3D Data Processing

Camera calibration

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Today

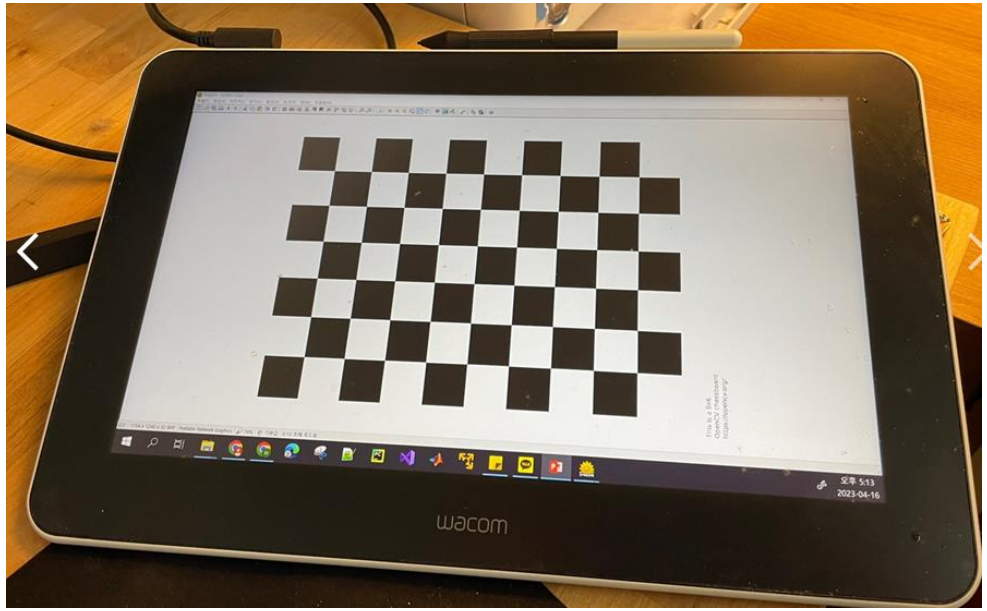
- Camera calibration
  - Display pattern images
  - Estimate intrinsic parameter of your phone
- 3D rendering
  - Open3D
  - Rendering an image on 3D space

