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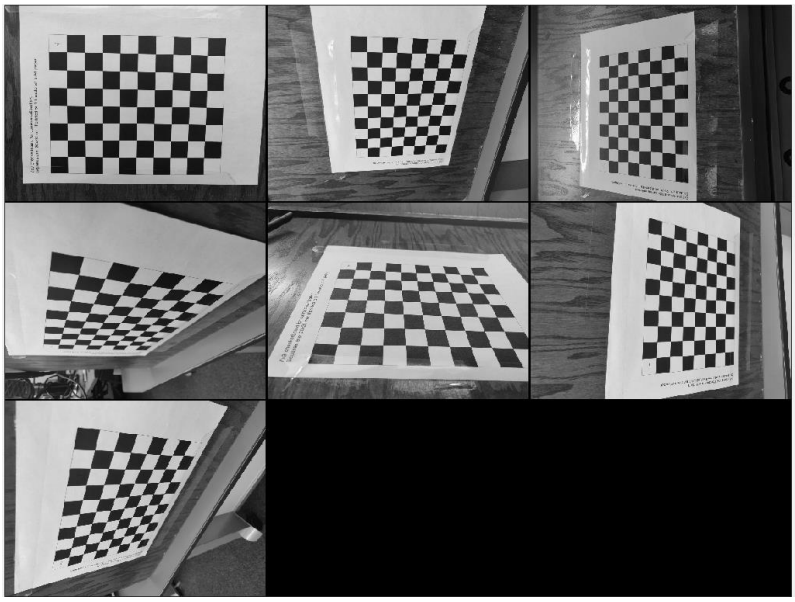
EECE 5554 – Robotic Sensing and Navigation

LAB 4

1. CAMERA CALIBRATION

a. Below are the pics of the checker from different angles:



When I calibrated the above images using Caltech Camera Calibration toolbox. Below are the results I got:

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Calibration parameters after initialization:

Focal Length:          fc = [ 914.22435   914.22435 ]
Principal point:       cc = [ 575.50000   431.50000 ]
Skew:             alpha_c = [ 0.00000 ]   => angle of pixel = 90.00000 degrees
Distortion:            kc = [ 0.00000   0.00000   0.00000   0.00000   0.00000 ]

Main calibration optimization procedure - Number of images: 7
Gradient descent iterations: 1...2...3...4...5...6...7...8...9...10...11...12...13...14...15...16...17...18...19...done
Estimation of uncertainties...done


Calibration results after optimization (with uncertainties):

Focal Length:          fc = [ 914.47439   913.11414 ] +/- [ 3.78649   4.12439 ]
Principal point:       cc = [ 573.36549   430.66959 ] +/- [ 7.16913   6.21176 ]
Skew:             alpha_c = [ 0.00000 ] +/- [ 0.00000  ]   => angle of pixel axes = 90.00000 +/- 0.00000 degrees
Distortion:            kc = [ -0.00536   -0.01311   -0.00162   0.00057  0.00000 ] +/- [ 0.01595   0.05082   0.00239   0.00274  0.00000 ]
Pixel error:          err = [ 0.40426   0.54094 ]

