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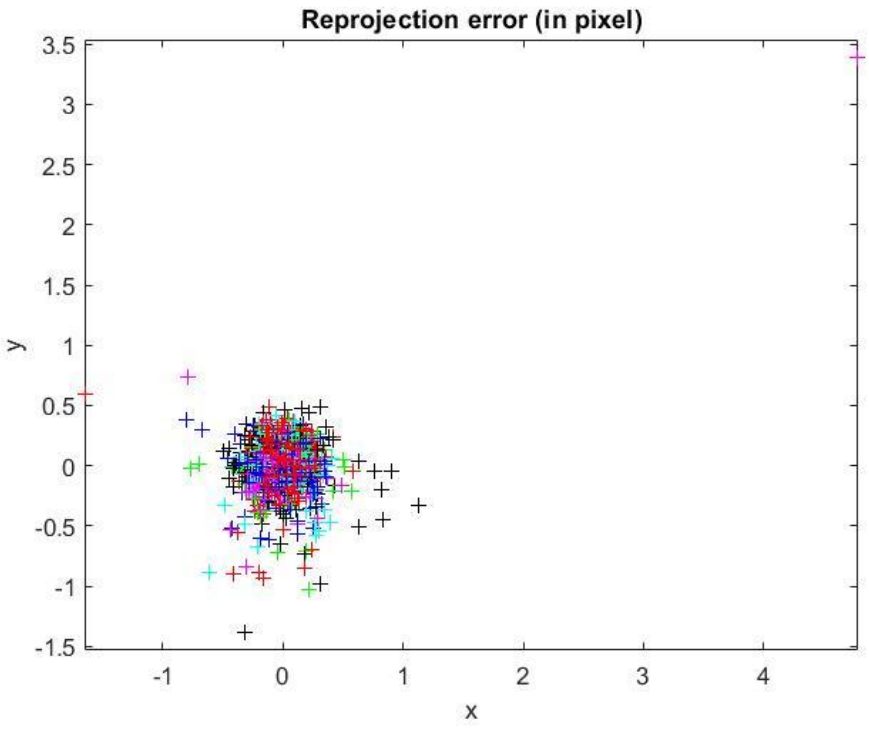
LAB-5 REPORT

Part 2: Camera Calibration:

The following are the images taken for camera calibration using the Caltech Camera Calibration toolbox:

The resultant reprojection error plot is as shown:



The calibration parameters including the reprojection pixel error is as shown:

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Calibration results (with uncertainties):

Focal Length:          fc = [ 1200.85007   1199.61812 ] ± [ 3.17766   3.27074 ]
Principal point:       cc = [ 794.04183   347.91228 ] ± [ 4.31515   3.63160 ]
Skew:             alpha_c = [ 0.00000 ] ± [ 0.00000  ]   => angle of pixel axes = 90.00000 ± 0.00000 degrees
Distortion:            kc = [ 0.01995   0.10209   -0.00378   -0.00152  0.00000 ] ± [ 0.00842   0.04135   0.00107   0.00146  0.00000 ]
Pixel error:          err = [ 0.25035   0.23864 ]

