

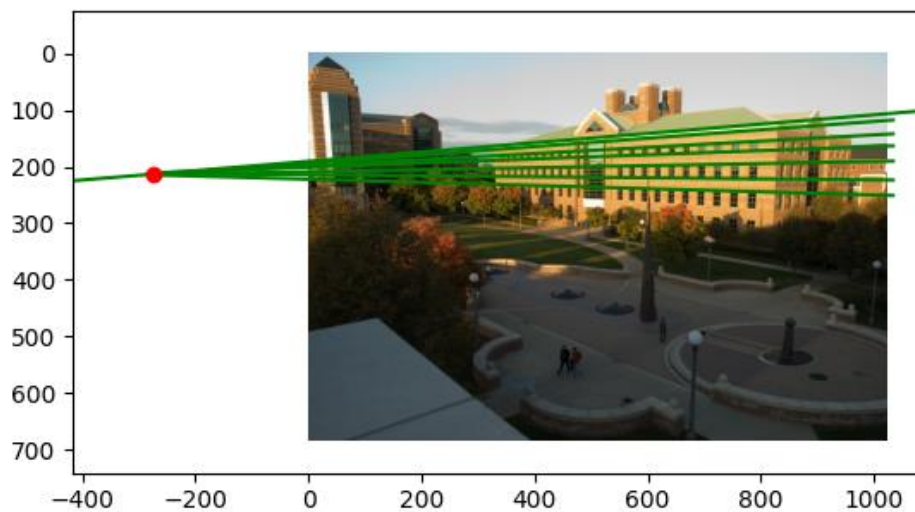
CS543 Assignment 4

Your Name: Yiyang Liu

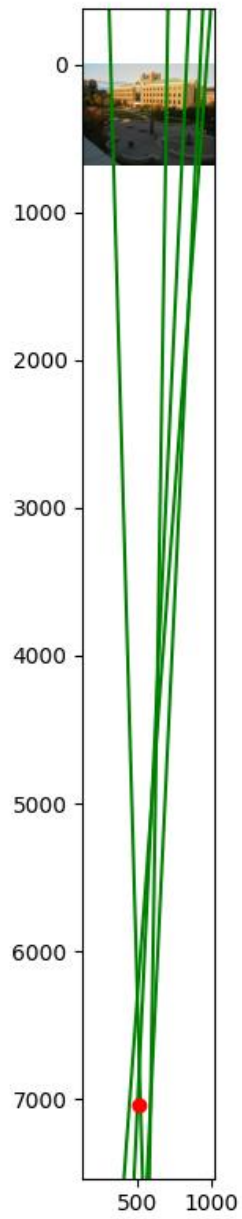
Your NetId: yiyang34

Part 1 Single-View Geometry:

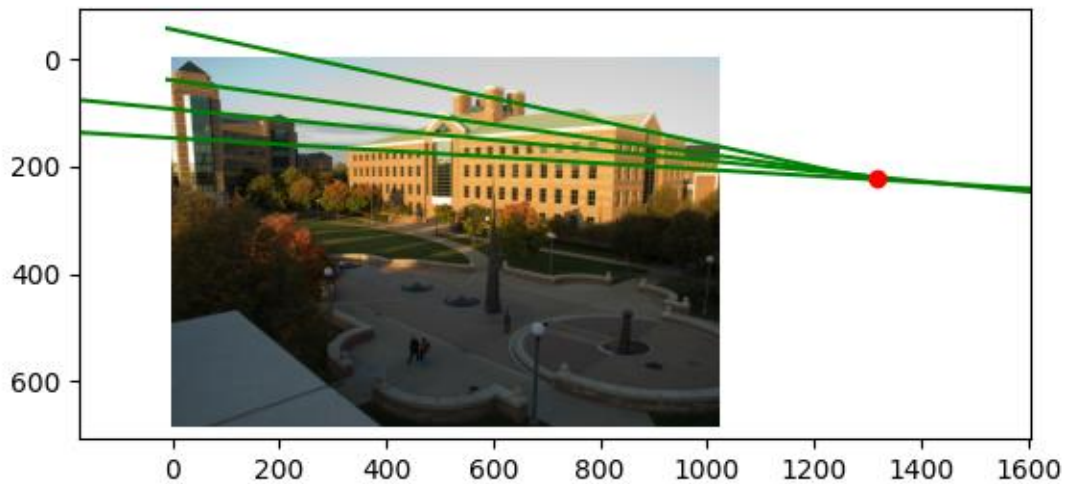
Plot the VPs and the lines used to estimate them on the image plane using the provided code.



