Report of Computer Vision

Name: Wenjie Yi

Camera calibration:

1. Phone Information:

   - Apple iPhone 12 mini
   - Wide Angle Camera (ISO80, 26mm, 0ev, f1.6, 1/60s)
   - Photo (12MP, 4032*3024)

   (1) Miniatures of the Calibration Photos:


Photo_1018_1a


Photo_1018_2a


Photo_1018_3a


Photo_1018_5a


Photo_1018_6a


Photo_1018_7a

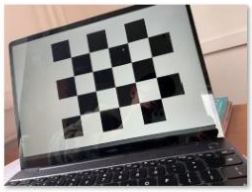


Photo_1018_8a

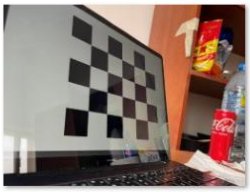


Photo_1018_9a


Photo_1018_10a


Photo_1018_11a


Photo_1018_12a

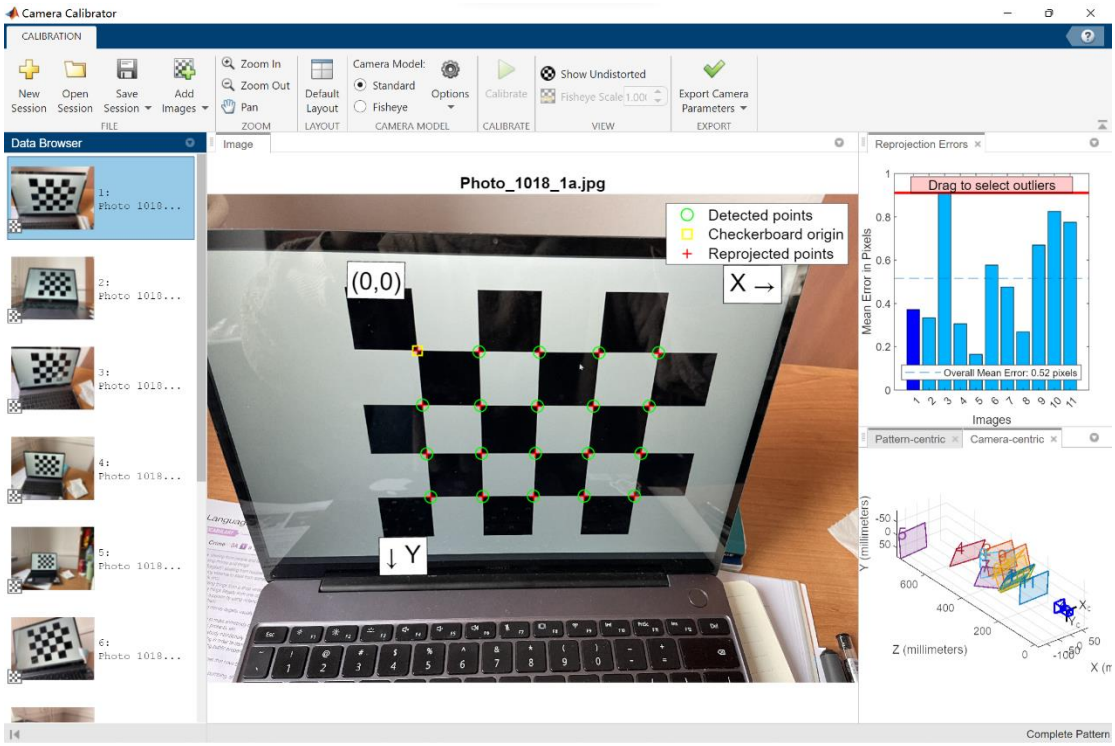

Photo_1018_13a

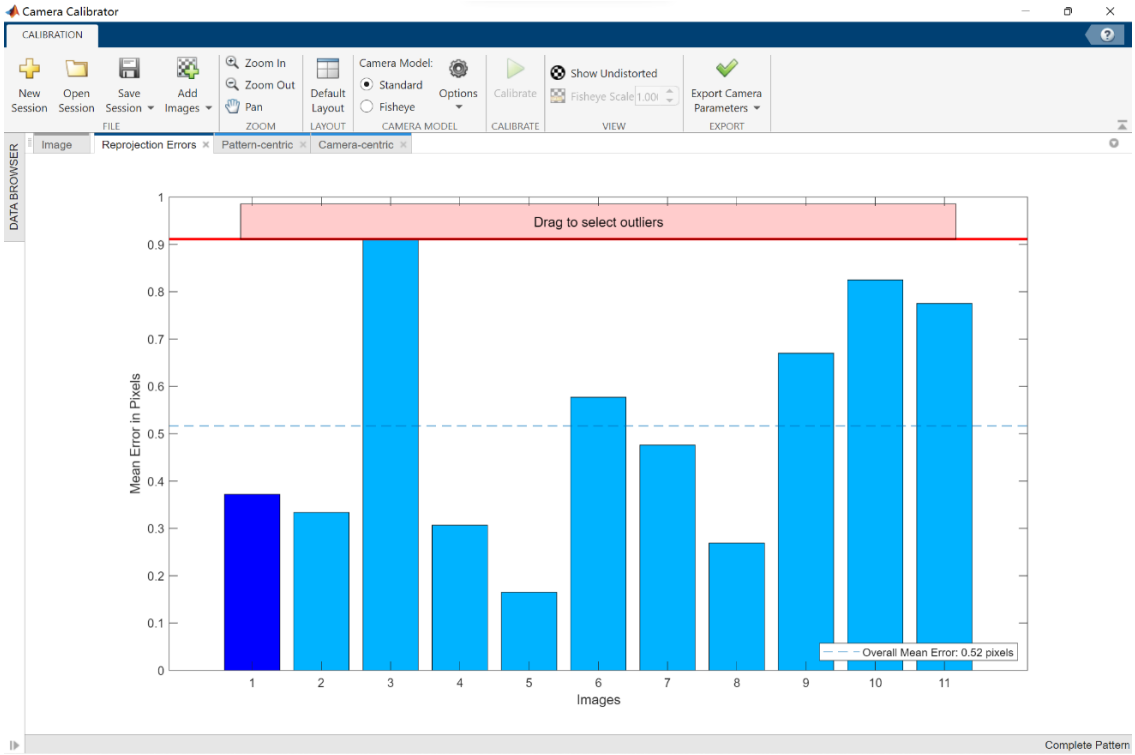

Photo_1018_14a

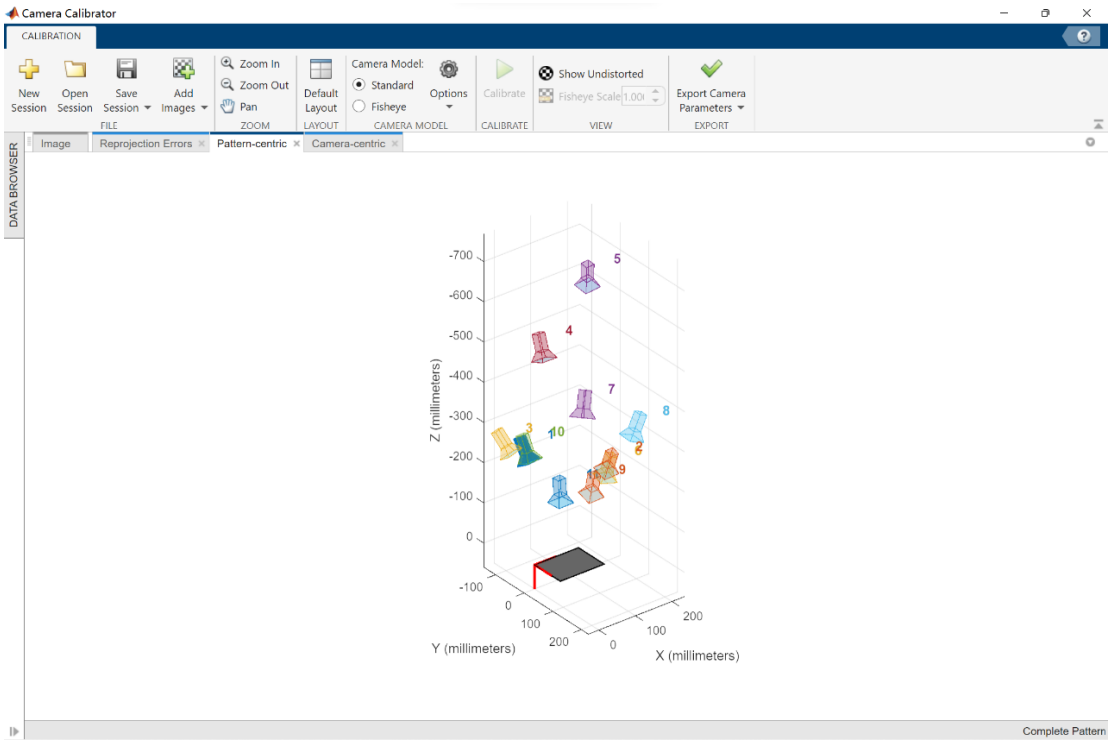

Photo_1018_15a

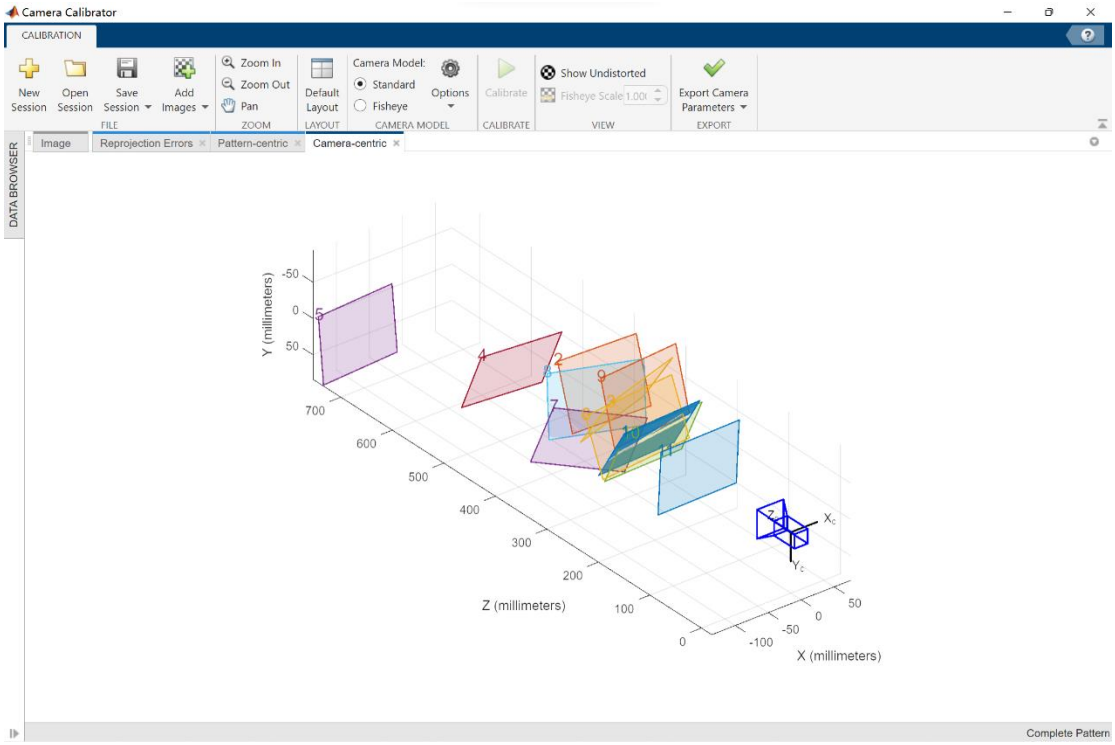

Photo_1018_16a

(2) Screenshot of the Calibrator App:






Camera Calibrator
CALIBRATION
New Session
Open Session
Save Session
Add Images
FILE
Zoom In
Zoom Out
Pan
ZOOM
Default Layout
LAYOUT
Camera Model:
Standard
Fisheye
Options
CAMERA MODEL
Calibrate
CALIBRATE
Show Undistorted
Fisheye Scale
VIEW
Export Camera Parameters
EXPORT
DATA BROWSER
Image
Reprojection Errors
Pattern-centric
Camera-centric
Z (millimeters)
Y (millimeters)
X (millimeters)
Complete Pattern


Camera Calibrator
CALIBRATION
New Session
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CAMERA MODEL
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EXPORT
DATA BROWSER
Image
Reprojection Errors
Pattern-centric
Camera-centric
Y (millimeters)
Z (millimeters)
X (millimeters)
Complete Pattern

(3) Camera Calibration Parameters:

Variables - cameraParams

cameraParams | cameraParams.Intrinsics

1x1 cameraParameters

Property	Value
ImageSize	[3024,4032]
RadialDistortion	[0.1446,-0.3634]
TangentialDistortion	[0,0]
WorldPoints	*20x2 double*
WorldUnits	'millimeters'
EstimateSkew	0
NumRadialDistortionCoefficients	2
EstimateTangentialDistortion	0
ReprojectionErrors	*20x2x11 double*
DetectedKeypoints	*20x11 logical*
RotationVectors	*11x3 double*
K	[3.1429e+03,0,2.0177e+03;0,3.1462e+03,1.4974e+03;0,0,1]
NumPatterns	11
Intrinsics	*1x1 cameraIntrinsics*
PatternExtrinsics	*11x1 rigidtform3d*
FocalLength	[3.1429e+03,3.1462e+03]
PrincipalPoint	[2.0177e+03,1.4974e+03]
Skew	0
MeanReprojectionError	0.5164
ReprojectedPoints	*20x2x11 double*

Variables - cameraParams.Intrinsics | Editor - untitled6.m

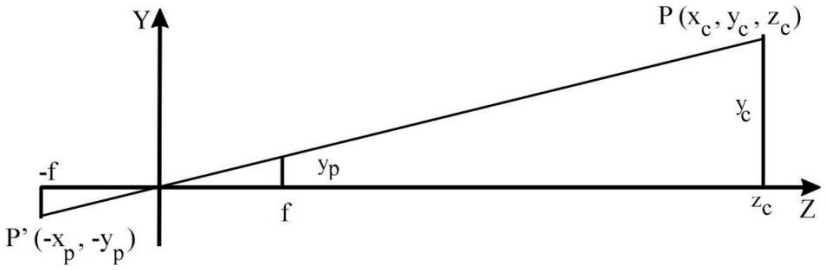
cameraParams | cameraParams.Intrinsics

cameraParams.Intrinsics

Property	Value
FocalLength	[3.1429e+03,3.1462e+03]
PrincipalPoint	[2.0177e+03,1.4974e+03]
ImageSize	[3024,4032]
RadialDistortion	[0.1446,-0.3634]
TangentialDistortion	[0,0]
Skew	0
K	[3.1429e+03,0,2.0177e+03;0,3.1462e+03,1.4974e+03;0,0,1]

2. Distance Measurement Section

(1) Distance Measure Model:



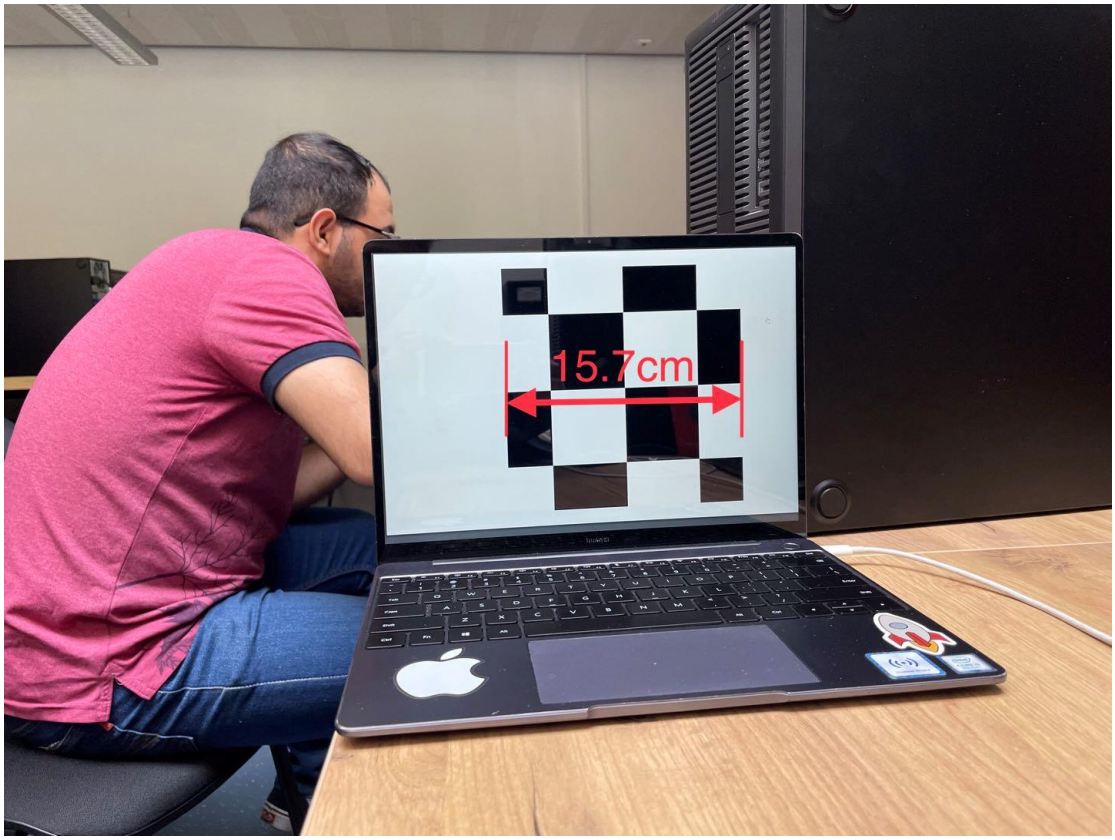
We know:

$$x_p = \frac{f \cdot X_c}{Z_c}, \quad y_p = \frac{f \cdot Y_c}{Z_c}$$

$$Z_c = \frac{f.X_c}{x_p}$$

So, we can get the distance Z_c, use the parameters of focal length, target length and pixel length.

(2) Target:



(3) Table with Results:

Focal Length = 3142.9

Pattern Size (in pixels)	Measured Distance (in centimeters)	Calculated Distance (in centimeter)	Absolute Error (in centimeter)
858.65	50	$Z_{50}= \frac{f.X_c}{x_p}$ =57.466	7.466
472.11	100	$Z_{100}= \frac{f.X_c}{x_p}$ =104.517	4.517
326.93	150	$Z_{150}= \frac{f.X_c}{x_p}$ =150.929	0.929

(4) Measurement Error:

if we measure one pixel more,

for 50cm distance: $Z_e= Z_{50}-\frac{3142.9*15.7}{(858.65+1)}$ = 0.066

for 100cm distance: $Z_e= Z_{100}-\frac{3142.9*15.7}{(472.11+1)}$ = 0.221

for 150cm distance: $Z_e= Z_{150}-\frac{3142.9*15.7}{(326.93+1)}$ = 0.459

For the conclusion, The farther camera is from the target, the greater errors can get.