

# EECE5554 LAB-5

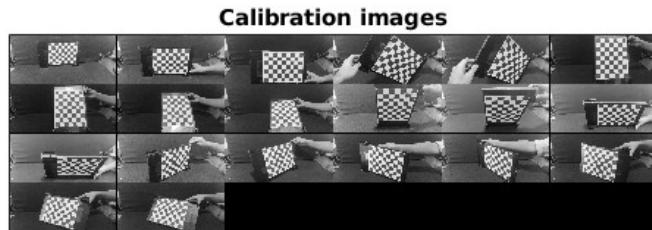
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## 1 Analysis and Report

### 1.1 Camera Calibration

The images used for calibration:



Calibration parameters I got:

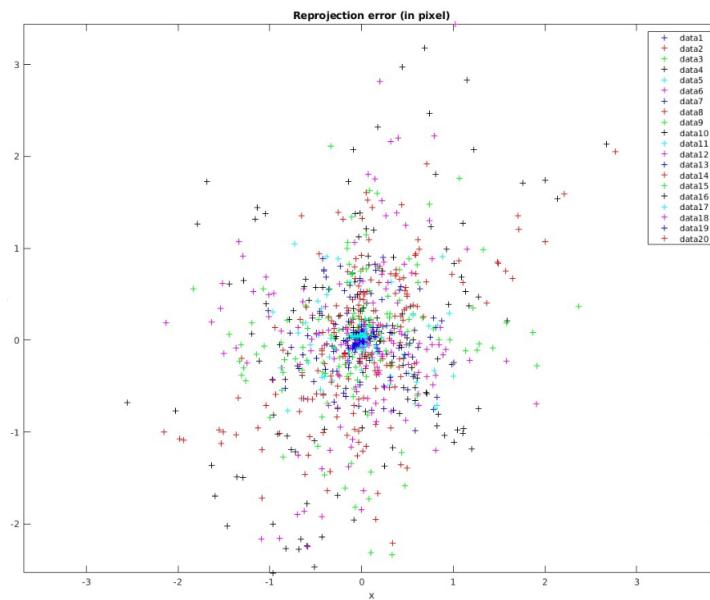
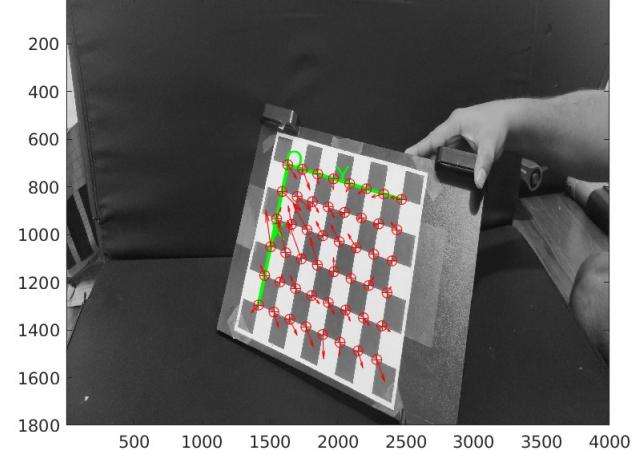
```
Calibration results after optimization (with uncertainties):
Focal Length:      fc = [ 3434.00738  3452.69110 ] +/- [ 17.79339  17.56358 ]
Principal point:   cc = [ 2335.39560 1070.04842 ] +/- [ 22.87620  17.81394 ]
Skew:              alpha_c = [ 0.00000 ] +/- [ 0.00000 ] => angle of pixel axes = 90.00000 +/- 0.00000 degrees
Distortion:        kc = [ 0.08005 -0.32250  0.00161  0.00200  0.00000 ] +/- [ 0.01520  0.07215  0.00195  0.00280  0.00000 ]
Pixel error:       err = [ 1.04911  1.02185 ]
```