Vanishing point 1 (Left)



Vanishing point 2 (Bottom)



Vanishing point 3 (Right)

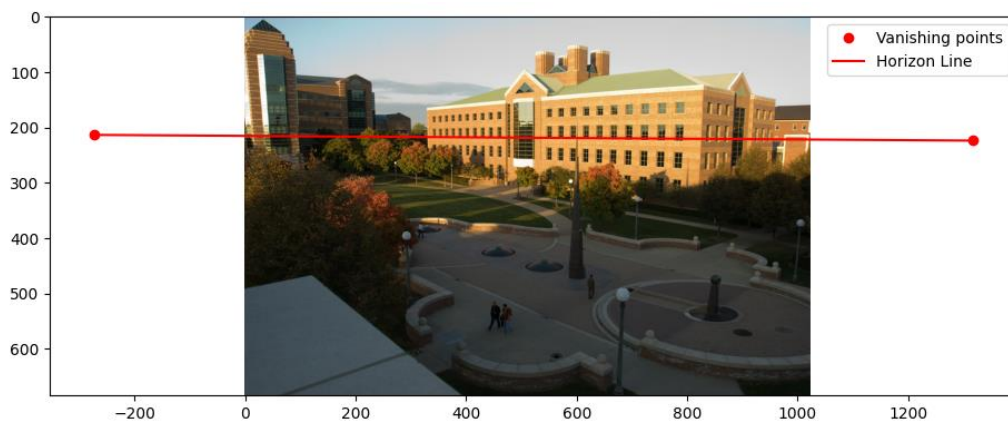
Specify the VP pixel coordinates.

Vanishing point 1 (Left): [-273.468 213.255 1.0]

Vanishing point 2 (Bottom): [516.005 7045.453 1.0]

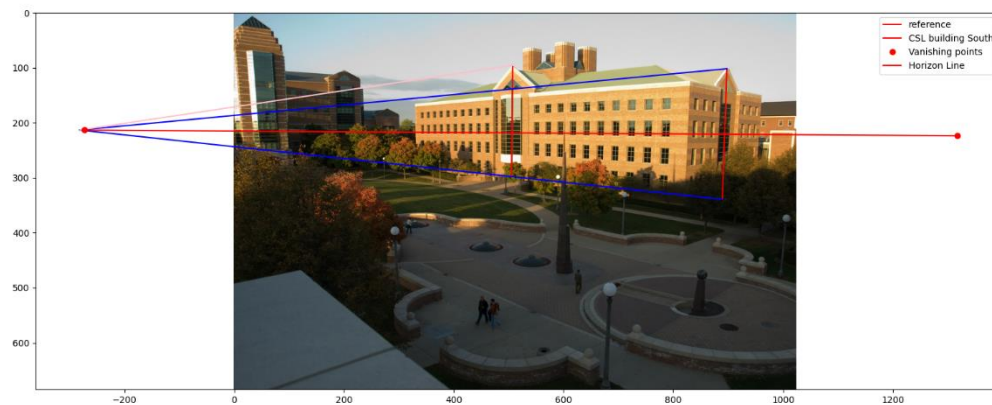
Vanishing point 3 (Right): [1317.774 223.583 1.0]