Note: The numerical errors are approximately three times the standard deviations (for reference).
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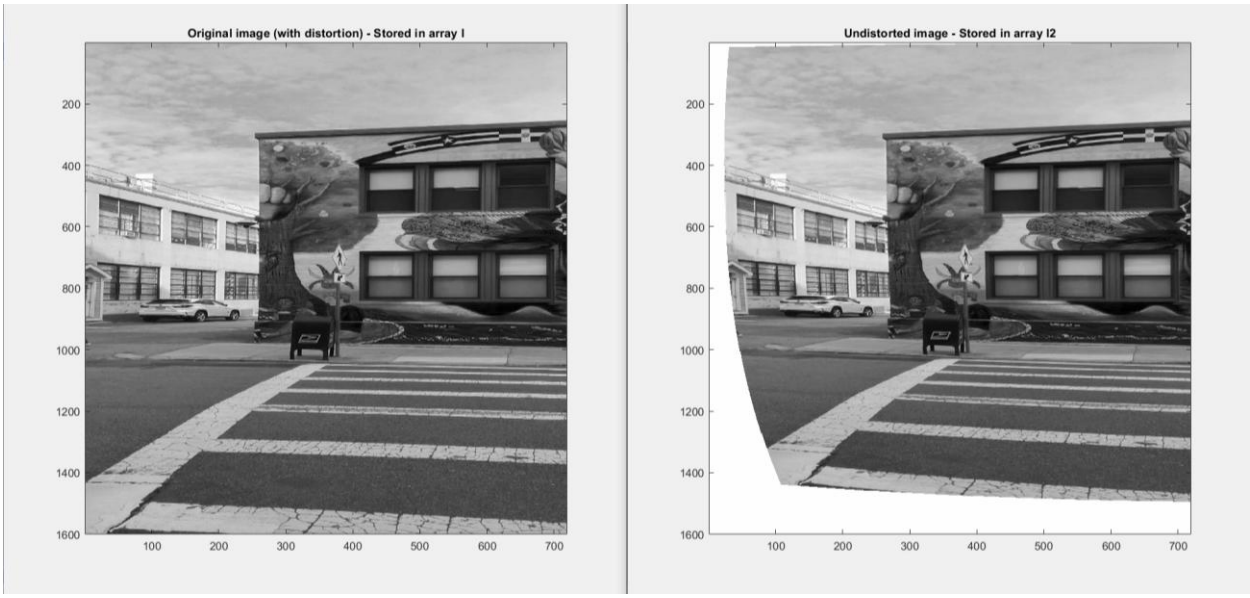
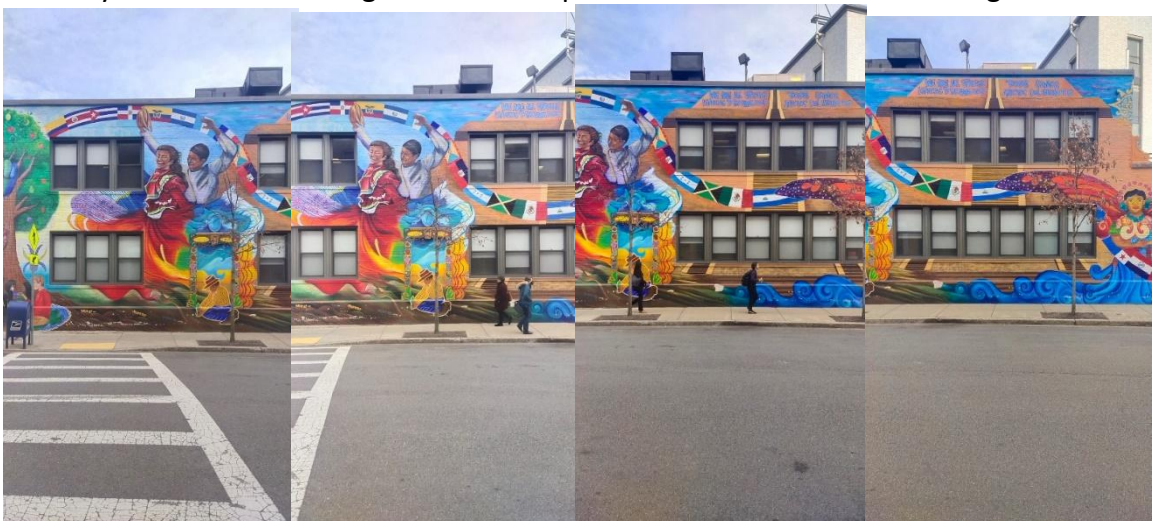
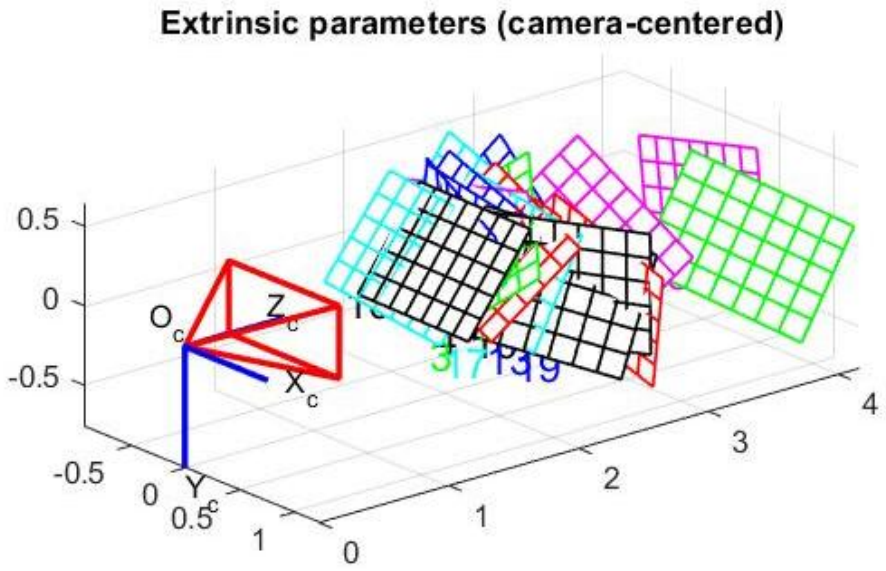
We see that the Pixel error is [0.25035 0.23864]. This is quite an acceptable value which implies there is not much distortion in the image. This is because the camera in the camera phone used to take the images are already calibrated.
Further, the below images before and after distortion show that the undistorted images show a bit more curvature after the distortion-compensation from the toolbox:



Similarly the rest of the images can be compared with their undistorted images:

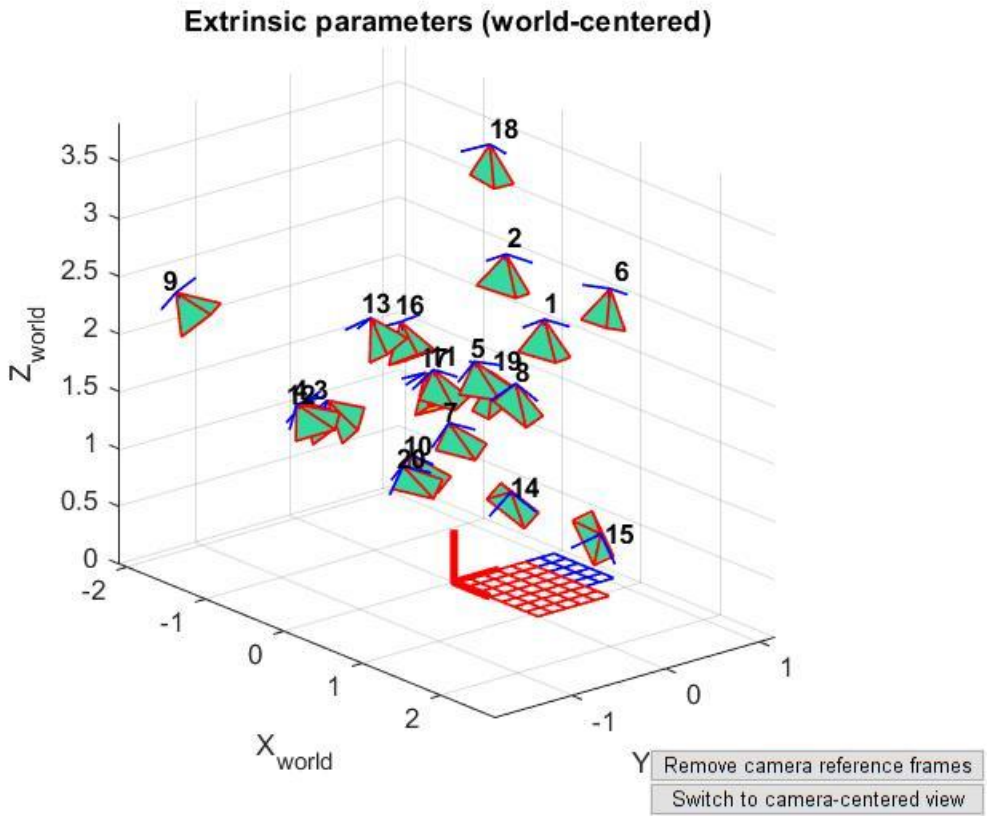


The extrinsic parameters for camera-centered and world centered frame are as shown:



Remove camera reference frame

Switch to world-centered view

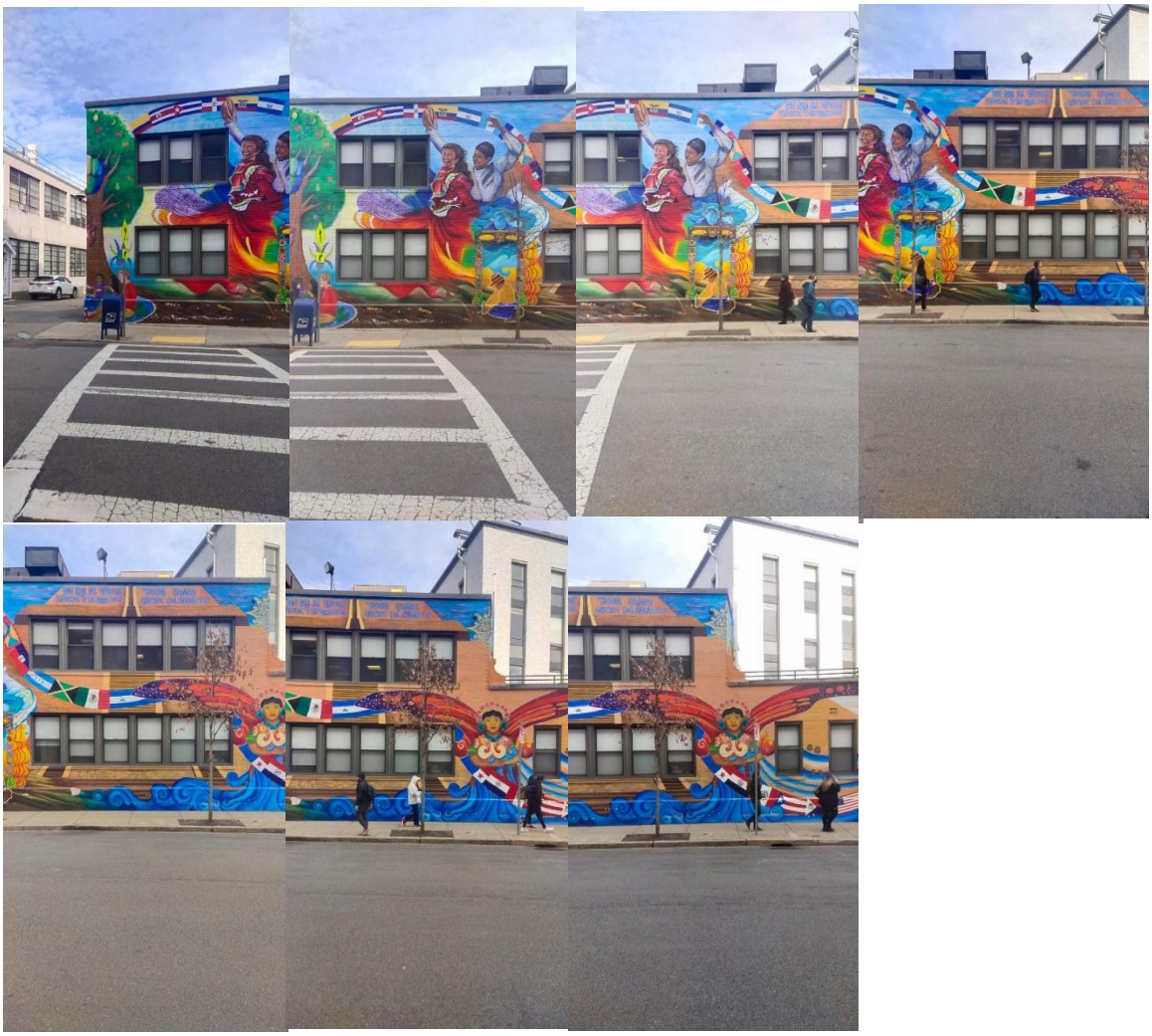


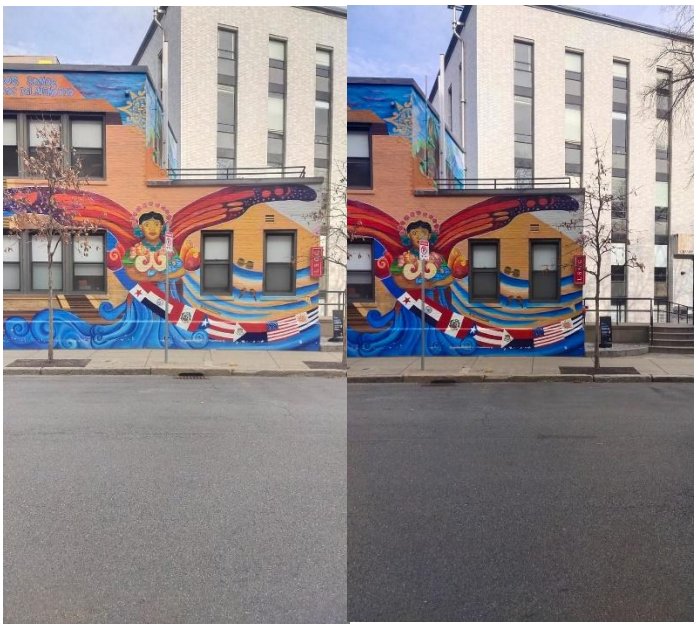
Remove camera reference frames

Switch to camera-centered view

Part 3: Data Collection:

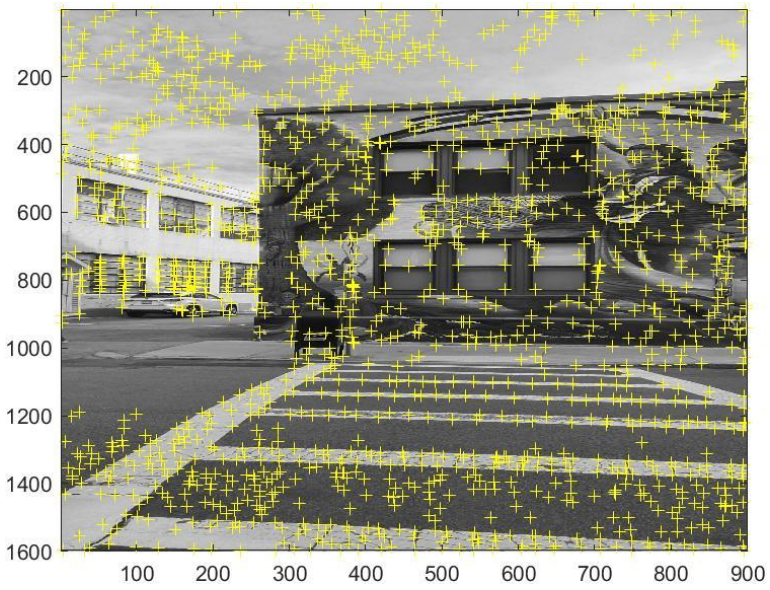
The Forsyth Street Latino Student Culture Centre was chosen as the graffiti for the 9 images. As stated above, the images are calibrated automatically through the current phones and hence we use the default images without explicit calibration with the toolbox again.





Part 4. Harris Corner Distribution:

The Harris corner detection feature is used to detect the corners in the image. The input to the Harris function is a set of 1800 points in the code. The code applies Harris feature on each of the 9 original images to detect prominent corners. The below is one of the 9 images demonstrating the Harris Corner Detection.



