Report for lab4

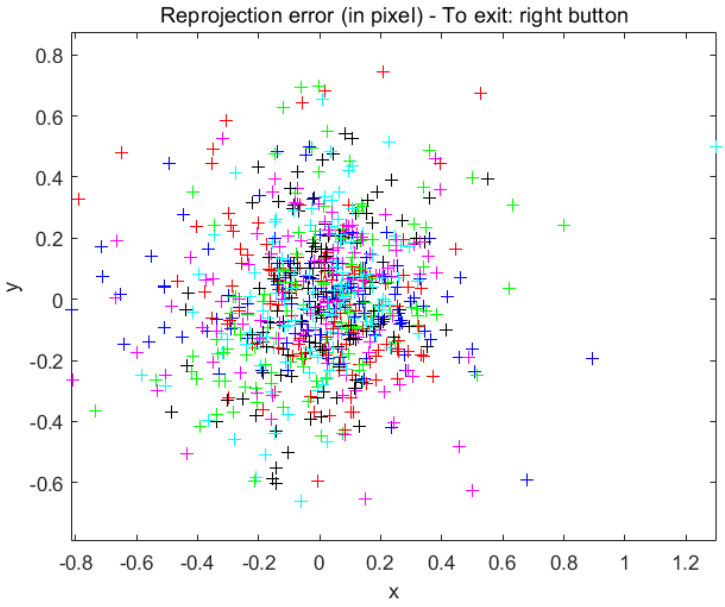
EECE 5554: ROBOTIC SENSOR AND NAVIGATION

HAOJIE HUANG

Part 1 – camera calibration

Following the instructions posted on the camera calibration toolbox for Matlab:
http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/example.html

The mean projection error and the plot



Loading calibration results from Calib_Results.mat

Calibration results (with uncertainties):

Focal Length: fc = [1024.94484 1028.90639] ± [2.10096 2.07646]

Principal point: cc = [489.94099 491.72926] ± [1.97984 1.83416]

Skew: alpha_c = [0.00000] ± [0.00000] => angle of pixel axes = 90.00000 ± 0.00000 degrees

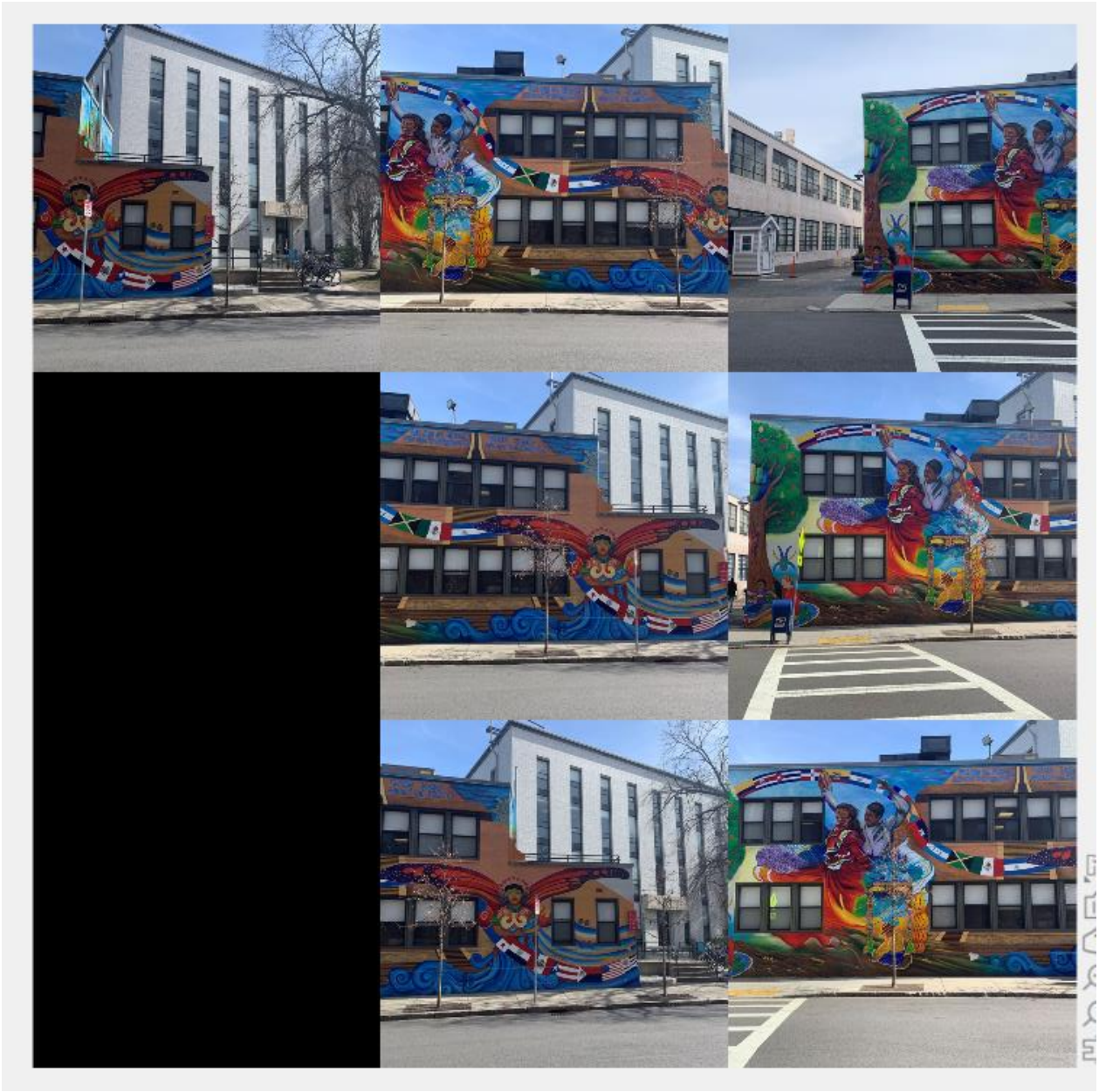
Distortion: kc = [0.22330 -0.78800 0.00003 0.00122 0.00000] ± [0.00908 0.04481 0.00084 0.00084 0.00000]

