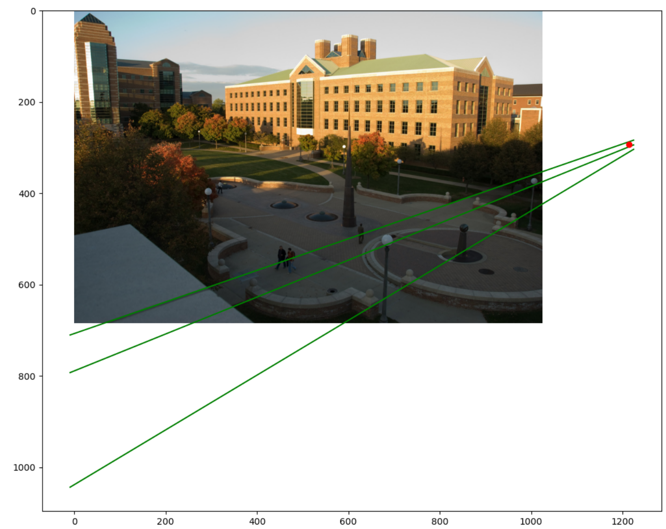
Part 1 Single-View Geometry:

Plot the VPs and the lines used to estimate them on the image plane using the provided code.

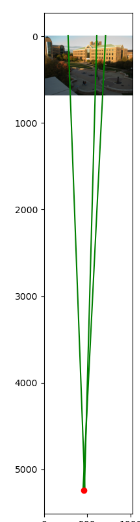
X VP



Y VP



Z Vp



Specify the VP pixel coordinates.

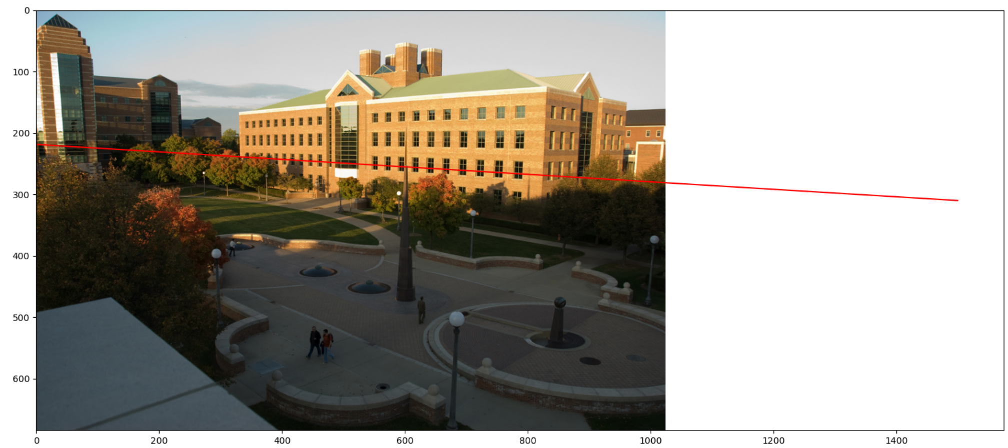
X: [1.21412856e+03 2.92407693e+02 1.00000000e+00]

Y: [-284.08074121 201.06980256   1.   ]

Z: [4.58627643e+02 5.23919846e+03 1.00000000e+00]

Plot the ground horizon line and specify its parameters in the form a * x + b * y + c = 0. Normalize the parameters so that: a^2 + b^2 = 1.

[A = 4.28276130e-04, B = -4.43976478e-03, C= 1.00000000e+00]



Using the fact that the vanishing directions are orthogonal, solve for the focal length and optical center (principal point) of the camera. Show all your work.

```
def get_camera_parameters(v_pts):
    """
    Computes the camera parameters. Hint: The SymPy package is suitable for 
this.
    """
    v_0 = np.reshape(v_pts[:, 0], (3,1))
    v_1 = np.reshape(v_pts[:, 1], (3,1))
    v_2 = np.reshape(v_pts[:, 2], (3,1))
    f, px, py = symbols('f,px,py')
    K_inv = Matrix([[1/f, 0 , -px/f],
                    [0,  1/f, -py/f],
                    [0,  0,    1]])
    eq1 = v_0.T* K_inv.T * K_inv *v_1
    eq2 = v_0.T* K_inv.T * K_inv *v_2
    eq3 = v_1.T* K_inv.T * K_inv *v_2
    f, px, py = solve((eq1[0], eq2[0], eq3[0]),(f,px,py))[0]
```

```
    return f, px, py

def get_rotation_matrix(v_pts, f, px, py):
    """
    Computes the rotation matrix using the camera parameters.
    """
    v_0 = np.reshape(v_pts[:, 0], (3,1))
    v_1 = np.reshape(v_pts[:, 1], (3,1))
    v_2 = np.reshape(v_pts[:, 2], (3,1))
    K_inv = Matrix([[1/f, 0 , -px/f],
                    [0,  1/f, -py/f],
                    [0,  0,    1]])
    return np.vstack((np.array(K_inv*v_0).T, np.array(K_inv*v_1).T,
np.array(K_inv*v_2).T))
```

