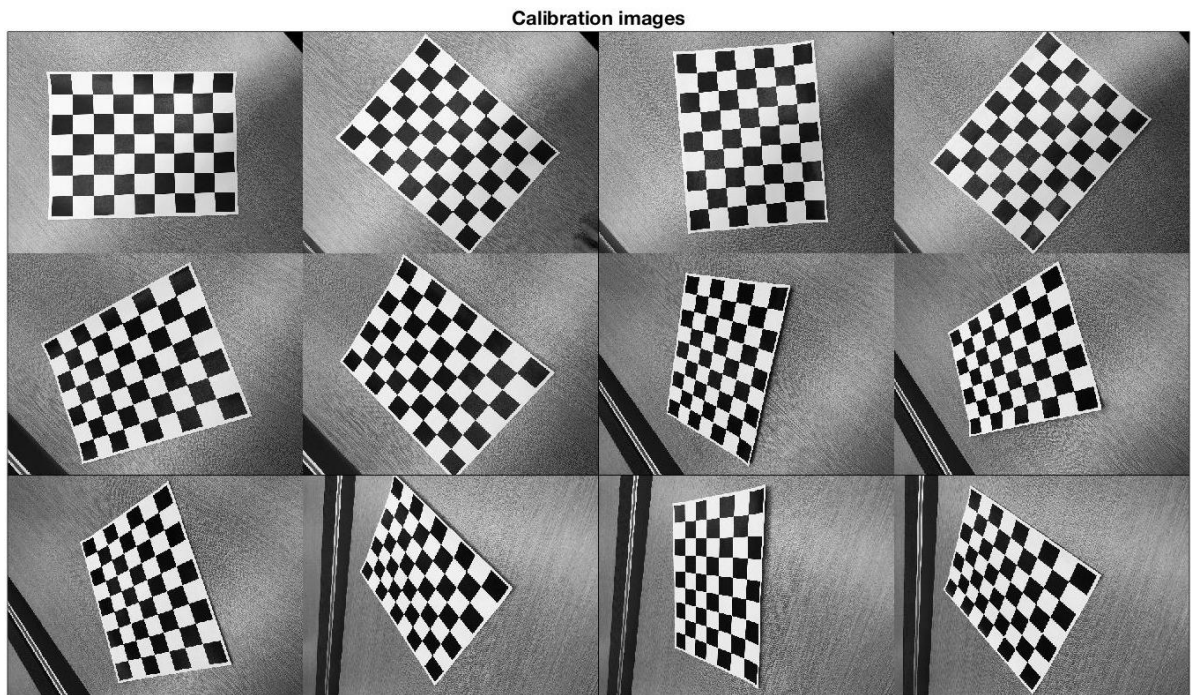


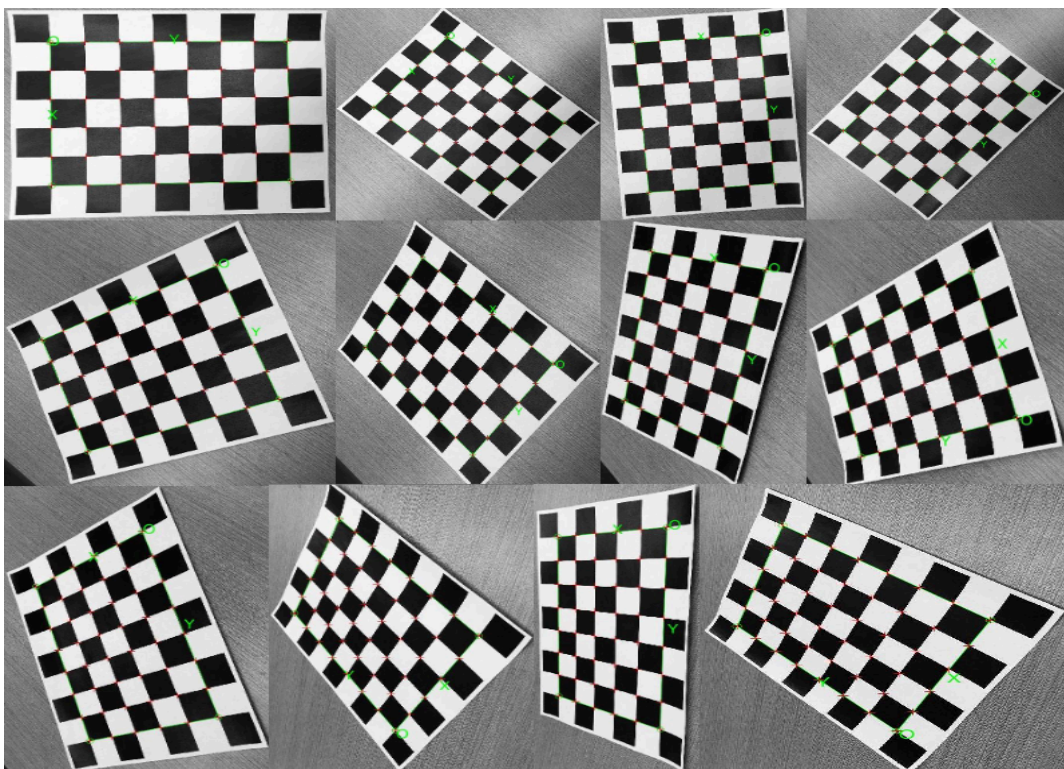
A brief technical overview of Flexible Camera Calibration

