

Part1. Camera Calibration.

1.1 Camera images used for calibration

The image I used for camera calibration is the 9x16 Checkerboard from on ISEC 5th. This checkboard is rigid which is an ideal tool for camera calibration.

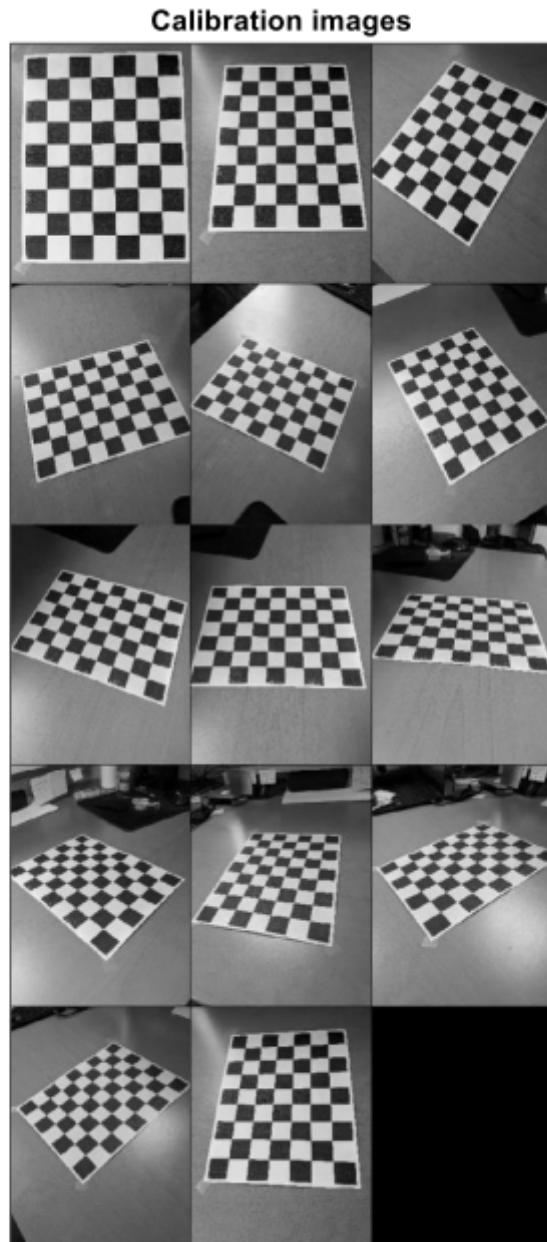


Figure 1: Calibration Images

1.2 Reprojection pixel error in report

Figures below shows the result of reprojection error(in pixel) before and after calibration, as we can see, the data is more concentrated and uniform after calibration compared with the raw data.

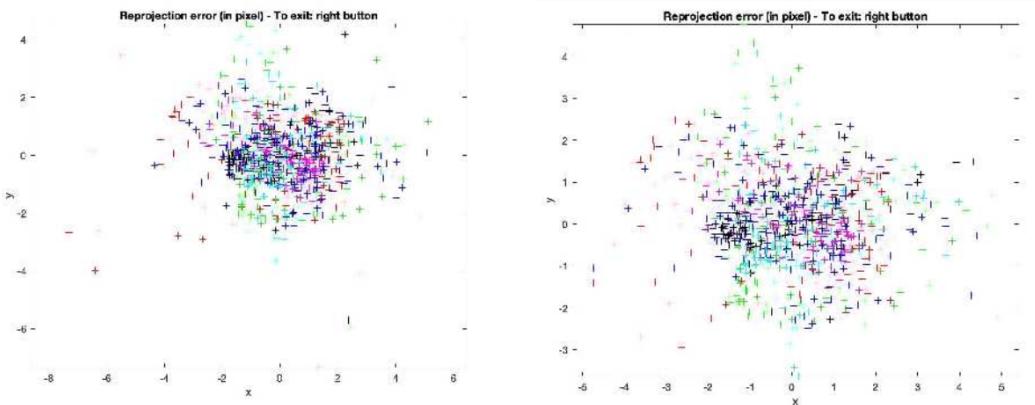


Figure 2: Reprojection error (in pixel) before and after calibration

1.3 Calibration parameters in report

The calibration result parameters show below

Focal Length	$fc = [3032.86679 \ 3049.99673] +/- [10.14884 \ 8.04948]$
Principal point	$cc = [1476.98281 \ 2037.29713] +/- [8.19094 \ 12.20210]$
Skew	$\alpha_c = [0.00000] +/- [0.00000]$ angle of pixel axes = $90.00000 +/- 0.00000$ degrees
Distortion	$kc = [0.17254 \ -0.42635 \ 0.00649 \ -0.00097 \ 0.00000]$ $+/- [0.01147 \ 0.04590 \ 0.00166 \ 0.00110 \ 0.00000]$
Pixel error	$err = [1.47600 \ 1.20798]$

1.4 Image before and after calibration

A set of pictures on Forsyth Street are used to compare the picture that before and after calibration.