f =-682.430316018545
px=756.090783609853
py=359.930481705981

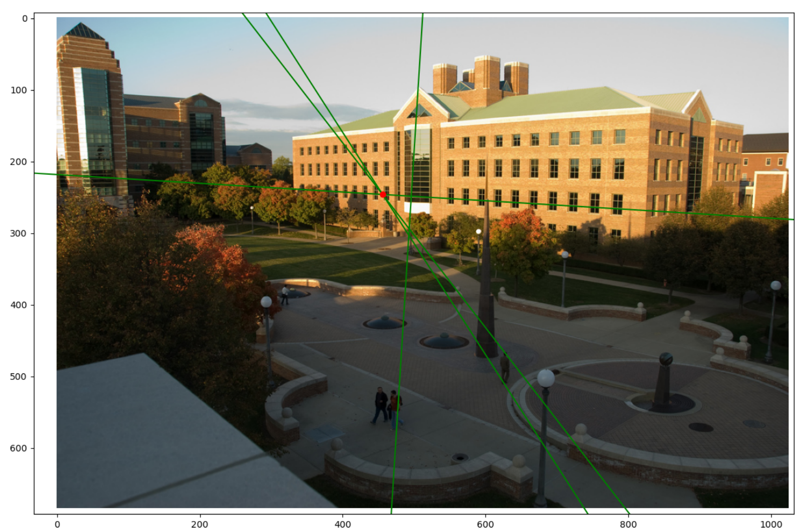
Compute the rotation matrix for the camera.

Rotation Matrix
[[-0.671186149909700 0.0989445912953050 1.00000000000000]
 [1.52421646636165 0.232786667615839 1.00000000000000]
 [0.435887934090210 -7.14984059729466 1.00000000000000]]

Estimate the heights of (a) the CSL building, (b) the spike statue, and (c) the lamp posts assuming that the person nearest to the spike is 5ft 6in tall. In the report, show all the lines and measurements used to perform the calculation.

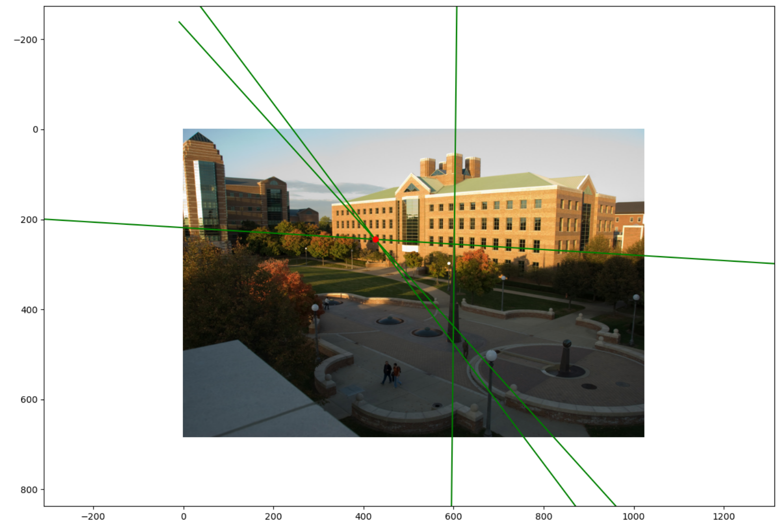
CSL building

39.514181498675164 meters



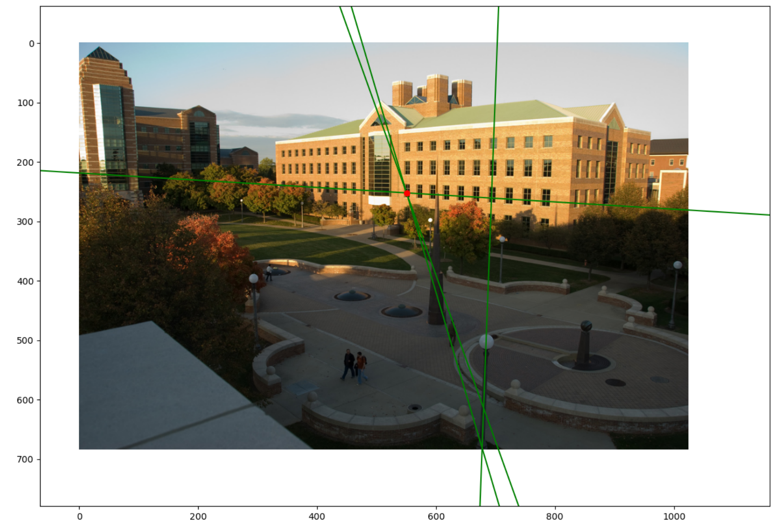
Spike Statue

9.93648707981547 meters



Lamp

4.90627301062275 meters



How do the answers change if you assume the person is 6ft tall?

Assuming the proportion didn't change; the image is the same. We just change the person's height to 6ft. The the answers of other things should be bigger because

```
return r/h * p_height
```

So height increases then the computed height of the object increases

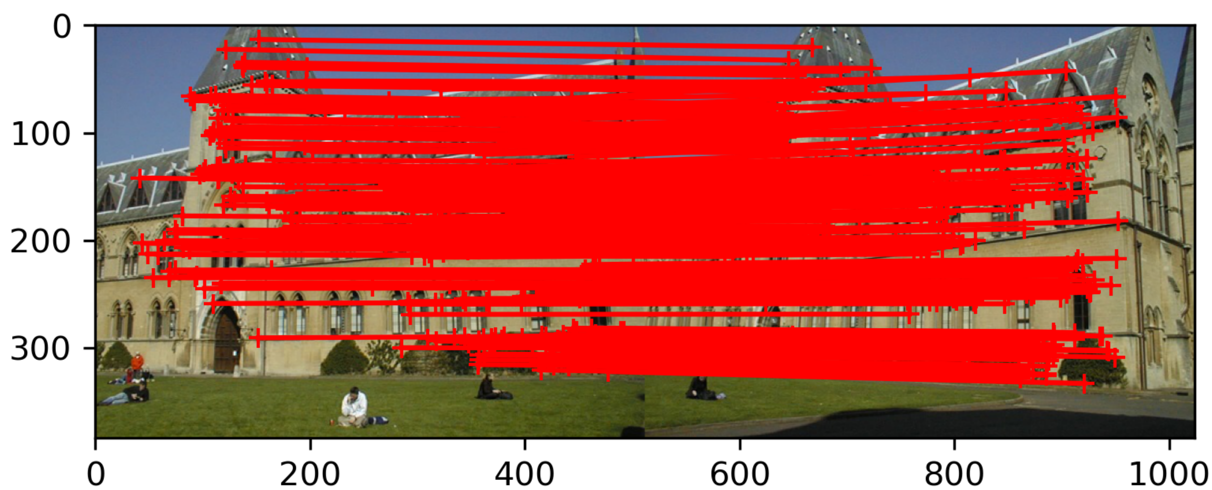
However if the person in the picture is changed by enlarging it; thence the proportion changes. Then the answers of other thing should be smaller

