

REPORT

T1 : CAMERA GEOMETRY

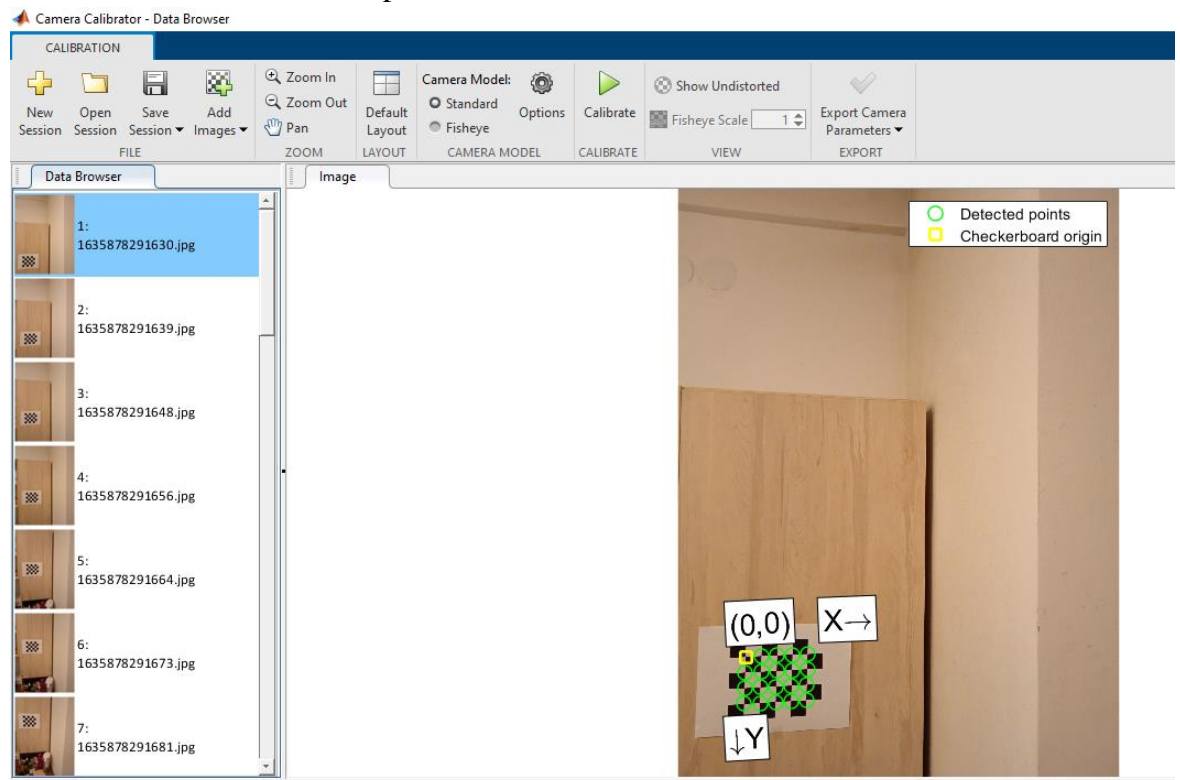
Name : Jafar Jafar

Faculty : Power and Aeronautical Engineering

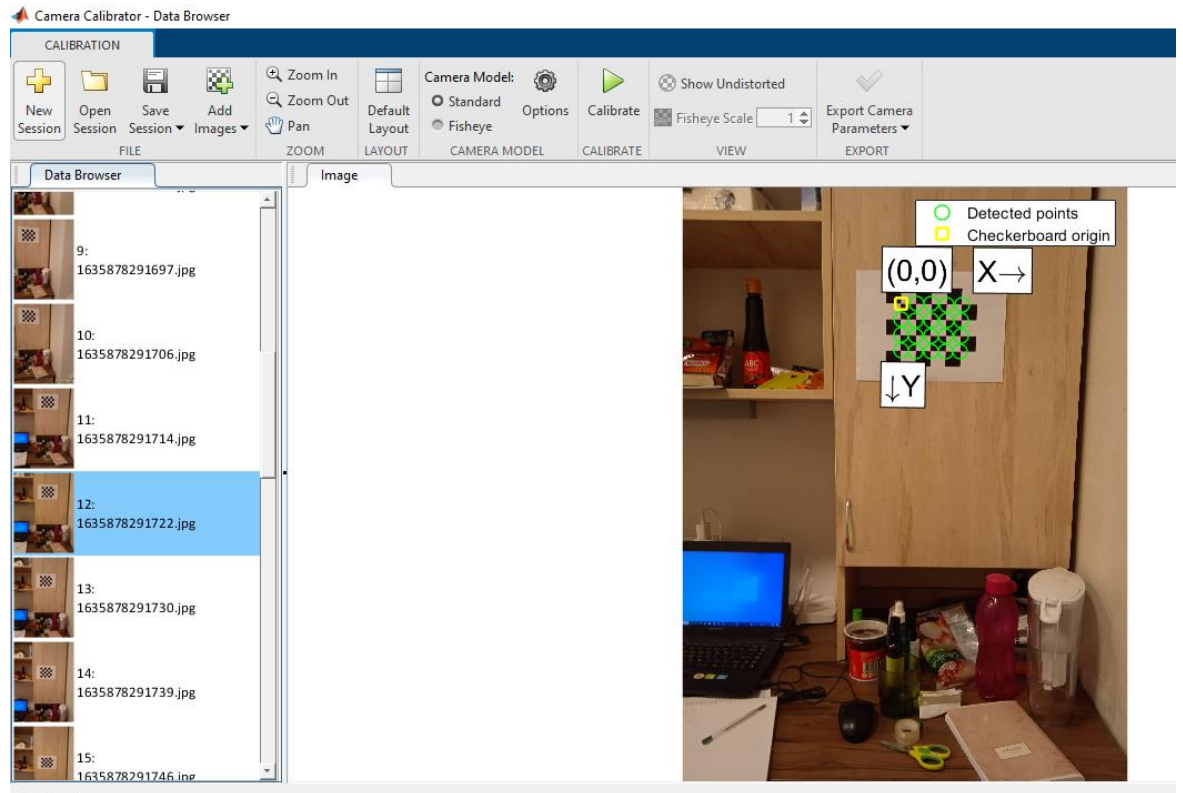
Major : Robotics

1. Calibration section

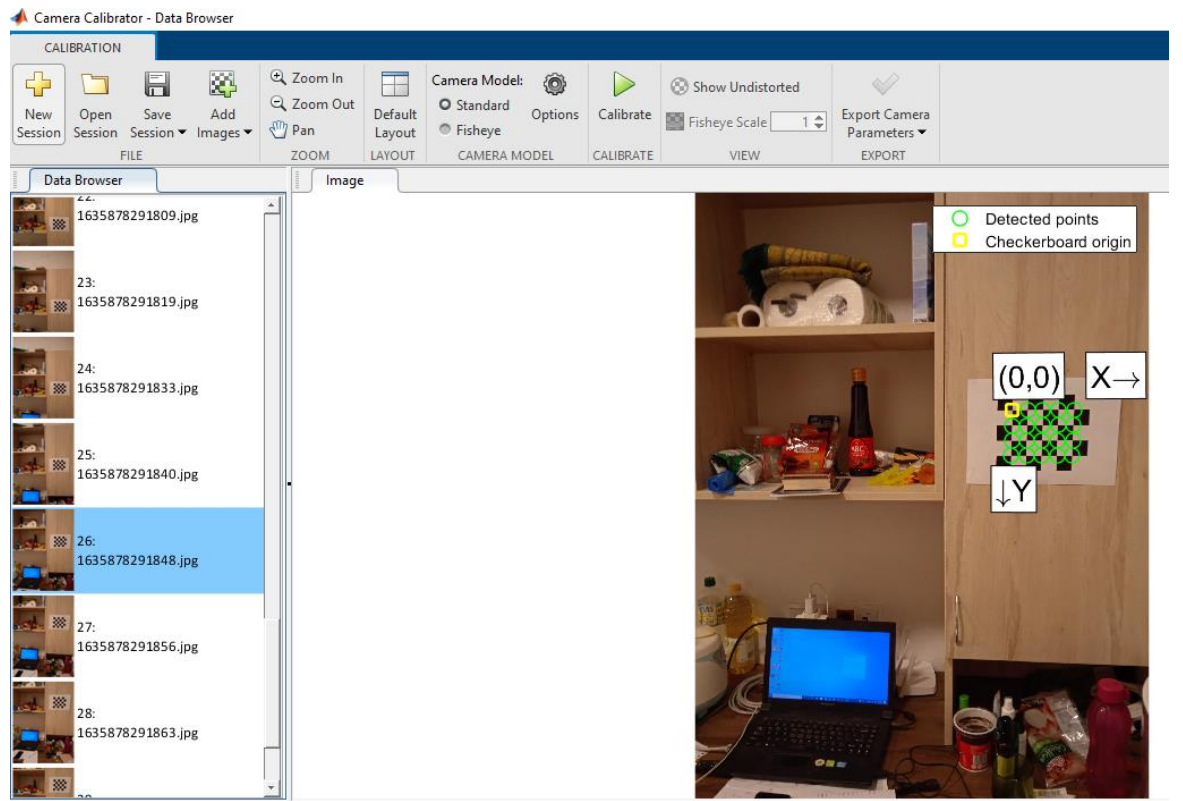
- Maker and model of the phone / camera used
Redmi 9C
- Picture information (resolution, camera setting used etc)
Resolution : 13 MP
ISO : 400
Mode : Pro
Dimensions : 3120 x 4160 px
EV : 0
WB : Sun
S : 1/30
F-stop : f/2.2
- Miniatures of the calibration photos