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



$$a = 0.006490352548607008, \quad b = -0.9999789374400817, \quad c = 215.0256$$

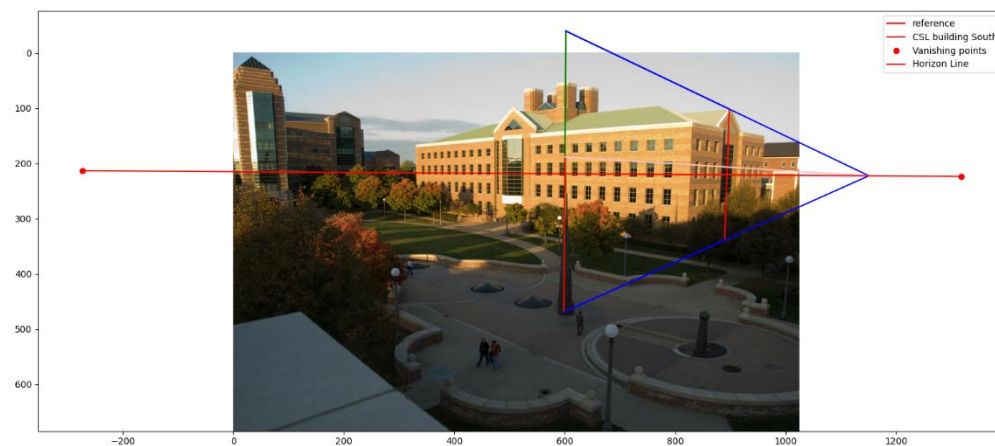
Using the interface, construct the lines on the image that establish that the two gables on the CSL building are the same height. Explain why these lines do so.

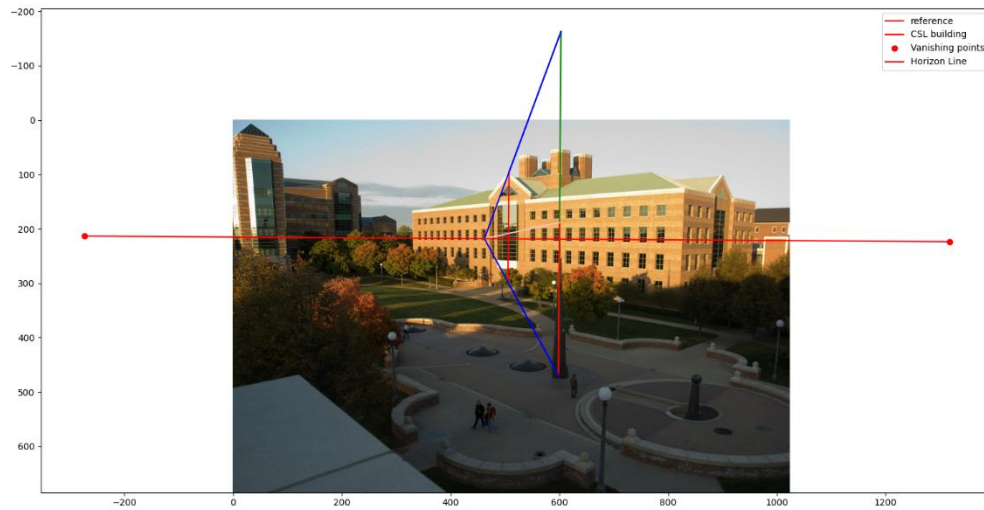


Draw the line as shown above, we can draw the conclusion that the west gable is taller than that of the CSL building.

Noted that the line on the two bottom points of objects do not intersect perfectly with the vanishing point. It is just a coincidence!

Alternatively, we can also use a third object to be the reference. In my case, I used this the spike statue and assume its height is 12 meters.