Note: The numerical errors are approximately three times the standard deviations (for reference).
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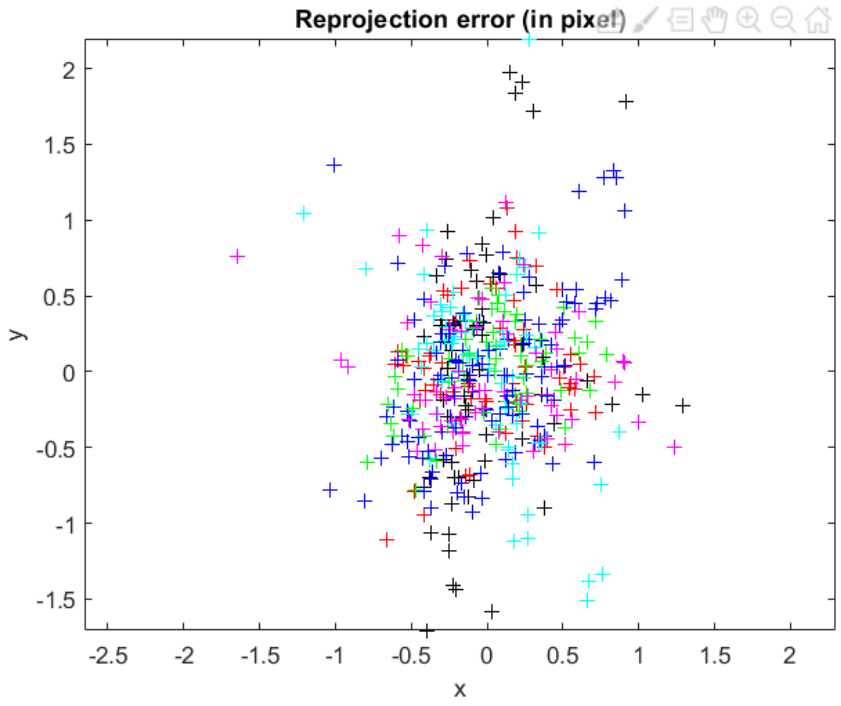
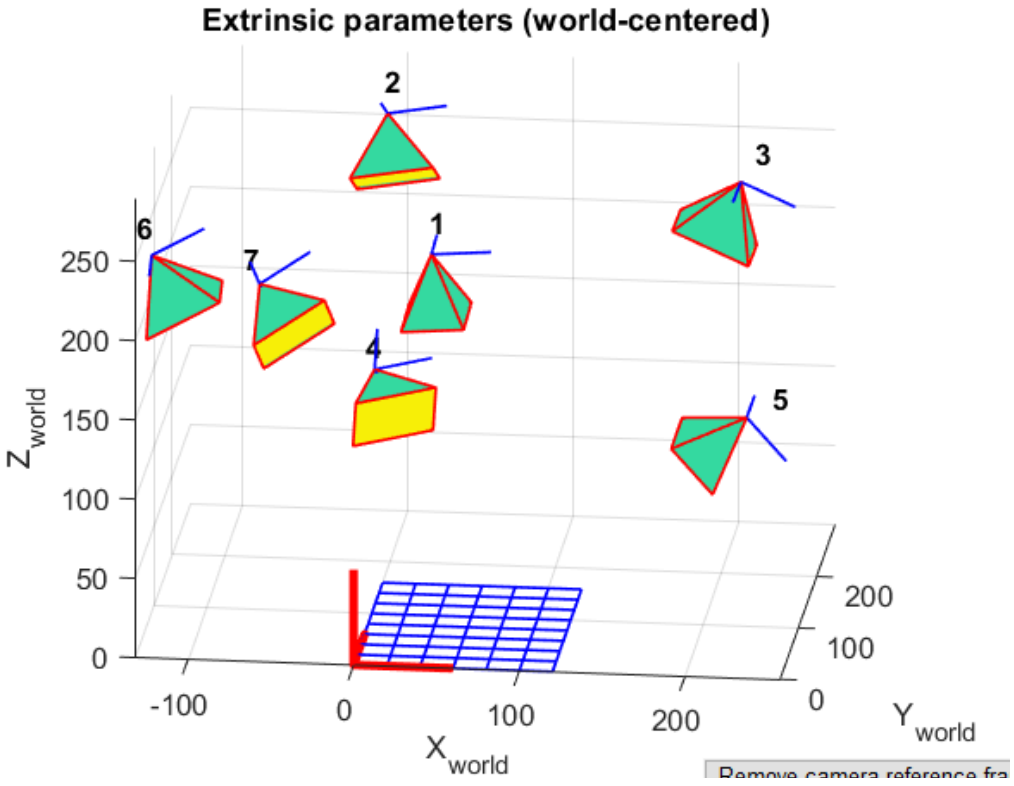
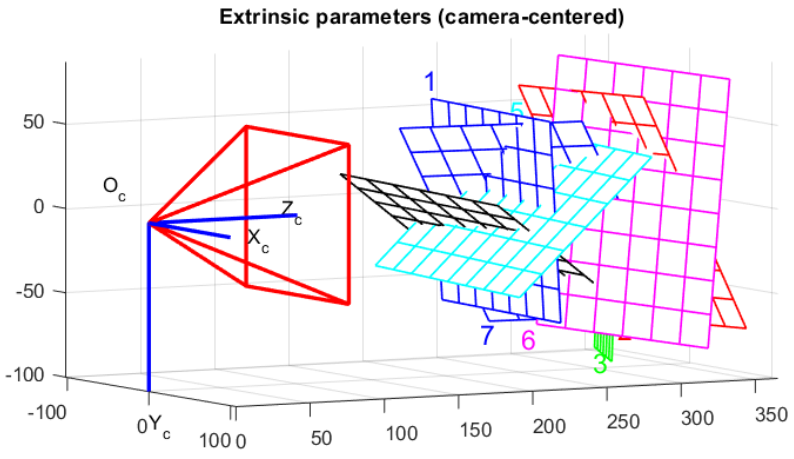