Figure 3 Image before and after calibration

Part2. LSC mosaic

2.1 LSC image set

Here are the raw image set we collected from Forsyth Street about Latino Student

Center.



Figure 4: Latino Student Center image set

2.2 Harris corners across LSC image set

Figure below shows the distribution of Harris Corners. We can see that most of the features are present on the road. In comparison, the features on the mural are much less.

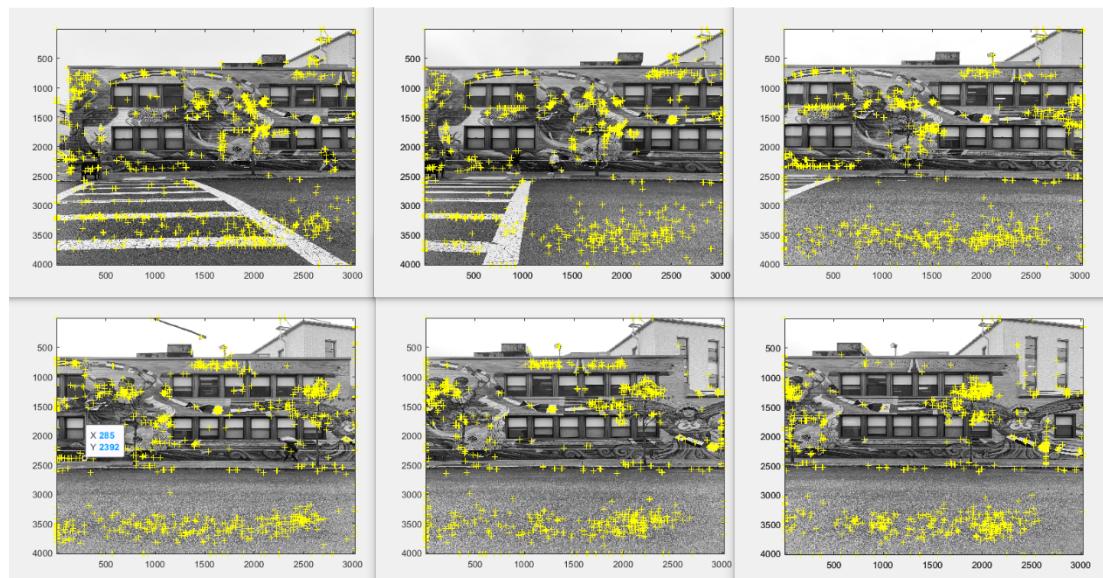


Figure 5: Distribution of Harris corners across LSU image set

2.3 Final LSC mosaic

Here are results of mosaic picture using different algorithm, first figure shows the result by using SURF, the second is generated by Harris.



Figure 6: Final LSC mosaic

2.4 Adjustment of images

At first, after I finished taking photos of the LSC buildings, I tried to build the final mosaic image. However, MATLAB gave me feedback that the problem which said: *specified transformation matrix is invalid because it is singular within the working precision*. Through the discussion on piazza, I realized that during the picture shooting, the picture cannot be reversed, only panning. So, I re-collected the dataset of images of LSC buildings, making sure they were taken with horizontal/vertical translations. In the next process of photo processing, I eliminated two images to reduce the accuracy, and finally I generated Figure 6.