By calculation the cross-ratio, we get the height of the two gables of CSL building:

Height of CSL building West gable is 27.00m

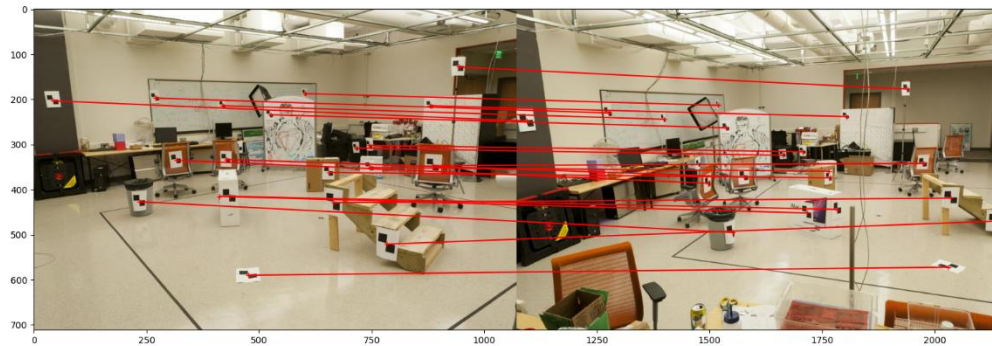
Height of CSL building South gable is 21.74m

We can draw the conclusion that the west gable is taller than that of the CSL building.

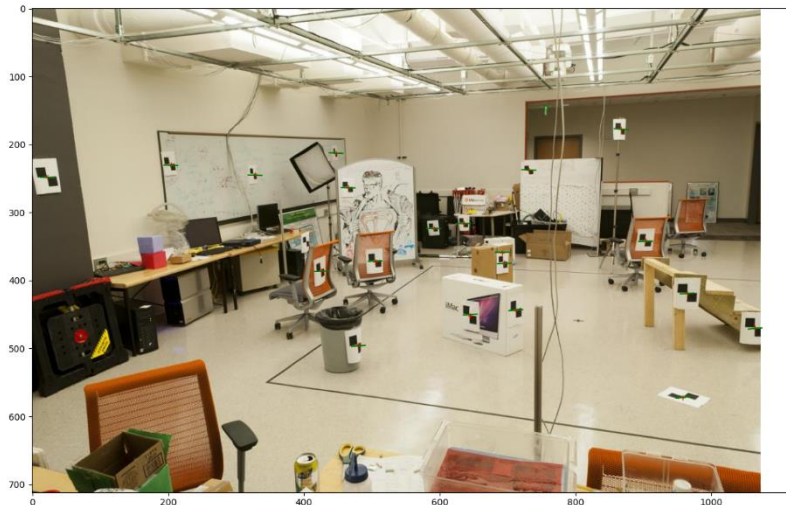
Part 2 Fundamental Matrix Estimation, Camera Calibration, Triangulation:

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.

Lab Matches:



Lab with normalization:

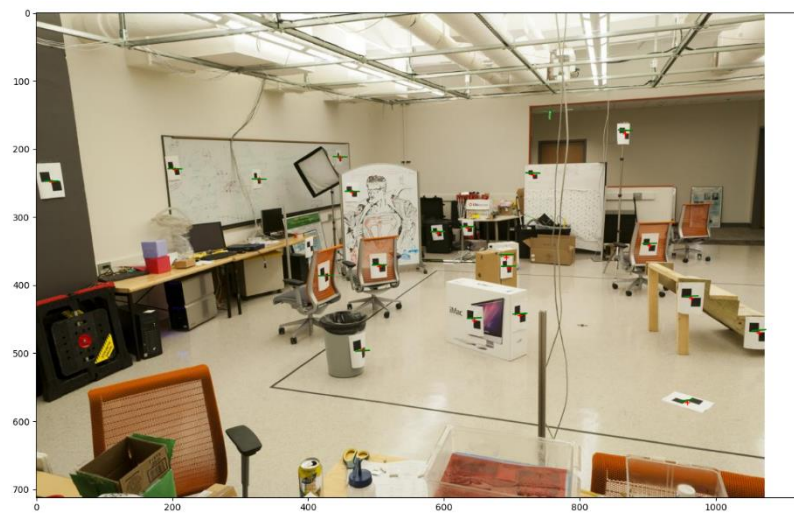


Residual with normalization: 0.6162303537752223

Fundamental matrix with normalization:

$[-2.02478523e-07$	$2.78039315e-06$	$-6.94781145e-04]$
$[1.92581510e-06$	$-4.74398800e-07$	$5.59813726e-03]$
$[-4.16157075e-05$	$-7.69192568e-03$	$1.78588215e-01]]$