Part 5. Final Mosaic Image:

As stated above, the original color undistorted images are used for the panorama stitching as shown below:

The features being detected are the corners of buildings, windows, and the other graffiti details. A full image is detected by the Harris code to match the prominent corners. The stitched image is similar to the overall original. There are a few places it is not perfectly aligned, but very close. The zebra-crossing mismatch is because the road does not offer a lot of detectable corners for the Harris feature to give a good stitch.

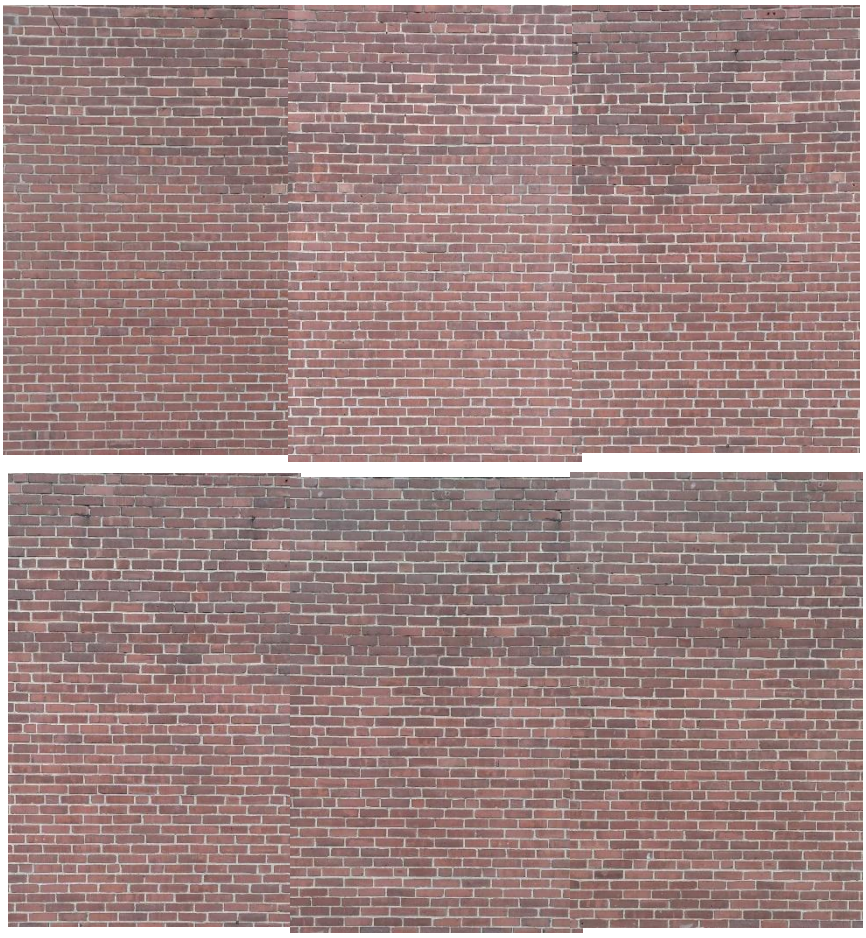
<u>Part 6. Mosaic Overlap for Cinder Brick wall</u>

The following set of images are obtained from a cinder block wall on Ryder Hall. We are using 6 images with 50% overlap to see the result. The stitched image is as below. It is not as good as before because there are not many evident features that can be picked up in a continuous image such as a brick wall.

