Warsaw University of Technology

Computer Vision
Lab Report - 1

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1. Calibration section

Camera Brand: Xiaomi

Camera Model: Redmi Note 9 Pro

Picture Resolution: 4640x2610px

Camera setting: Auto focus and auto exposure locked, Default settings with 16:9

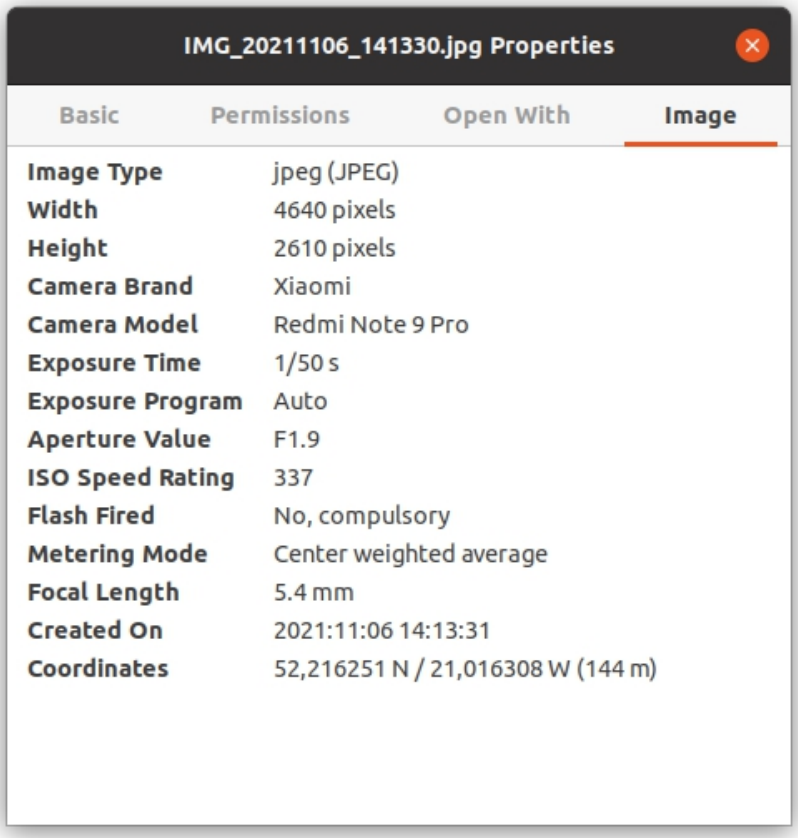
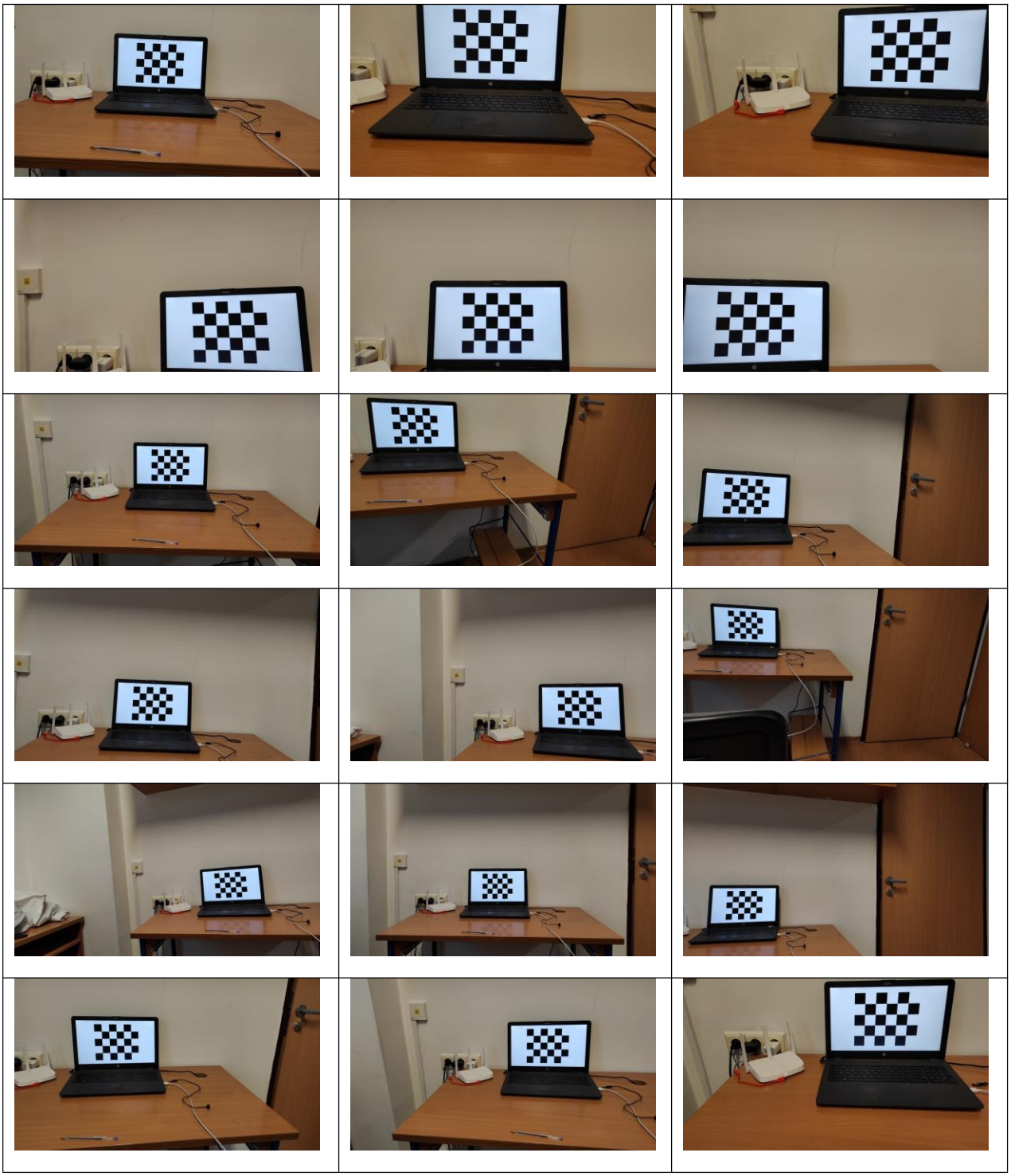