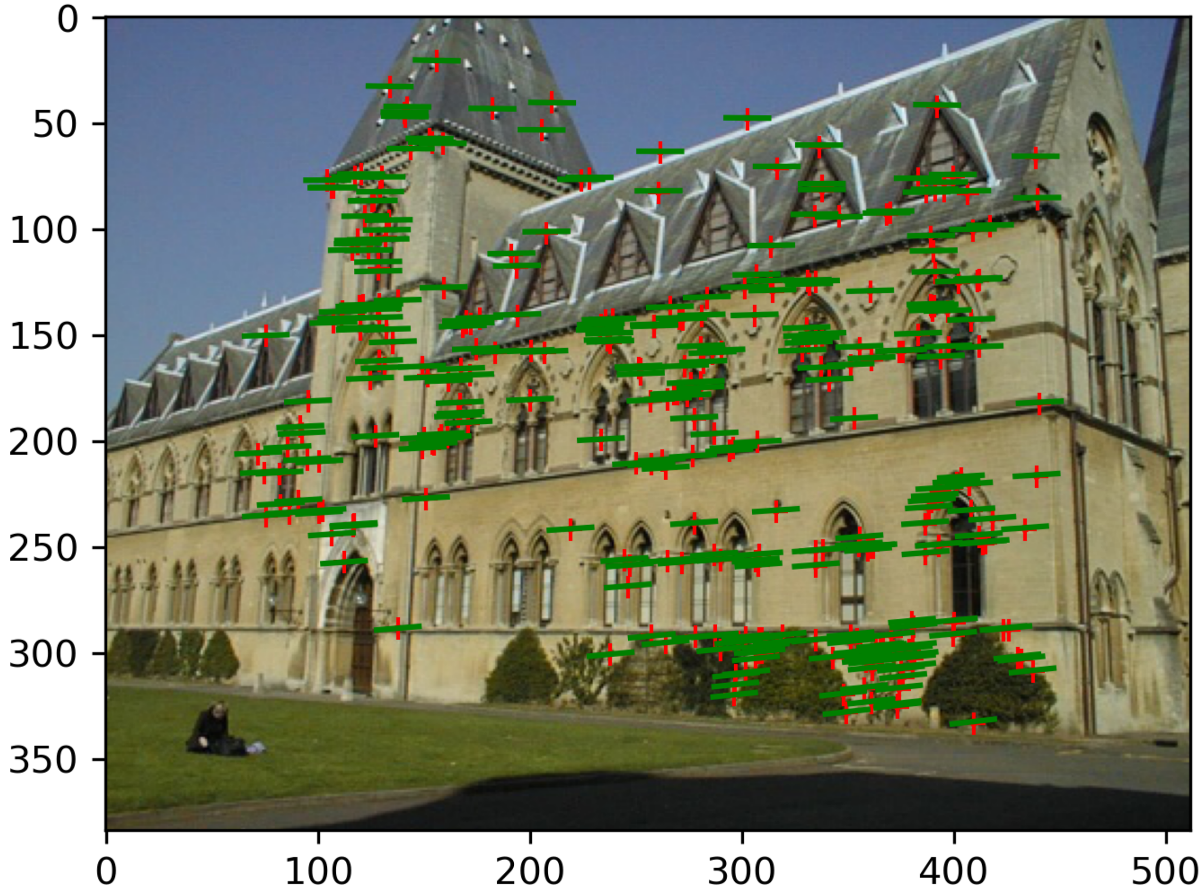
Part 2 Fundamental Matrix Estimation, Camera Calibration, Triangulation:

For the lab and library image pairs, display your result (points and epipolar lines) and report your residual for both unnormalized and normalized fundamental matrix estimation.

