Stereo Calibration in Opencv

유용길

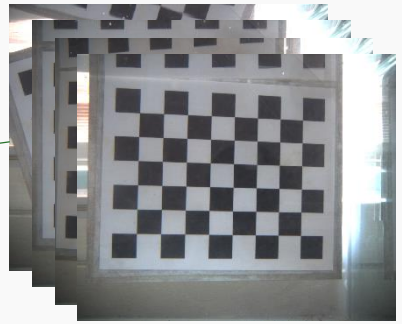
ISL Image System Laboratory

CONTENTS

Stereo Calibration

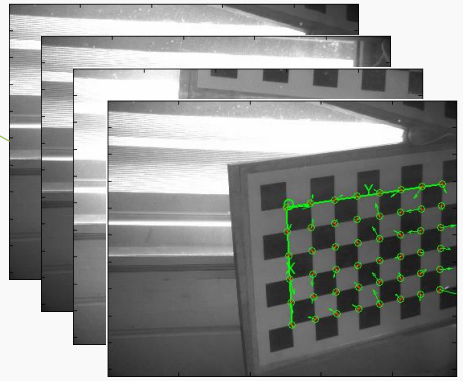
Capture Chessboard

Capture Chess board image



Extract Corner

Extract corner in chessboard



Solve Simultaneous equations

Solve equation using SVD

Set Parameter

Set parameter at intrinsic and extrinsic matrix and distortion coefficiant

Singular Value Decomposition

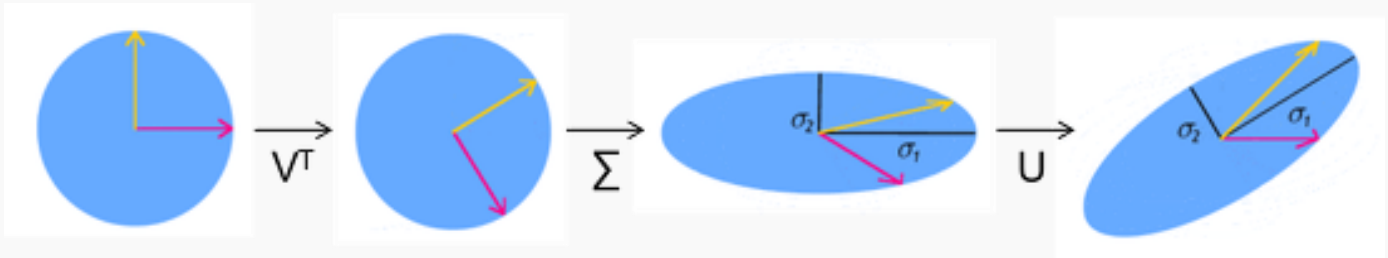
Diagonal matrix

Orthogonal matrix

Orthogonal matrix

$$A = U \sum V^T = \begin{bmatrix} u_1 & u_2 & \cdots & u_m \end{bmatrix} \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \sigma_2 & \ddots & 0 \\ 0 & \ddots & \ddots & 0 \\ 0 & 0 & \cdots & \sigma_k \end{bmatrix} \begin{bmatrix} v_1^T \\ v_2^T \\ \vdots \\ v_{n1}^T \end{bmatrix}$$

Singular Value of A



Solve Simultaneous equations

$$By = c$$

$$\begin{bmatrix} B & c \\ 0 & 1 \end{bmatrix} \begin{bmatrix} y \\ - \\ 1 \end{bmatrix} = Ax = 0$$

01

Convert Homogeneous Format

02

Singular Value Decomposition

$$A = U \sum V^T$$

03

Extract V column

$$V^T = \begin{bmatrix} v_1^T \\ v_2^T \\ \vdots \\ v_n^T \end{bmatrix}$$

04

Solve equations

$$x = v_n^T$$

Solve Simultaneous equations

$$Ax = 0 = U \sum V^T x$$

$$Q = OrthogonalMatrix$$

$$\|Qa\| = \|a\|$$

$$\|x\| = 1$$

$$\left\|U \sum V^T x\right\| = \left\|\sum V^T x\right\|$$

$$\|x\| = \left\|V^T x\right\|$$

$$y = V^T x$$

$$\begin{cases} \|\sum y\| = 0 \\ \|y\| = 1 \end{cases}$$

$$\begin{cases} \|\sum y\| \approx 0 \\ \|y\| = 1 \end{cases}$$

$$\sum = DiagonalMatrix$$

$$\sum = \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \sigma_2 & \ddots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_k \end{bmatrix}$$