Lab without normalization:

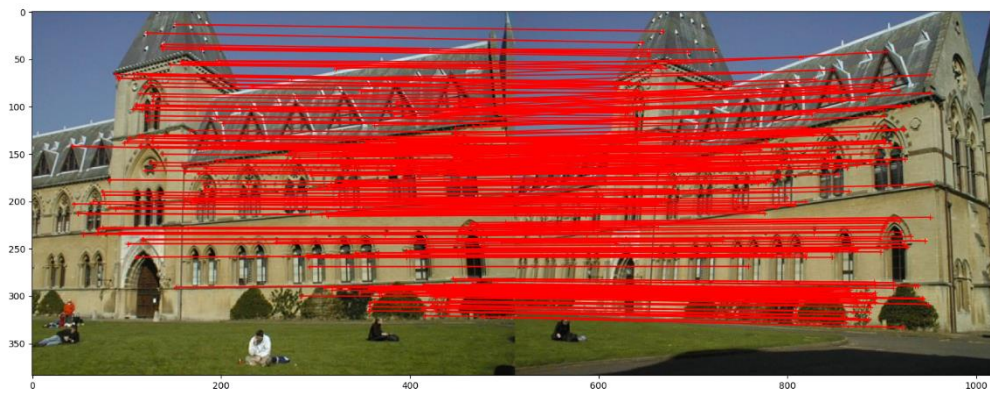


Residual without normalization: 2.2379774252589186

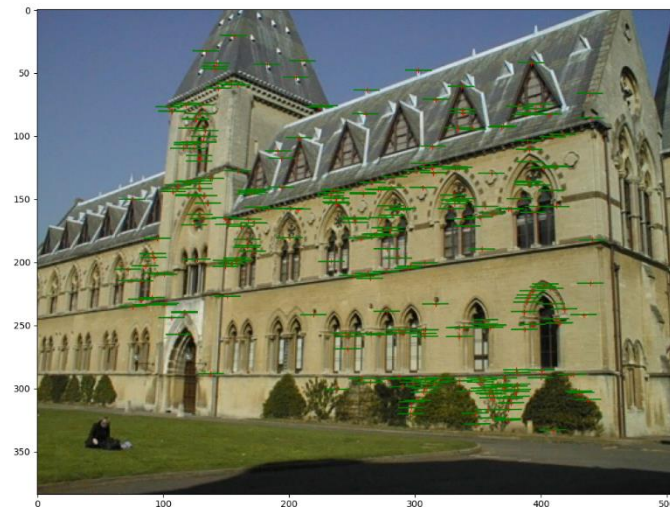
Fundamental matrix without normalization:

```
[[-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]]
```

Library Matches:



Library with normalization:

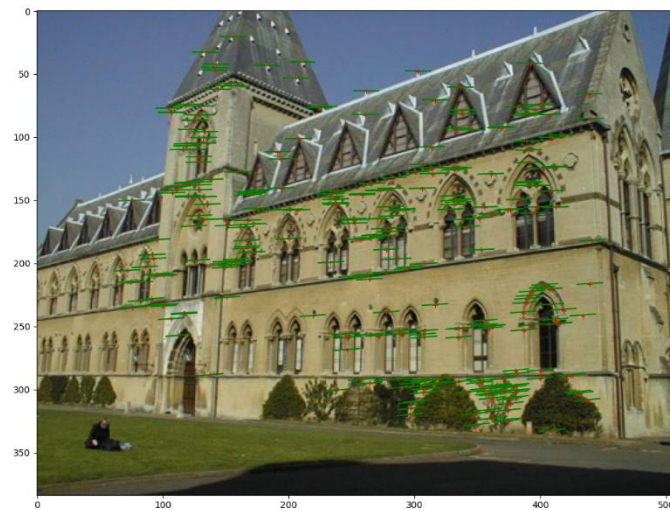


Residual with normalization: 0.18396850606472787

Fundamental matrix with normalization:

```
[[-4.86210796e-08  9.98237781e-07  -1.47341026e-04]
 [-5.80698246e-06  -5.65060960e-08  1.07254893e-02]
 [ 1.38164930e-03  -9.63586245e-03  -2.60674702e-01]]
```

