# CS543 Assignment 3

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# Part 1: Homography estimation

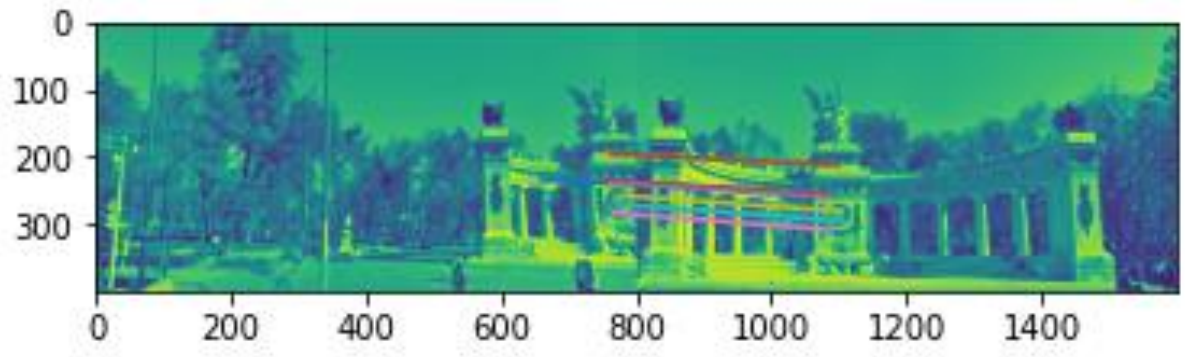
**Describe your solution, including any interesting parameters or implementation choices for feature extraction, putative matching, RANSAC, etc.**
I carried out the feature matching using the sift.detectAndCompute function from the cv2 library. Then I used the cv2.drawKeypoints function to display the detected key points.

Then using the scipy.spatial.distance.cdist function, I obtained coordinates for pairs of matching key point descriptors using a threshold of 7000.

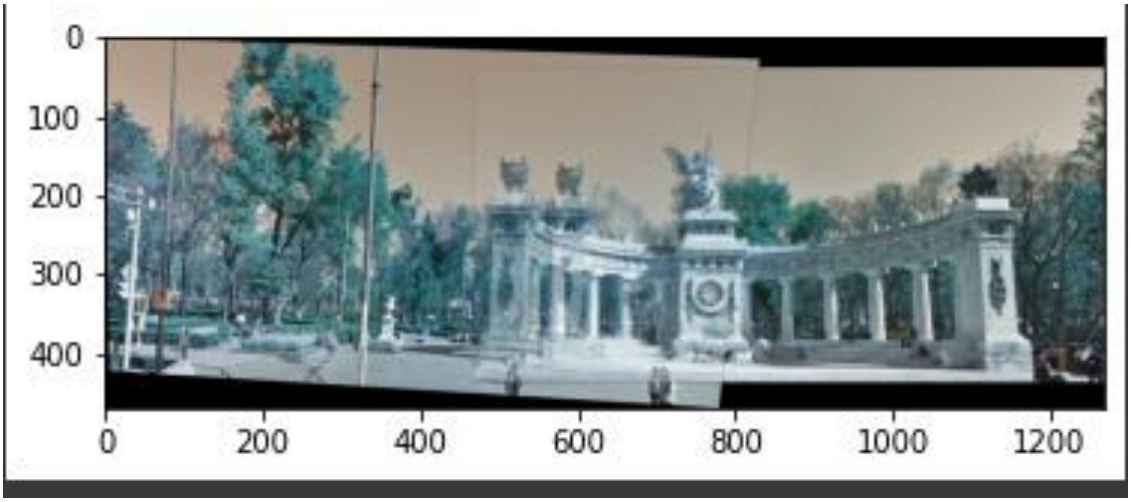
For RANSAC, I iterated 1000 times to find the best homography for the images. The function obtains random samples from the coordinate matches and picks the coordinates that have errors less than the ransac threshold of 0.5 and the corresponding homography which has the largest number of coordinate pair inliners. The average residual is also calculated here for each homography and the value for the best one is printed.