From the above graph, we can infer that the deviation in y-axis is much wider when compared to x-axis. The pixel error is [0.40426 0.54094] =

Extrinsic Parameters: (World Centered)



Extrinsic Parameters: (Camera Centered)

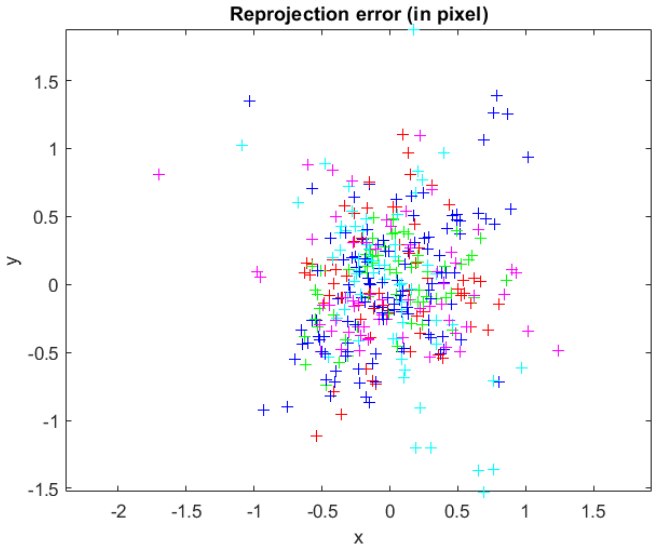


In the above set of pictures, image 4 had most reprojection error. So I removed the image 4 and recalibrated it. The result is:

Calibration results after optimization (with uncertainties):

Focal Length: fc = [916.97089 915.70187] +/- [4.29631 4.60245]
Principal point: cc = [572.93695 433.93250] +/- [6.87674 6.29307]
Skew: alpha_c = [0.00000] +/- [0.00000] => angle of pixel axes = 90.00000 +/- 0.00000 degrees
Distortion: kc = [-0.00264 -0.00513 -0.00012 -0.00062 0.00000] +/- [0.01576 0.04945 0.00246 0.00266 0.00000]
Pixel error: err = [0.41043 0.46587]

The overall pixel error in x axis has increased a bit but in y axis there is a significant decrease (from 0.54094 to 0.465) in error



Here, in the above graph the distribution is uniform with some outliers with improved mean reprojection error.

2. PHOTO MOSAICING

The below pictures are used for mosaicking

Here, for mosaicking the image size is set to 1152*864 which is less than 1M.

3. For images with overlap of less than 15%, mosaicking is difficult because the number of unique features are more which makes it difficult to mosaic