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April 4, 2019

CS 543 Assignment 3

Part 1

Homography estimation:

a. Describe your solution, including any interesting parameters or implementation choices for feature extraction, putative matching, RANSAC, etc.

In feature extraction, I use the cv2 sift to get the key points and the descriptions and calculate the distance between every pairs. There are 4410 key points in the left image and 3384 key points in the left images. I choose the distance below 10000 and there are 61 pairs, which I think are 'good matches'.

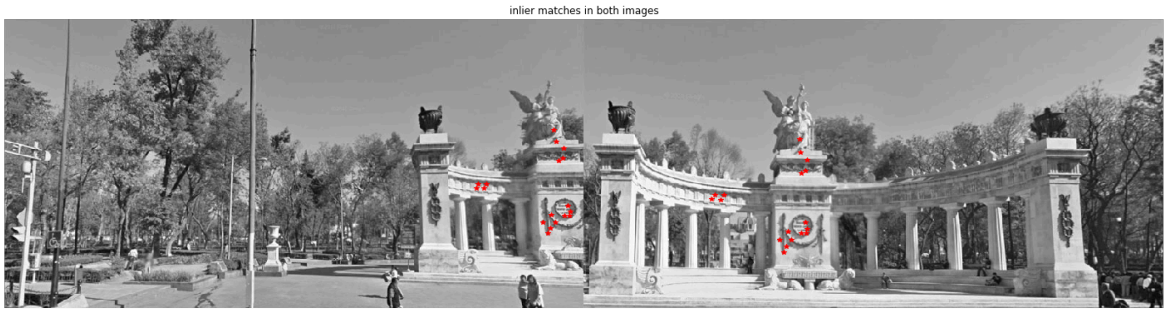
I use RANSAC to fit the transform matrix. In the RANSAC function, first, randomly choose 4 pairs of the key points (minimum) and get the transform matrix, and then I get the number of inlier numbers with a threshold of distance. (With several experiments, 5 is a property number). And if there are above 15 inliers points, this matrix is regarded as a "good" transform matrix and I use all of these key points to fit a new transform matrix, otherwise if the inlier number is less than 15, I give up this matrix and randomly choose 4 pairs and do this again.

b. For the image pair provided, report the number of homography inliers and the average residual for the inliers (squared distance between the point coordinates in one image and the transformed coordinates of the matching point in the other image). Also, display the locations of inlier matches in both images.

