Farhan Sarfraz
EECE 5554 - Robotics Sensing and Navigation

Lab 5 - Camera Mosaicing

Overview

In this lab, images were taken in order to calibrate the used camera, as well as making panoramic images by mosaicing singular images. The objective of this lab is to be able to understand the Harris corner detector algorithm, identify features in an image, and be able to understand the mosaic algorithms, while also assessing for poor and good mosaicing scenarios.

Analysis

Camera Calibration

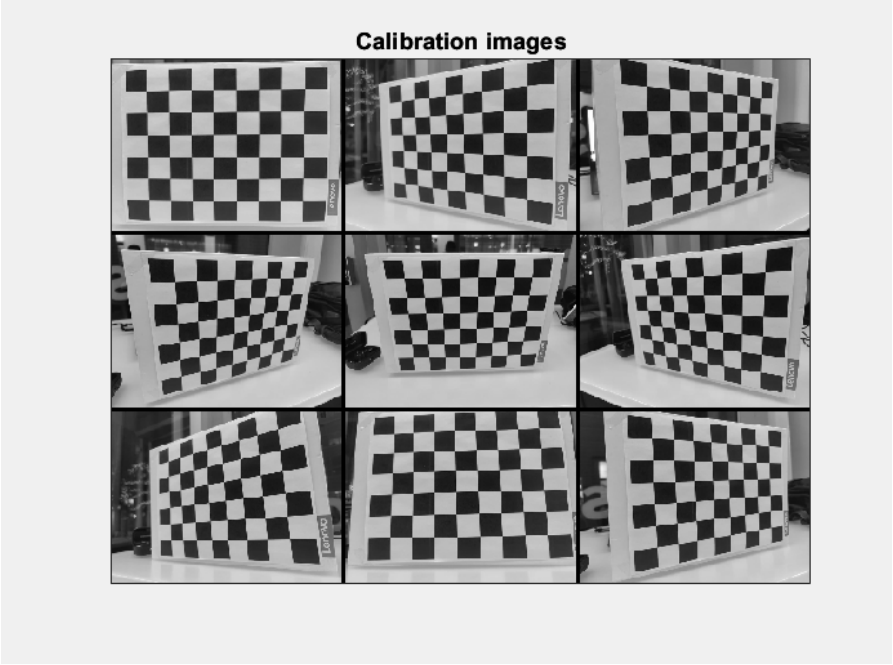

Figure 1: Camera Calibration Photos

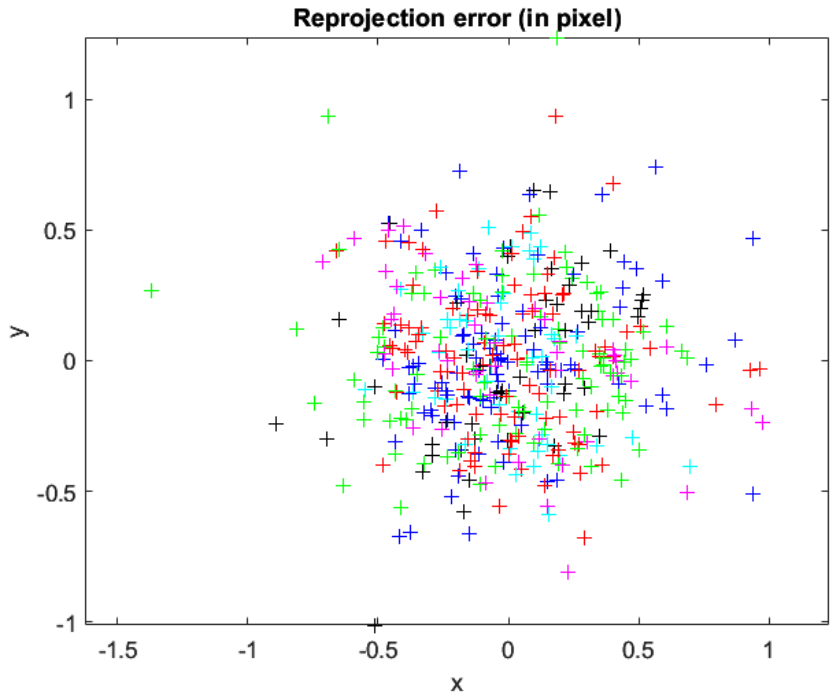