#### 1.1.1 Reprojection Error graphs

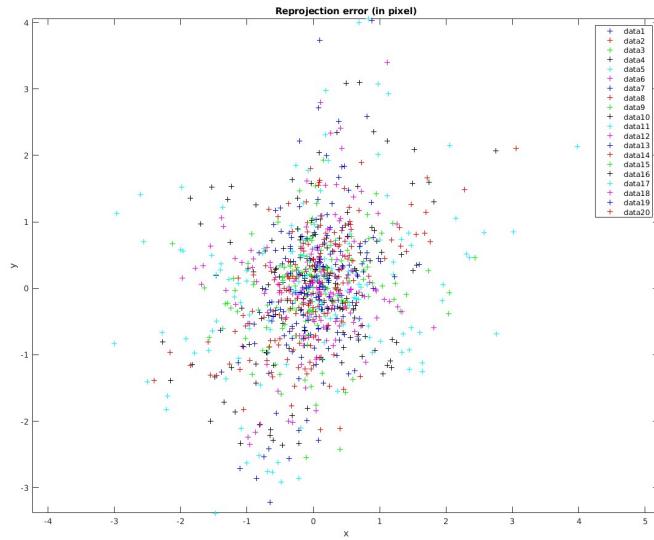
1. After initial calibration, I noticed a more spread out graph for RP error, denoting that the values have not yet converged to a good value hence

showing more spread out error. The calibration values were not optimal.

**Image 20 - Image points (+) and reprojected grid points (o)**



This meant we needed more iterations, to attain convergence. After selection of multiple images and multiple iterations, the graph improved:



```
Calibration results (with uncertainties):
Focal Length:    fc = [ 3042.2933  3044.35369 ] ± [ 9.91680  10.44969 ]
Principal point: cc = [ 2018.67549  926.33376 ] ± [ 17.77493  15.16760 ]
Skew:           alpha_c = [ 0.00000  0.00000 ] ± [ 0.00000  0.00000 ] degrees
Distortion:     k = [ 1.7298  -0.7943  -0.00239  0.00145  0.00000 ] ± [ 0.01832  0.13327  0.00236  0.00297  0.00000 ]
Pixel error:    err = [ 0.60953  0.73846 ]
```

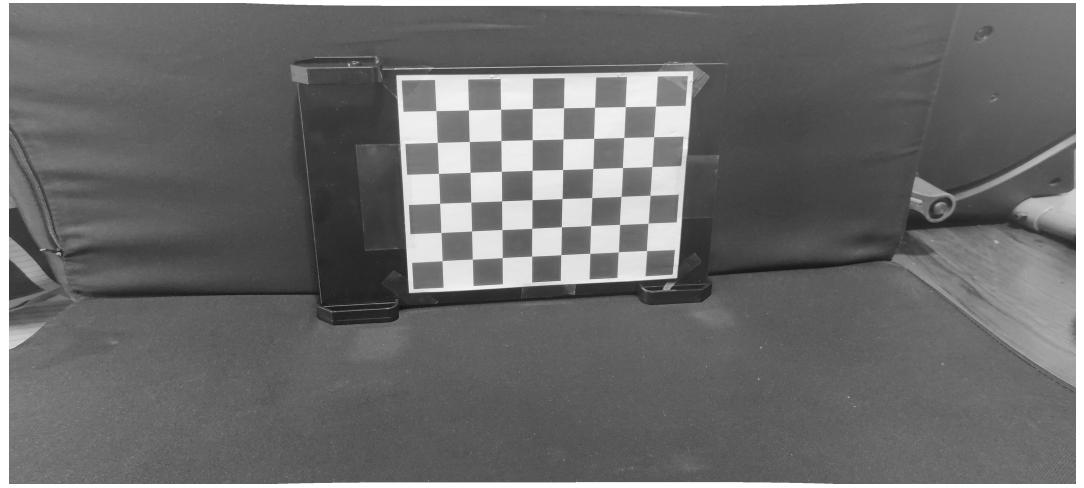
We use these calibration values as they are closer to optimum.