Pixel error: err = [0.23224 0.22527]

- I used 12 photos for the calibration and each has a pixel size of 1000*1000
- The mean squared error is 0.23224 and 0.22527 pixel along x and y direction

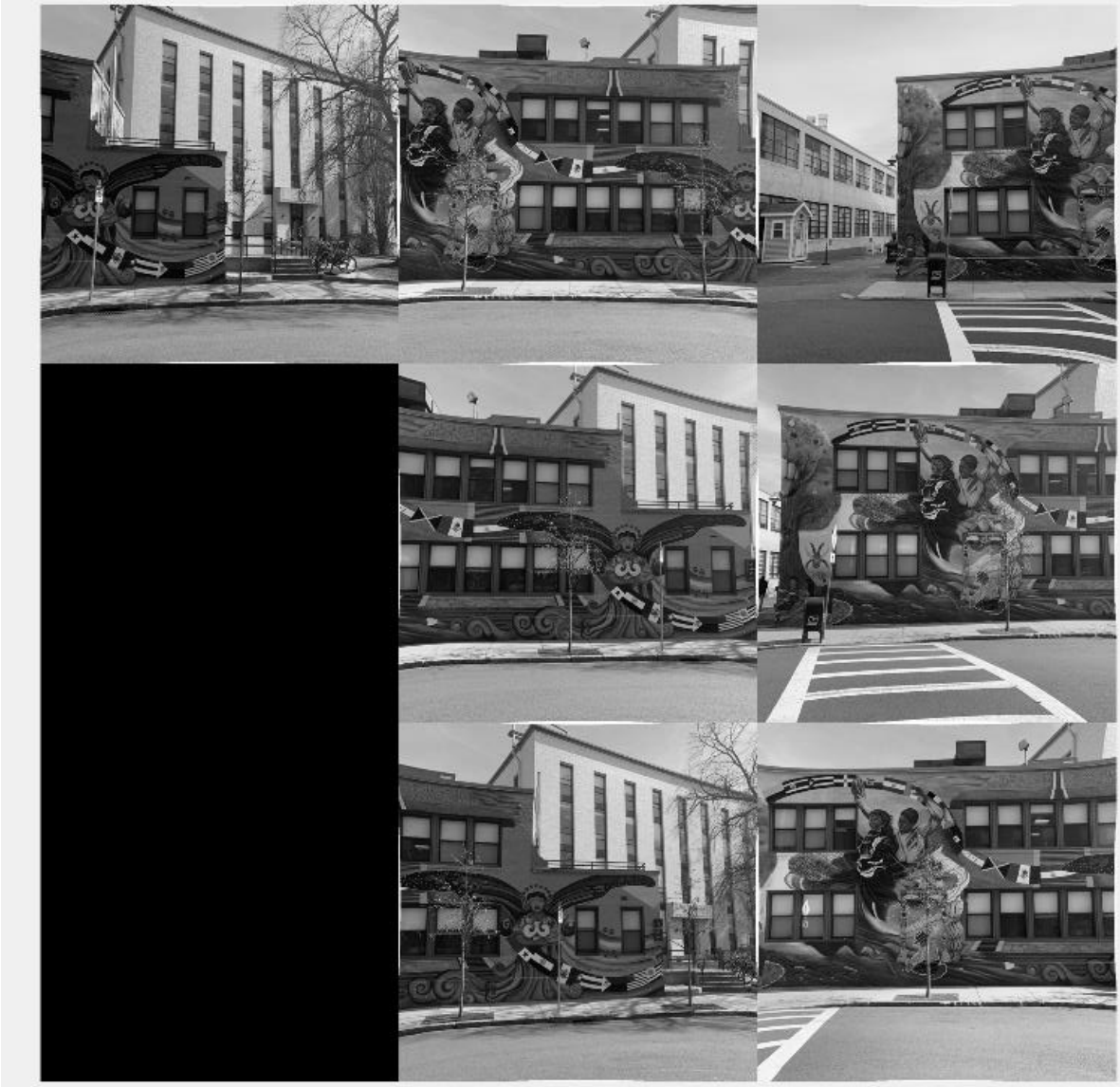
Part 2: photo mosaicing

The Latino student center before calibration



The first image is at the top-left corner, the second is below the first and so on.

