

Homogeneous division:

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} \sim \begin{bmatrix} a/c \\ b/c \\ 1 \end{bmatrix}$$

Recall the projection equation:

$$u = \frac{fk_u X_c}{Z_c} + u_0$$

$$v = \frac{fk_v Y_c}{Z_c} + v_0$$

In matrix-vector product:

$$\begin{bmatrix} fk_u & 0 & u_0 \\ 0 & fk_v & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_c \\ Y_c \\ Z_c \end{bmatrix} = \begin{bmatrix} fk_u X_c + u_0 Z_c \\ fk_v Y_c + v_0 Z_c \\ Z_c \end{bmatrix}$$

After homogeneous division:

$$\begin{bmatrix} fk_u X_c + u_0 Z_c \\ fk_v Y_c + v_0 Z_c \\ Z_c \end{bmatrix} \sim \begin{bmatrix} (fk_u X_c + u_0 Z_c) / Z_c \\ (fk_v Y_c + v_0 Z_c) / Z_c \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{fk_u X_c}{Z_c} + u_0 \\ \frac{fk_v Y_c}{Z_c} + v_0 \\ 1 \end{bmatrix}$$