Testing these values on images:

Image before rectification:

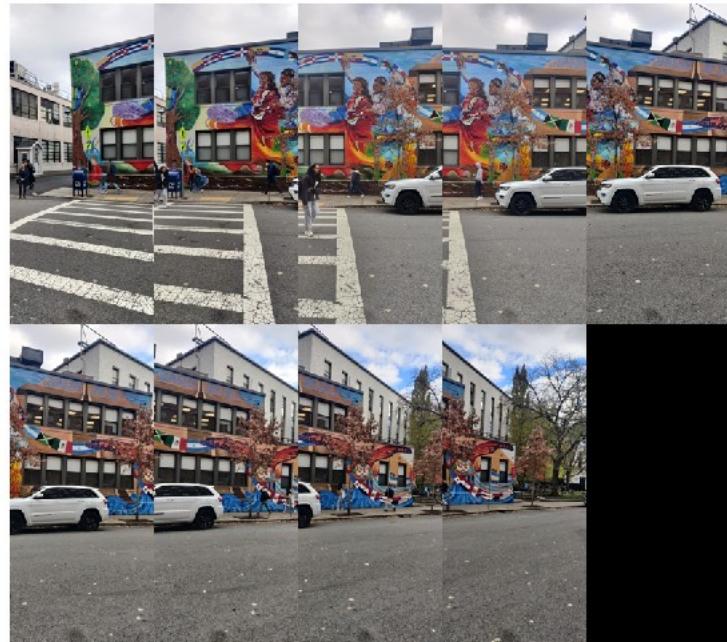


The same image post rectification (in greyscale):



