

Camera Calibration Mathematical Basis

Camera Calibration.

Step ① - Form Geometry of Image.

→ Transform the points from world coordinate system to camera coordinate system.

Step ② - Project the point onto the image plane

The eqⁿ.

$$\begin{bmatrix} u' \\ v' \\ z' \end{bmatrix} = P \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} \quad u = \frac{u'}{w'} \quad v = \frac{v'}{w'}$$

P - projection Matrix. of size 3×4 .

↳ consists of 2 parts - Intrinsic Matrix (K)

(containing intrinsic Parameters)

$$P = K [R | t]$$

- Extrinsic Matrix [R | t]

→ Intrinsic Matrix K is upper triangular.

$$K = \begin{bmatrix} f_x & \gamma & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}$$

Rotation R Matrix Extrinsic Matrix (t)

$f_x, f_y \rightarrow x, y$ focal lengths.

$c_x, c_y \rightarrow x, y$ coordinates of optical center in image plane.

$\gamma \rightarrow$ skew between the axes.

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The camera calibration process refers to determining the intrinsic camera matrix and the parameters for the distortion models.