Figure 2: Reprojection Error for All Images

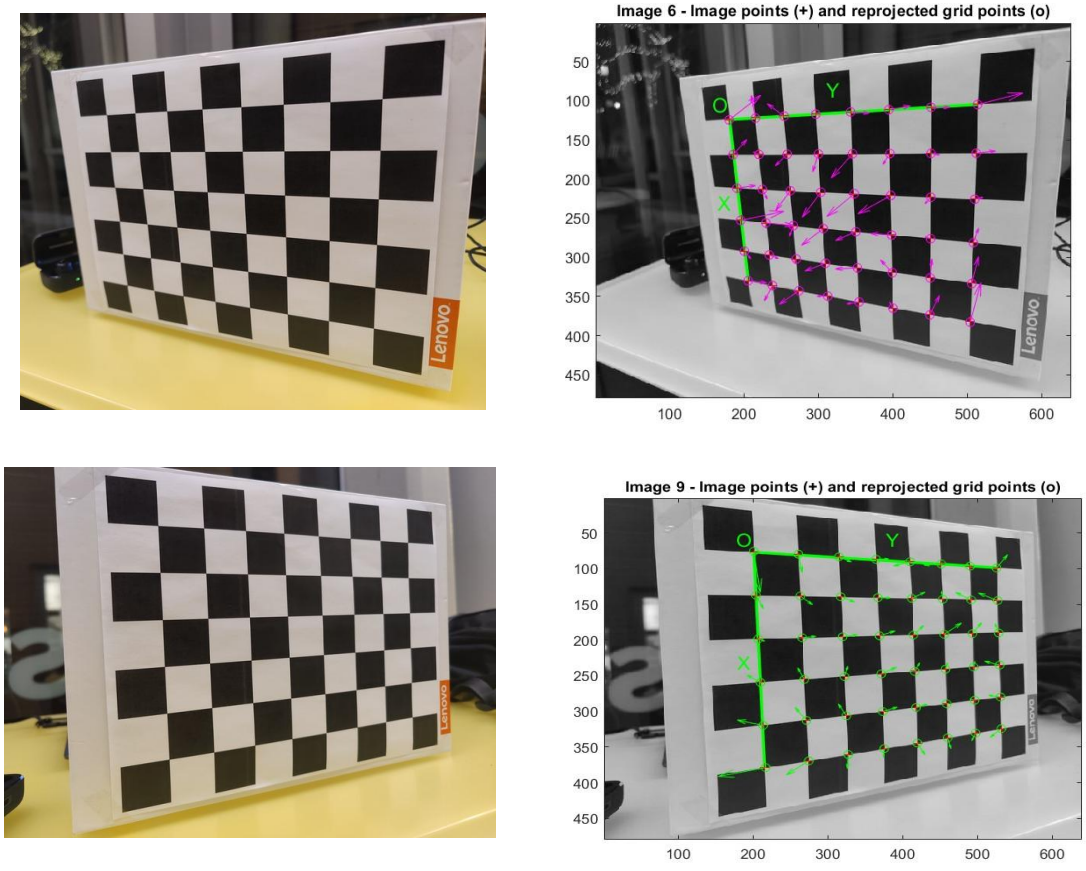

Figure 3: Image Before and After Calibration

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Focal Length:          fc = [ 488.17117   486.71170 ] ± [ 3.17018   2.93435 ]
Principal point:       cc = [ 321.99152   230.59872 ] ± [ 2.82268   2.27076 ]
Skew:             alpha_c = [ 0.00000 ] ± [ 0.00000  ]   => angle of pixel axes = 90.00000 ± 0.00000 degrees
Distortion:            kc = [ -0.09160   0.15820   -0.00264   0.00066  0.00000 ] ± [ 0.01721   0.05231   0.00149   0.00181  0.00000 ]
Pixel error:          err = [ 0.33277   0.29580 ]
```