The Latino student center after calibration

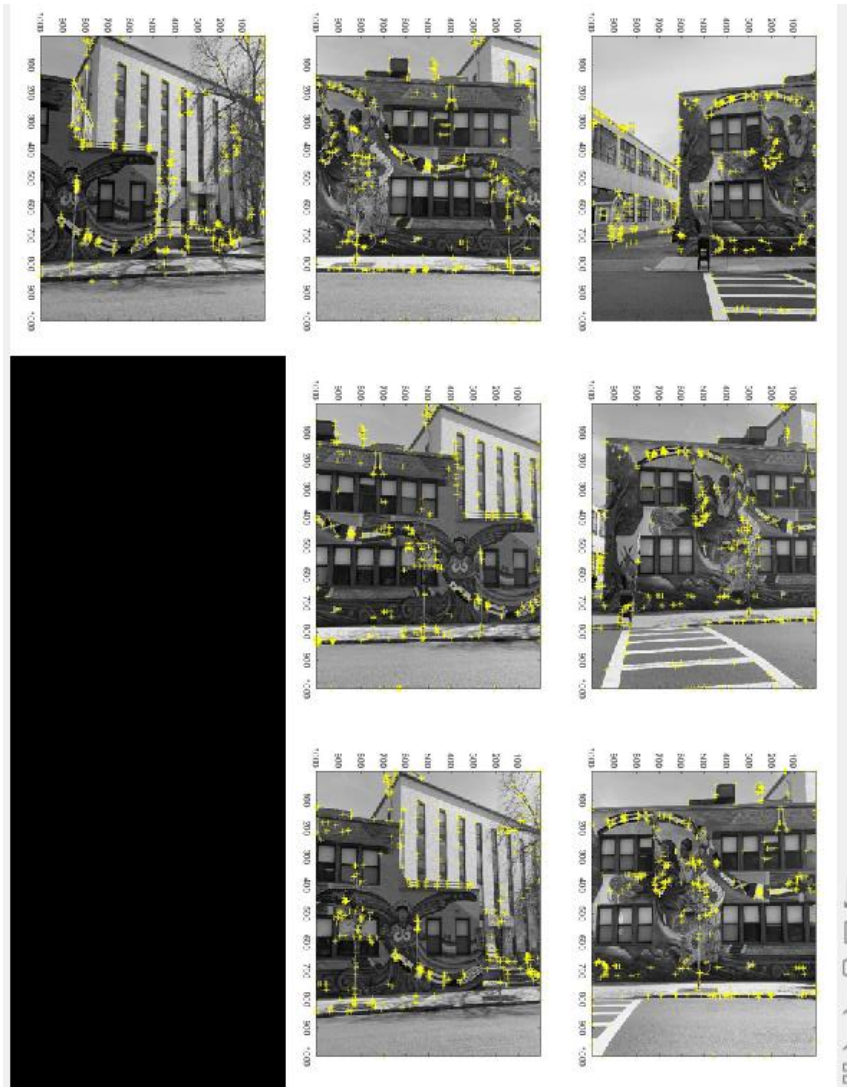


After calibration, the **image is even more distorted than the original.** This is due to that **apple now calculates the intrinsic parameters of its cameras and undistorts the image.** I will use the original image to do the panorama.

https://developer.apple.com/documentation/avfoundation/avcameracalibrationdata

Use the harris detector to get the features on the image:

- maximum number of interest points = 500
- break the image into regions [3,3] to distribute the feature points more uniformly



Stitching image:

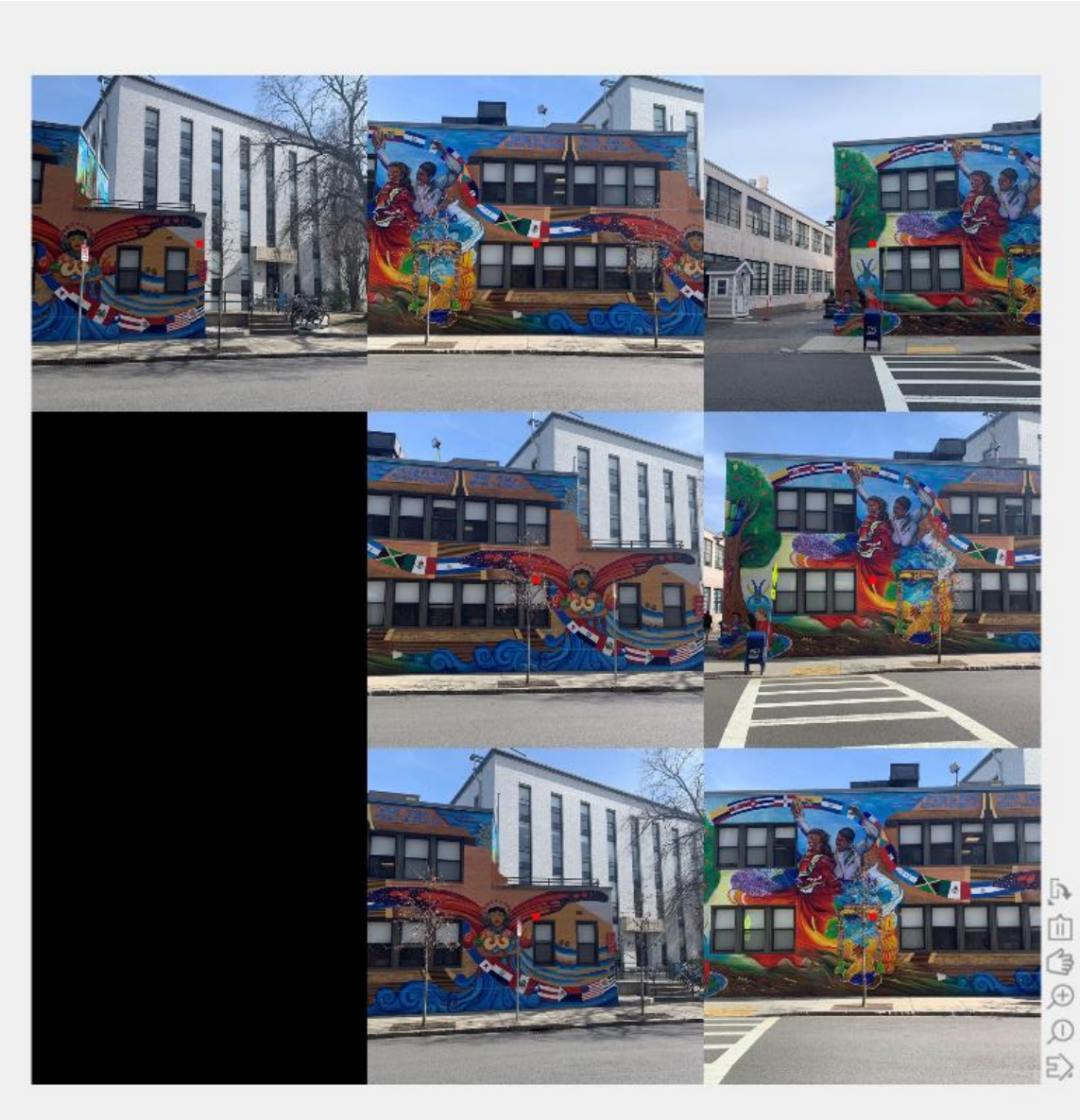
Use the Matlab example: **Feature Based Panoramic Image Stitching** from the link