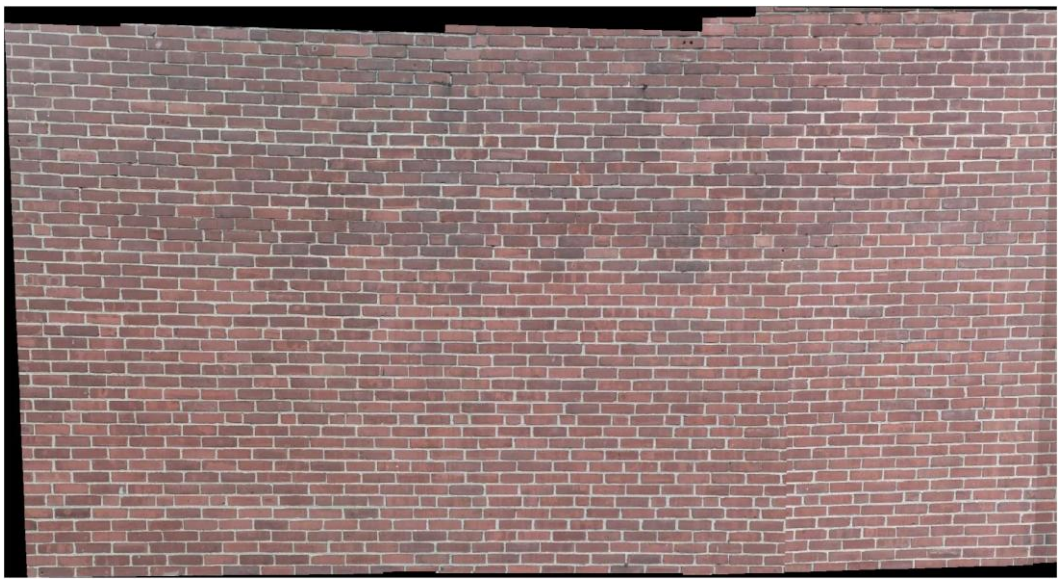
It is clearly evident that the stitched imaged is quite good but still is not perfectly aligned. The images are a match in the mid-section signifying the stitching taking place near the 50% mark. Further, **the slight discoloring of some bricks** stands out as a detectable feature.

For this part of the lab the parameters were the same as the previous. The feature detected are well distributed, due to the uniform design the stitched image looks aligned. The Harris feature

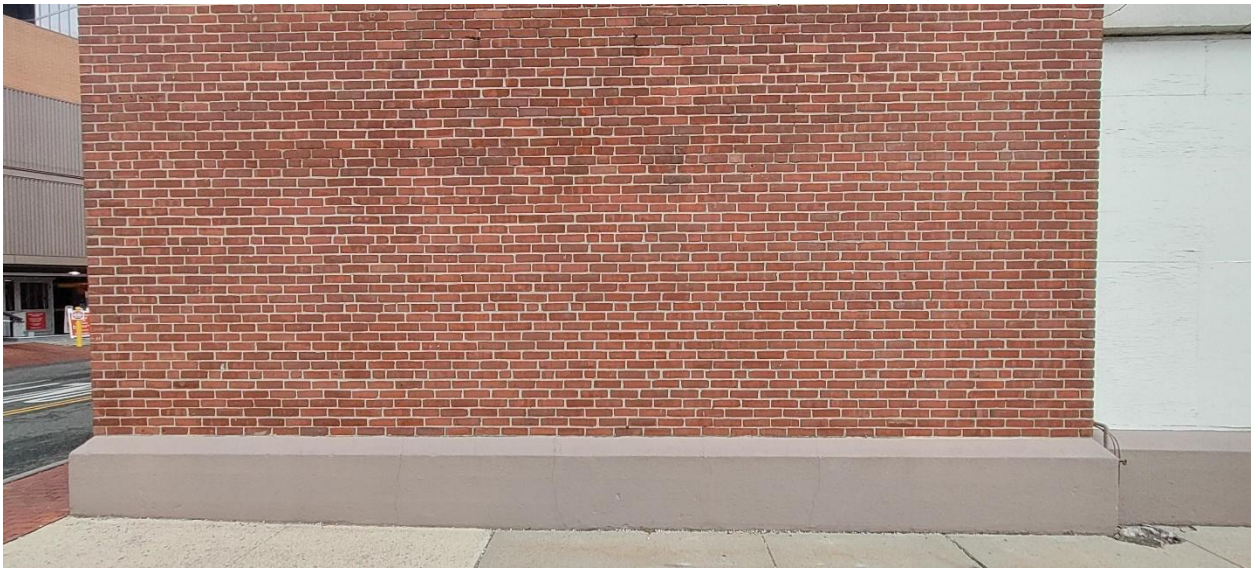
detects the corner but fails to match it with the next image because they all look alike and the features are alike. This is noticed only looking at the borders where we can see the images placed a little higher and lower trying to match the features.



