EECE-5554 Robot Sensing and Navigation
LAB-5 Report

Abstract – This document provides the analysis report of the photo/ image mosaic stitching using MATLAB, simply known as Camera Mosaic.

I. Camera Calibration

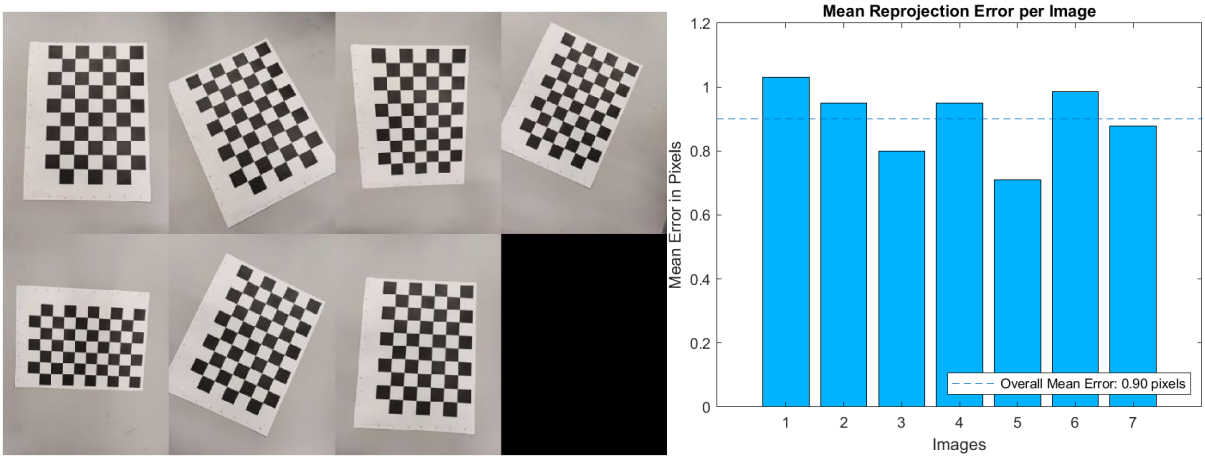

Figure 1: (a) Camera images used for calibration ***(b)Reprojection pixel error***

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Standard Errors of Estimated Camera Parameters
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Intrinsics
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Focal length (pixels):   [ 3023.9932 +/- 26.6210    3023.3155 +/- 26.9674 ]
Principal point (pixels):[ 1550.3409 +/- 3.7992     2021.2491 +/- 3.7399  ]
Radial distortion:       [   -0.0054 +/- 0.0046       -0.0677 +/- 0.0233  ]

Extrinsics
----------
Rotation vectors:
                         [   -0.0604 +/- 0.0011        0.0764 +/- 0.0011        1.5780 +/- 0.0002  ]
                         [   -0.1336 +/- 0.0015        0.1153 +/- 0.0011        1.1043 +/- 0.0002  ]
                         [    0.0949 +/- 0.0014       -0.2058 +/- 0.0020        1.5464 +/- 0.0002  ]
                         [   -0.0867 +/- 0.0014        0.0112 +/- 0.0014        1.9912 +/- 0.0002  ]
                         [    0.0503 +/- 0.0016        0.1143 +/- 0.0025       -3.0959 +/- 0.0002  ]
                         [   -0.0891 +/- 0.0013        0.0059 +/- 0.0012        2.0062 +/- 0.0002  ]
                         [   -0.0674 +/- 0.0012        0.0732 +/- 0.0012        1.6164 +/- 0.0002  ]

Translation vectors (millimeters):
                         [   76.0261 +/- 0.3850     -119.2370 +/- 0.3690      308.3886 +/- 2.7372  ]
                         [   10.8628 +/- 0.4047     -131.0728 +/- 0.3772      329.6423 +/- 2.8535  ]
                         [   60.1340 +/- 0.4009     -116.0831 +/- 0.4017      319.2327 +/- 2.8050  ]
                         [   80.4716 +/- 0.4490     -111.0400 +/- 0.4345      360.7280 +/- 3.1965  ]
                         [   92.1853 +/- 0.4637       69.6021 +/- 0.4580      374.3995 +/- 3.3252  ]
                         [  100.0769 +/- 0.4091      -71.7755 +/- 0.4001      330.5223 +/- 2.9284  ]
                         [   76.5784 +/- 0.4060      -93.4456 +/- 0.3922      325.6688 +/- 2.8836  ]
```

Figure 2: Calibration parameters

Figure 3: (a) Before Calibration ***(b) After Calibration***

Here, 7 checkerboard images are used to calibrate the camera. We can observe from Figure 1(b) that the mean **reprojection error** is **0.9** pixels. The camera parameters can be obtained from Figure 2. The before and after calibration of the checkerboard can be observed in Figure 3 (a) and Figure (b).