Picture 1

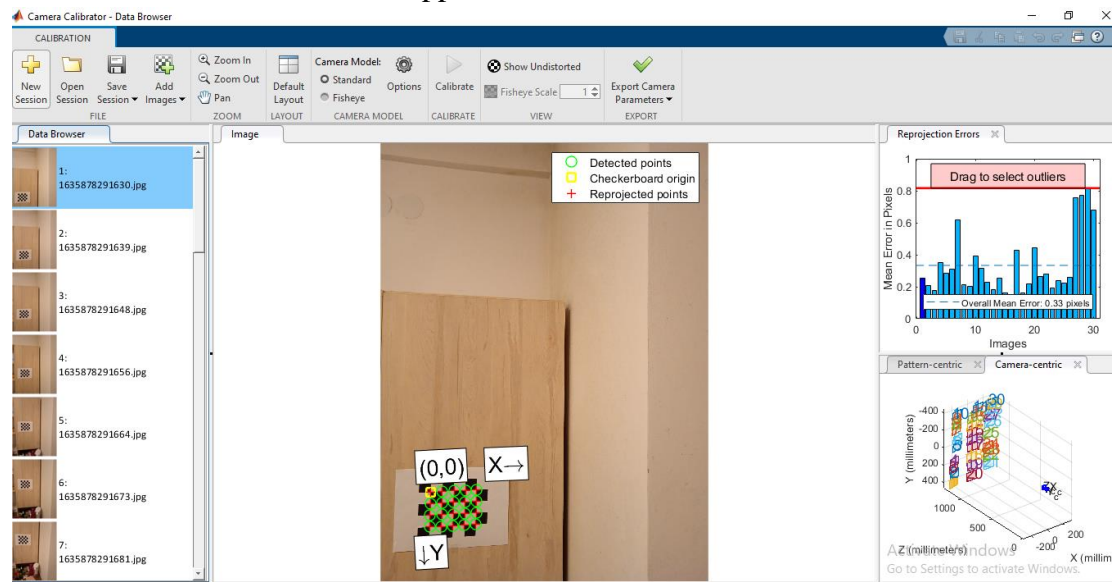


Picture 2

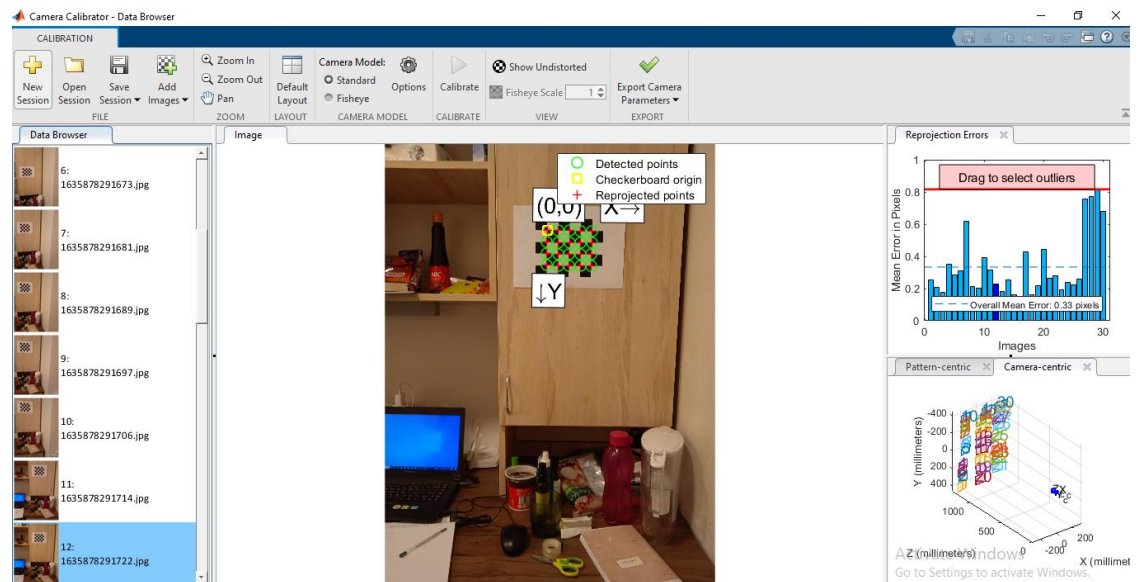