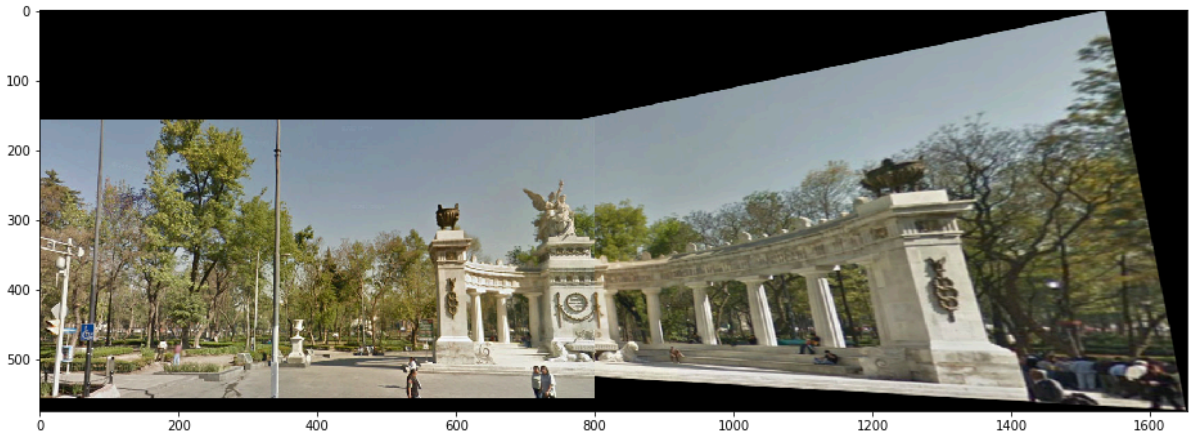
the number of homography inlier: 18

the average residual for the inliers: 0.24

Inlier matches in both images



c. Display the final result of your stitching

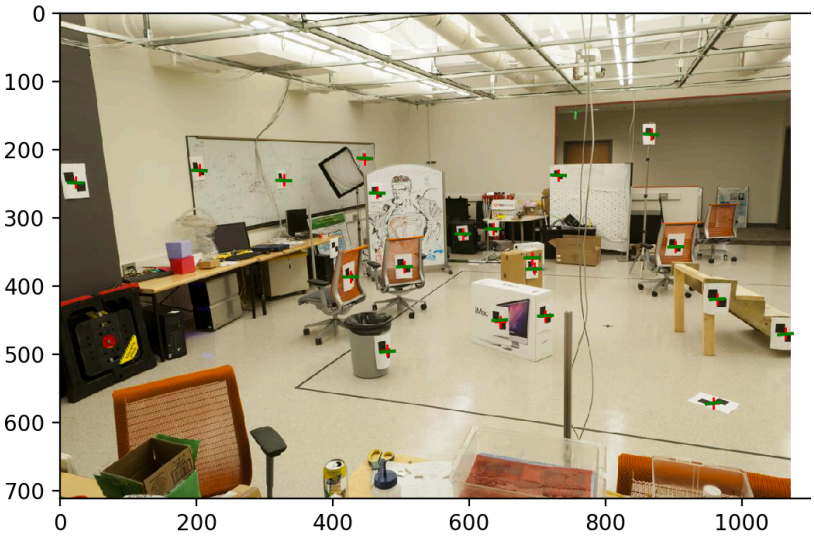


Part 2

1. Fundamental matrix estimation

lab photo:

Normalized:

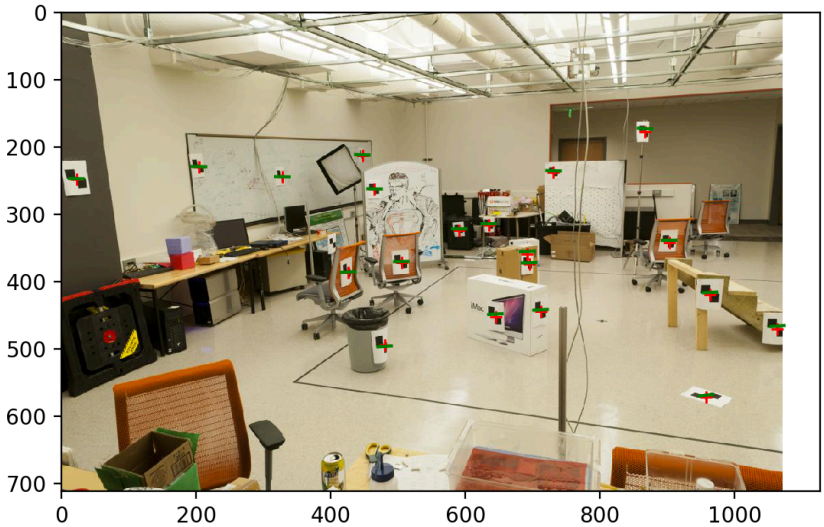


Residual:

distance of points:0.0025

distance of lines:0.0019

Unnormalized:



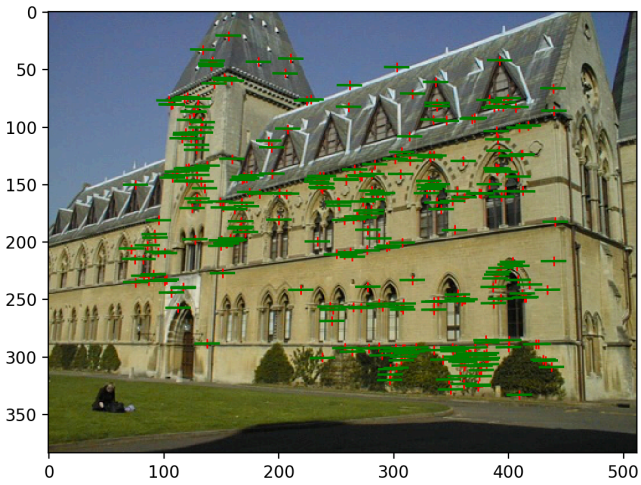
Residual:

distance of points:0.0025

distance of lines:0.0019

Library:

Normalized:

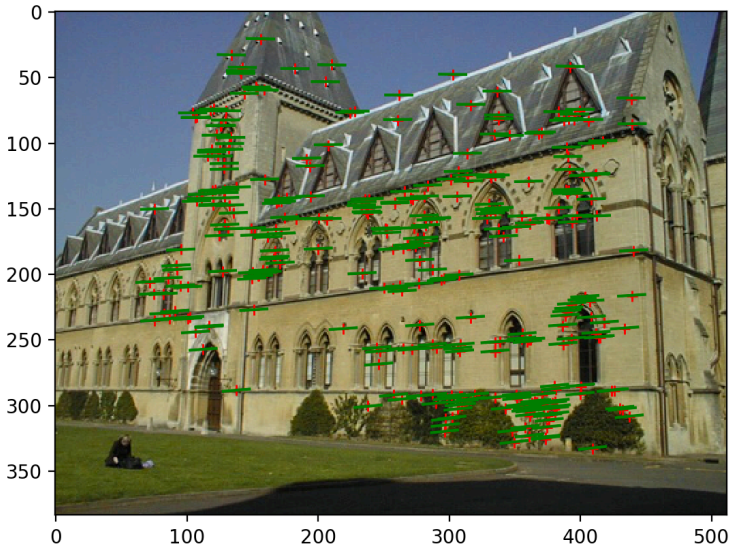


Residual:

distance of points:0.0017

distance of lines:0.0013

Unnormalized:



Residual:

distance of points:0.0025

distance of lines:0.0021

2. camara projection matrix.

lab 1 & lab 2

```
In [46]: labcam1 = np.array([[ 3.10740501e-03,  1.38225705e-04, -4.30393249e-04,-9.79335944e-01],
                            [ 3.02102470e-04,  6.36588396e-04, -2.78063121e-03,-2.02191134e-01],
                            [ 1.67247027e-06,  2.75156573e-06, -6.60891275e-07,-1.32847591e-03]])
         labcam2 = np.array([[-6.95025729e-03,  4.04449978e-03,  1.24803741e-03,8.26152566e-01],
                            [-1.55403296e-03, -1.01963966e-03,  7.26123346e-03,5.63327635e-01],
                            [-7.63228489e-06, -3.69298847e-06,  1.80489202e-06,3.39276049e-03]])
```

Residual and distance

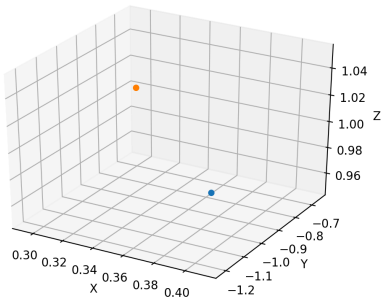
	residual error	squared distance
lab1	15.00	4.53
lab2	16.94	4.16

Camera Center:

Library:

1: (0.41,-1.21)

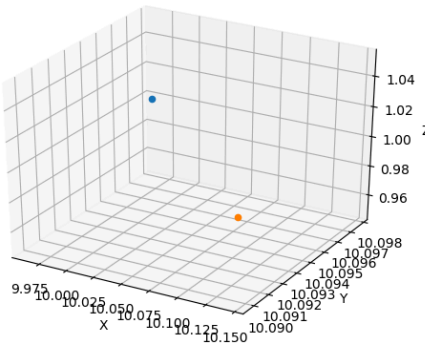
2: (0.29,-065)



Lab:

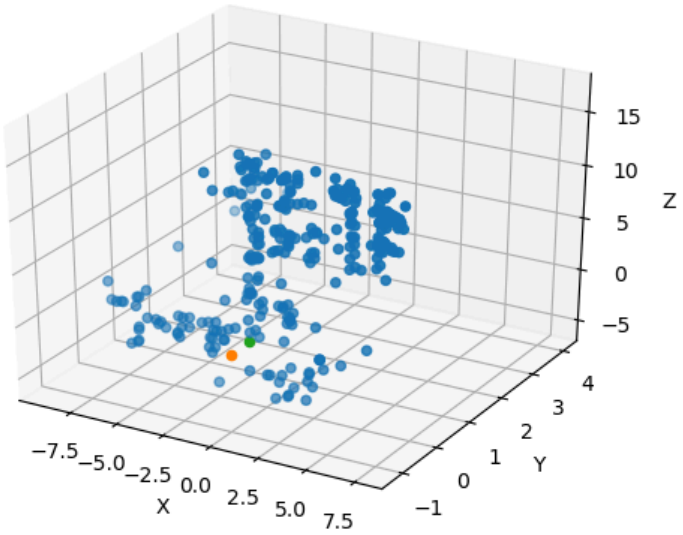
1: (9.96,10.1)

2: (10.14,10.08)



3. visualize 3D camera centers and triangulated 3D points.