II. LSC "mosaic"

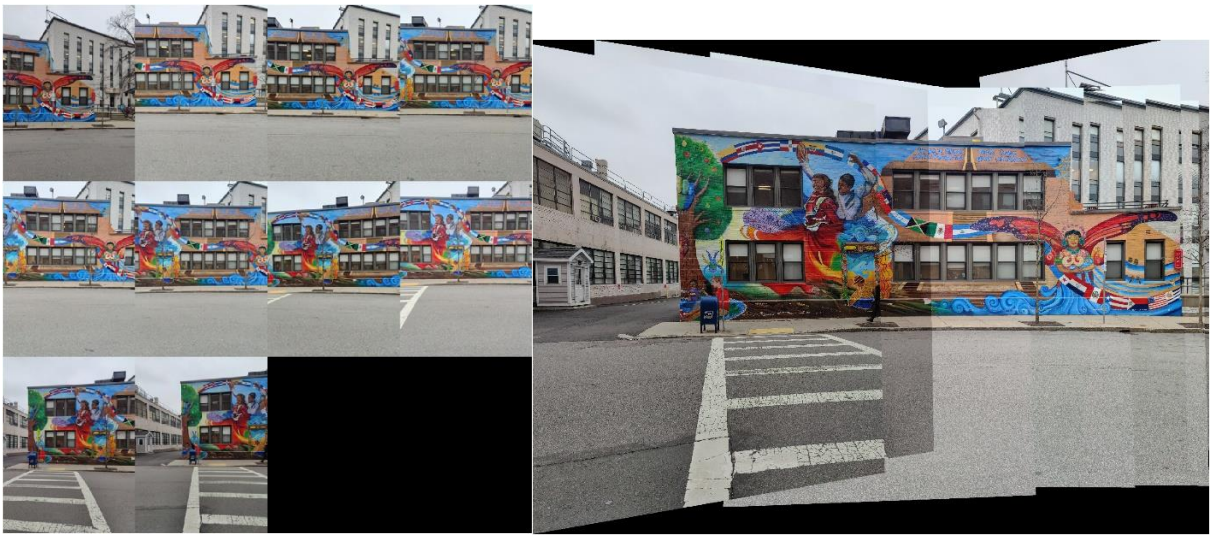

Figure 4: (a) ISC image set ***(b) ISC Mosaic***

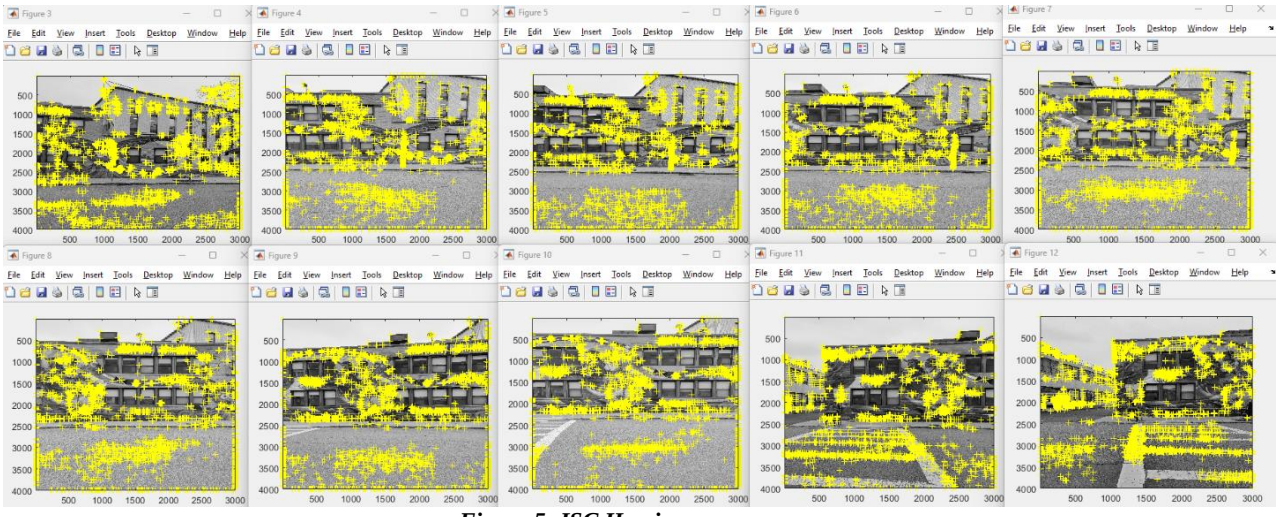

Figure 5: ISC Harris corners

Discussion of adjustment/intermediate image steps you took

Here, we attached Harris corners and Convolve2 mat files to the main mat file, so that it can compute, overlap and stitch the image correctly. Also, we tried various trails around 500 to 5000 (with intervals of 500) and used the best fit for the stitch.