Picture 3

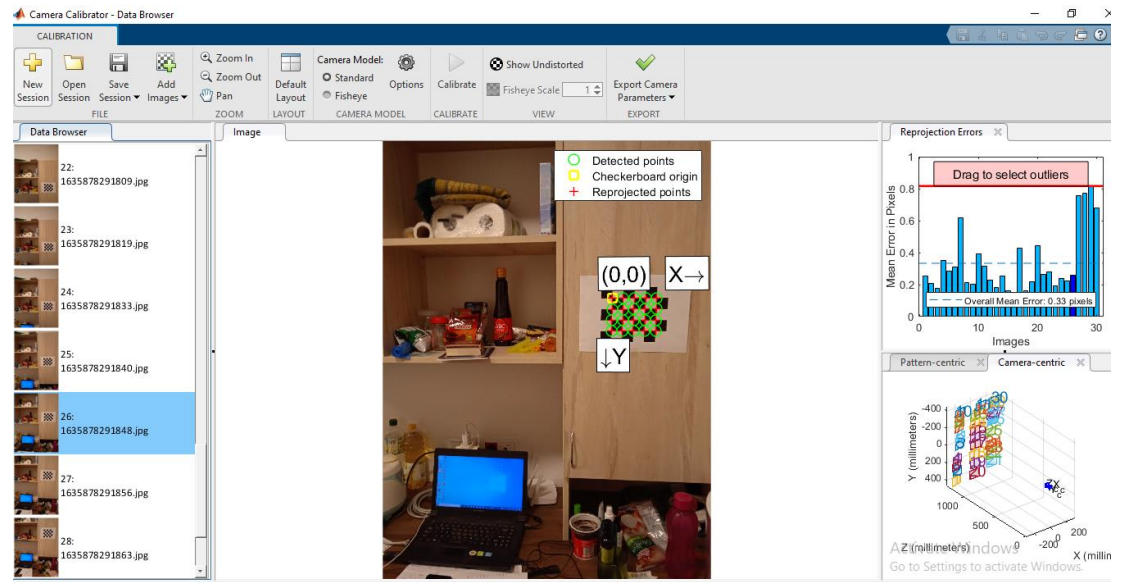
- Screenshot from the calibrator app or the calibration code