**For the image pair provided, report the number of homography inliers and the average residual for the inliers.**
Number of inliers: 10
Average Residual: 0.1928

**Also, display the locations of inlier matches in both images.**

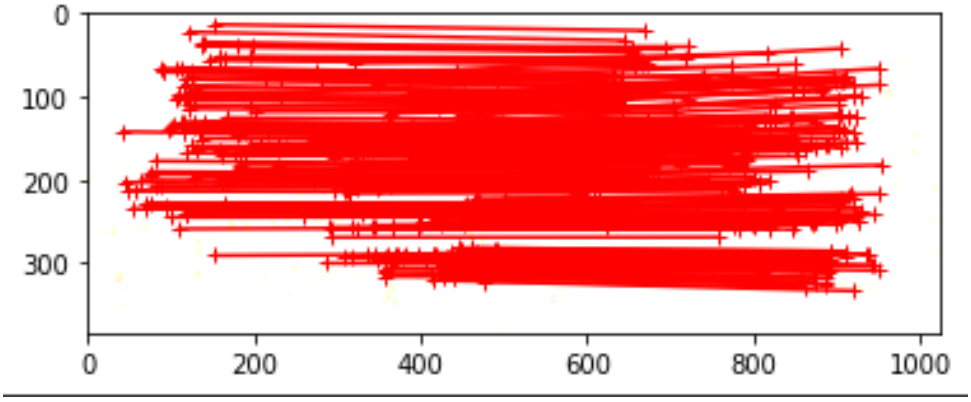



**Display the final result of your stitching.**



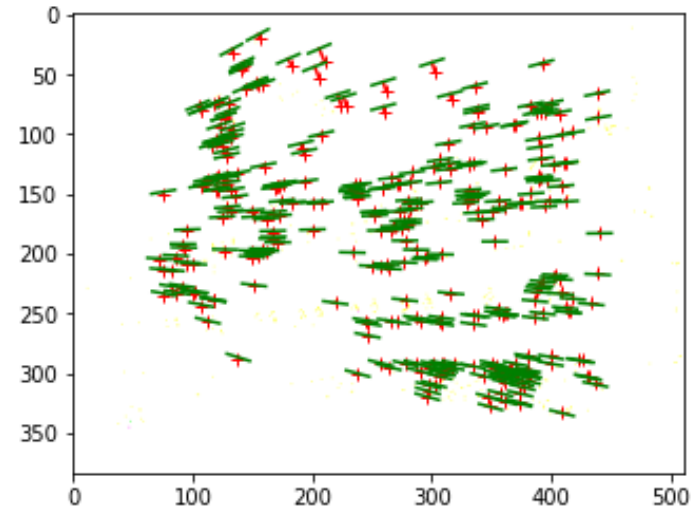

# Part 2: Fundamental Matrix Estimation, Camera Calibration, Triangulation

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



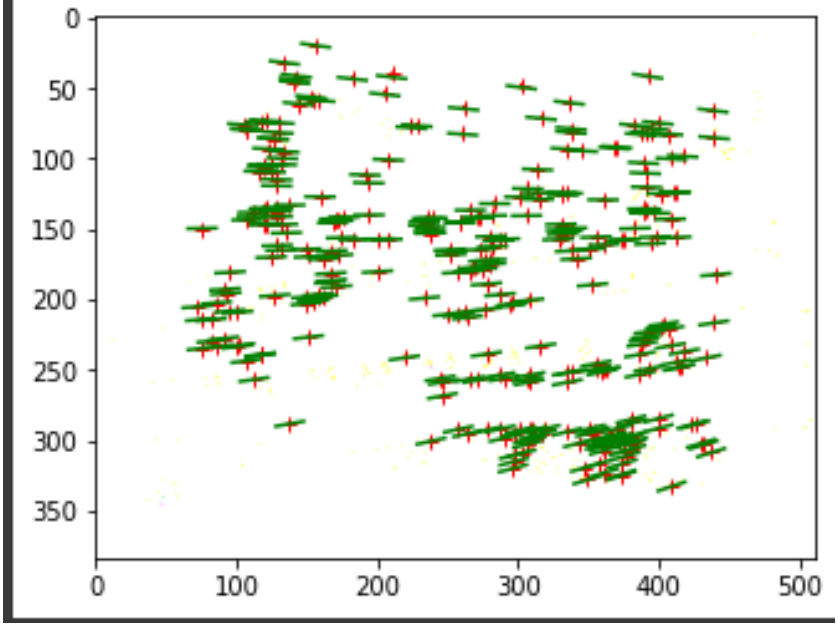
Normalized 8-point algorithm:

```
residual of method: 0.3429296218060371
```