Figure 4: Camera Calibration Parameters

Latino Student Center Mosaic

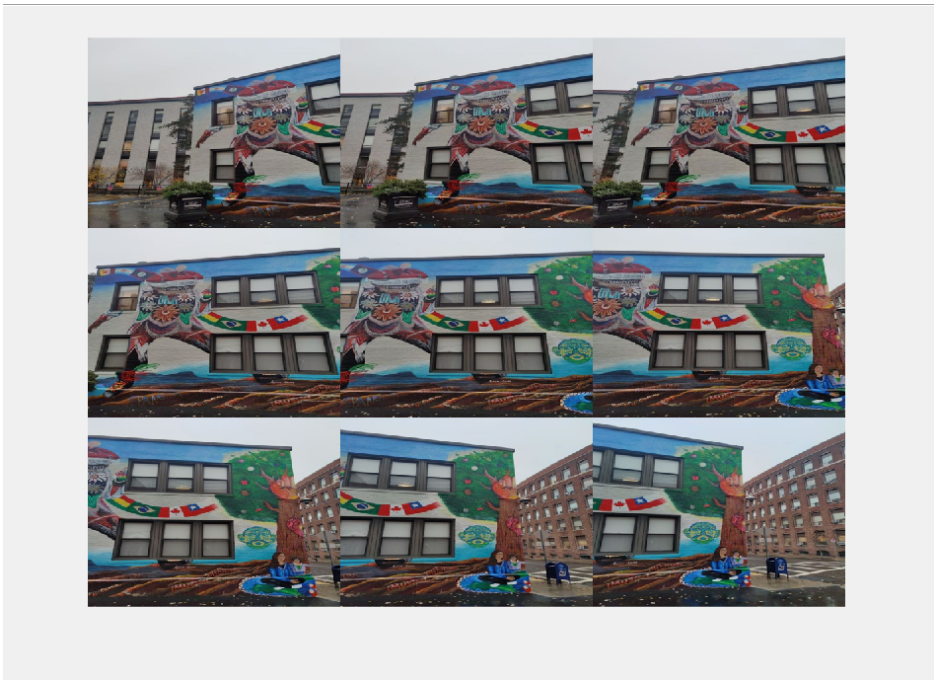

Figure 5: Latino Student Center Image Set

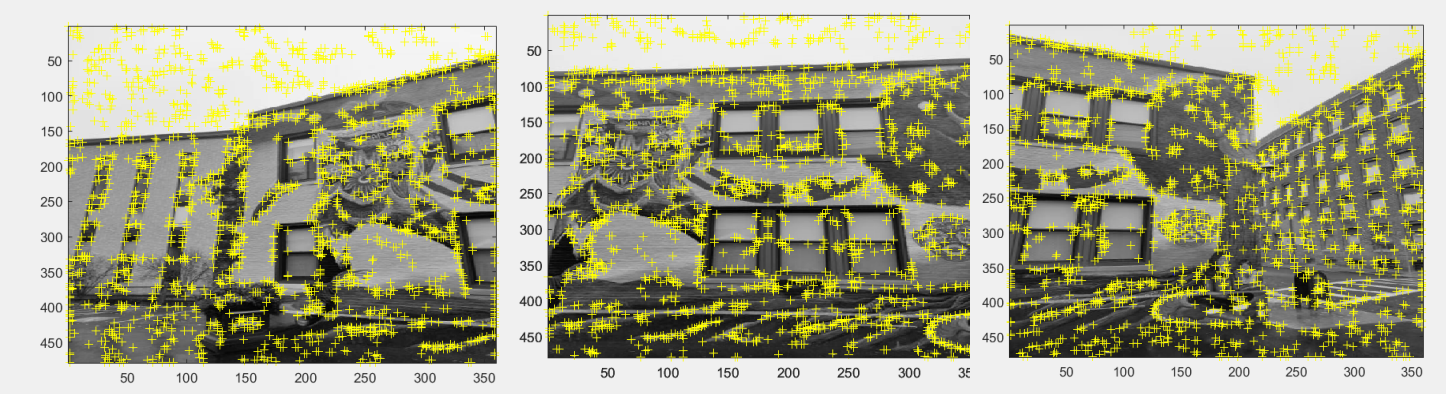

Figure 6: Latino Student Center With Distribution of Harris Corners (3 of 9 Images)

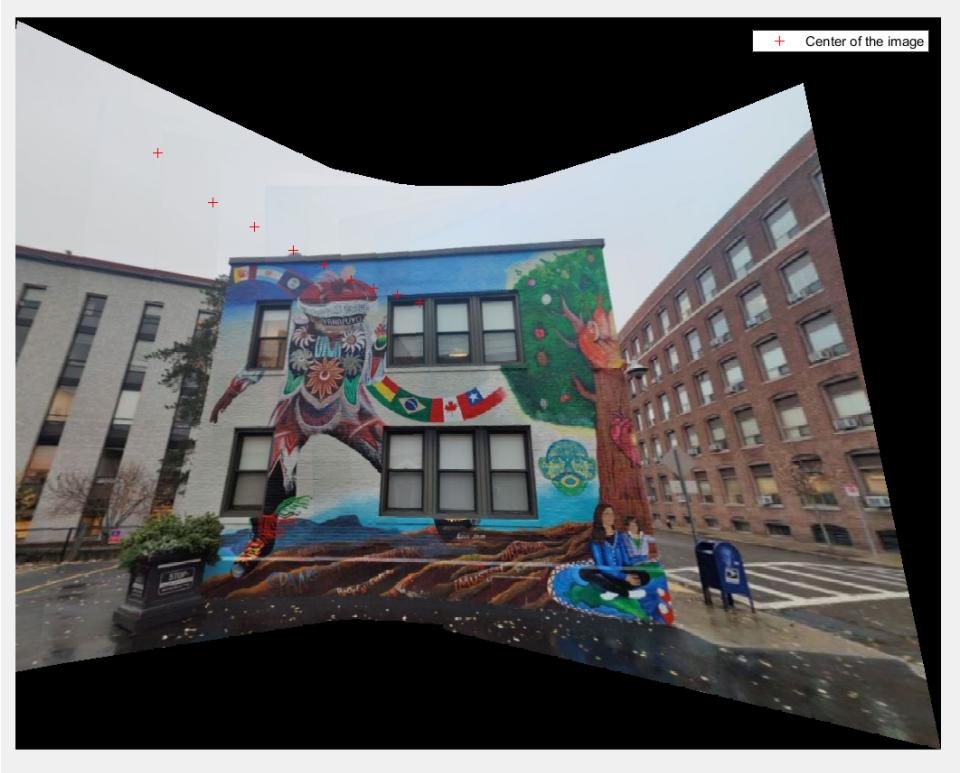

Figure 6: Latino Student Center Final Mosaic

Using the collective images shown in Figure 5, we were able to reproduce a panoramic image of the mural of the Latino Student Center, seen in Figure 6. When mosaicing, no immediate steps were taken other than resizing the 4k image that the cell phone took. In a