Part3. Cinder block imagery

3.1 Initial images with Harris corners

Here are the raw image set about brick wall and Harris Corners images set

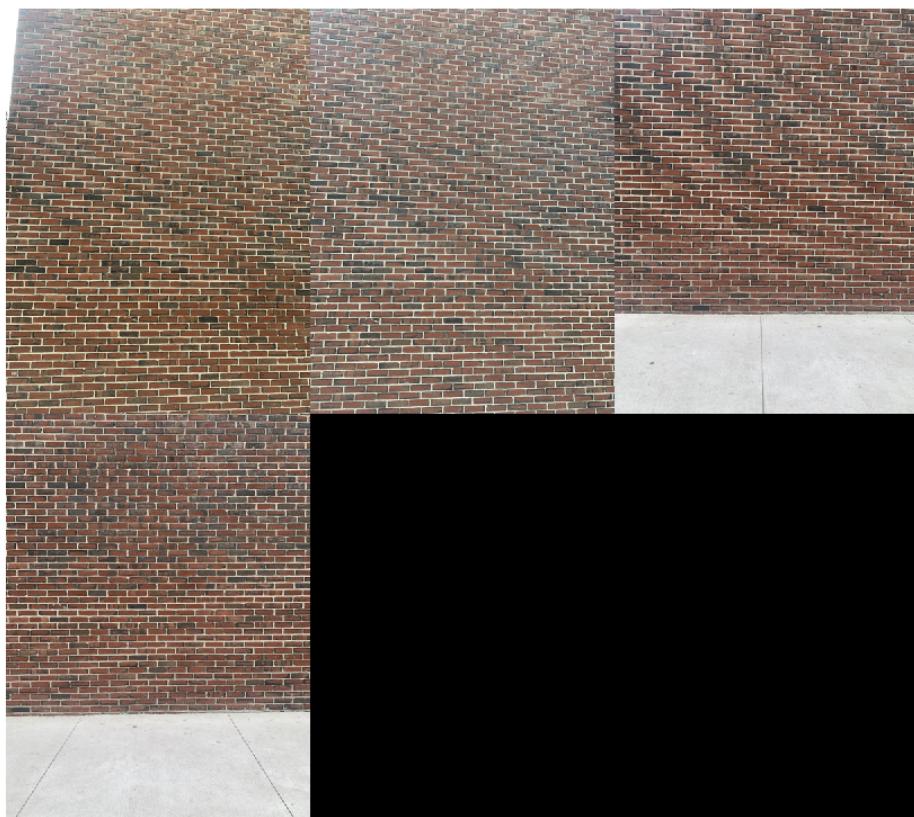


Figure 7: Initial brick wall image set

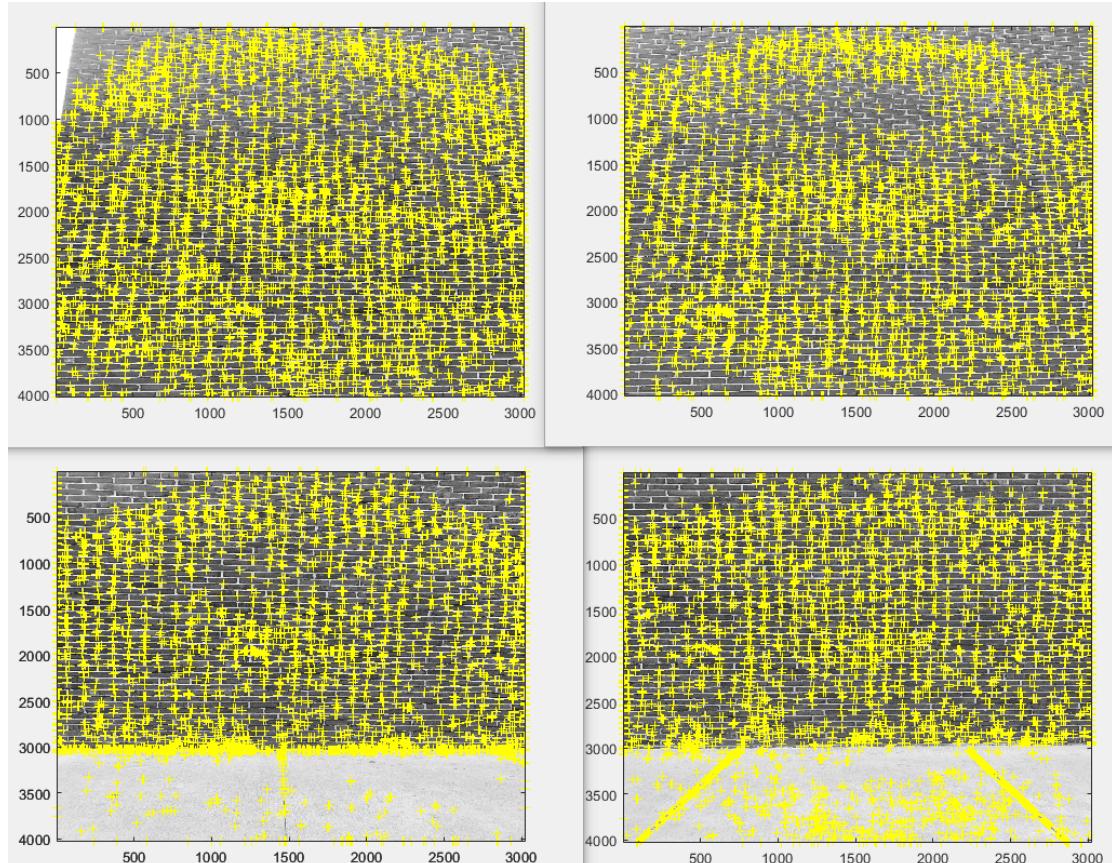


Figure 8: brick wall image set with Harris corners

3.2 Final cinder images

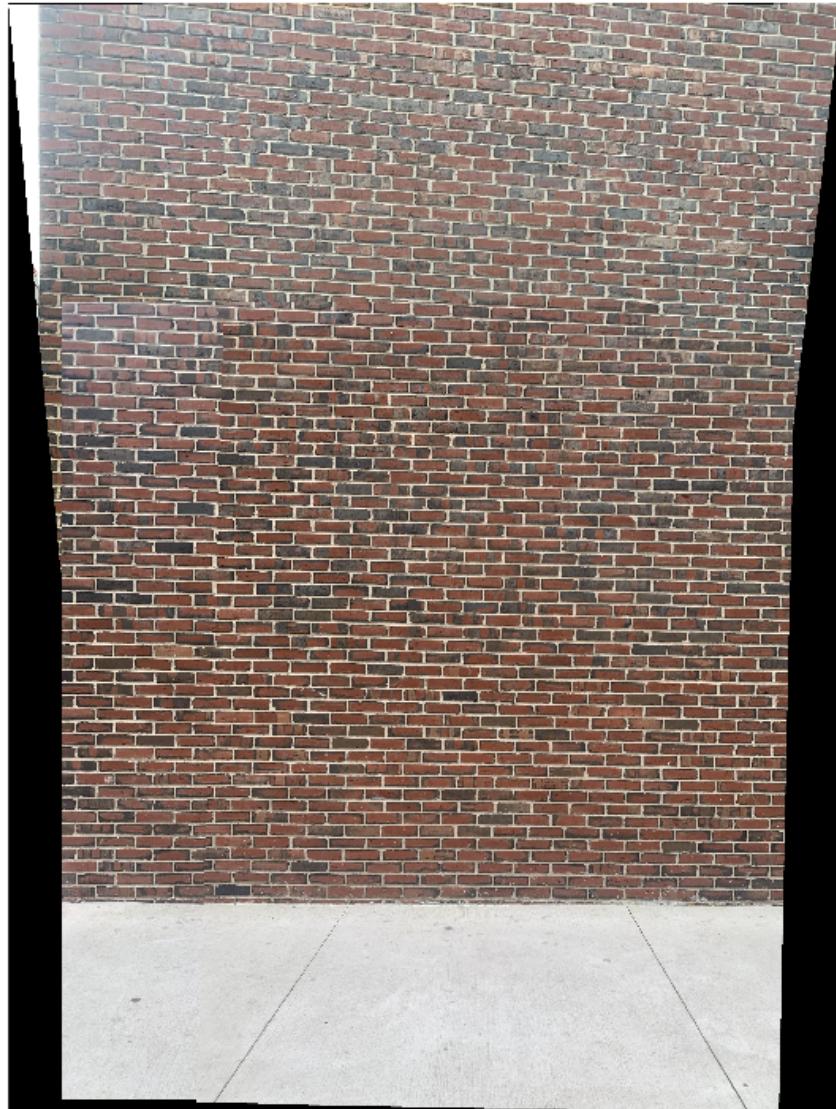


Figure 9: Final brick wall mosaic

3.3 Cinder brick wall VS LSC mural

Compared to the LSC building, the Harris corners of the brick wall have more corners point. Therefore, in the final mosaic, the coherence and integrity of the brick wall are higher than those of LSC building. This is also why we can feel the brick wall splicing more perfectly when we observe the final figures.