Picture 1



Picture 2



Picture 3

- Final camera calibration parameters

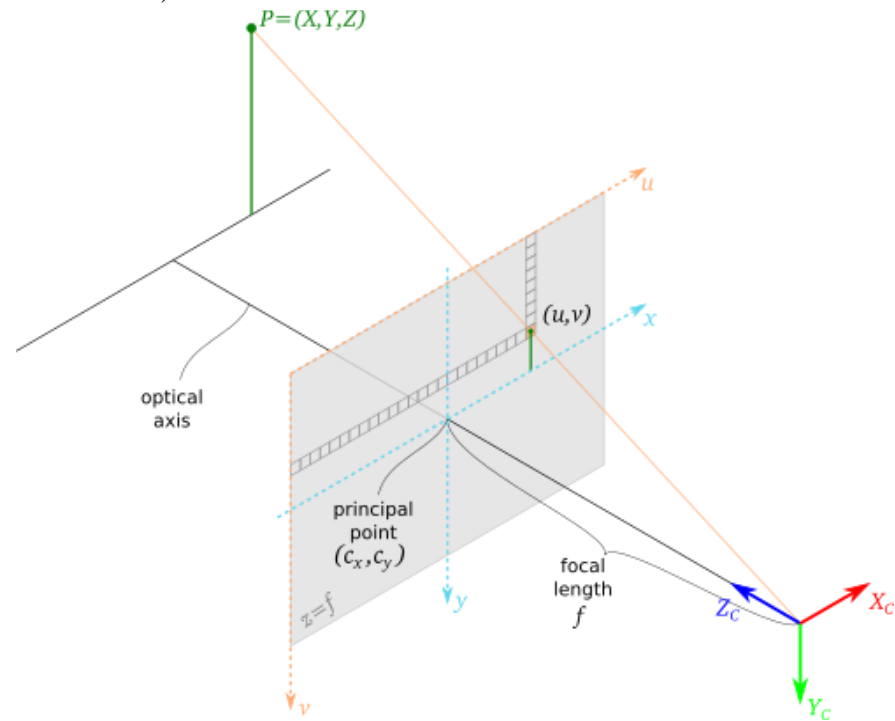
cameraParams		cameraParams.FocalLength
1x1 cameraParameters		
Property	Value	
TangentialDistorti...	[0,0]	
WorldPoints	20x2 double	
WorldUnits	'millimeters'	
EstimateSkew	0	
NumRadialDistorti...	2	
EstimateTangenia...	0	
TranslationVectors	30x3 double	
ReprojectionErrors	20x2x30 double	
DetectedKeypoints	20x30 logical	
RotationVectors	30x3 double	
NumPatterns	30	
Intrinsics	1x1 cameraIntrinsics	
IntrinsicMatrix	[4.1788e+03,0,0;0,4.1...	
FocalLength	[4.1788e+03,4.1870e+...	
PrincipalPoint	[1.5666e+03,2.0824e+...	
Skew	0	
MeanReprojection...	0.3332	
ReprojectedPoints	20x2x30 double	
RotationMatrices	3x3x30 double	

Focal length : [4.178832277603336e+03, 4.187010897201240e+03]

Principal point : [1.566607107538351e+03, 2.082383515834004e+03]

2. Distance measurement section

- Equation used for distance measurement (with the whole derivation method explained / shown)



$$Z = f \cdot \frac{x}{z} + Cx$$

f = Focal length

x = Pattern length

z = Size in pixels

Cx = Principal point

We can obtain the distance from the camera to the picture using that calculation.