Unnormalized 8-point algorithm:

```
residual of method: 0.0109109061890163 82
```




**For the lab image pair, show your estimated 3x4 camera projection matrices.**

Camera1:

```
[[-3.09963996e-03 -1.46204548e-04  4.48497465e-04  9.78930678e-01]
 [-3.07018252e-04 -6.37193664e-04  2.77356178e-03  2.04144405e-01]
 [-1.67933533e-06 -2.74767684e-06  6.83964827e-07  1.32882928e-03]]
```

Camera2:

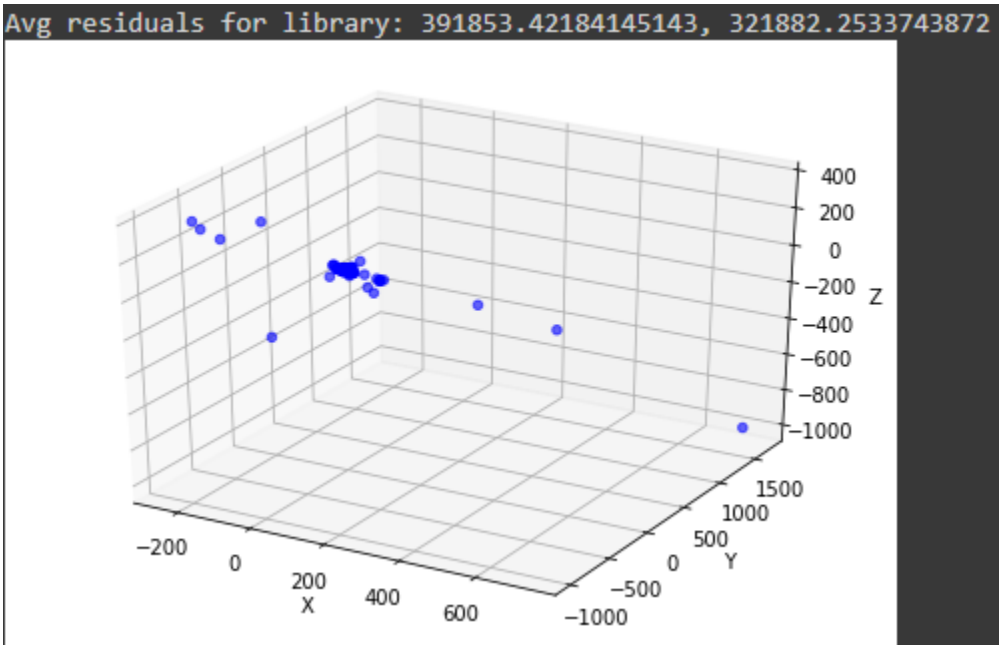
```
[[ 6.93154686e-03 -4.01684470e-03 -1.32602928e-03 -8.26700554e-01]
 [ 1.54768732e-03  1.02452760e-03 -7.27440714e-03 -5.62523256e-01]
 [ 7.60946050e-06  3.70953989e-06 -1.90203244e-06 -3.38807712e-03]]
```

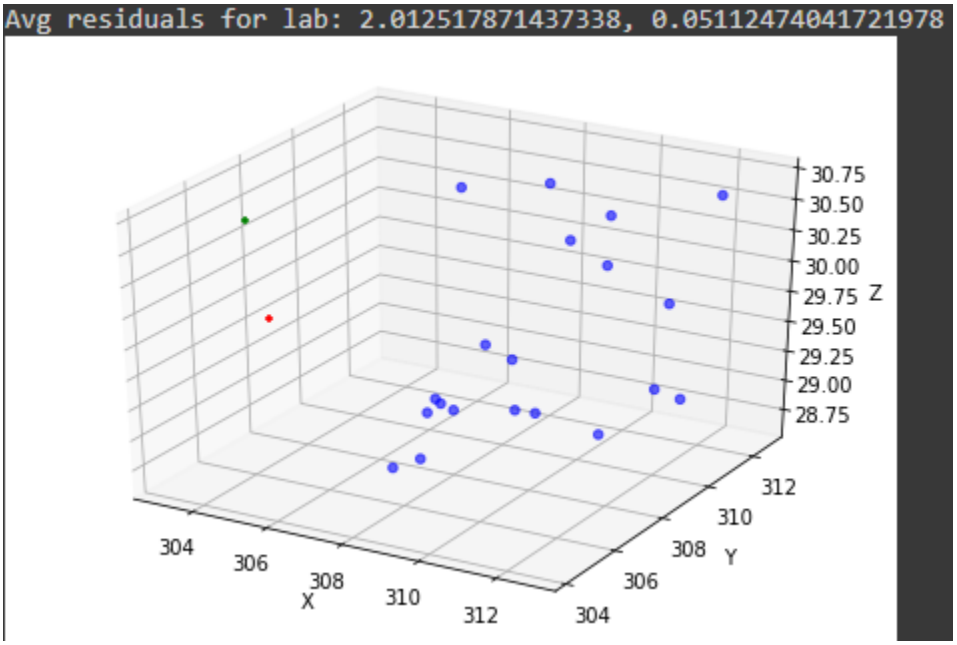
**Report the residual between the projected and observed 2D points.**