III. Cinder block/ brick wall “mosaic”

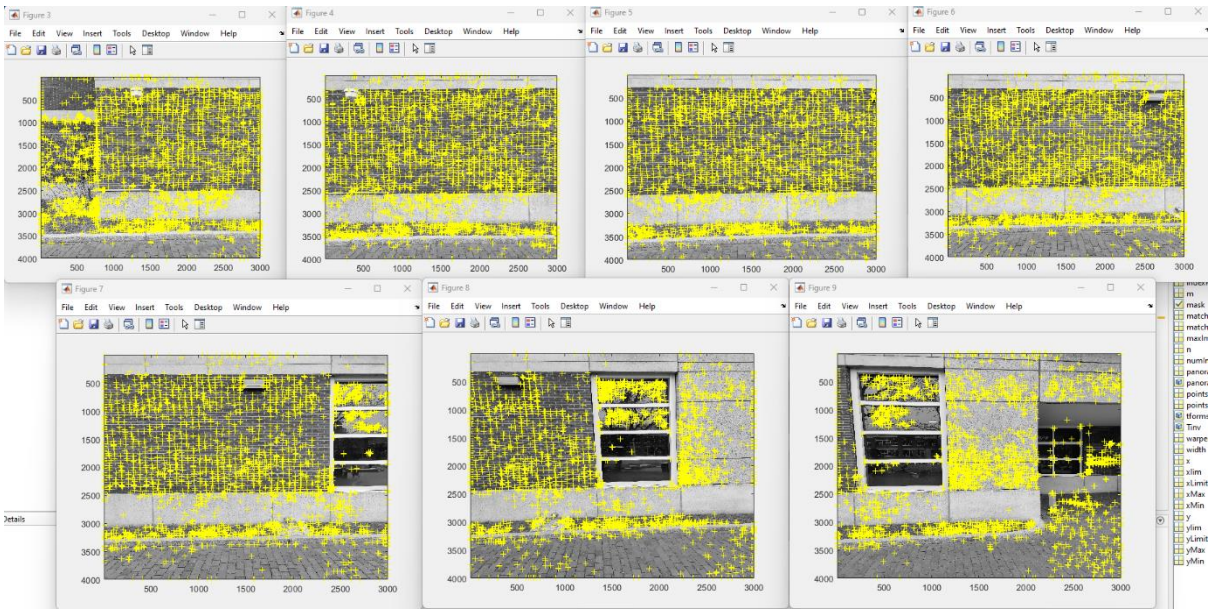

Figure 6: Brick wall Harris corners

Figure 7: Brick wall Mosaic

Explanation of cinder block/brick wall performance compared to the LSC mural

Though the structures nearby LSC have distorted, the LSC was stitched well. Whereas, the brick wall was distorted in the middle. The better performance of the LSC over the brick wall is due to more features detected (Harris corners) in the mosaic art.