misunderstanding of the lab handout, I took a picture of the sidewall of the LSC instead of the front side of the building. Due to this, more overlap was available to match more features, resulting in a very accurate panoramic image.

Cinder block/Brick Wall Mosaic

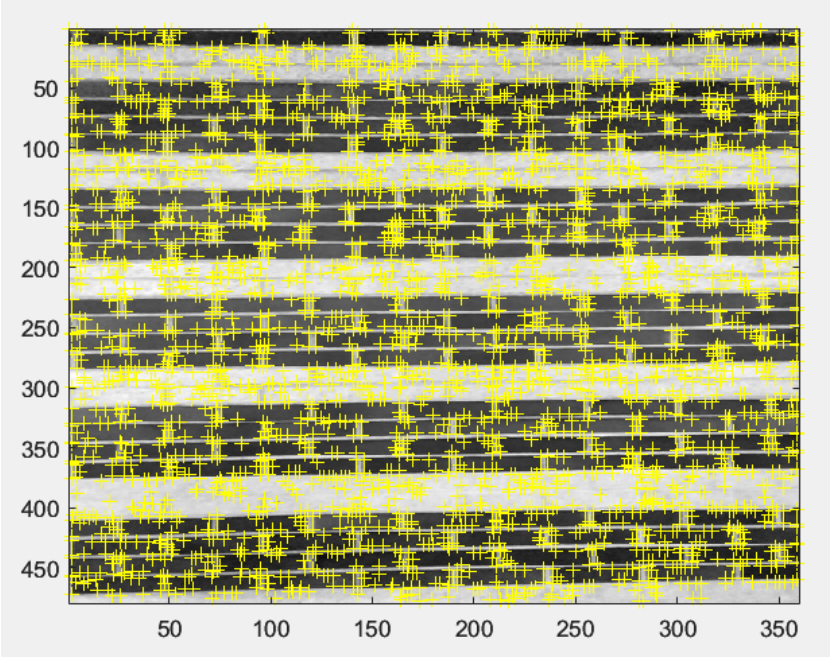

Figure 7: Harris Corners for Brick Wall (1 of 5 Images)

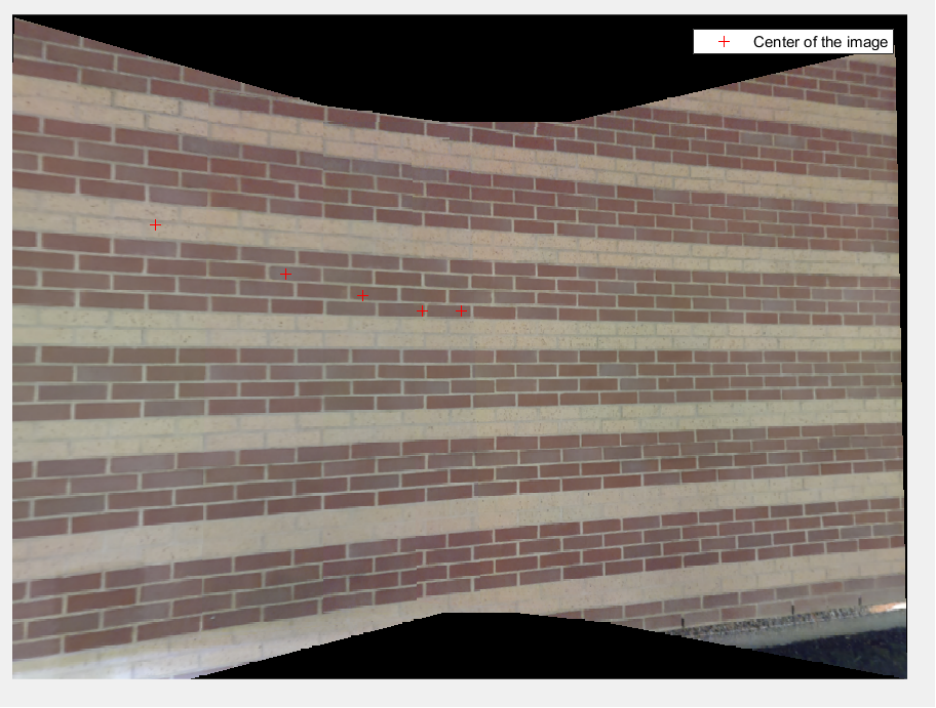

Figure 8: Final Mosaic of Brick Wall

In Figure 7 and 8, we mosaiced a brick wall. Due to the Harris corners detector, hundreds of features were detected. Given that so many features were found, the brick wall mosaic in