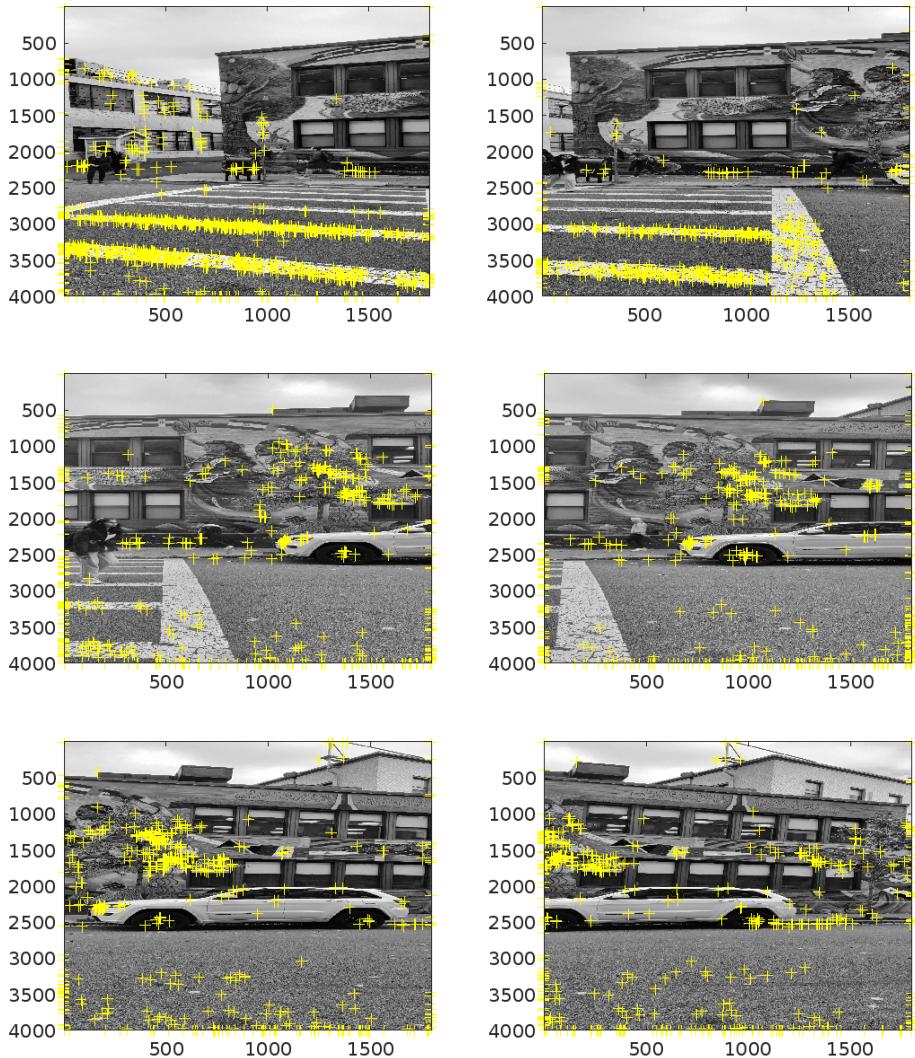
## 1.2 LSC Data

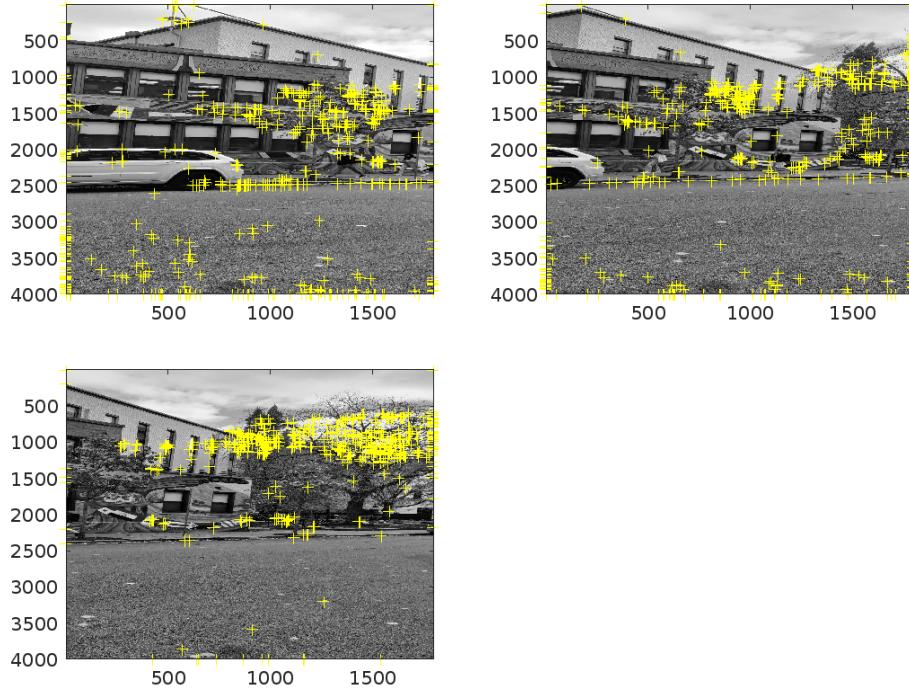
1. Image data Mosaic:



There was also a car in the image, which could help in stitching the images later.

2. Harris Corner Detection:





I could see a few corners on the car, which could also act as features or could disrupt the stitching process.

### 3. Final Stitched image:



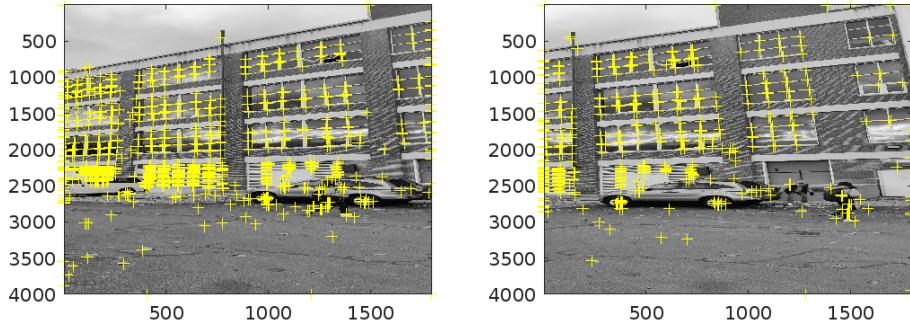
As we can see we are able to stitch the panorama without much error, and also get the car to check consistency on stitching. For accurate Harris corner detection, the corner count was adjusted to 800, and the images underwent calibration using intrinsic calibration parameters. As a result, distinct Harris corners were visible in the images, simplifying the ICP algorithm's task of identifying correspondences between successive image point sets. Consequently, the image stitching quality notably improved when compared to the brick wall image dataset seen later.