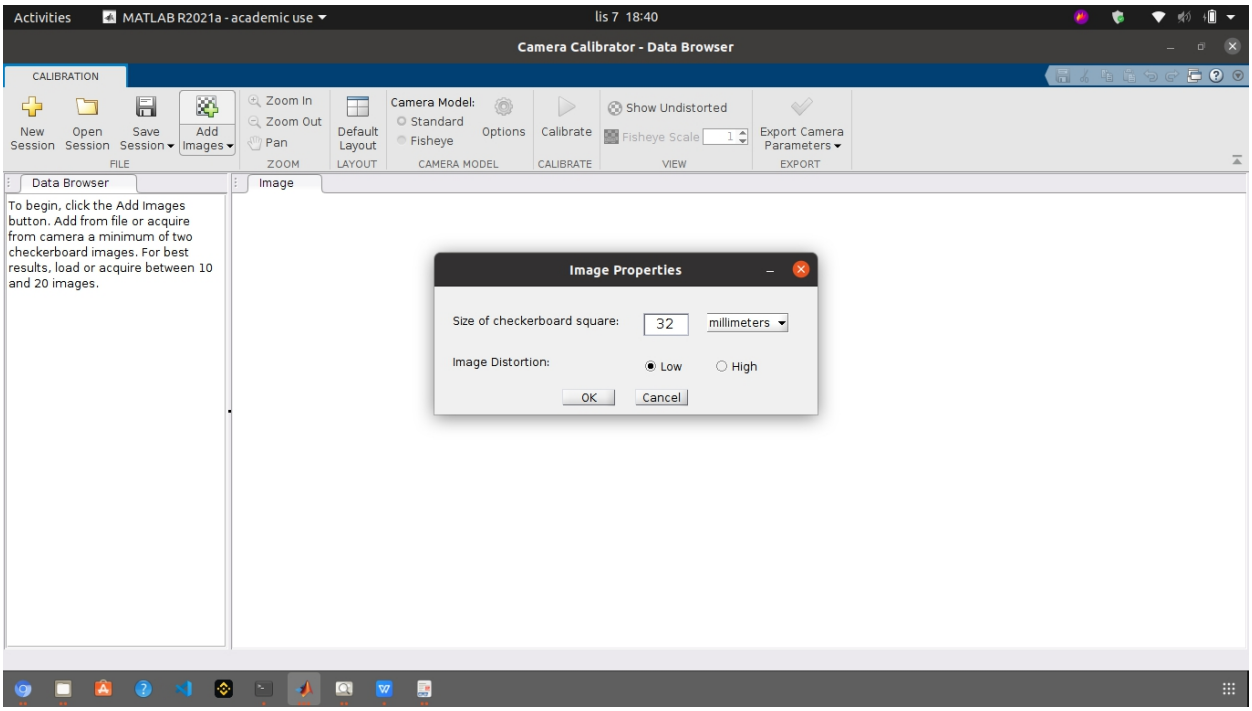
Figure 1 Screenshot from Image properties