Unnormalized Library

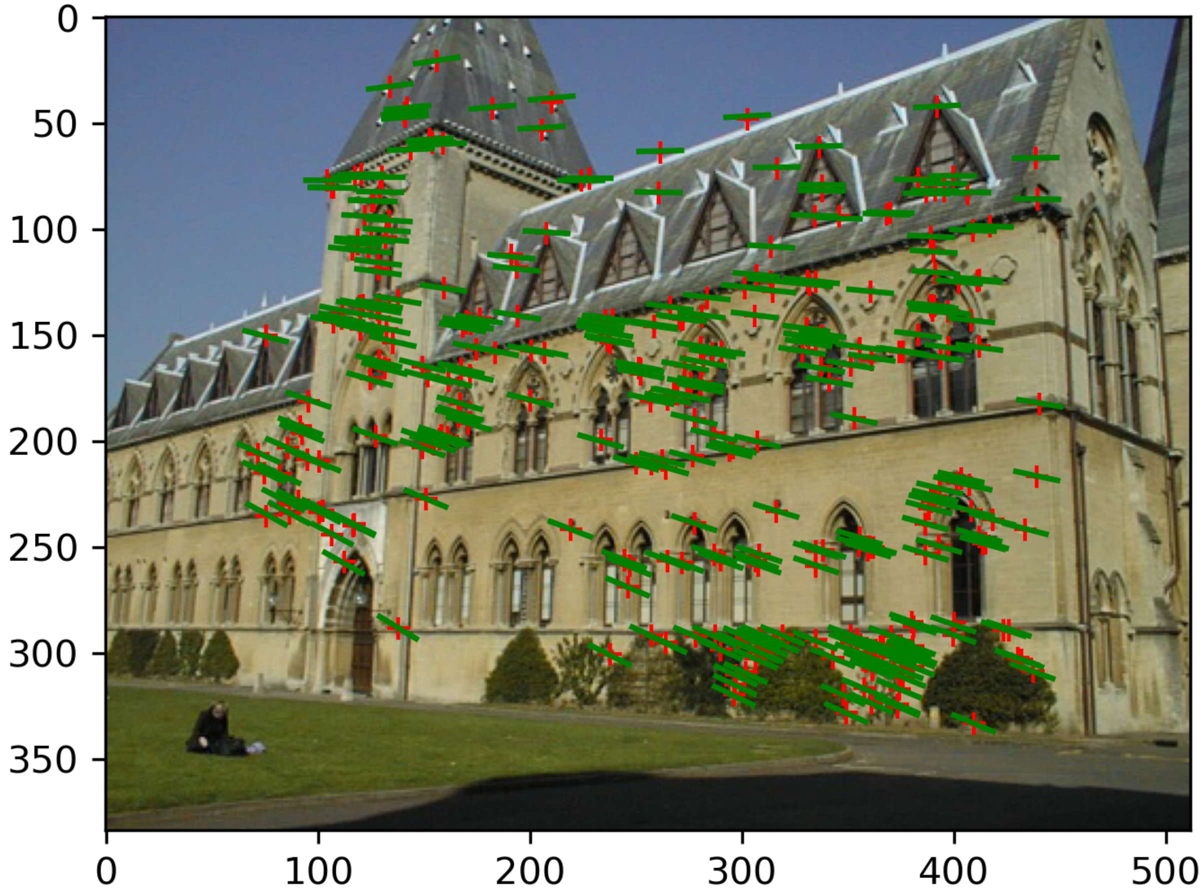
```
[[-1.32341616e-06  1.36640519e-05 -6.82803870e-04]
 [-2.88178174e-05  2.66440807e-07  4.09069255e-02]
 [ 5.62362952e-03 -3.72771609e-02 -9.98451273e-01]]
residual: 0.17921336680337674
```





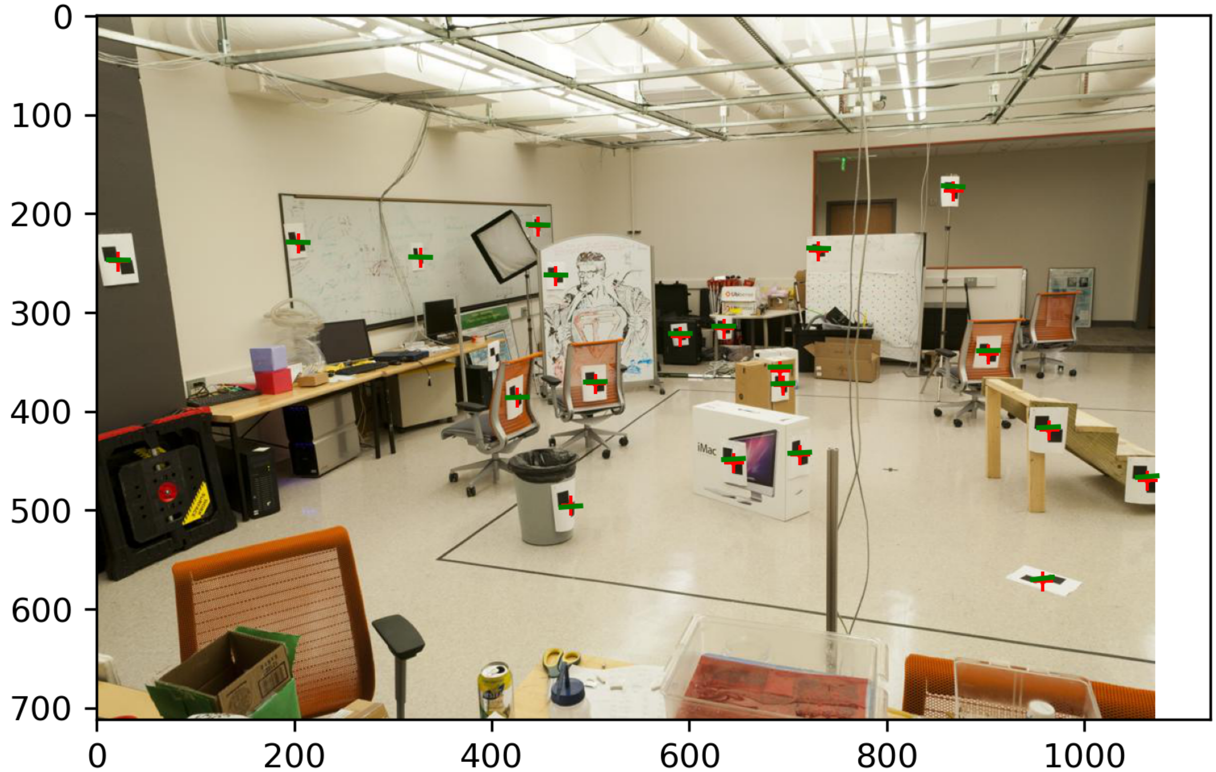
Normalized Library

```
[[ 6.58380216e-10 -7.09544066e-09  3.96341120e-07]
 [ 3.78236415e-09 -4.72763177e-10  2.14504524e-06]
 [-1.44098390e-07 -1.47735233e-06 -7.68246839e-05]]
residual: 0.16116620555974873
```