theory should be much more refined compared to the LSC mosaic when comparing features between images. However, due to maybe some processing in the photos, one of the images in the brick wall is slightly offset from the rest of the images.

Third Mosaic of Graffiti

Figure 9: Initial Images of Third Mosaic(50% overlap)

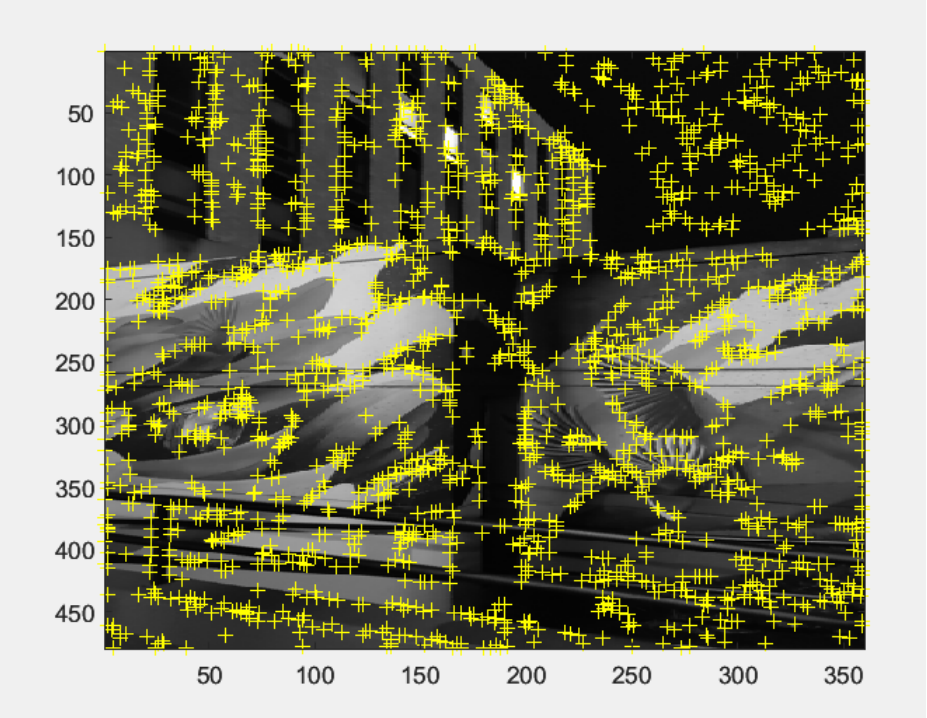

Figure 10: Harris Corners for 50% Overlap (1 of 8 Images)

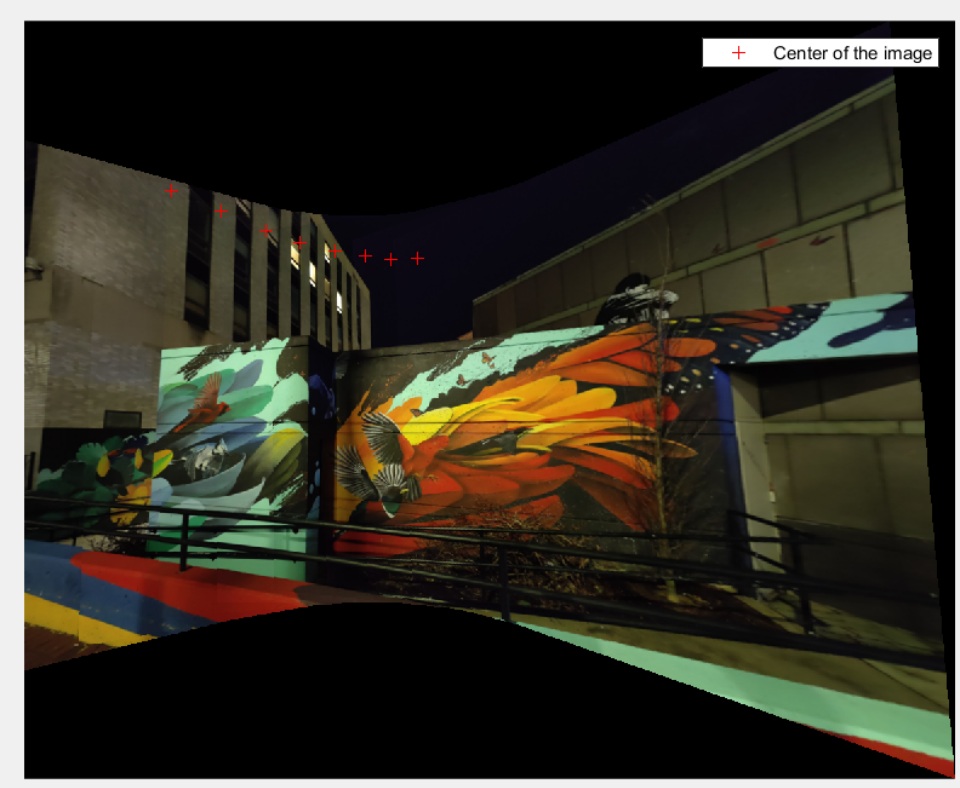

Figure 11: Final Mosaic of 50% Overlap

Figure 12: Initial Images of Third Mosaic (15% overlap)

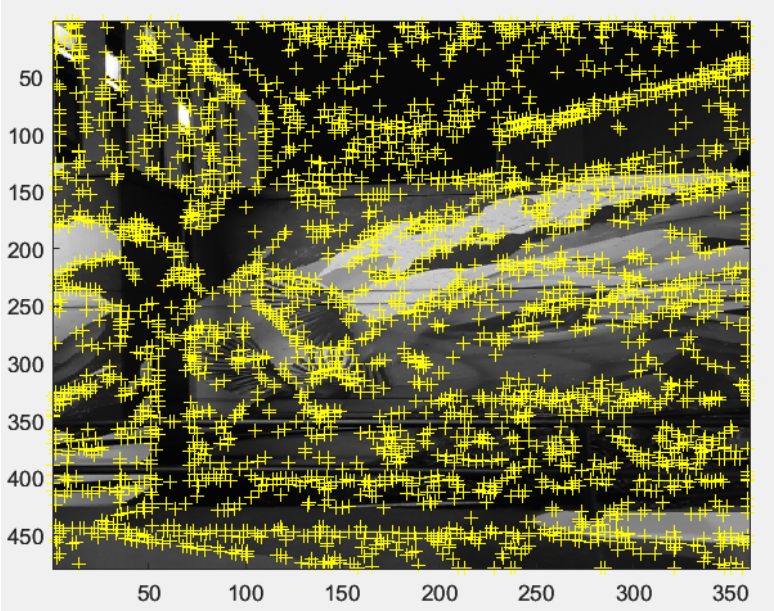

Figure 13: Harris Corners for 15% Overlap (1 of 3 Images)