$$\sigma_1 > \sigma_2 > \cdots > \sigma_k$$

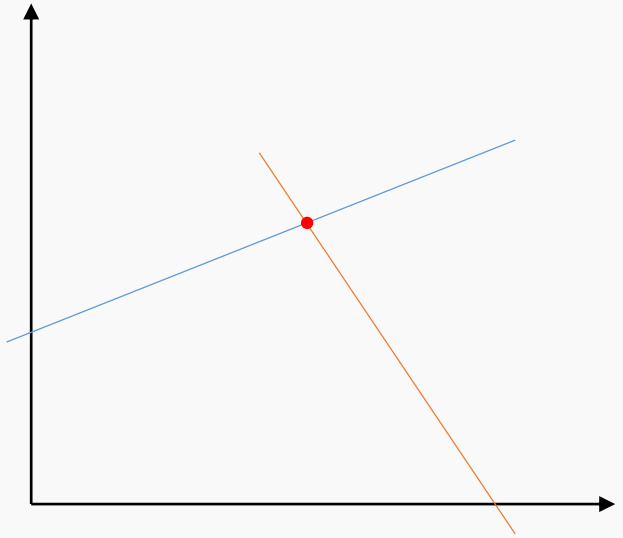
$$y = (0,0,\cdots,1)^T$$

$$Vy = x$$

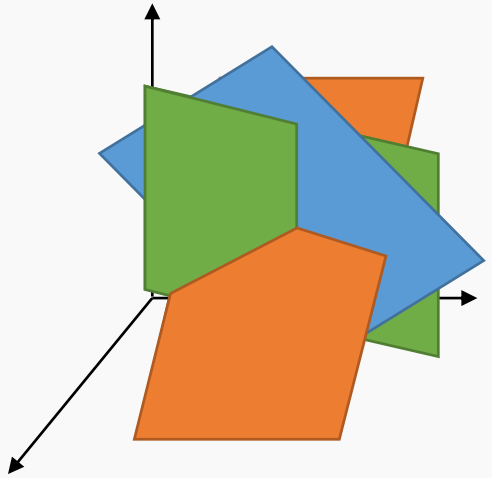
$$x = v_n^T$$

Solve Simultaneous equations

2-dimensional



3-dimensional



Stereo Calibration in OpenCV

```
stereoCalibrate(vObjectPoints,
                vImagePoints[0], vImagePoints[1],
                MCameraMatrix[0], MDistortionCoef[0],
                MCameraMatrix[1], MDistortionCoef[1],
                SImageSize, MR, MT, ME, MF,
                CALIB_RATIONAL_MODEL,
                TermCriteria(TermCriteria::COUNT+TermCriteria::EPS, 100, 1e-5));
```

Corner information

Image size

Extrinsic Matrix

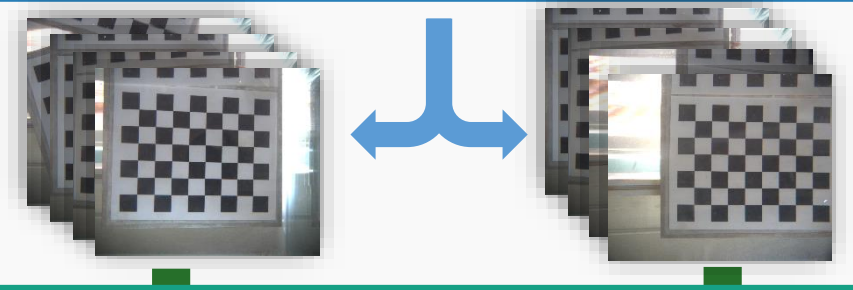
Intrinsic Matrix

Besides the stereo-related information, the function can also perform a full calibration of each of two cameras. However, due to the high dimensionality of the parameter space and noise in the input data, the function can diverge from the correct solution. If the intrinsic parameters can be estimated with high accuracy for each of the cameras individually (for example, using calibrateCamera), you are recommended to do so and then pass CV_CALIB_FIX_INTRINSIC flag to the function along with the computed intrinsic parameters. Otherwise, if all the parameters are estimated at once, it makes sense to restrict some parameters, for example, pass CV_CALIB_SAME_FOCAL_LENGTH and CV_CALIB_ZERO_TANGENT_DIST flags, which is usually a reasonable assumption.

Stereo Calibration in OpenCV

01

Capture stereo chessboard image.



02

Calibrate each camera and estimate two intrinsic matrix.

MCameraMatirx[0]
Mdistortcoef[0]

MCameraMatirx[1]
Mdistortcoef[1]

03

Stereo Calibrate using intrinsic matrix estimated step1 with fix intrinsic option.

Another consideration

01 Mask size

- Mask size unit is pixel.
- Mask size adjustment consider image size

02 Find chessboard corner option

- Don't use **CV_CALIB_CB_ADAPTIVE_THRESH** option.
- Process can fall into infinite loop.

03 Reduce parameter

- First, estimate intrinsic matrix each camera.
- Then, estimate extrinsic matrix using fix intrinsic matrix option.