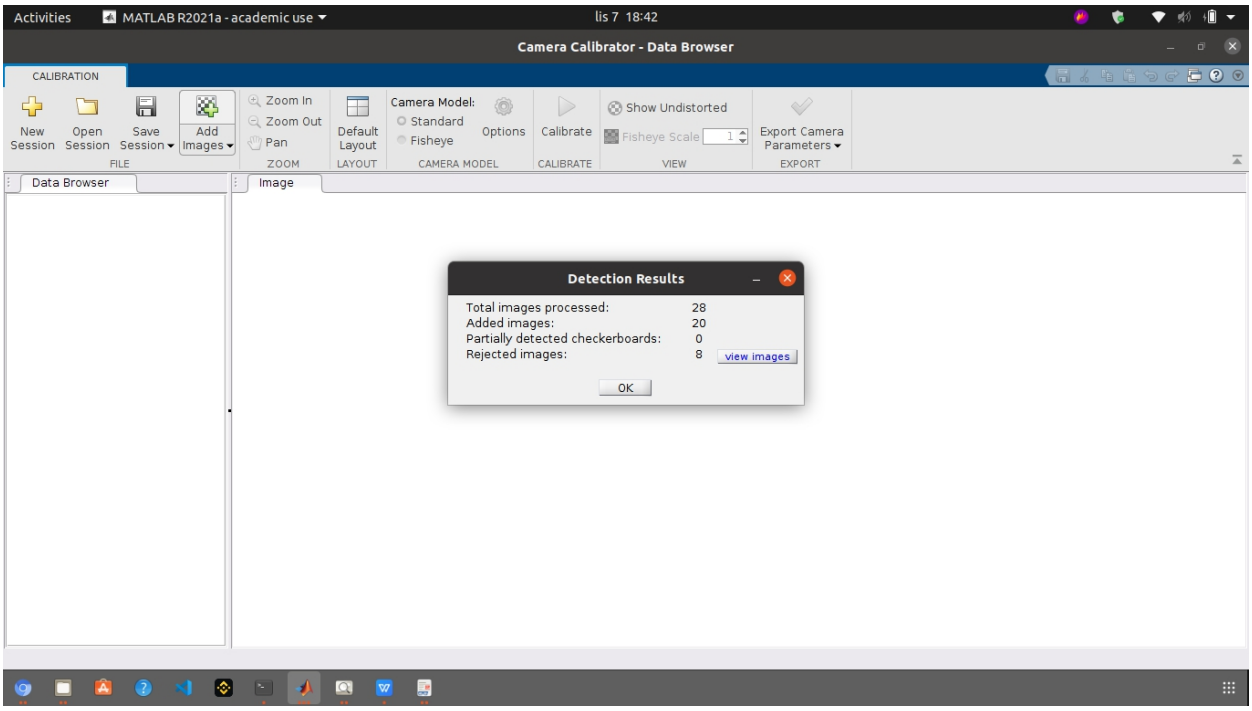
Miniatures of the calibration photos

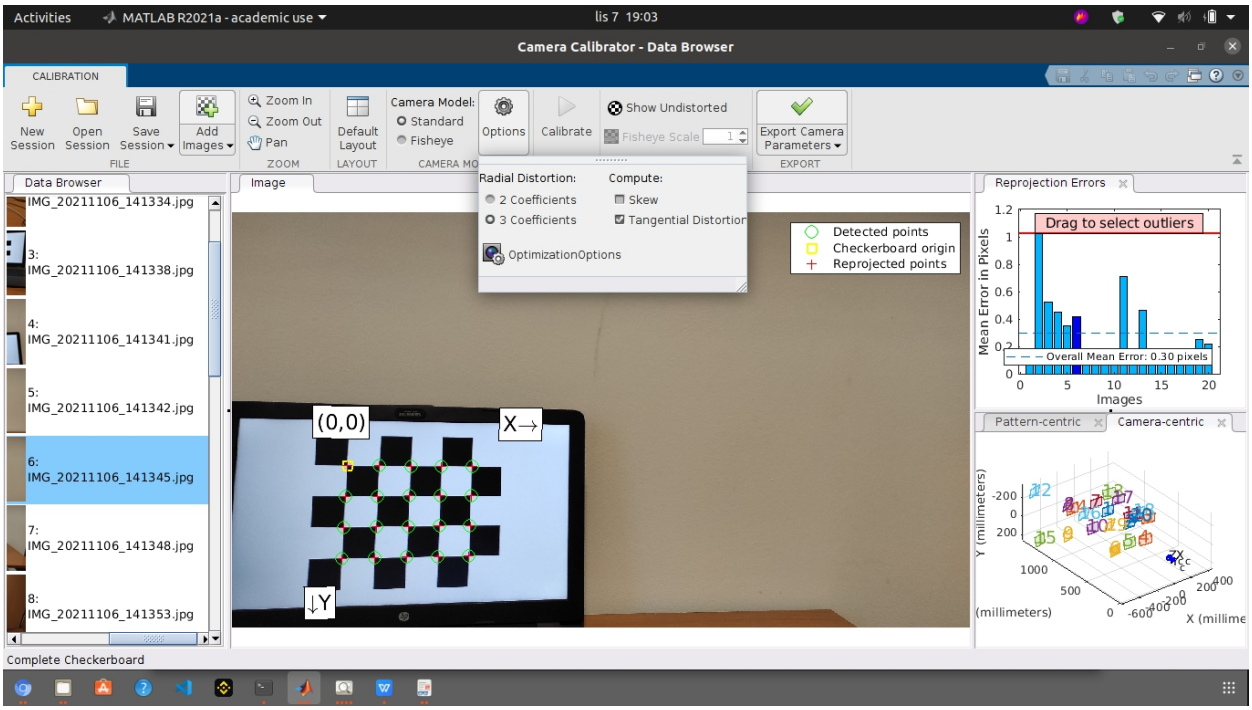


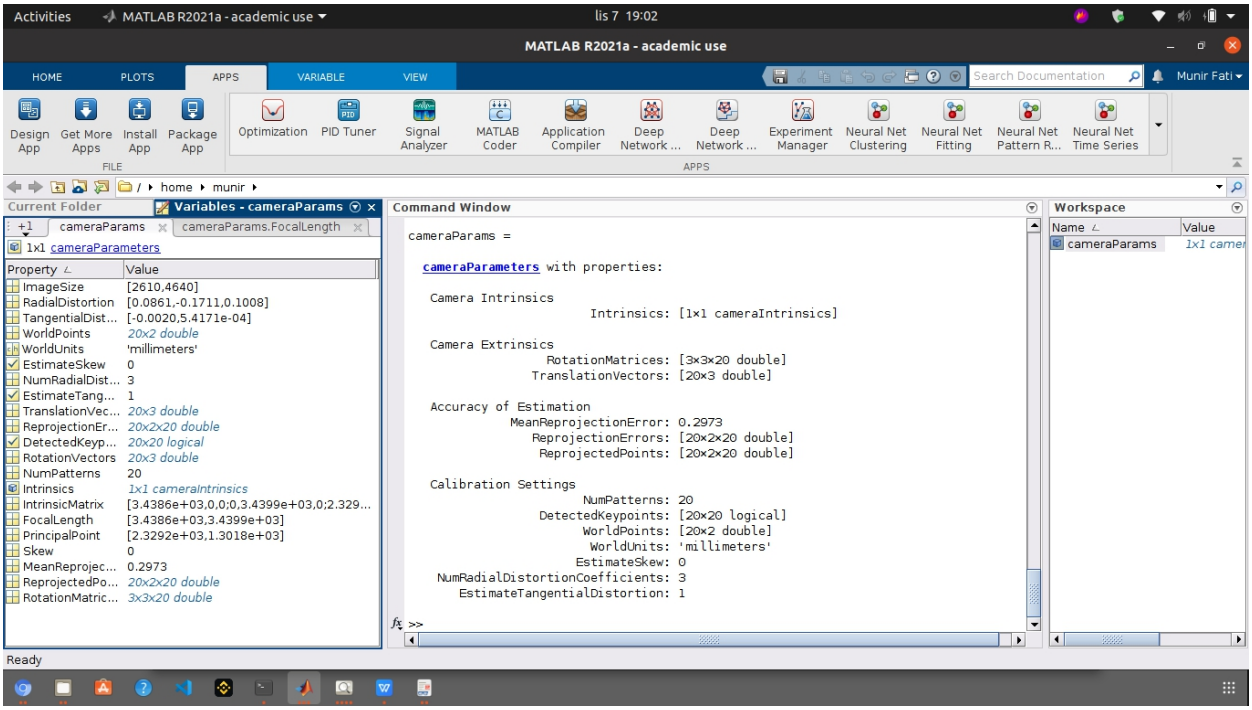
Screenshot from the calibrator app




Activities
MATLAB R2021a - academic use
lis 7 18:42
Camera Calibrator - Data Browser
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
Detection Results
Total images processed: 28
Added images: 20
Partially detected checkerboards: 0
Rejected images: 8
view images
OK


Activities
MATLAB R2021a - academic use
lis 7 19:03
Camera Calibrator - Data Browser
CALIBRATION
New Session
Open Session
Save Session
Add Images
FILE
Zoom In
Zoom Out
Pan
ZOOM
Default Layout
LAYOUT
Camera Model:
Standard