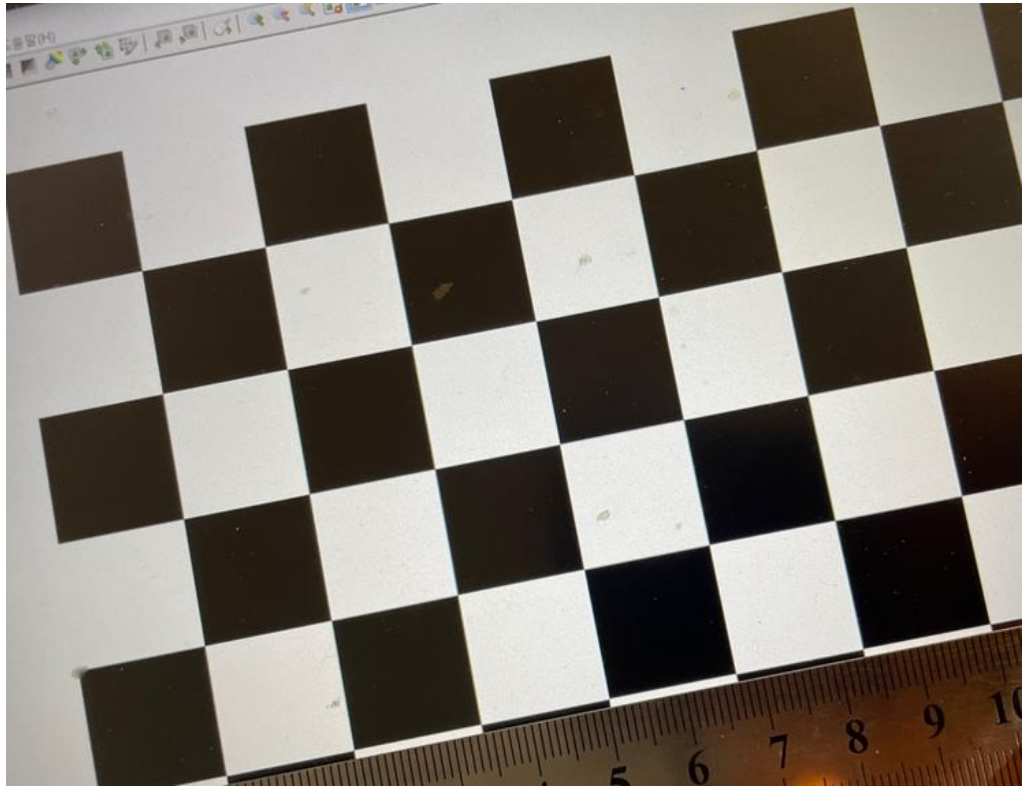
Calibration

- Prepare check board images
- Display on your notebook or tablet (pattern.png)
  - Check all rectangles are squares
  - Measure length of each rectangle edge

Display on your notebook or tablet

- Display on your PC
- Measure the length of one side





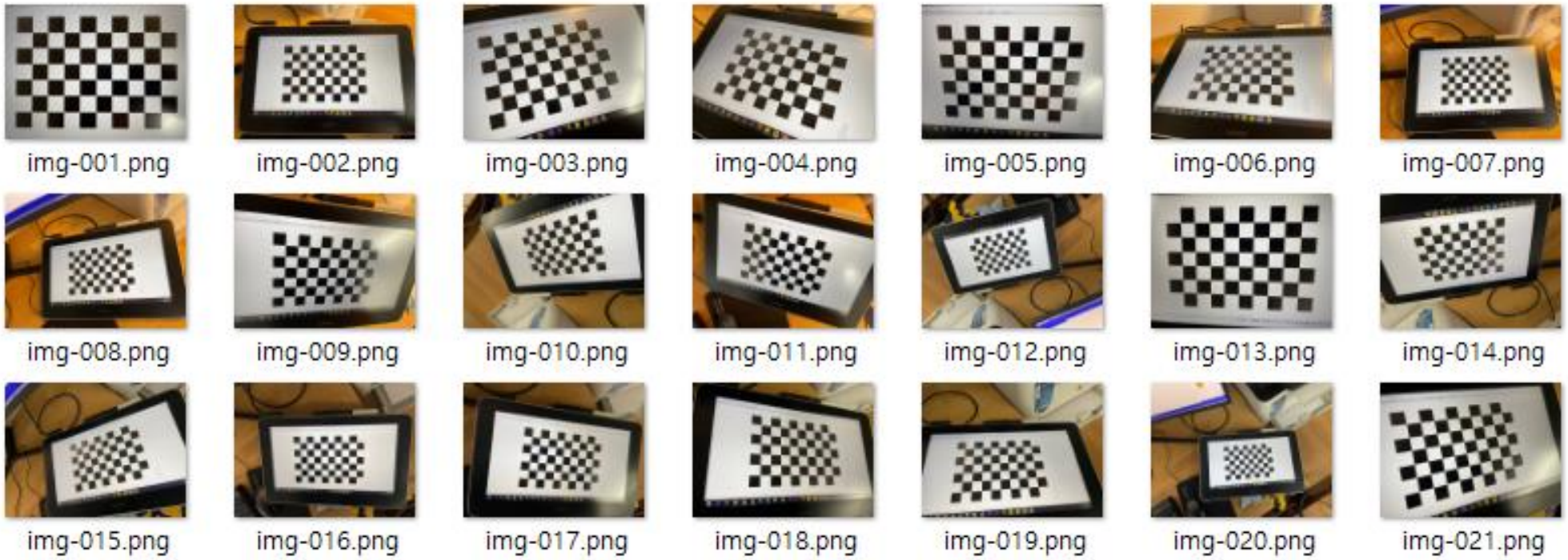
Capture

- Capture pattern images (10~20)
  - from different angle
  - from different distance
  - from different location
- Patterns should not be truncated.