https://www.mathworks.com/help/vision/examples/feature-based-panoramic-image-stitching.html

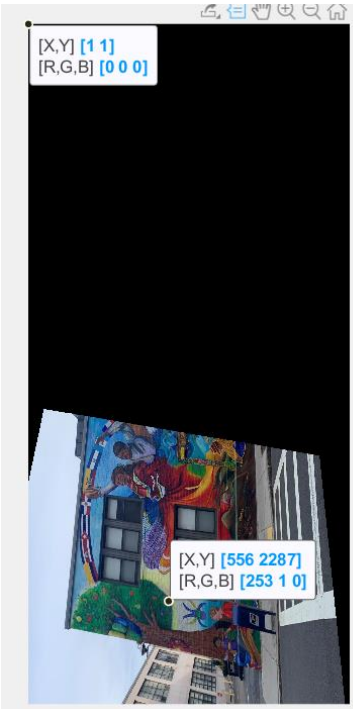
The composite mosaic looks good because the **edge of the building is almost straight**. However, not all of the edges are straight lines such as the right part of the top edge of the building, and right part of the edge of the road. It is because of the pose of the camera are not always same during picturing.

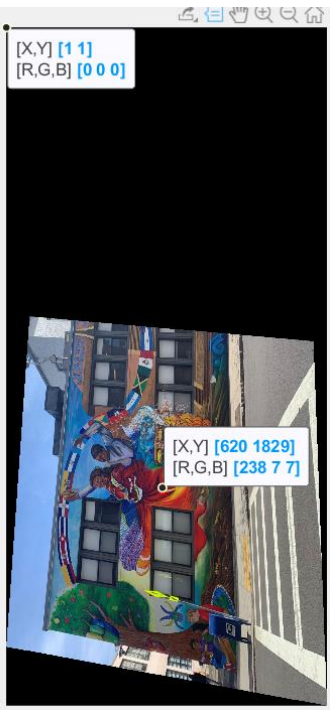
The position of the camera position:

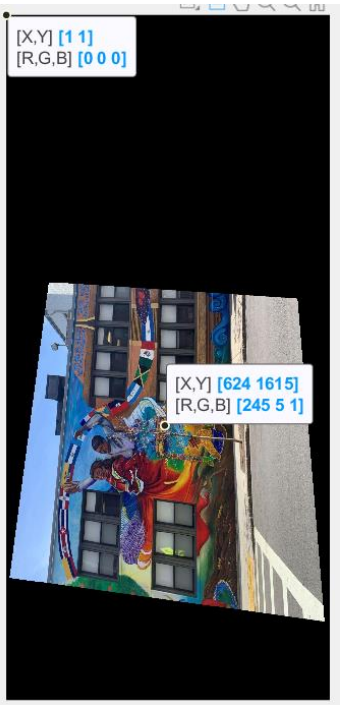
Suppose that the camera's location is at each center of the image. I mark a small red region at the center of each image (1000*1000)