Fisheye
Options
Calibrate
Show Undistorted
Fisheye Scale
Export Camera Parameters
EXPORT
Data Browser
IMG_20211106_141334.jpg
3: IMG_20211106_141338.jpg
4: IMG_20211106_141341.jpg
5: IMG_20211106_141342.jpg
6: IMG_20211106_141345.jpg
7: IMG_20211106_141348.jpg
8: IMG_20211106_141353.jpg
Image
Radial Distortion:
2 Coefficients
3 Coefficients
Compute:
Skew
Tangential Distortion
OptimizationOptions
Detected points
Checkerboard origin
Reprojected points
(0,0)
X→
↓Y
Reprojection Errors
Drag to select outliers
Mean Error in Pixels
Overall Mean Error: 0.30 pixels
Images
Pattern-centric
Camera-centric
Y (millimeters)
X (millimeters)
Complete Checkerboard

Final camera calibration parameters



Focal Length

$f_x = 3.4386 \times 10^3$

$f_x = 3.4399 \times 10^3$

Principal point

$c_x = 2.3292x\ 10^3$

$c_y = 1.3018 \times 10^3$

2. Distance measurement section

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

From the **intrinsic equation we have**

$$u = f_x . \frac{x}{z} + c_x$$

Let distance measured between two points in mm is

$$D_x = x_2 - x_1$$

And distance Measured in pixel is

$$d_x = u_2 - u_1$$

substituting the values of u2 and u1 with the intrinsic equations we get

$$d_x = [f_{x_2} . \frac{x_2}{z} + c_{x_2}] - [f_{x_1} . \frac{x_1}{z} + c_{x_1}]$$

Focal length and principal point has the same value for single image thus simplifying the equation we get