Library without normalization:



Residual without normalization: 0.3384950960964087

Fundamental matrix without normalization:

```
[[-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]]
```


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

Lab Data Camera Projection Matrix (Camera 1):

$[[-2.33260962e+00$	$-1.10025080e-01$	$3.37513233e-01$	$7.36686567e+02]$
$[-2.31044166e-01$	$-4.79515070e-01$	$2.08722206e+00$	$1.53627263e+02]$
$[-1.26377057e-03$	$-2.06774255e-03$	$5.14712341e-04$	$1.00000000e+00]]$

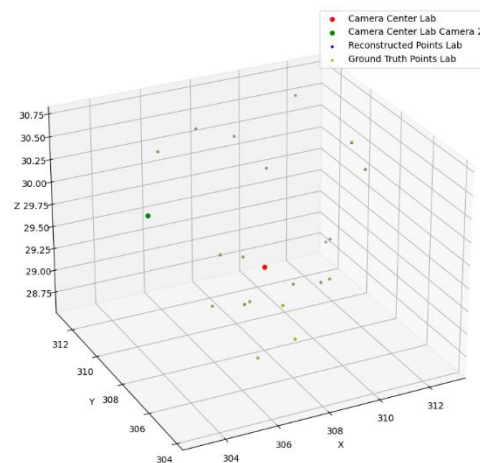
Lab Data Calibration Residual Error: 13.545832896704121

Lab Data Camera Projection Matrix (Camera 2):

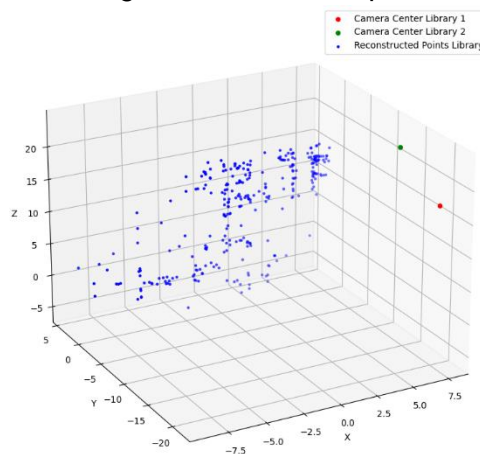
$[[-2.04586455e+00$	$1.18558243e+00$	$3.91381081e-01$	$2.44002874e+02]$
$[-4.56804042e-01$	$-3.02392053e-01$	$2.14706068e+00$	$1.66030240e+02]$
$[-2.24595257e-03$	$-1.09488059e-03$	$5.61389950e-04$	$1.00000000e+00]]$