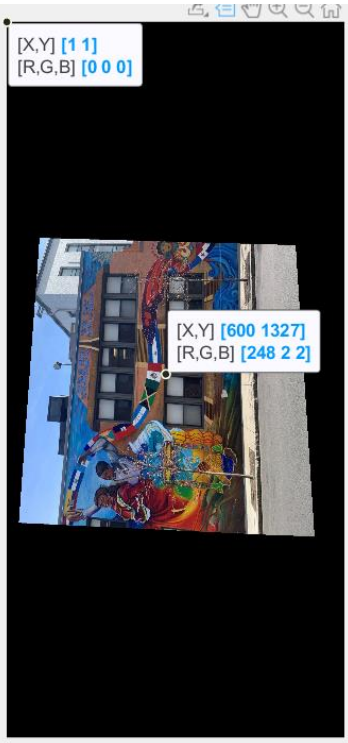


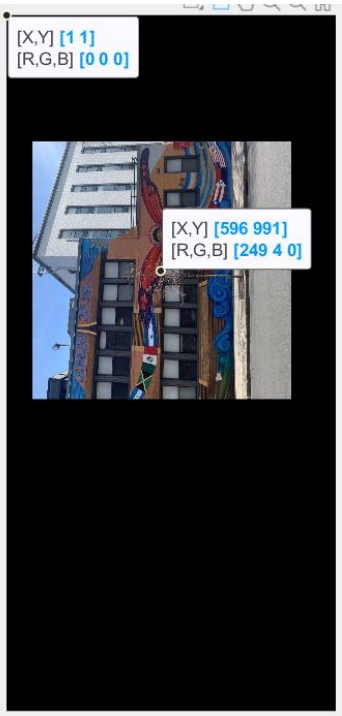
Secondly, apply the transform matrix to each of the image and find the pixel position of the centered marked region.

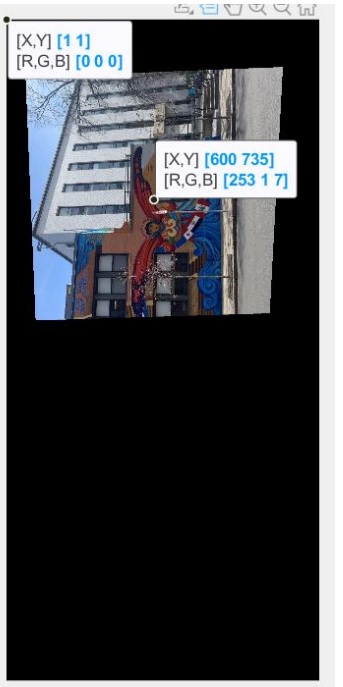

[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [556 2287]
[R,G,B] [253 1 0]

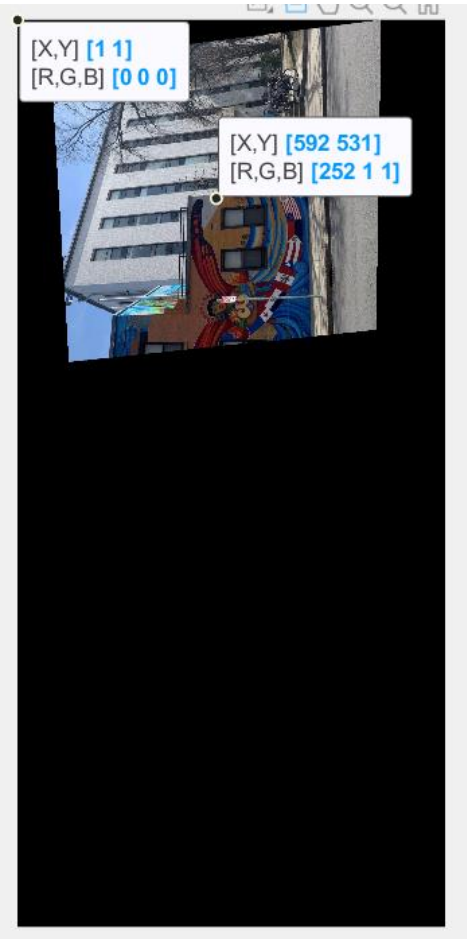

[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [620 1829]
[R,G,B] [238 7 7]


[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [624 1615]
[R,G,B] [245 5 1]


[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [600 1327]
[R,G,B] [248 2 2]


[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [596 991]
[R,G,B] [249 4 0]


[X,Y] [1 1]
[R,G,B] [0 0 0]
[X,Y] [600 735]
[R,G,B] [253 1 7]



After applied the transform matrix to each of the picture, we can easily find the pixel coordiante of the red centered mark. The origin is the top left and the camera positions are:

Camera 1: (556,2287)

Camera 2: (620,1829)

Camera 3: (624,1615)

Camera 4: (600,1327)

Camera 5: (596,991)

Camera 6: (600,735)

Camera 7: (592,531)

Part3: Varying overlapping

The cinder block:

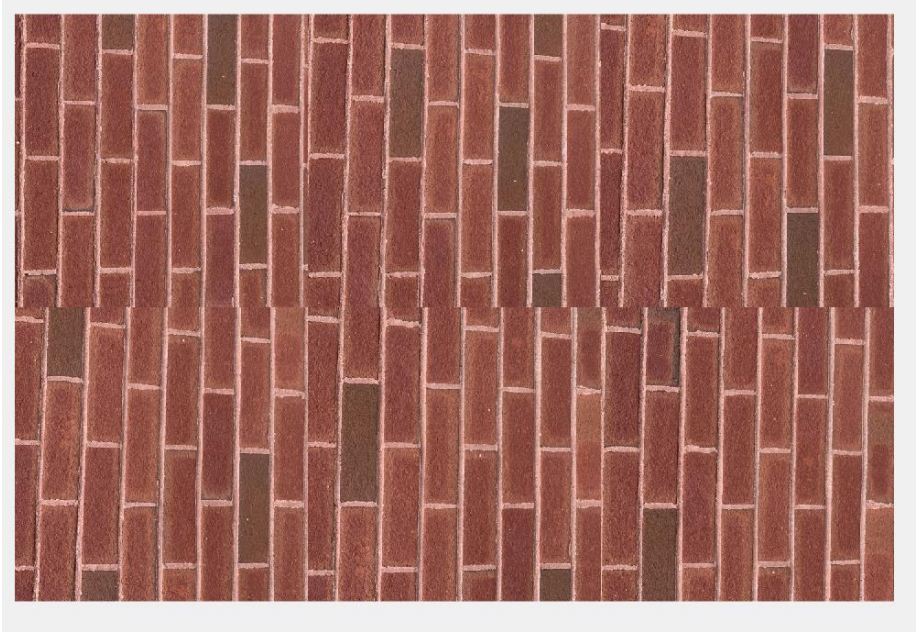


Figure: Six cinder blocks with overlapping by 50%

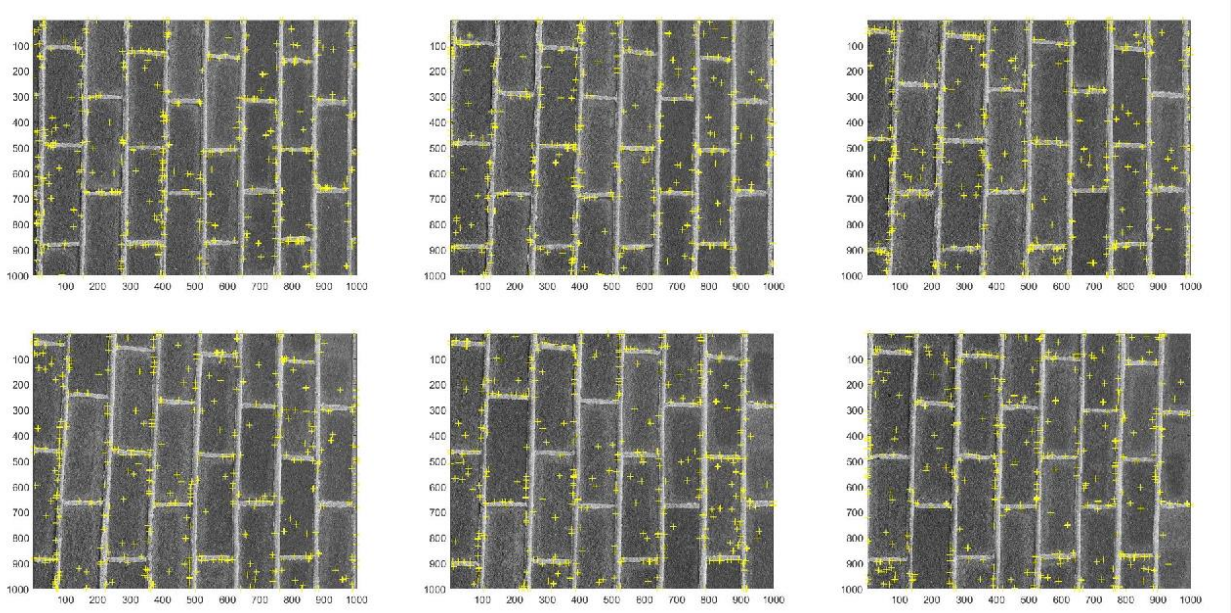
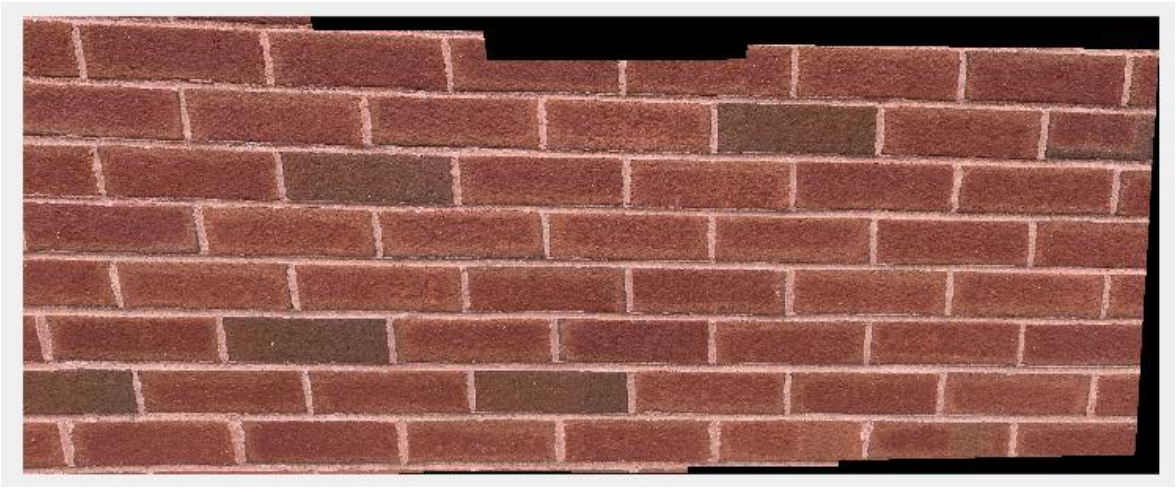