$$d_x = f_x [\frac{x_2}{z} - \frac{x_1}{z}] + [c_x - c_x]$$

$$d_x = f_x [\frac{x_2 - x_1}{z}] + [0]$$

and $D_x = x_2 - x_1$ thus

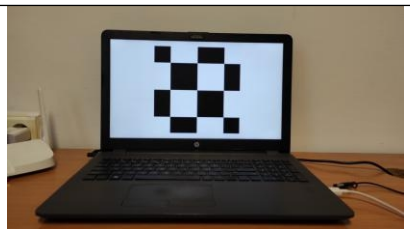
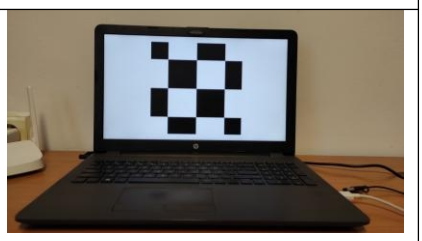
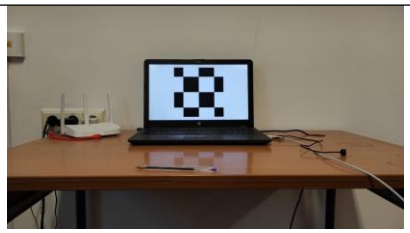
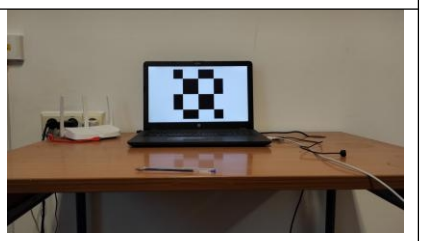
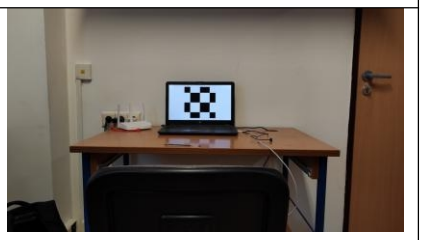
$$d_x = f_x [\frac{D_x}{z}]$$

now solving for z

$$z = f_x [\frac{D_x}{d_x}]$$

So here f_x is the focal length we get from the calibration process D_x is distance measured between points in mm and d_x is the distance measured in pixels

Pictures of the target pattern and measured pattern size (in centimetres)

Measured Distance to pixel	Picture 1	Picture 2
~0.5m		
~1m		
~1.5m		

Measure pattern size in cm is 10.7cm or 107mm

Measurement values in pixel

Measured distance to the pattern	Picture	Measurement in pixel in x direction	Measurement in pixel in y direction
0.5m	Picture 1	627.33	631.13
	Picture 2	663.45	668.29
1m	Picture 1	359.74	359.73
	Picture 2	360.43	358.98
1.5m	Picture 1	227.28	227.80
	Picture 2	226.97	227.22

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

Measured distance to the pattern	Picture Label	Measurement in pixel	Calculated distance to the pattern	Relative Error (%)	Absolute Error
0.5m	Picture 1 x	627.33	0.586501841	0.173003682	0.086501841
	Picture 1 y	631.13	0.583190943	0.166381886	0.083190943
	Picture 2 x	663.45	0.554571106	0.109142211	0.054571106
	Picture 1 y	668.29	0.550762842	0.101525685	0.050762842
1m	Picture 1 x	359.74	1.022766998	0.022766998	0.022766998
	Picture 1 y	359.73	1.023182109	0.023182109	0.023182109
	Picture 2 x	360.43	1.020809034	0.020809034	0.020809034
	Picture 2 y	358.98	1.025319795	0.025319795	0.025319795
1.5m	Picture 1 x	227.28	1.618841077	0.079227385	0.118841077
	Picture 1 y	227.80	1.615756365	0.07717091	0.115756365
	Picture 2 x	226.97	1.621052121	0.080701414	0.121052121
	Picture 2 y	227.22	1.619880732	0.079920488	0.119880732

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

Measured distance to the pattern	Picture	Measurement in pixel + one pixel	Previously Calculated distance to the pattern	Newly Calculated distance to the pattern	Difference (m)	Difference (mm)
0.5m	1 x	628.33	0.586501841	0.585568412	0.000933429	0.933429
	1 y	632.13	0.583190943	0.582268363	0.00092258	0.92258
	2 x	664.45	0.554571106	0.553736474	0.000834632	0.834632
	1 y	669.29	0.550762842	0.549939936	0.000822906	0.822906
1m	1 x	360.74	1.022766998	1.019931807	0.002835191	2.835191
	1 y	360.73	1.023182109	1.020345688	0.002836421	2.836421
	2 x	361.43	1.020809034	1.017984672	0.002824362	2.824362
	2 y	359.98	1.025319795	1.022471526	0.002848269	2.848269
1.5m	1 x	228.28	1.618841077	1.611749606	0.007091471	7.091471
	1 y	228.8	1.615756365	1.608694493	0.007061872	7.061872
	2 x	227.97	1.621052121	1.613941308	0.007110813	7.110813
	2 y	228.22	1.619880732	1.612782841	0.007097891	7.097891