Also, the brick wall has a constant pattern with similar features, so it might have mixed up the features while warping/ stitching up the image. Whereas, the mosaic consists of different features due to the art, which leads to higher accuracy of image stitching even with image capturing differences/ transformation differences.

IV. Third “mosaic”

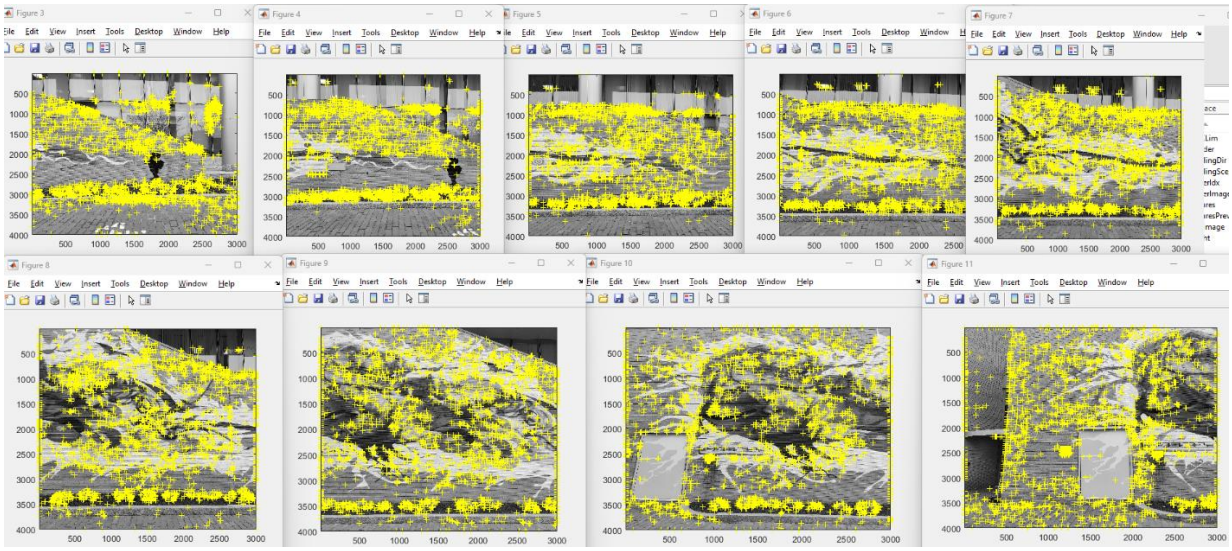

Figure 8: Dino - 15% overlap Harris corners

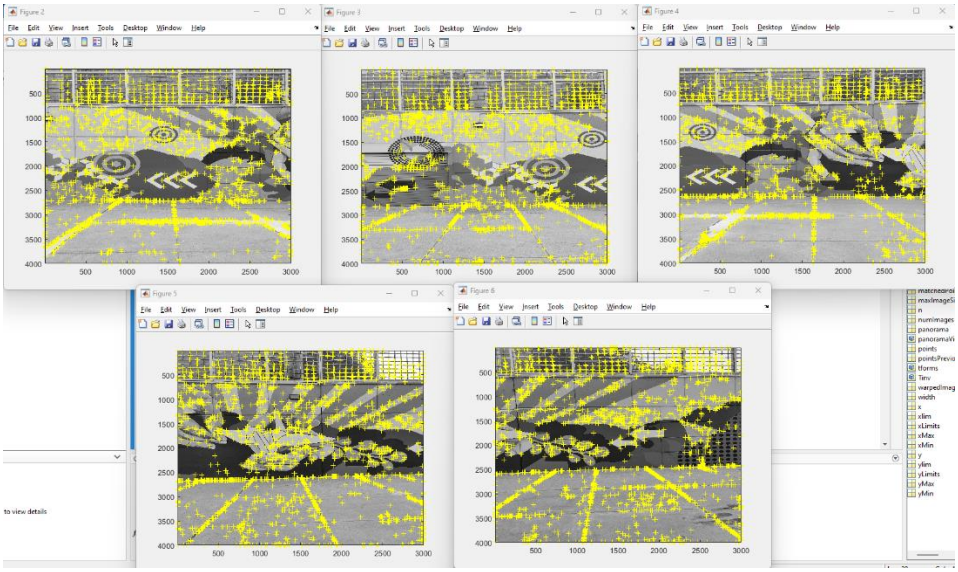

Figure 9: Ruggles - 50% overlap Harris corners

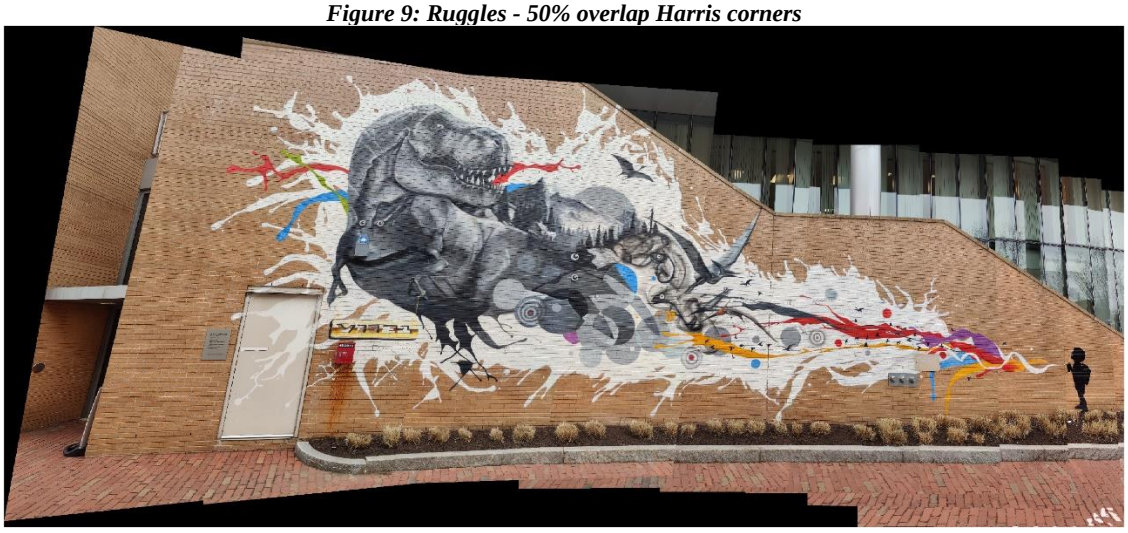

Figure 10: Dino - 15% overlap Mosaic

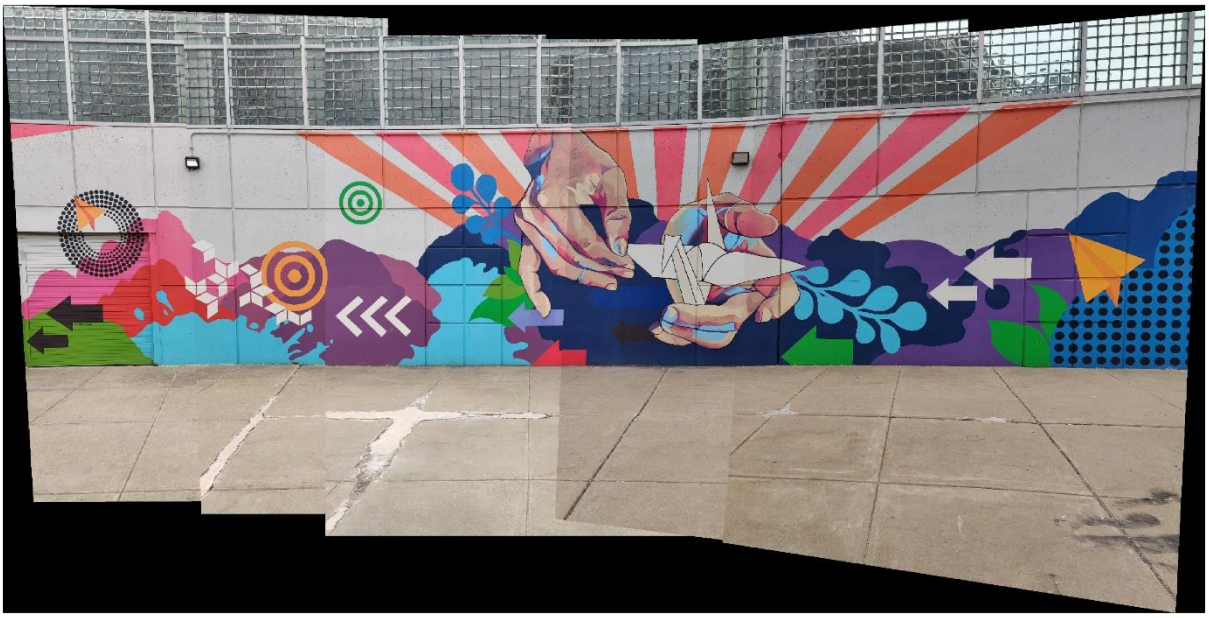

Figure 11: Ruggles - 50% overlap Mosaic

Discussion of performance with 15% and 50% overlap