Figure: The 500 features detected by the Harris

The panorama

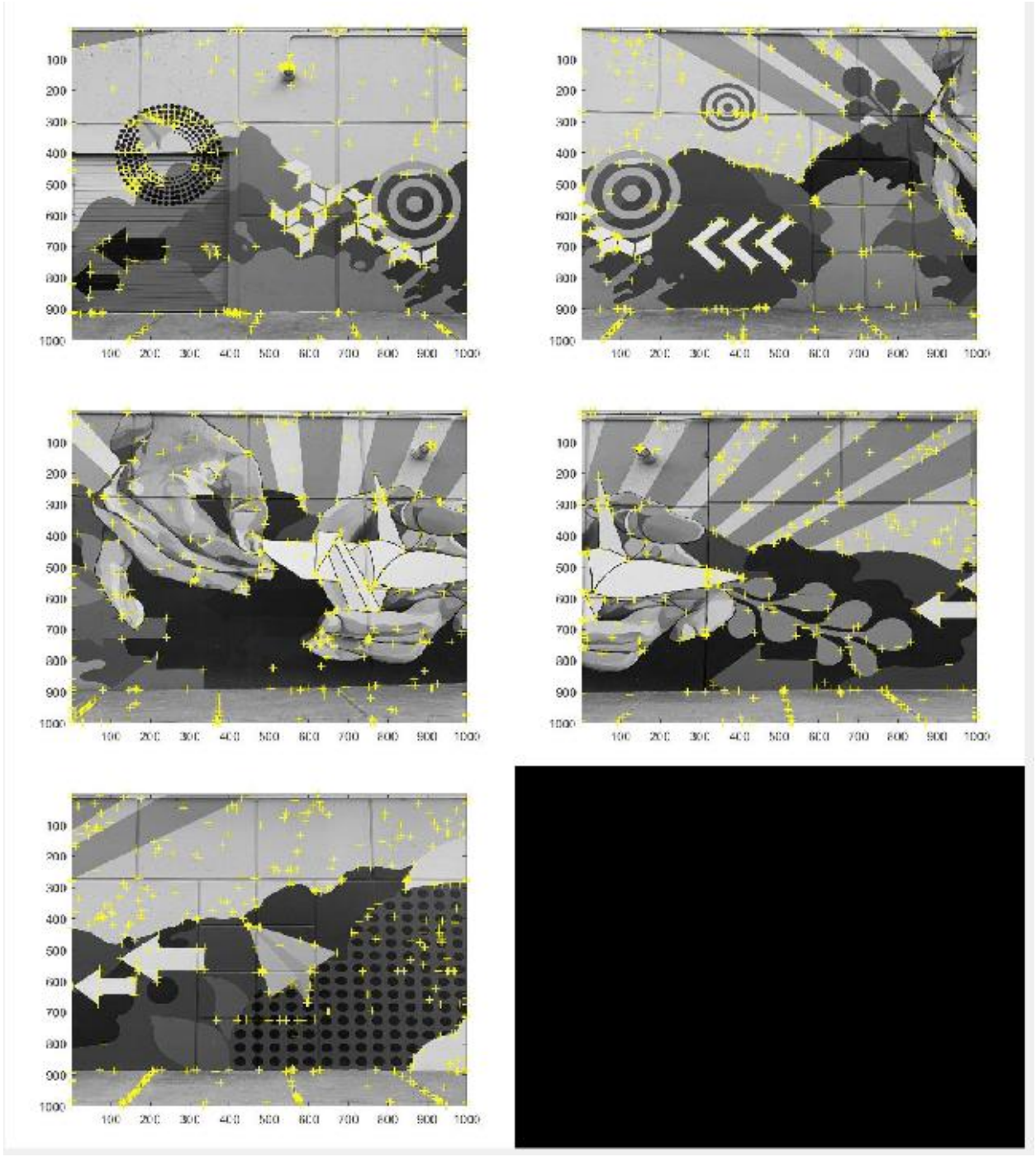


The 50% overlapping give us many same feature points between two sequential images, and the transform matrix is easy to be calculated. As a result, the panorama seems good.

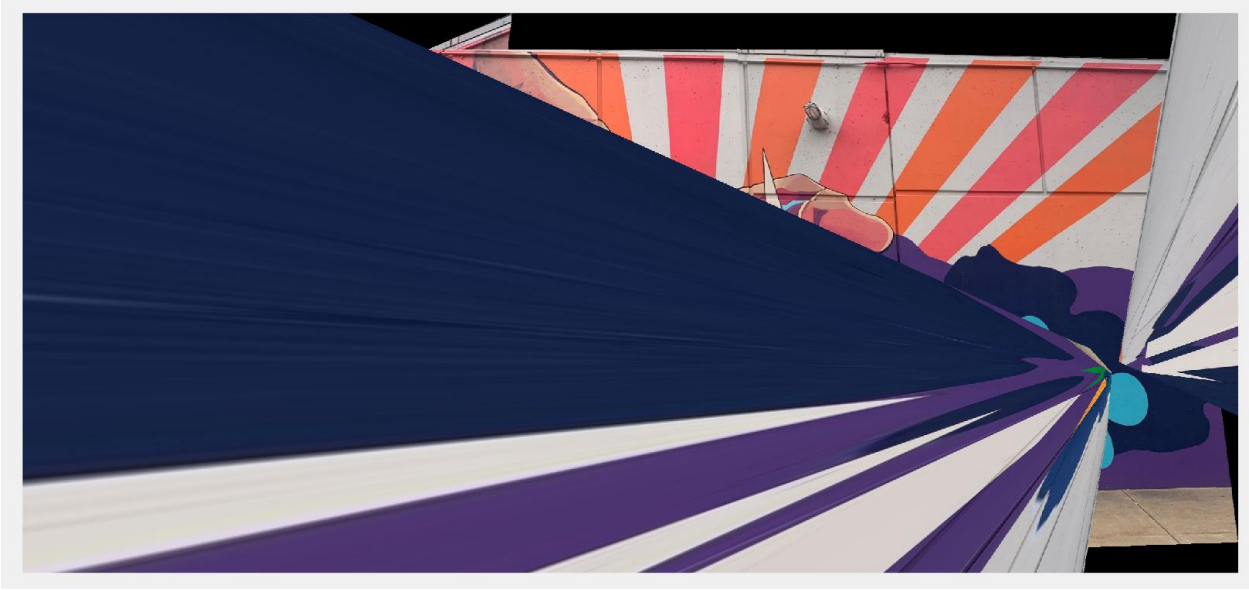
The graffiti:

The overlap is considerably small between the six pictures (12%-15%).

The 500 feature points detected by the Harris



The outcome of the panorama is wired as the following:



This is **due to the small overlap**. The algorithm cannot find the right transform matrix, and this wired panorama often comes with the following warning:

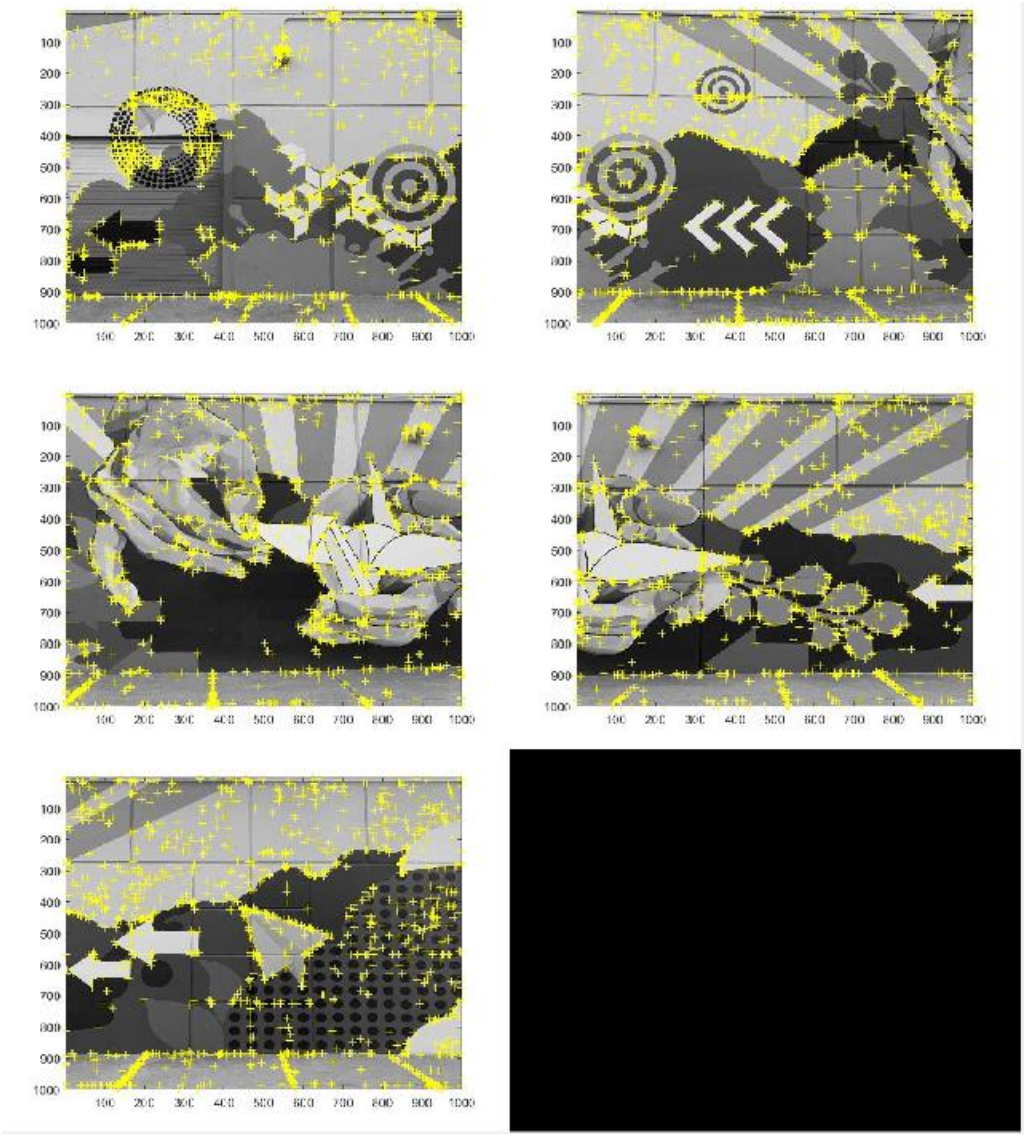
Maximum number of trials reached. Consider increasing the maximum distance or decreasing the desired confidence.

In this case, we can increase the maximum feature points and might also break the image into more regions distribute the feature points more uniformly. With more uniformly distributed features, the transform matrix between two pictures is easy to be calculated.

Use the Harris detector to get the features on the image:

- maximum number of interest points = **1500**
- break the image into regions [3,3] to distribute the feature points more uniformly

1500 feature points on each image



For now, it seems better the previous panorama.