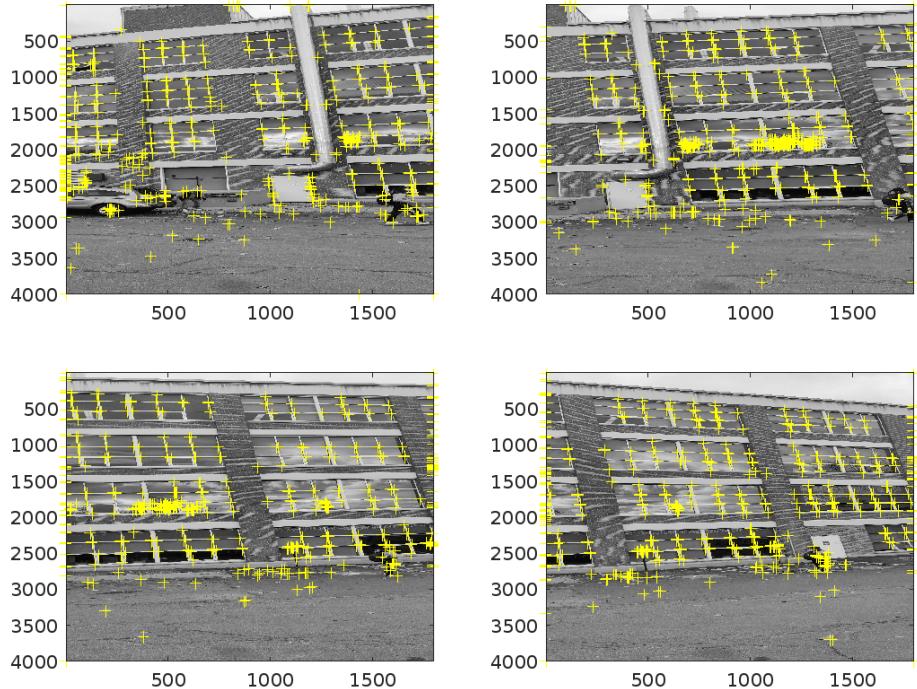
### 1.3 BrickWall Data

1. The data set mosaic:

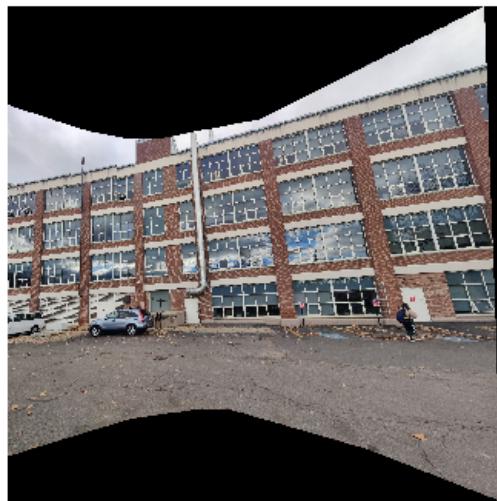


2. Harris Corner detection similarly,





3. Stitched image:



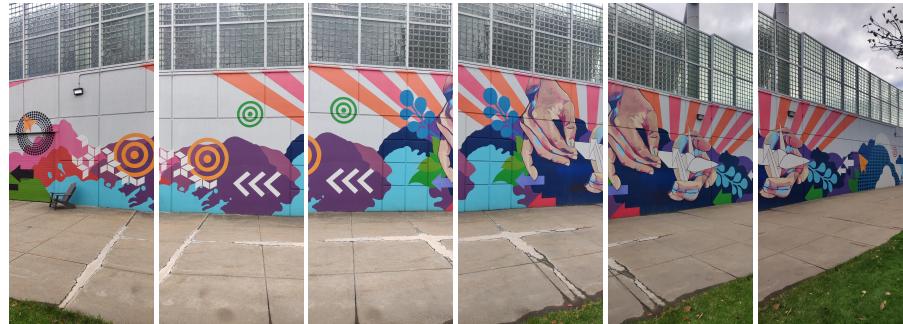
Due to the uniformity of corners caused by the brick pattern on the wall,

significant challenges arose during the image stitching process, necessitating numerous trial-and-error attempts to achieve satisfactory results.