Library:

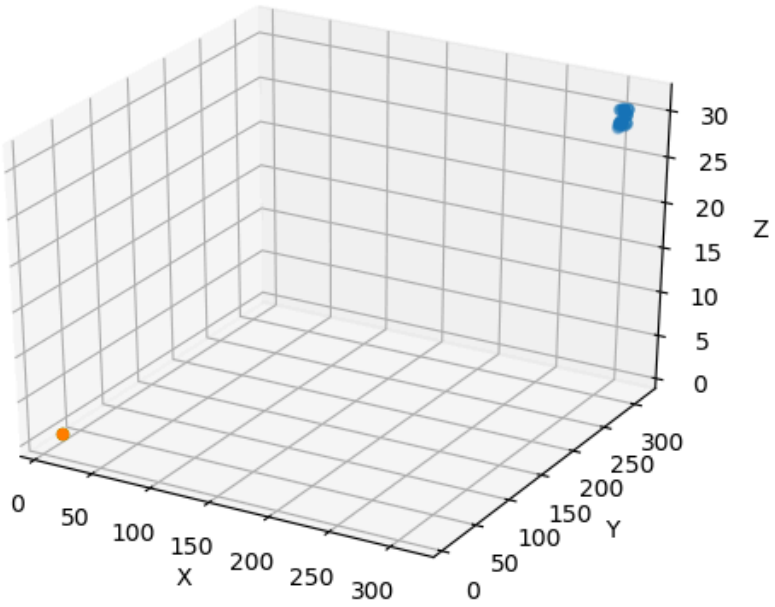


residual:

Library1 : 0.073

Library2: 0.267

Lab:



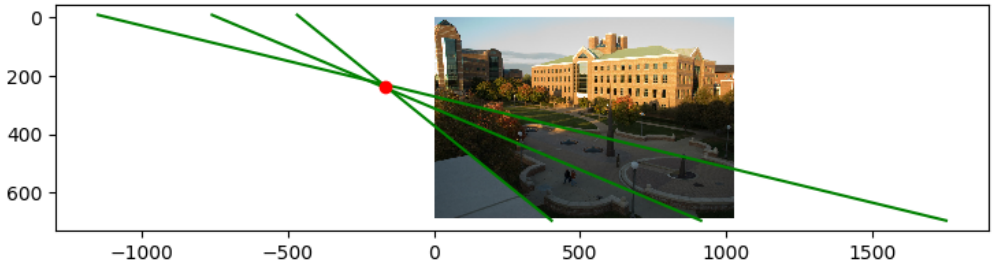
residual:

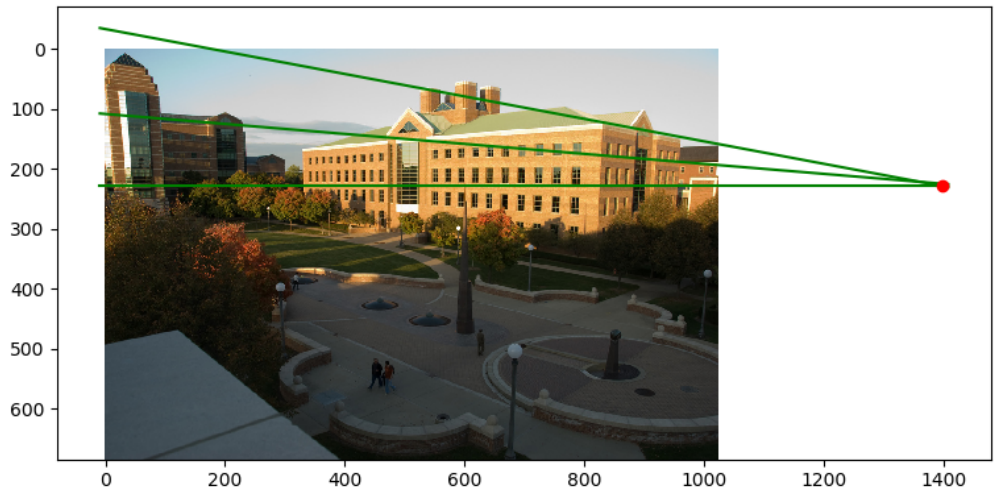
Lab1: 0.52

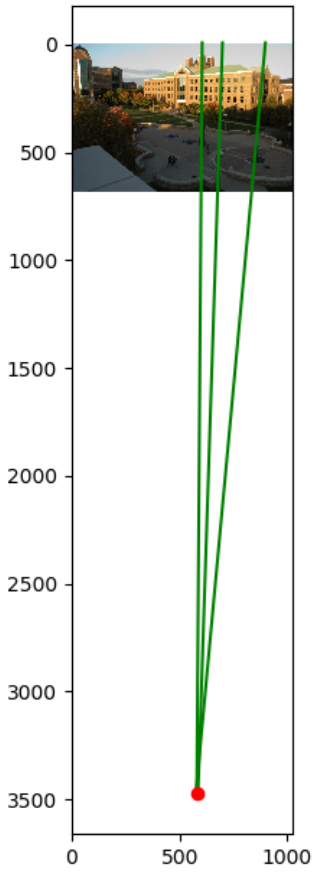
Lab2: 0.58

Part 3

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







Above four images are 3 vanishing points and the horizon line.

Horizon line: 0.0047x+0.99y-235.02 = 0

Three vanishing points: (-168.8,235.8), (1358.9,2285.9),(617.3,2740)

2. 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.

f = 727.67, u = 606.54, v = 464.37

I use this equation to solve this problem:

$$\mathbf{v}_i^T \mathbf{K}^{-T} \mathbf{K}^{-1} \mathbf{v}_j = 0$$

There are 3 unknown variables: f, u , v in this equation, so I need 3 equations. I already have 3 vanishing points.

(i, j) equals to (1,2),(1,3),(2,3) to solve this. I use sympy package to solve the equations.

3. Compute the rotation matrix for the camera, setting the vertical vanishing point as the Y-direction, the right-most vanishing point as the X-direction, and the left-most vanishing point as the Z-direction.

R = [[0.70123136 0.00450802 -0.71291953]
[-0.21975607 0.95265574 -0.21012927]
[0.67821962 0.30401762 0.66902275]]

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

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0
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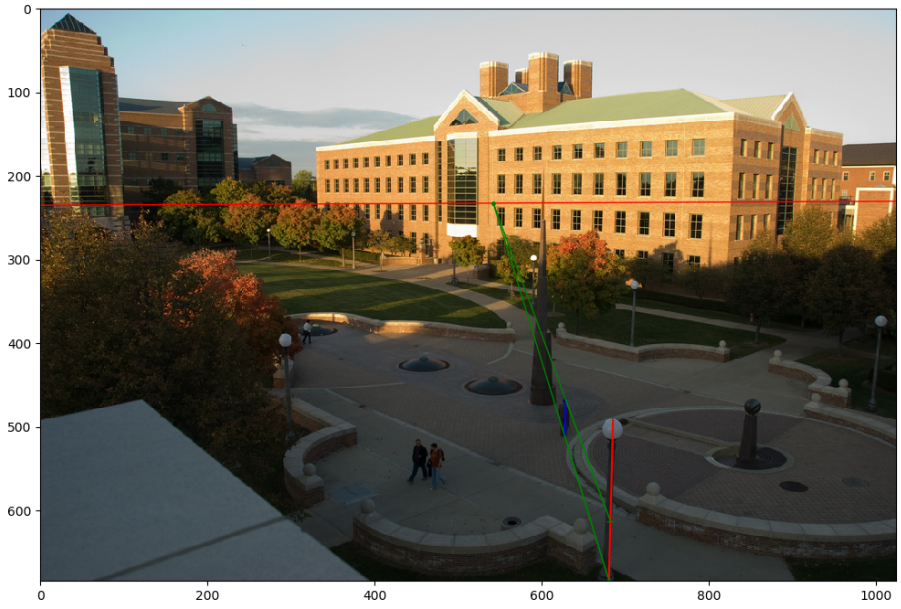
200
300
400
500
600
0
200
400
600
800
1000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People	CSL	Spike	Lamp
5ft 6in	27.24m	10.93m	4.28m
6 feet	24.16m	10.05m	4.11m