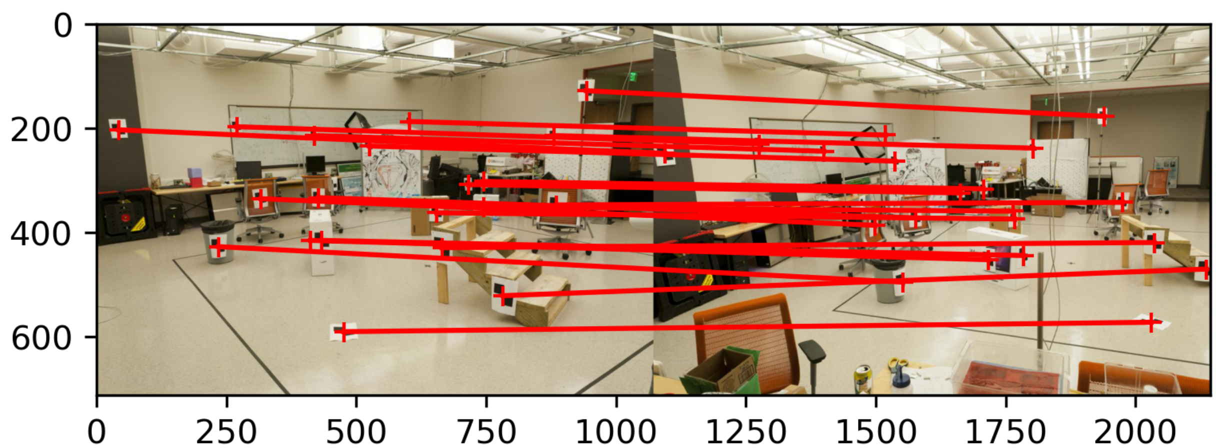
Unnormalized Lab

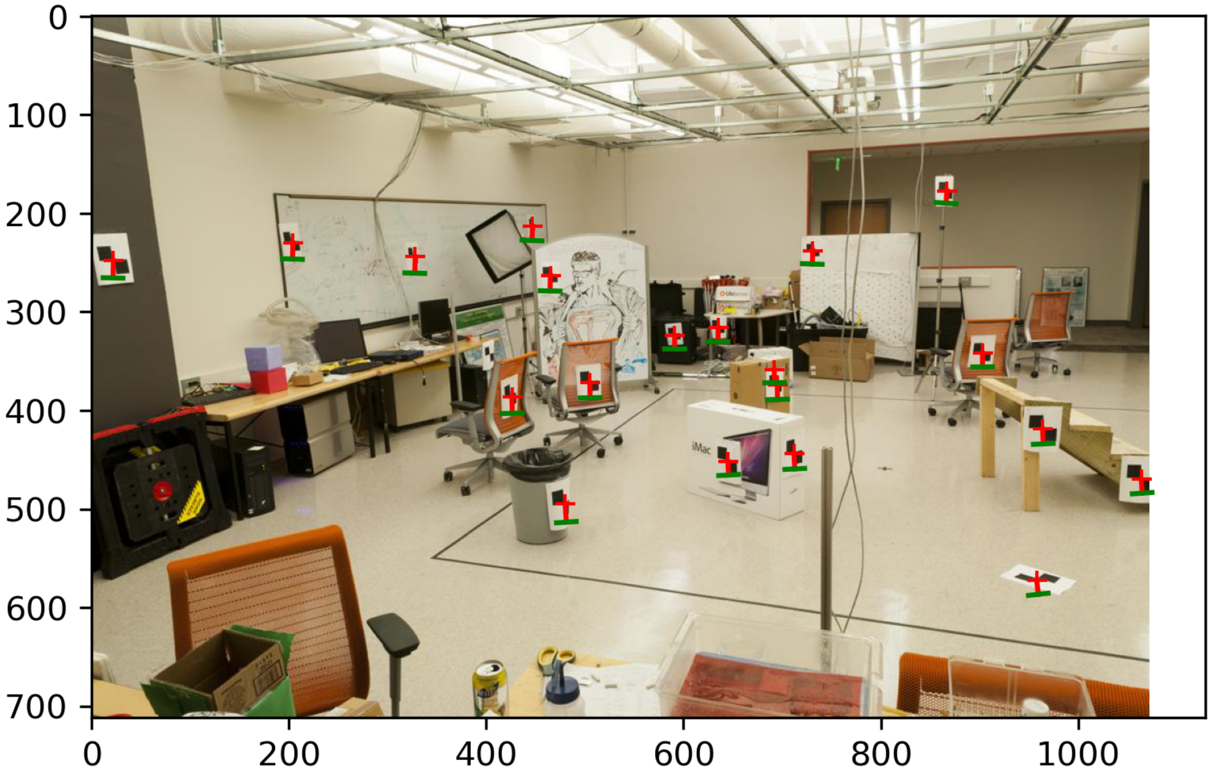
```
[[-5.36264198e-07  7.90364771e-06 -1.88600204e-03]
 [ 8.83539184e-06  1.21321685e-06  1.72332901e-02]
 [-9.07382264e-04 -2.64234650e-02  9.99500092e-01]]
residual: 6.567091501496526
```



