Computer Vision
Lab 01: Calibration

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1   Matlab file of 2D-3D correspondences

The 2D points are saved in **xy.mat** file and the corresponding 3D points are saved in **XYZ.mat**, in *student_code* directory.

2   Images used for calibration

The images used for calibration is given in *images_my_camera* directory.

3   Visualize hand-clicked points and reprojected 3D points

3.1   Direct Linear Transform (DLT)

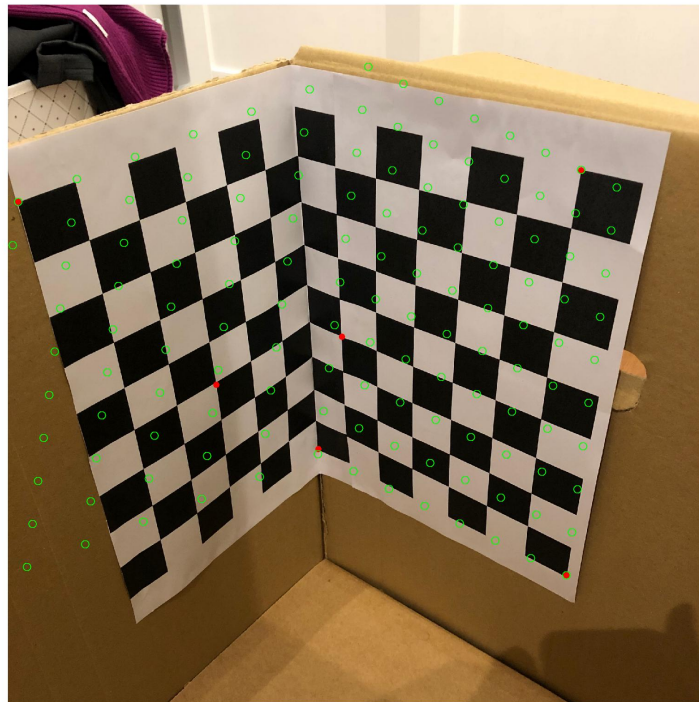**Figure 1.** Hand-clicked points and reprojected 3D points

Figure 2. Reprojection of all the checkboard corners
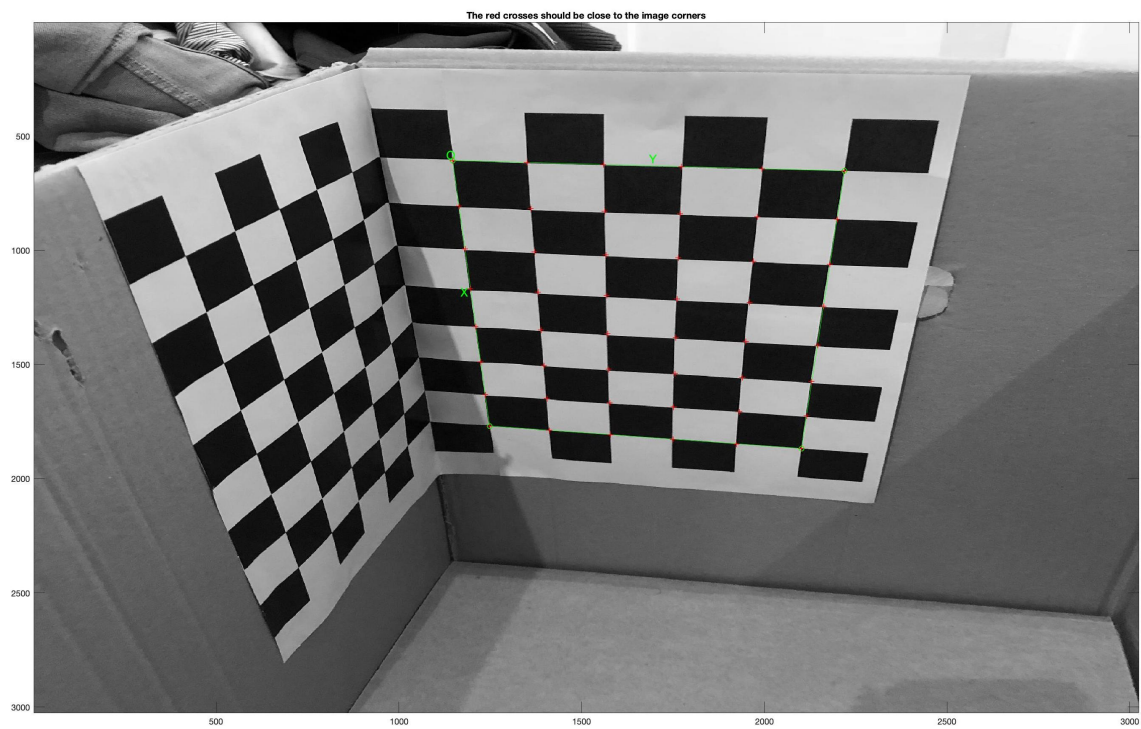
3.2 Gold Standard algorithm