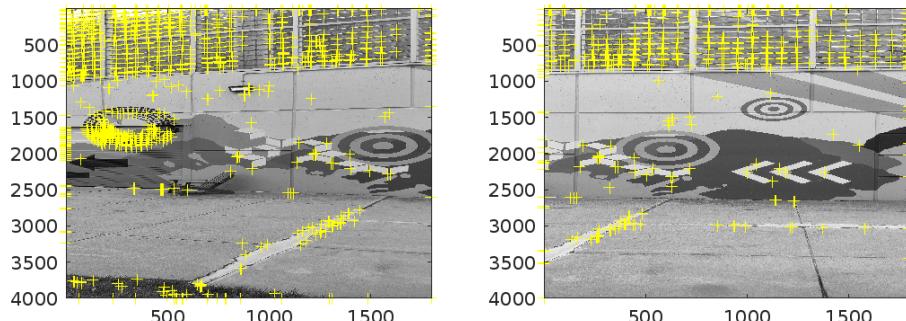
The number of corners detected might be causing this issue, which can be addressed with the threshold. Additionally, the image warp function faced difficulty identifying overlapping areas between consecutive images due to the similarity in these regions across all image pairs. A crucial aspect of achieving improved results involved reducing the threshold for Harris corner detection.

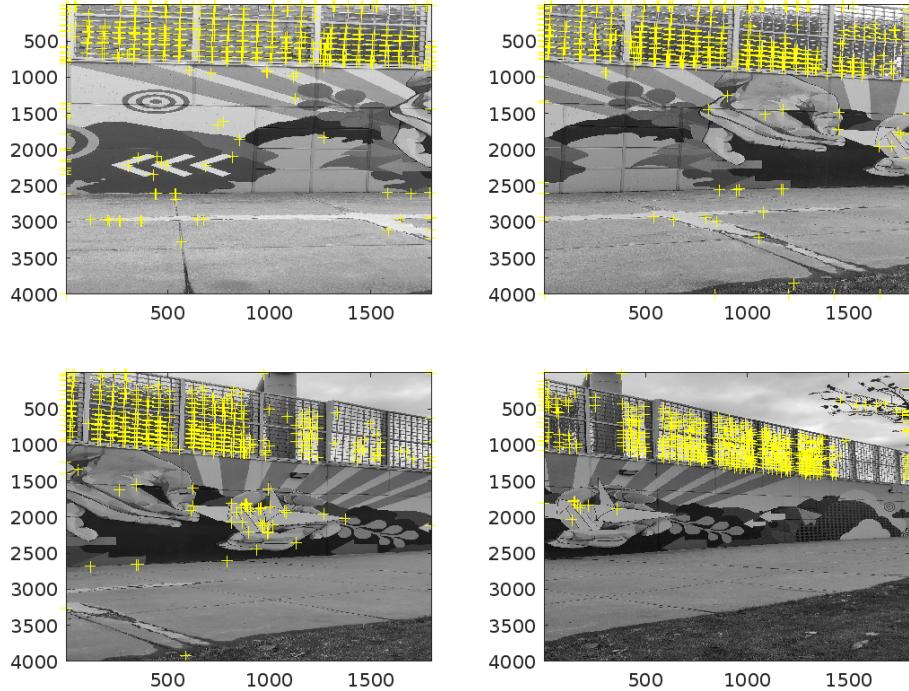
#### 1.4 Mosaic image - Ruggles

1. Image Mosaic:



2. Image Mosaic with Harris corner overlap : **15 percent**





3. Stitched Image for the same:



4. Image Mosaic with Harris corner overlap : **50 percent**



5. Final stitched image



The resulting panoramic image from the dataset with a **15 percent** overlap exhibits **significant distortion** compared to the dataset with a 50 percent overlap. The 50 percent dataset contains sufficient overlapping details, simplifying the image stitching process, unlike the 15 percent overlap dataset where the limited overlap results in fewer correspondence points for the ICP algorithm to match between any two image pairs. No adjustments were necessary to create the panorama image for the 50 percent overlap dataset whereas for the 15 percent overlap dataset, **an increase** in the number of Harris corner points detected to 800-1000 was **required** to generate the panorama image with less errors.