Residual for camera1 = 13.545

Residual for camera 2 = 3078.501

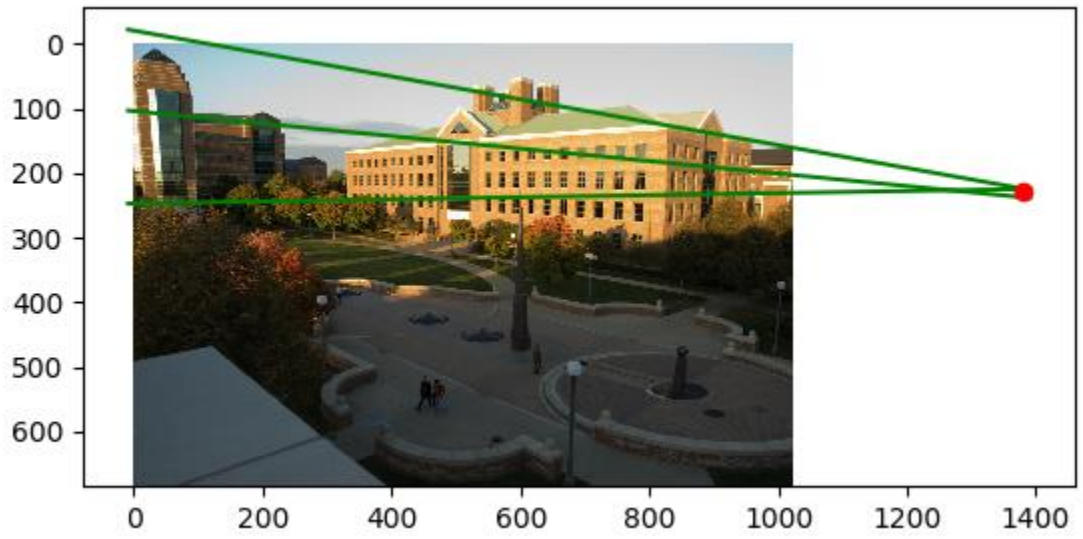
**For both image pairs, visualize 3D camera centers and triangulated 3D points.**