Normalized Lab

```
[[-1.30976244e-11  1.67026556e-10 -4.12162724e-08]
 [ 1.70825603e-10  1.60424126e-11  3.59666824e-07]
 [-1.50326555e-08 -5.39050779e-07  1.19330325e-05]]
residual: 225.83678578657887
```





For the lab image pair, show your estimated 3x4 camera projection matrices. Report the residual between the projected and observed 2D points.

left Lab image

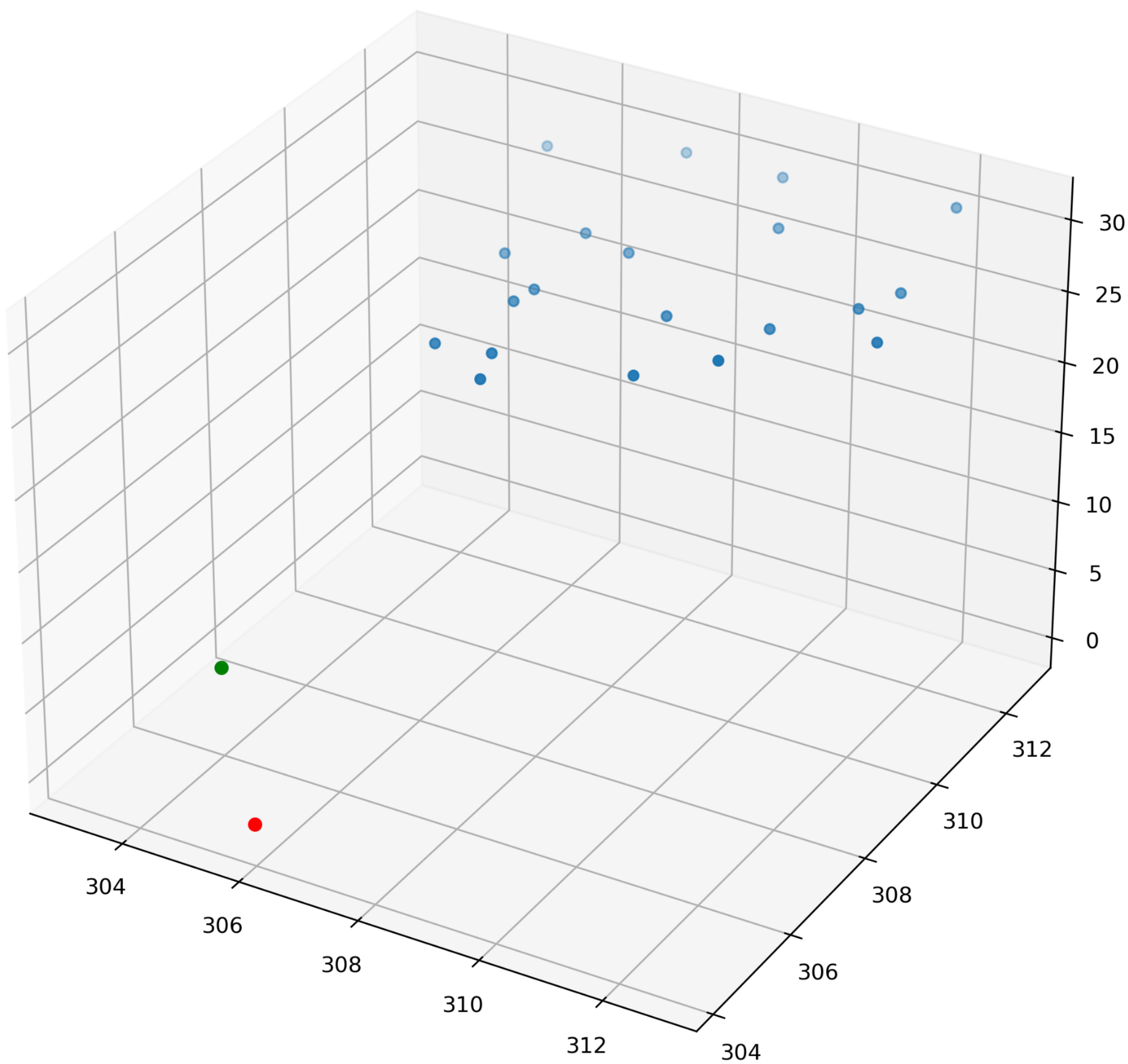
```
Calibration matrix:
 [[-3.09963979e-03 -1.46204814e-04  4.48498177e-04  9.78930687e-01]
 [-3.07018136e-04 -6.37193634e-04  2.77356174e-03  2.04144362e-01]
 [-1.67933508e-06 -2.74767706e-06  6.83965536e-07  1.32882925e-03]]
residual: 0.6772887010896272
```