by Chuan Sun

12 images of the pattern file with different angles, rotations and tilts are taken, shown as below.



Then grid corners are manually extracted:



Begin the calibration:

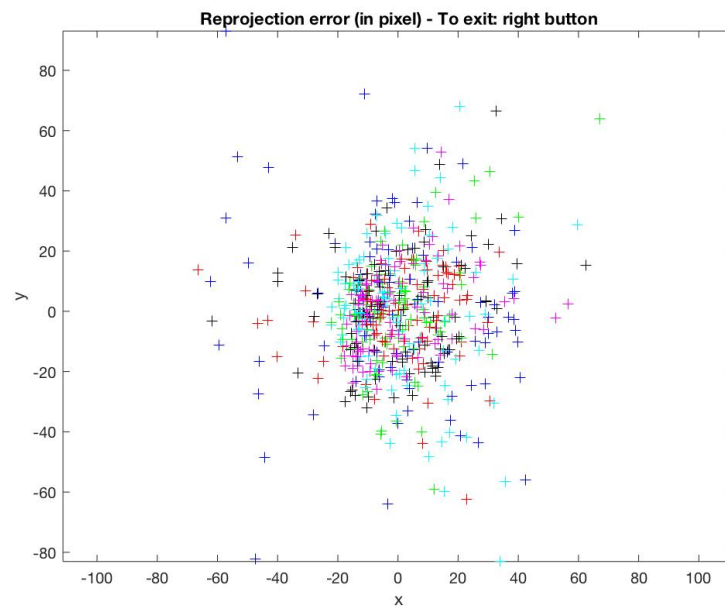
Calibration parameters after initialization:

```
Focal Length:      fc = [ 2561.75440  2561.75440 ]
Principal point:    cc = [ 2015.50000  1511.50000 ]
Skew:              alpha_c = [ 0.00000 ] => angle of pixel = 90.00000 degrees
Distortion:        kc = [ 0.00000  0.00000  0.00000  0.00000  0.00000 ]
```

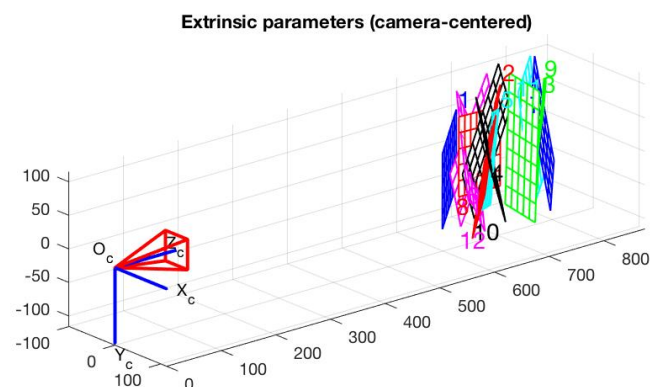
Calibration results after optimization (with uncertainties):

```
Focal Length:      fc = [ 9399.45033  7510.42980 ] +/- [ 1486.64902  940.77508 ]
Principal point:    cc = [ 2015.50000  1511.50000 ] +/- [ 0.00000  0.00000 ]
Skew:              alpha_c = [ 0.00000 ] +/- [ 0.00000 ] => angle of pixel axes = 90.00000 +/- 0.00000 degrees
Distortion:        kc = [ -2.48221  37.74475 -0.01868 -0.11358  0.00000 ] +/- [ 2.24096  78.63654  0.01972  0.03970  0.00000 ]
Pixel error:       err = [ 18.16346  20.19553 ]
```

According to the paper, the tool first runs the initialization based on the closed-form solution, then it provides optimization using maximum likelihood estimation. The errors are quite big at this stage.