Final stitched image:

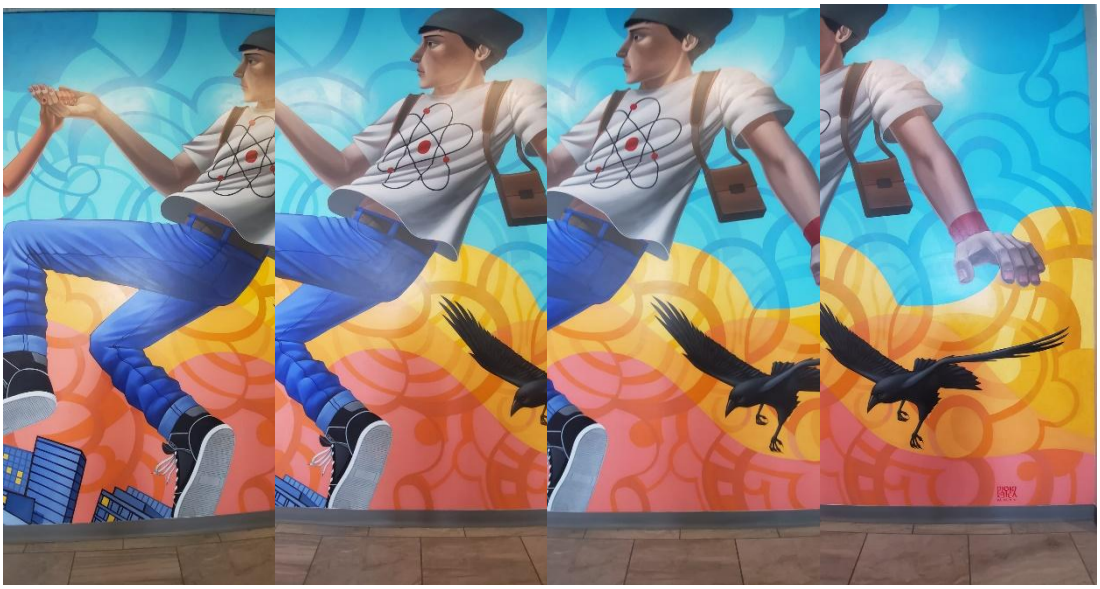


Actual image of the wall:



Part 7. Mosaic for 15% Overlap-East Village mural:

The mural from East Village was used for mosaicing in an overlap of about 15%. We are using 7 images to generate the panorama image. With all the parameters unchanged, the panoramic image wasn't as fine as the previous one. Changing the number of points in the parameters to about 2000 points resulted in some improvement in the resultant panoramic image.



Having fewer features detected over the overlapped areas one of the issues of using images of ~15% overlap. There are 2 issues to handle while picking a an appropriate N corner detection value. Increasing the N value throws a running out of memory error. Too few values for N points would give an inappropriate matching.

Another issue observed was that overcrowding of points detected in the overlapped area. This caused the resultant panorama mismatch even though the corners were detected efficiently. The tile value was [3,3] for this part of the lab. The tile value is a parameter which can be manipulated to find a sweet spot to get rid of mismatch, where the panorama image is perfect. Large tile values accommodate many features leading to a well stitched image.

Conclusion:

Photomosaicing for consecutive image sets was tried out to give panoramas. The Camera Calibration toolbox in matlab was used for camera calibration to give reprojection parameters based on a checkered pattern. A Harris corner detector was implemented in matlab for feature/corner extraction to give out complete panoramas.

Reference:

- http://www.vision.caltech.edu/bouguetj/calib_doc/htmls/example.html
- https://www.mathworks.com/help/vision/camera-calibration.html
- https://www.mathworks.com/help/vision/ug/feature-based-panoramic-image-stitching.html?searchHighlight=panorama&s_tid=doc_srchtitle