Right Lab Image

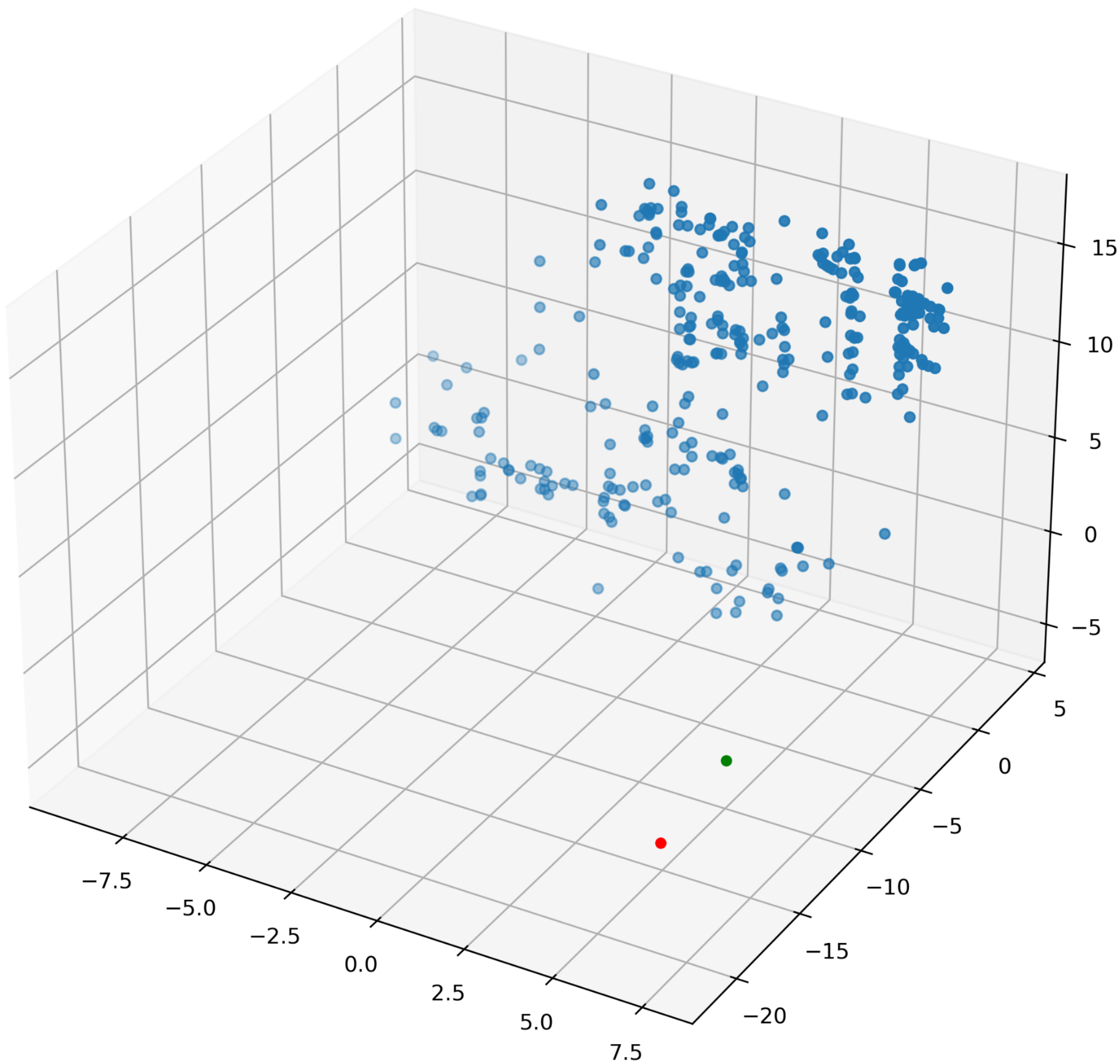
```
Calibration matrix:
[[-6.93154396e-03  4.01684176e-03  1.32603092e-03  8.26700532e-01]
 [-1.54768693e-03 -1.02452786e-03  7.27440504e-03  5.62523287e-01]
 [-7.60945746e-06 -3.70953984e-06  1.90203444e-06  3.38807613e-03]]
residual 0.777247216189391
```

For the lab and library image pairs, visualize 3D camera centers and triangulated 3D points.