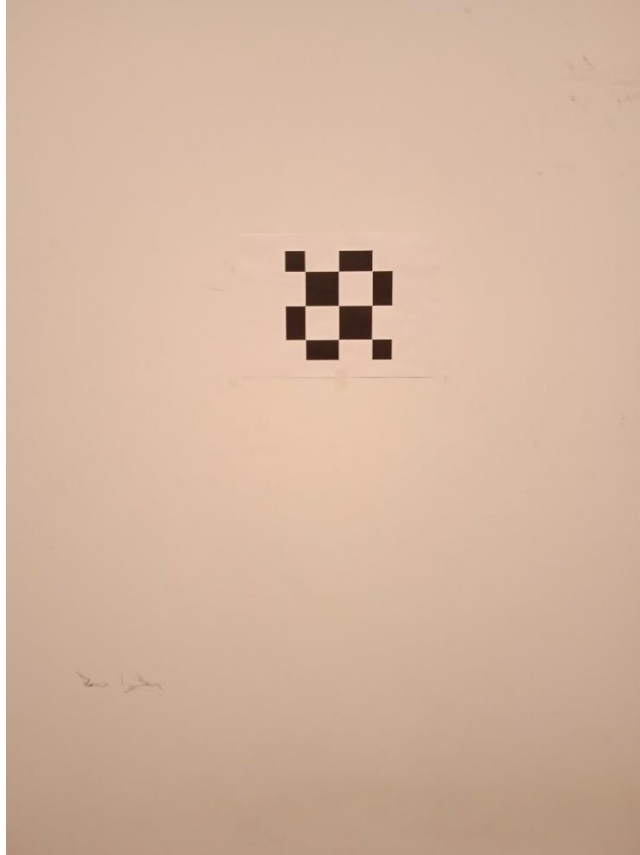
- Pictures of the target pattern and measured pattern size (in centimeters)



Picture 1 with a distance ± 50 cm and pattern length 16 cm



Picture 2 with a distance ± 100 cm and pattern length 16 cm



Picture 3 with a distance ± 150 cm and pattern length 16 cm

- Table with results (measured pattern size in pixels, measured distance to the pattern, calculated distance to the pattern, relative and absolute error)

Picture number	Size in pixels	Distance (cm)	Calculated distance (cm)	Relative (cm)	Error (%)
1	1102.07	50	52.98	2.98	5.96
2	746.10	100	82.25	17.75	17.75
3	519.07	150	160.23	10.23	6.82

- Calculation of the measurement error impact on the final calculation for each case (what is the difference if you measure one pixel more)

Picture number	Size in pixels	Distance (cm)	Calculated distance (cm)	Relative (cm)	Error (%)
1	1103.07	50	52.96	2.96	5.92
2	747.10	100	82.213	17.78	17.78
3	520.07	150	159.97	9.97	6.64

Conclusion

Picture number	Size		Calculated distance (cm)		Error (%)		Relative	
	Original	Add 1 pixel	Original	Add 1 pixel	Original	Add 1 pixel	Calculated distance (cm)	Error (%)
1	1102.07	1103.07	52.98	52.96	5.96	5.92	0.02	0.03
2	746.10	747.10	82.25	82.213	17.75	17.78	0.037	0.04
3	519.07	520.07	160.23	159.97	6.82	6.64	0.26	0.16

Overall, if we add one pixel more it will affect well to the results of the distance calculation and the resulting error. The more precise pixel that we have, the calculated distance will approach the real distance.