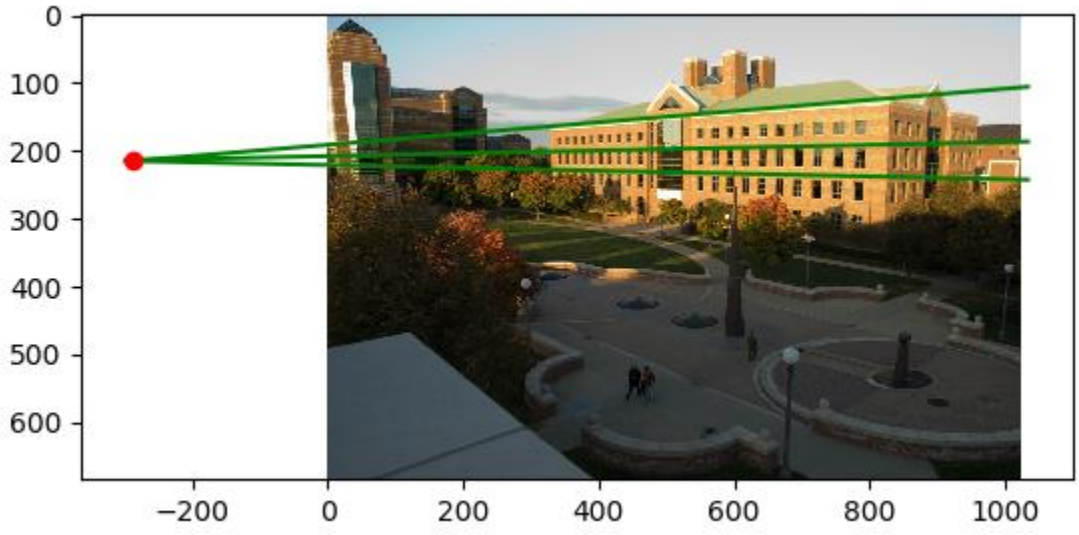


# Part 3: Single-View Geometry

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



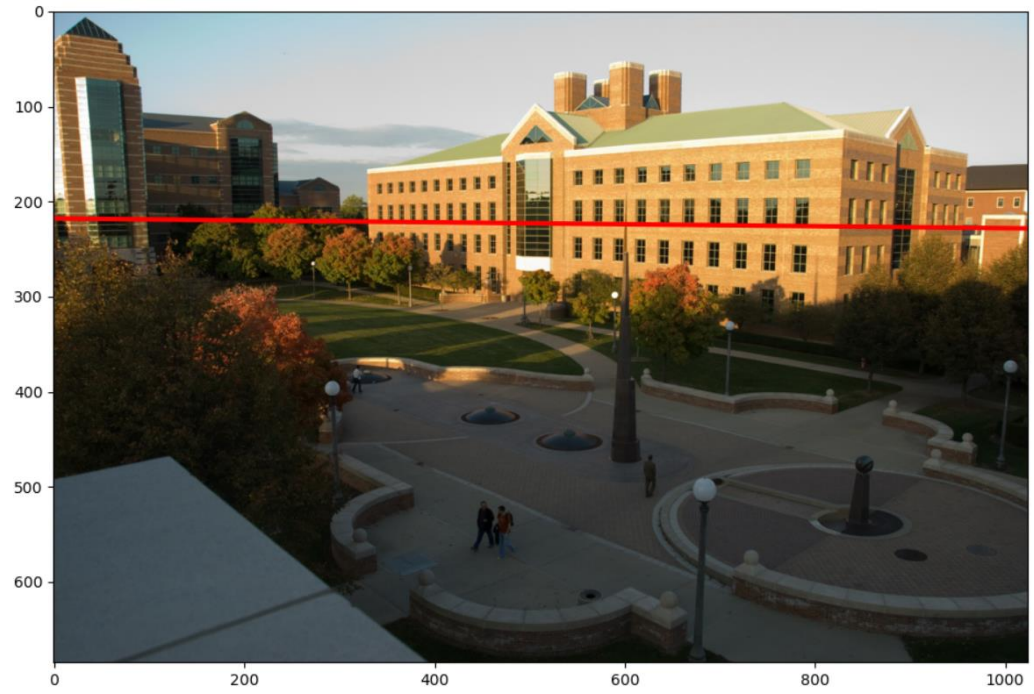




**Specify the VP pixel coordinates.**

In order from left to right (left horizontal, right horizontal, vertical)

```
[[-2.96469945e+02  1.28080923e+03  1.55304240e+02]
 [ 2.20520969e+02  2.19212527e+02  2.15434587e+04]
 [ 1.00000000e+00  1.00000000e+00  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.**




**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.**
Calculation was done using a function (get_camera_parameters) in the attached code

Focal length = 704.06

Principal point = (137.6, 243,43)

**Compute the rotation matrix for the camera.**

```
[[ 8.51330465e-01  8.29103367e-04 -5.24629156e-01]
 [-1.80373423e-02  9.99453804e-01 -2.76902042e-02]
 [ 5.24319648e-01  3.30364301e-02  8.50880427e-01]]
```

**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 19.667740734347916
the spike statue 10.841262417964026
the lamp posts 4.9292824511942
```

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

The heights are scaled by 6’/5’6” or 1.8288/1.6764 in meters

```
CSL building 23.072659298501254
spike statue 10.738230630692003
lamp posts 5.568722676958392
```

# 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**

**Part 3**