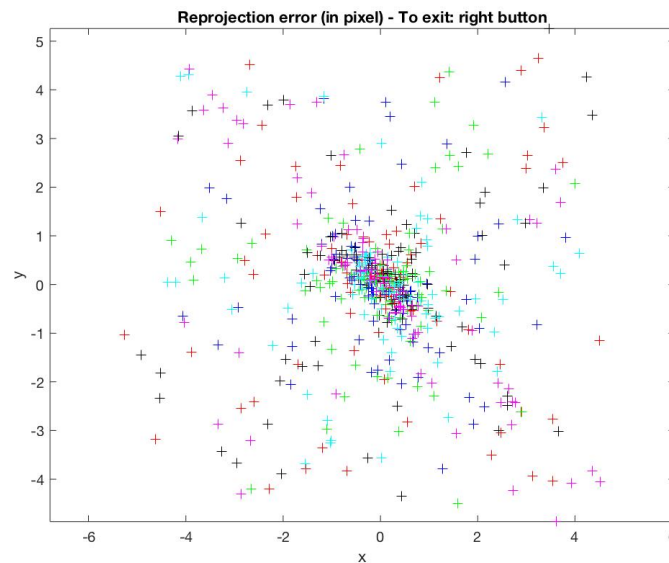
The extrinsic parameters of the camera-centered view:



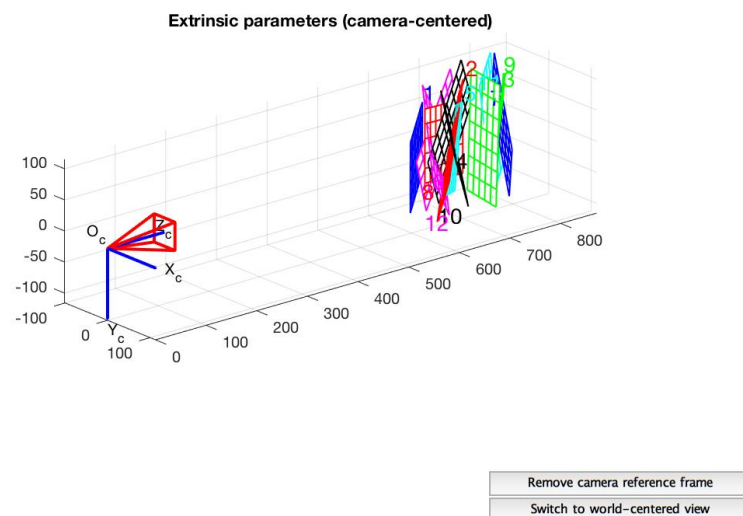
Remove camera reference frame

Switch to world-centered view

I tried another round of recomputing corners and then re-calibrating. It can be observed that after recalibration, both uncertainty and errors significantly declined.



The updated extrinsic parameters of the camera-centered view:



The calibration results after recomputing corners:

Calibration results after optimization (with uncertainties):

Focal Length: $fc = [9306.23266 \quad 7476.69010] \pm [123.85279 \quad 80.13645]$
Principal point: $cc = [2015.50000 \quad 1511.50000] \pm [0.00000 \quad 0.00000]$
Skew: $\alpha_c = [0.00000] \pm [0.00000] \Rightarrow \text{angle of pixel axes} = 90.00000 \pm 0.00000 \text{ degrees}$
Distortion: $kc = [-2.44052 \quad 37.64722 \quad -0.01853 \quad -0.11023 \quad 0.00000] \pm [0.19041 \quad 6.62915 \quad 0.00169 \quad 0.00342 \quad 0.00000]$
Pixel error: $err = [1.65362 \quad 1.64747]$