Camera Theory Notes

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Camera Matrix

Intrinsic Parameters

The instrinsic camera [1], having focal length f, shear s, sample spacing m_x and m_y, and camera center x_0 and y_0.

$$\begin{bmatrix} m_x f & s & x_0 \\ 0 & m_y f & y_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{1}$$

Extrinsic Parameters

$$\begin{bmatrix} \mathbf{R} & \mathbf{0}_{3x1} \\ \mathbf{0}_{1x3} & 1 \end{bmatrix} \begin{bmatrix} \mathbf{I}_{3x3} & \mathbf{t} \\ \mathbf{0}_{1x3} & 1 \end{bmatrix} \tag{2}$$

Representation

$$\mathbf{H} = \mathbf{KPRT} = \begin{bmatrix} m_x f & s & x_0 \\ 0 & m_y f & y_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{R} & \mathbf{0}_{3x1} \\ \mathbf{0}_{1x3} & 1 \end{bmatrix} \begin{bmatrix} \mathbf{I}_{3x3} & \mathbf{t} \\ \mathbf{0}_{1x3} & 1 \end{bmatrix} \tag{3}$$

$$\mathbf{t} = \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix} \tag{4}$$

$$\mathbf{R} = \mathbf{R_x}\left(\theta_\mathbf{x}\right)\mathbf{R_y}\left(\theta_\mathbf{y}\right)\mathbf{R_z}\left(\theta_\mathbf{z}\right) \tag{5}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\theta_x) & -\sin(\theta_x) \\ 0 & \sin(\theta_x) & \cos(\theta_x) \end{bmatrix} \begin{bmatrix} \cos(\theta_y) & 0 & \sin(\theta_y) \\ 0 & 1 & 0 \\ -\sin(\theta_y) & 0 & \cos(\theta_y) \end{bmatrix} \begin{bmatrix} \cos(\theta_z) & -\sin(\theta_z) & 0 \\ \sin(\theta_z) & \cos(\theta_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

References

[1] R. I. Hartley and A. Zisserman, *Multiple View Geometry in Computer Vision*, 2nd ed. Cambridge University Press, ISBN: 0521540518, 2004.