- Make sure your image is horizontal

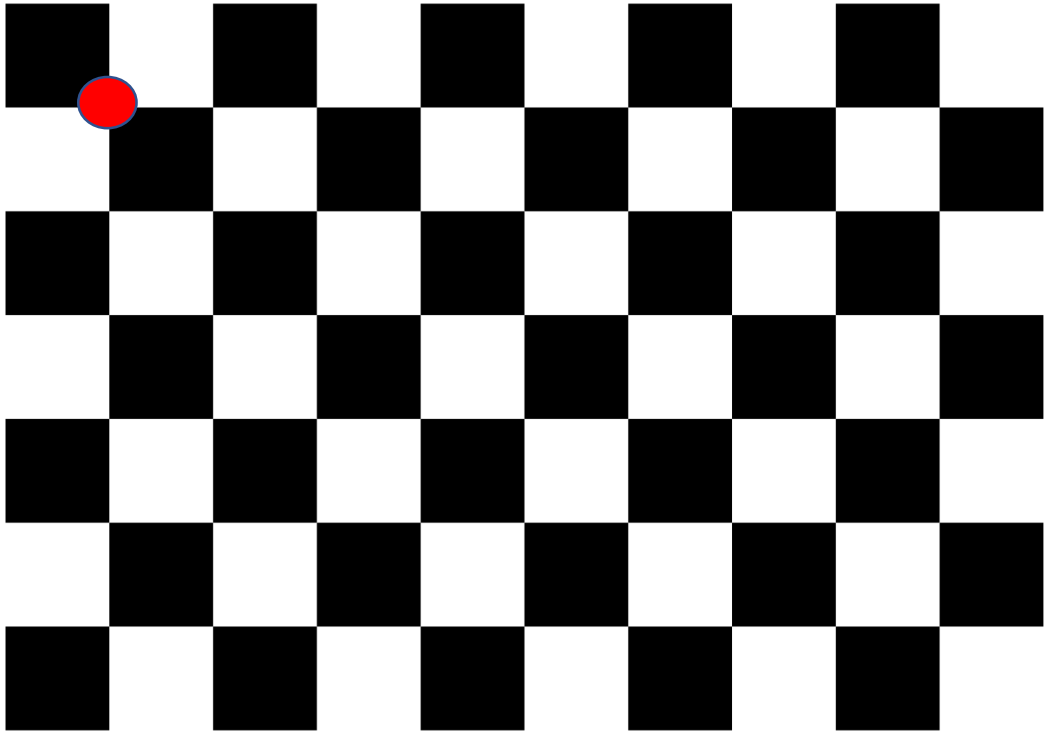
Capture

- Capture pattern images (10~20)
  - Set names: img-001.png, img-002.png…..



Patterns

- Number of cross corners
  - Case of given pattern
  - nH: 9
  - nV: 6
  - nSize: 00 mm



This is a 9x6
OpenCV chessboard
https://opencv.org/

Calibration

- Intrinsic parameter

```
Intrinsic matrix :

[[1.09012179e+03 0.00000000e+00 7.27990382e+02]
 [0.00000000e+00 1.09122127e+03 5.38934203e+02]
 [0.00000000e+00 0.00000000e+00 1.00000000e+00]]
```

- Distortion coefficient

```
dist :

[[ 1.82531761e-01 -7.75180384e-01 -7.21416657e-05  7.15952980e-04
   1.11231898e+00]]
```

Back projection

- Set direction

$$\begin{bmatrix} ku \\ kv \\ k \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

$$u = \frac{ku}{k} = \frac{f_x X + c_x Z}{Z} \qquad v = \frac{kv}{k} = \frac{f_y X + c_y Z}{Z}$$

$$f_x X + c_x Z = uZ \qquad f_y Y + c_x Z = vZ$$

$$X = \frac{(u - c_x)Z}{f_x} \qquad Y = \frac{(v - c_y)Z}{f_y}$$

Back projection

- Set point clouds
  - For each pixel, or sampled pixel
  - Set point clouds for 3D display
  - P = [x, y, z, r, g, b]

Thank you