We can observe from the above figures that the 50% has better stitching/ blending compared to 15% overlap, though the 15% has more features detected. This occurs due to point detection and alignment errors which leads to the high overlap. This can be observed in the right half of the 15% overlap (Figure 10).

For the overlapping of 15% and 50 %. Does the mosaicking algorithm still work? What changes, if any, did you have to make?

Yes, the mosaicking algorithm works for both 15% and 50% overlap of the images without any errors. There aren't any changes made to the stitching file as the stitching performance seemed to be fine without any changes. But, tried the stitching with different trail inputs.

V. Conclusion

How does Harris Corner Detector Works?

It works by computing the response for each pixel in image, thresholds, and suppresses weaker corners to localize the strongest corners by finding their sub pixel positions.

How photo/ image mosaic algorithms work?

Image mosaic algorithms use iterative closest points to align and stitch multiple images together into a larger image.

What scenes/images will work well or poorly for image mosaicking?

Image mosaicking works well for images with good overlap, lighting conditions, and stationary elements, but poorly for scenes with moving objects, large perspective changes, and variations in lighting or color.

VI. References

[1] H. Narasimhan and S. Satheesh, "A randomized iterative improvement algorithm for photomosaic generation," 2009 World Congress on Nature & Biologically Inspired Computing (NaBIC), Coimbatore, India, 2009.

[2] M. Mikamo, M. Slomp, S. Yanase, B. Raytchev, T. Tamaki and K. Kaneda, "Maximizing Image Utilization in Photomosaics," 2010 First International Conference on Networking and Computing, Higashi, Japan, 2010.