Lab Data Calibration Residual Error: 15.544953468279672

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



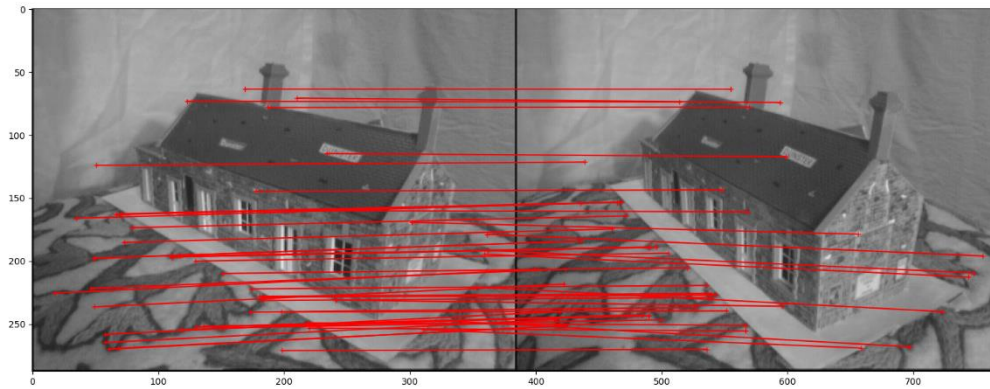
Triangulation for the lab pair



Triangulation for the library pair

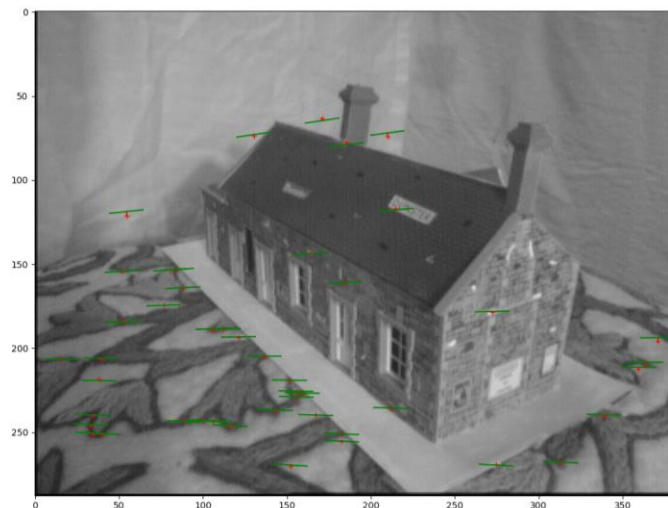
For the house and gaudi image pairs, display your result and report your number of inliers and average inlier residual for normalized estimation without ground truth matches.

House Matches:



of inliers: 49

Epipolar line:



Fundamental Matrix:

```
[[-1.39535429e-06  -1.34357195e-05  3.07202967e-03]
 [ 4.10086762e-06  -2.57795564e-06  1.29683832e-02]
 [-1.97162702e-03  -1.02439819e-02  -2.29960563e-01]]
```

Residual: 0.5396334695576237

Gaudi Matches:



of inliers: 31

Epipolar line:



Fundamental Matrix:

```
[[-1.41452123e-07  3.86471327e-06 -1.48303168e-03]
 [-1.30795271e-06  6.37531972e-08 -6.07945454e-03]
 [ 3.32533632e-04  6.22915394e-03  2.09165257e-01]]
```

Residual: 0.4635447740438541

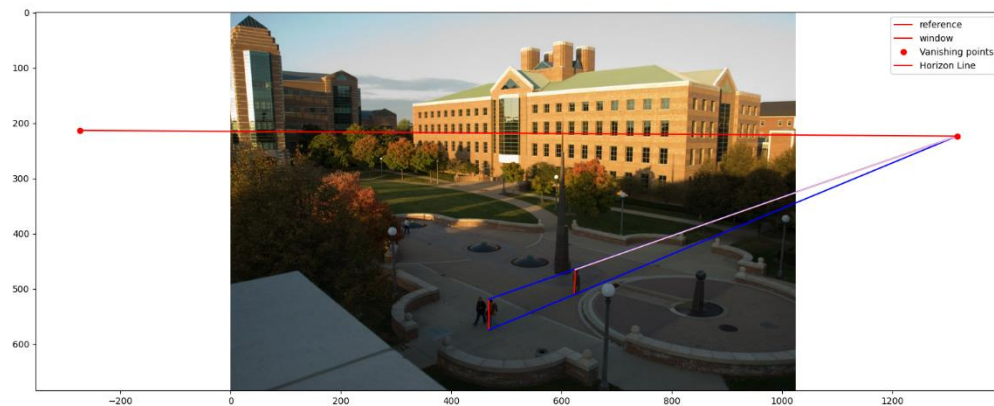
Extra Credit:

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

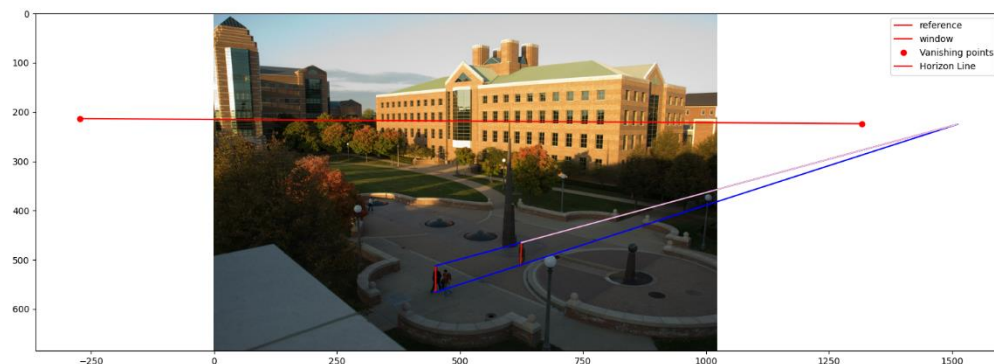
Part 1

Perform additional measurements on the image: which of the people visible are the tallest? What are the heights of the windows? etc.

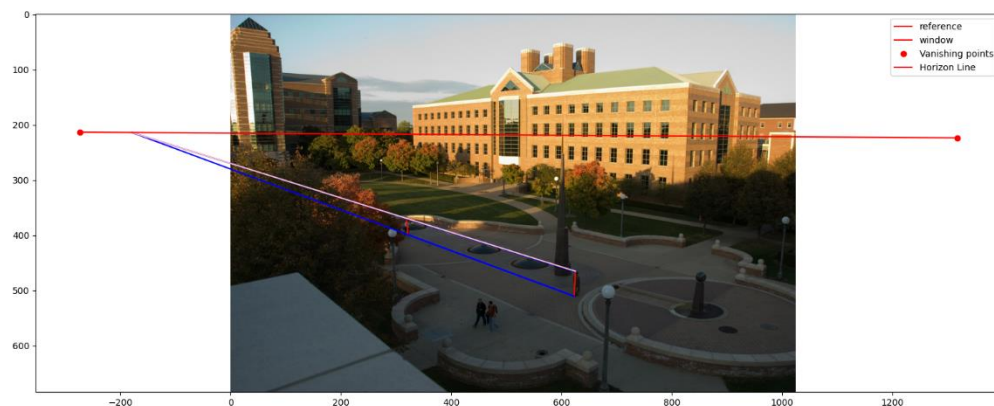
Using the person nearest to the spike statue as reference and assume its height was 5.5 inches.



The height of this person shown in the above figure is 5.607



The height of this person shown in the above figure is 5.506

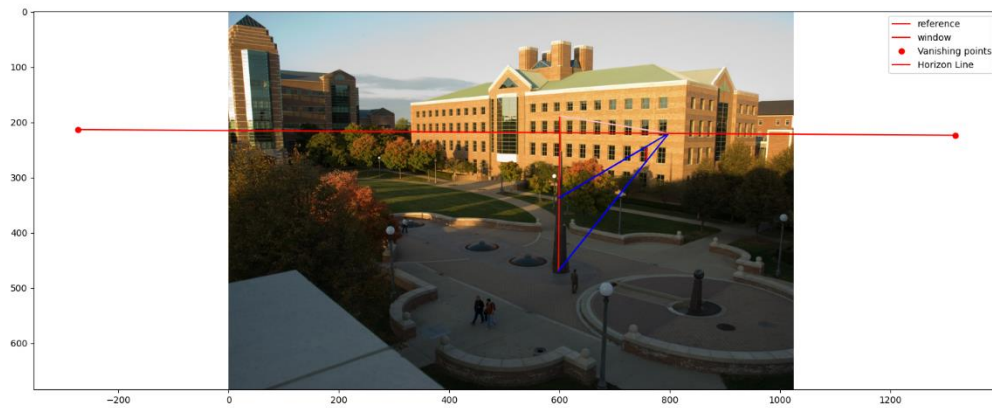


The height of this person shown in the above figure is 5.405



Therefore, the tallest guy in this figure is this guy:

Assume the reference is the spike statue and its height is 12 meters.



The height of window is 5.649 meters.

Part 2