Part4. Third mosaic

4.1 Initial images set with Harris corners with 15% overlap

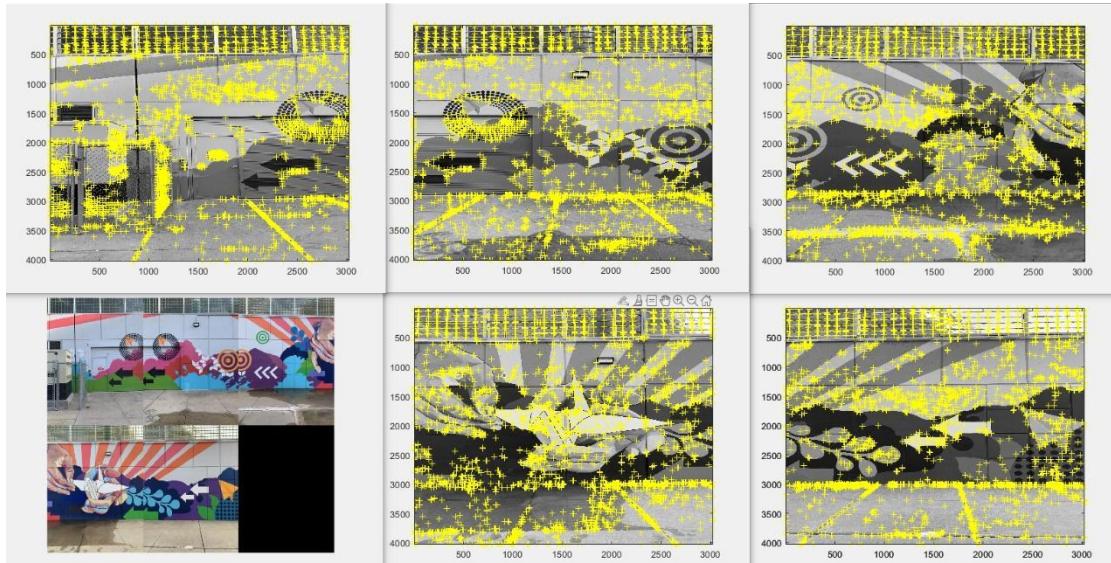


Figure 10: Initial images set with Harris corners with 15% overlap

4.2 Initial images set with Harris corners with 50% overlap



Figure 11: Initial images set with Harris corners with 50% overlap

4.3 Final mosaic with 15% overlap



Figure 12: Final mosaic with 15% overlap

4.4 Final mosaic with 50% overlap

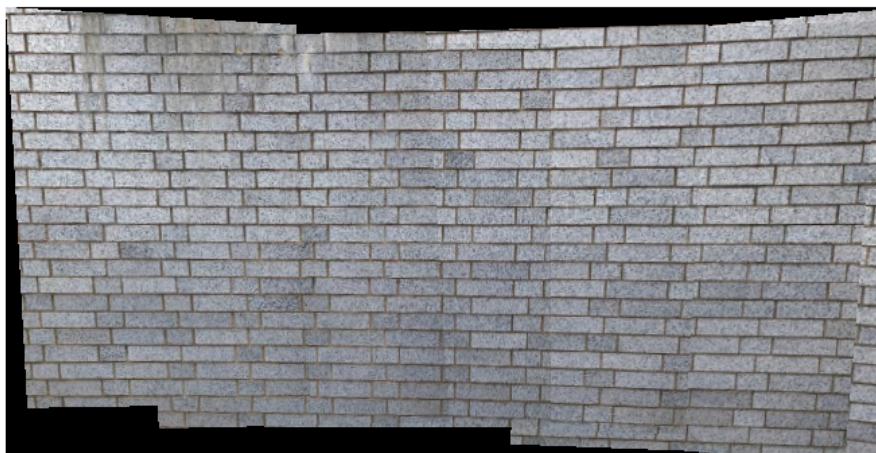


Figure 12: Final mosaic with 50% overlap

4.5 Performance with 15% and 50% overlap

The final dataset is pictures where the overlap is less than 15%, which took by street near Ruggles. Although the overlap is small, those features are relatively obvious. As for 50% overlap image set, I was using a brick wall image set. Since there are more 50% overlapping parts, this makes the final mosaic image more complete. The pictures are stitched together more perfectly. The corresponding 15% overlap is relatively smaller than 50%, and the accuracy of stitching the pictures will decrease. We can see from Figure 12 that the gaps between the brick walls are aligned, while the ground in Figure 11 is curved.

4.6 Adjustments

After feature detection, we could find the feature figure showed above. We can find most of the feature points lying on the upper part of the image. The image I was trying to use the Harris algorithm, which obviously failed (Figure 13), and then I was using the SURF algorithm, with remarkable results (Figure 12).



Figure 13 Mosaic with Harris corners algorithm