Figure 3. Hand-clicked points and reprojected 3D points

Figure 4. Reprojection of all the checkboard corners

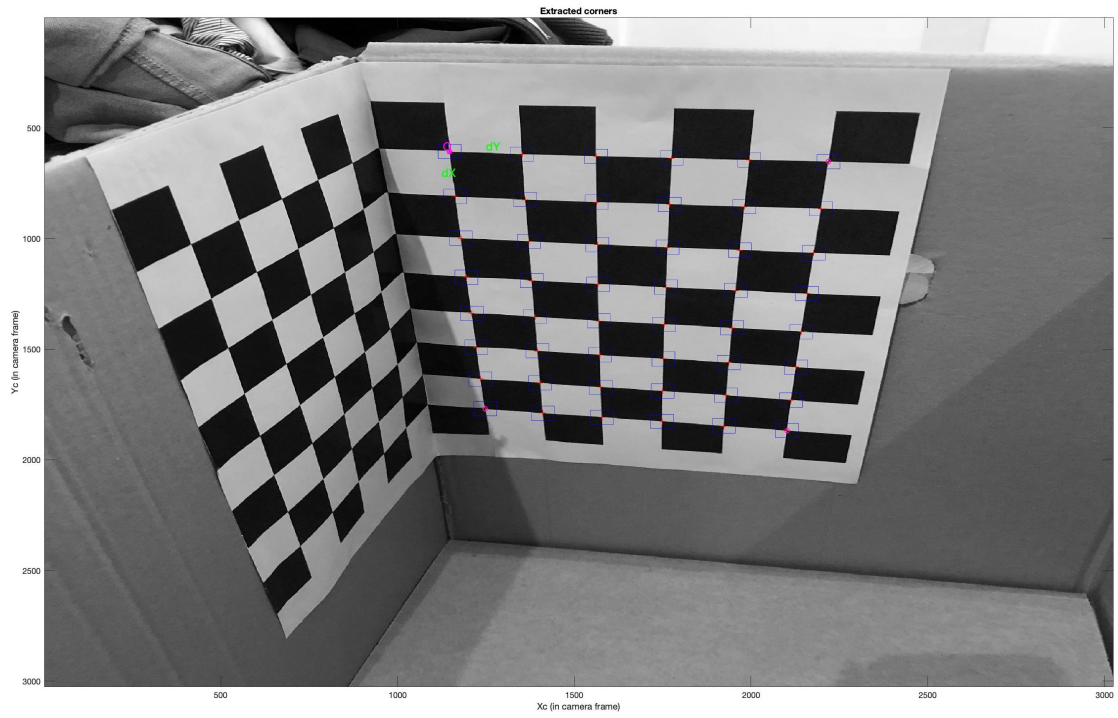## 3.3 Bouget's Calibration Toolbox

Figure 5. Predicted Corners
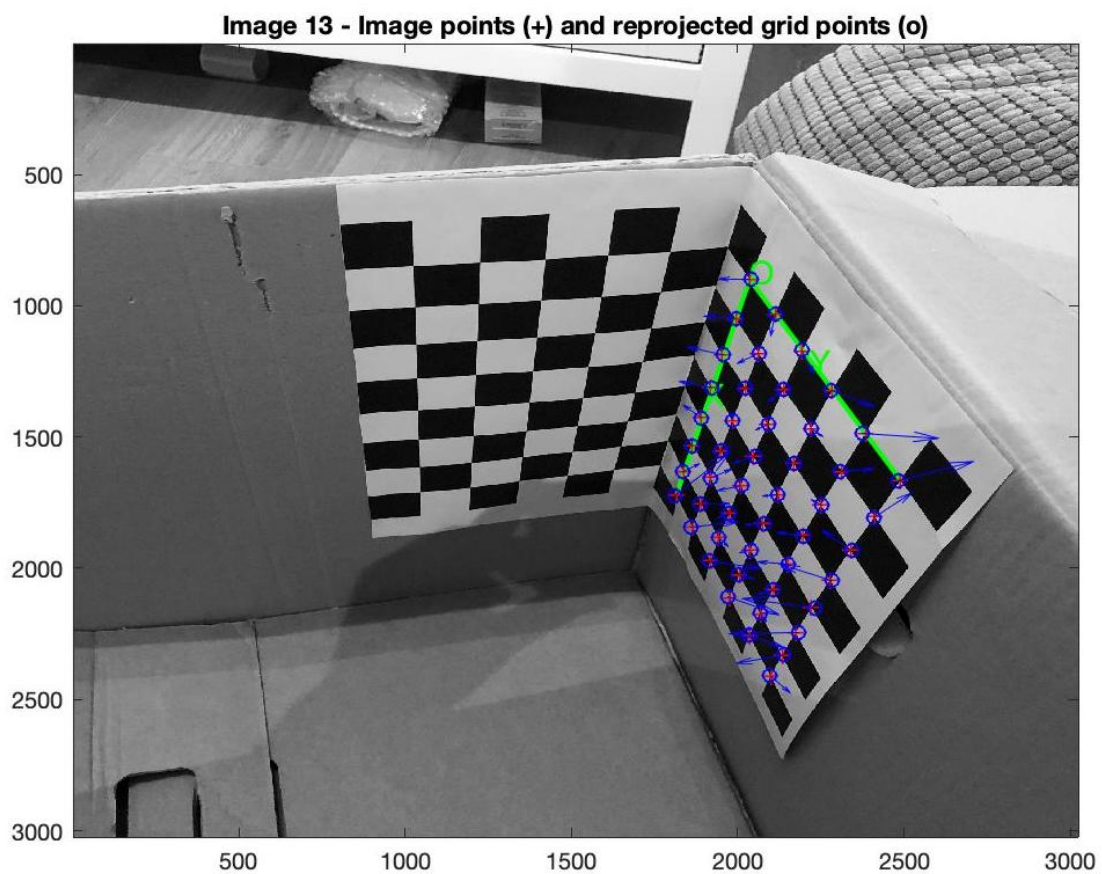
Figure 6. Extracted Corners

Figure 7. Reprojection of all the checkboard corners

4 Values of Calibration

4.1 Direct Linear Transform (DLT)

$$K = \begin{bmatrix} -3018.52 & 55.07 & 1559.73 \\ 0 & 3004.95 & 1402.25 \\ 0 & 0 & 1 \end{bmatrix}_{[3\times3]} \quad R = \begin{bmatrix} -0.59 & 0.81 & -0.003 \\ -0.43 & -0.31 & 0.85 \\ 0.69 & 0.50 & 0.53 \end{bmatrix}_{[3\times3]} \quad t = \begin{bmatrix} 303.96 \\ 222.11 \\ -353.72 \end{bmatrix}_{[3\times1]}$$

