

‘init\_intrinsic\_param.m’

initialize lense distortion and camera center as given (if not 0 for both). Then computing the vanishing point get the focal length of the camera.

‘go\_calib\_optim.m’

by finding the Jacobian matrix we optimize the intrinsic parameter.

## Results

- Given Data Set

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*Calibration parameters after initialization:*

Focal Length:  $fc = [ 670.65491 \ 670.65491 ]$   
Principal point:  $cc = [ 319.50000 \ 239.50000 ]$   
Skew:  $\alpha_c = [ 0.00000 ] \Rightarrow \text{angle of pixel} = 90.00000 \text{ degrees}$   
Distortion:  $kc = [ 0.00000 \ 0.00000 \ 0.00000 \ 0.00000 \ 0.00000 ]$

*Main calibration optimization procedure - Number of images: 20*

*Gradient descent iterations:*

*1...2...3...4...5...6...7...8...9...10...11...12...13...14...15...16...17...18...19...20...21...22...23...24...done*

*Estimation of uncertainties...done*

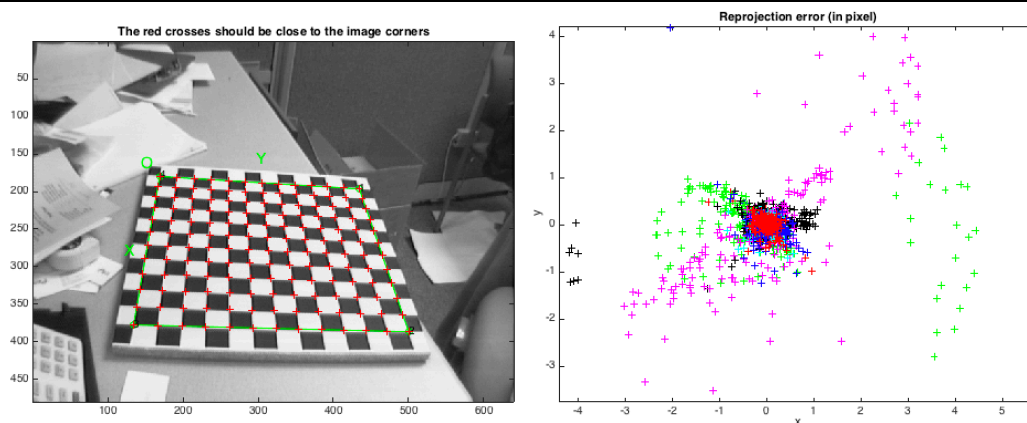
*Calibration results after optimization (with uncertainties):*

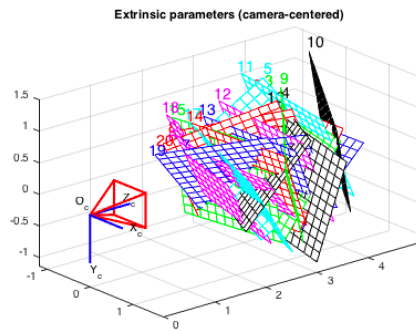
Focal Length:  $fc = [ 662.49528 \ 664.67741 ] \pm [ 1.43402 \ 1.54263 ]$   
Principal point:  $cc = [ 306.51277 \ 241.75102 ] \pm [ 2.83486 \ 2.60831 ]$   
Skew:  $\alpha_c = [ 0.00000 ] \pm [ 0.00000 ] \Rightarrow \text{angle of pixel axes} = 90.00000 \pm 0.00000 \text{ degrees}$   
Distortion:  $kc = [ -0.27907 \ 0.32025 \ 0.00050 \ 0.00028 \ 0.00000 ] \pm [ 0.01144 \ 0.04729 \ 0.00064 \ 0.00067 \ 0.00000 ]$   
Pixel error:  $err = [ 0.59063 \ 0.42184 ]$

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

*Pixel error:  $err = [0.59063 \ 0.42184]$  (all active images)*

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## - Own Data Set

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Aspect ratio optimized (est\_aspect\_ratio = 1) -> both components of  $f_c$  are estimated (DEFAULT).

Principal point optimized (center\_optim=1) - (DEFAULT). To reject principal point, set center\_optim=0

Skew not optimized (est\_alpha=0) - (DEFAULT)

Distortion not fully estimated (defined by the variable est\_dist):

Sixth order distortion not estimated (est\_dist(5)=0) - (DEFAULT) .

Initialization of the principal point at the center of the image.

Initialization of the intrinsic parameters using the vanishing points of planar patterns.

Initialization of the intrinsic parameters - Number of images: 25

Calibration parameters after initialization:

Focal Length:  $f_c = [ 11150.02668 \ 11150.02668 ]$

Principal point:  $cc = [ 2807.50000 \ 1871.50000 ]$

Skew:  $\alpha_c = [ 0.00000 ] \Rightarrow$  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: 25

Gradient descent iterations: 1...2...3...4...5...Warning: it appears that the principal point cannot be estimated. Setting center\_optim = 0

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:  $f_c = [ 11944.05609 \ 12392.23170 ] \pm [ 151.79308 \ 187.61667 ]$

Principal point:  $cc = [ 2952.61994 \ -341.72992 ] \pm [ 0.00000 \ 0.00000 ]$

Skew:  $\alpha_c = [ 0.00000 ] \pm [ 0.00000 ] \Rightarrow$  angle of pixel axes = 90.00000  $\pm$  0.00000 degrees

Distortion:  $kc = [ 0.34422 \ -0.40179 \ -0.10323 \ 0.00594 \ 0.00000 ] \pm [ 0.10863 \ 0.62208 \ 0.01467 \ 0.00215 \ 0.00000 ]$

Pixel error:  $err = [ 3.28597 \ 2.74973 ]$

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

Pixel error:  $err = [ 3.28597 \ 2.74973 ]$  (all active images)

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\* Reprojection error is quite large due to blurry image and not enough sufficient position of the image.