Lab 3D



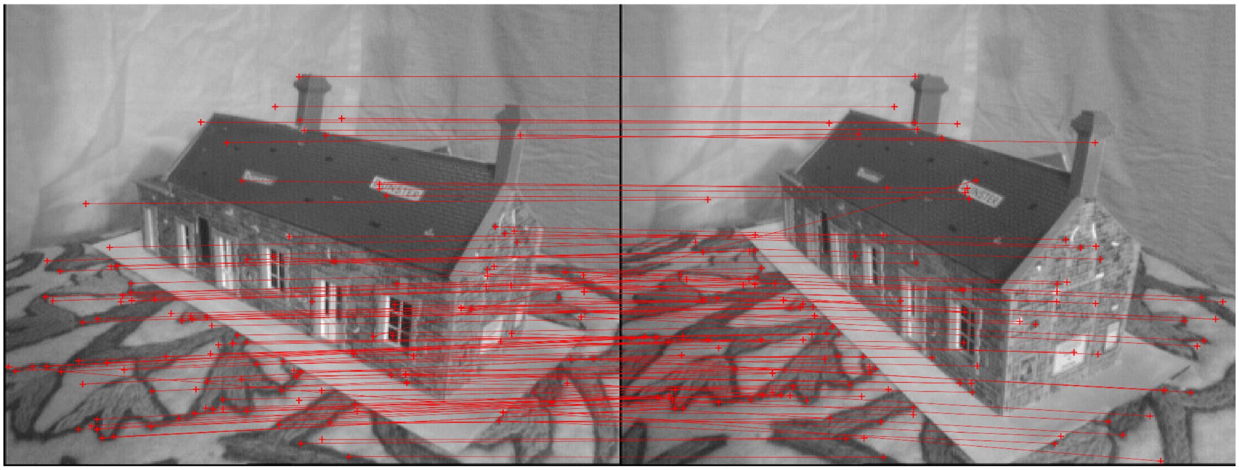
Library 3D



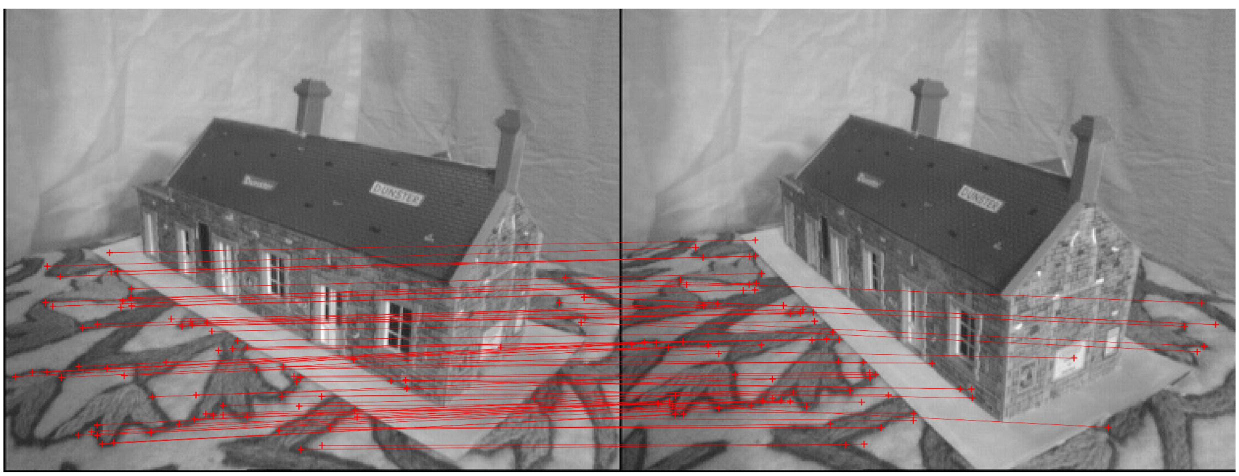
For the house and gaudi image pairs, display your result and report your number of inliers and average inlier residual for normalized estimation without ground truth matches.

House:
Residual: 0.12937001374010038
Inliers: 82

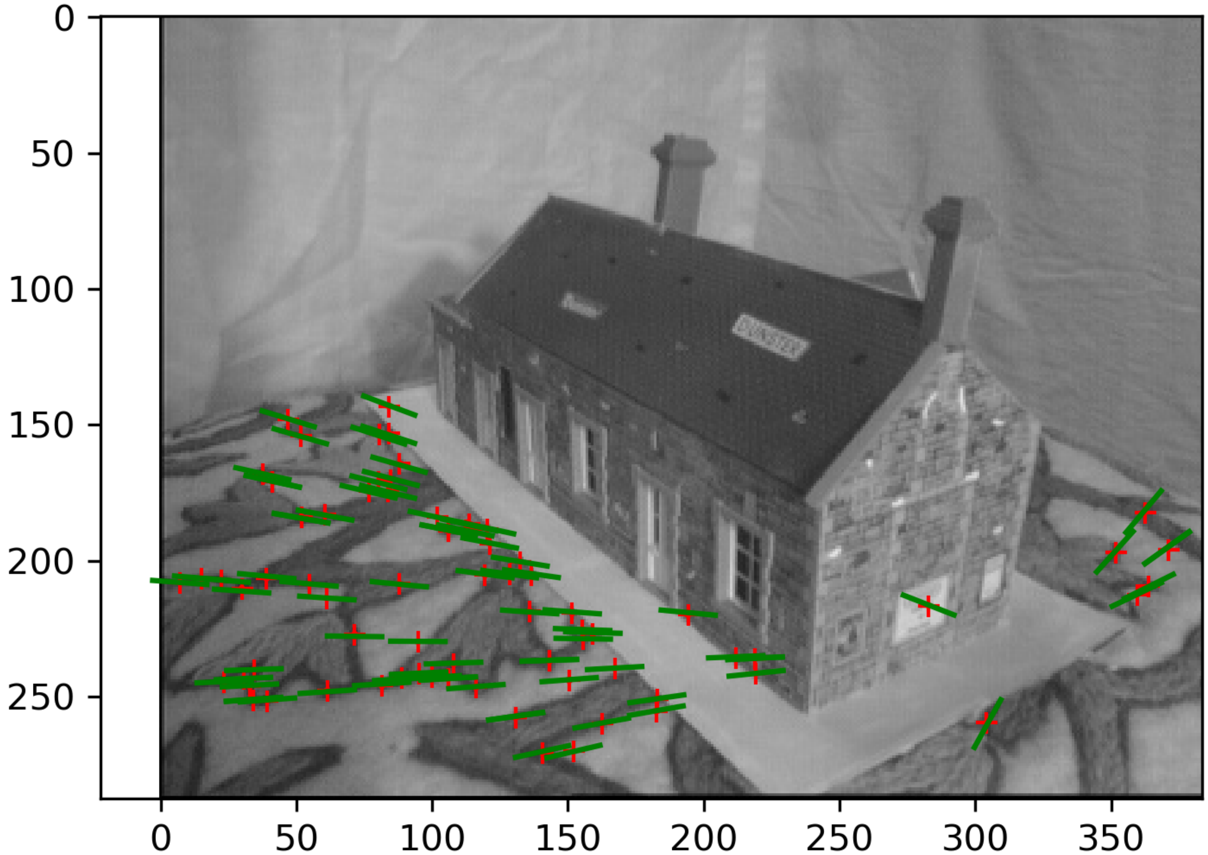
SIFT matches



Inliers



Normalized estimation



Gaudi:
Inliers: 81
Average residual: 0.2118504350705233

SIFT Matches

Inliers

Normalized estimation

Extra Credit:

Don’t forget to include references, an explanation, and outputs to receive credit. Refer to the assignment for suggested outputs.

Part 1

Part 2