4.2 Gold Standard algorithm

$$K = \begin{bmatrix} -652153.31 & -139737.54 & 128621.50 \\ 0 & 461354.64 & -219837.11 \\ 0 & 0 & 1 \end{bmatrix}_{[3\times3]} \quad R = \begin{bmatrix} -0.72 & 0.69 & -0.10 \\ -0.16 & -0.02 & 0.99 \\ 0.67 & 0.72 & 0.13 \end{bmatrix}_{[3\times3]} \quad t = \begin{bmatrix} 49681.49 \\ 11360.80 \\ -46492.59 \end{bmatrix}_{[3\times1]}$$
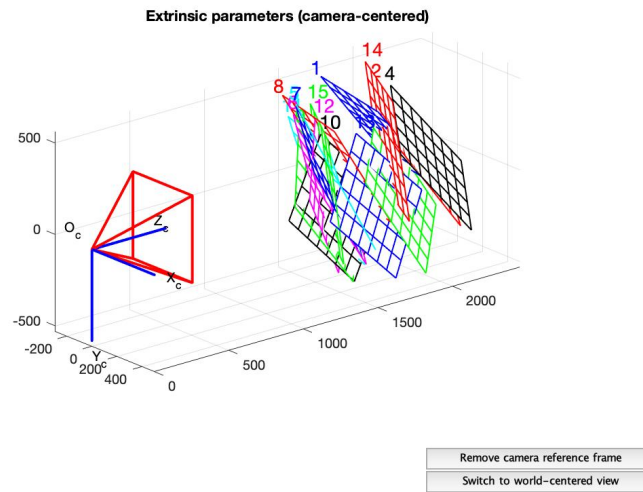
4.3 Bouget's Calibration Toolbox

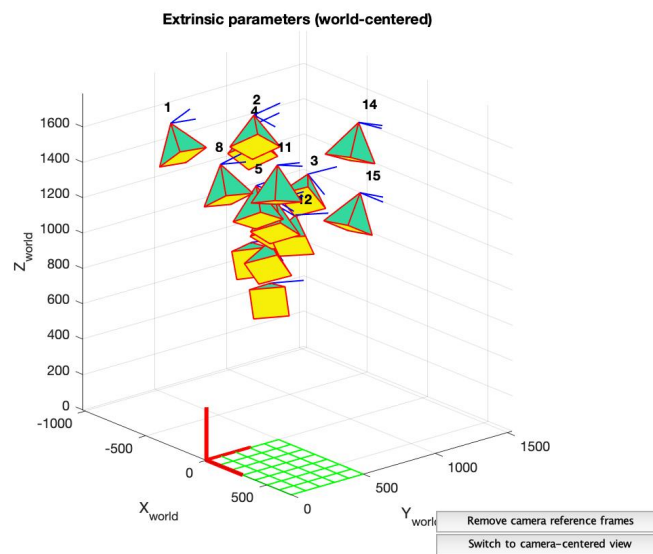**Figure 8.** The 3D plot of extrinsic parameters: camera centered view

Figure 9. The 3D plot of extrinsic parameters: world centered view

Focal Length: fc = [3208.46429 3197.60418] [26.57561 26.87173]
Principal point: cc = [1702.26094 1502.44010] [35.57927 29.97307]
Skew: alpha_c = [0.00000] [0.00000] => angle of pixel axes = 90.00000 0.00000 degrees
Distortion: kc = [0.23716 -1.36546 -0.00133 0.03028 0.00000] [0.04665 0.37102 0.00420 0.00409 0.00000]

5 Average reprojection error

The average error in Direct Linear Transform is similar to Bouget's Calibration Toolbox, while the error from Gold Standard Algorithm is quite high.

Error coordinate	Direct Linear Transform (DLT)	Gold Standard algorithm	Bouget's Calibration Toolbox
X	5.04	11703.59	1.77
Y	5.63	8304.58	1.38

Table 1. X and Y component of average reprojection error