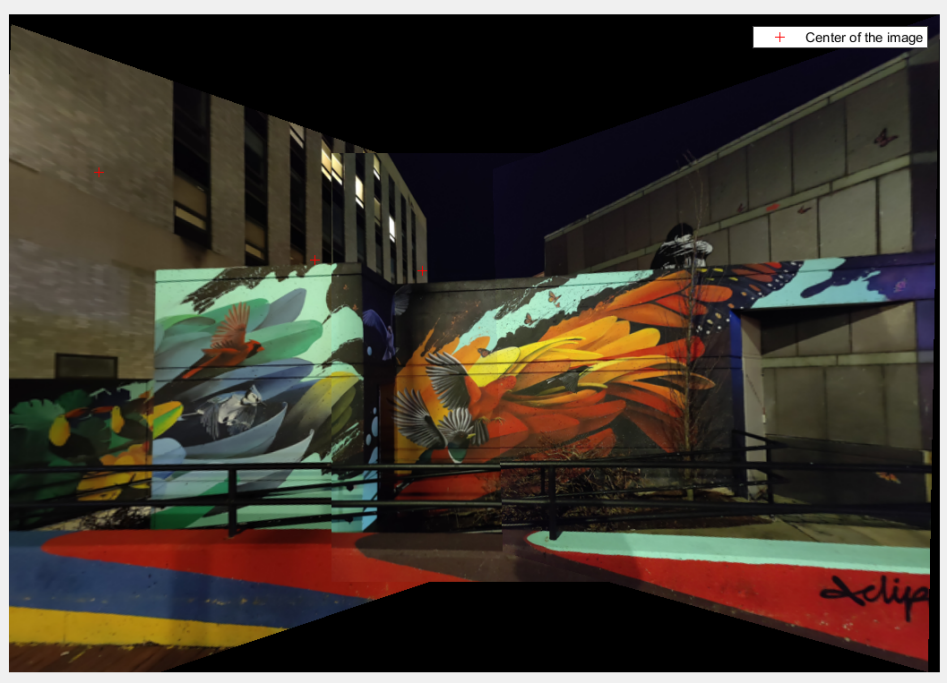

Figure 14: Final Mosaic of 15% Overlap

In comparing Figures 11 and 14, for the mosaicing that had 50% and 15% overlap for the images, we can see that there are not many distinct differences in the images. The mosaicing program does a very good job in recreating a stitched image using the features. This is because, even in the 15% overlap of images, it is still able to use a lot less features to produce matches, and still produce a very accurate panoramic image. By looking a little more closely at the 15% overlap mosaic, we can see there is a slight offset in the images. For example, the railing is noticeably off put in the image. Despite this, the performance of the 50% overlap is smoother. Within these images, no adjustments were made other than resizing the 4k images into a size of 480x360.

Conclusion

All in all, we were able to complete the learning objectives of this lab by describing how Harris corner detector works, identifying corner features in an image, discussing how image mosaic algorithms (e.g., ICP) work, applying image mosaic algorithms to stitch together a mural photograph, and articulate what scenes/images will work well or poorly for image mosaicing.