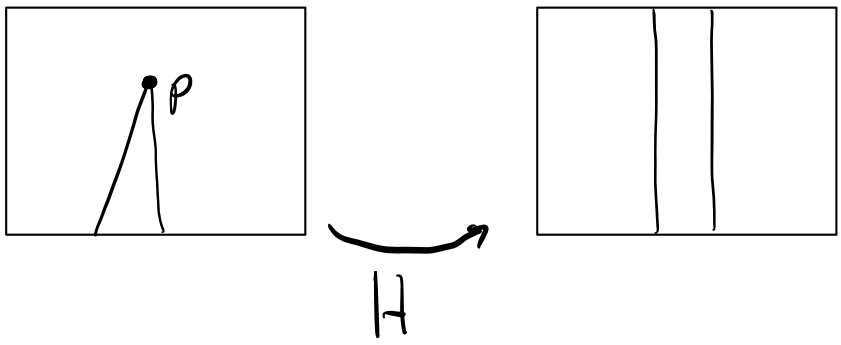
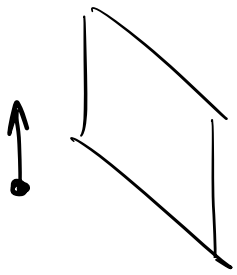
Points at Infinity



$$H\mathbf{p} \overset{?}{=} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$



Transforming Points at infinity

$$\begin{bmatrix} M & t \\ 0\,0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 0 \end{bmatrix} = \begin{bmatrix} M \begin{bmatrix} x \\ y \end{bmatrix} \\ 0 \end{bmatrix}$$

Epipolar Geometry

Assume:

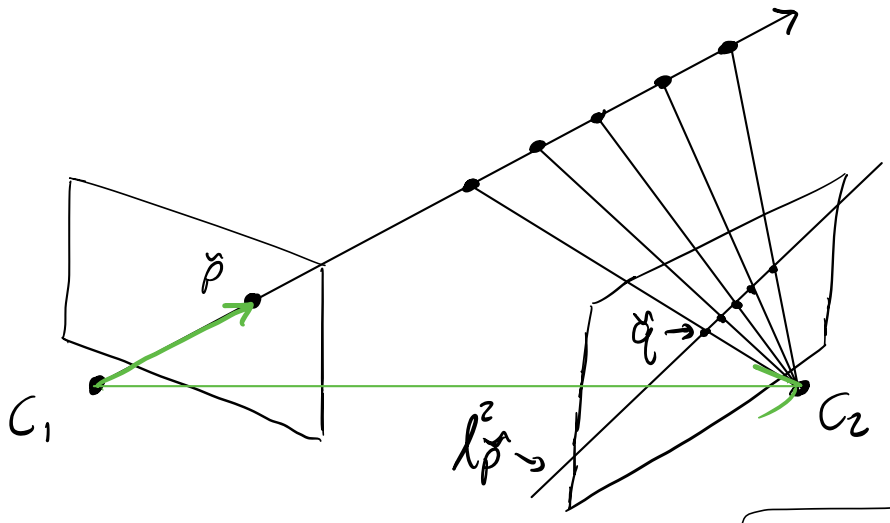
$K_1 = I_{3\times3}$

$K_2 = I_{3\times3}$

$R_1 = I_{3\times3}$

$t_1 = \vec{0}$

R_2, t_2 known



$$R_2(t_2 \times \check{p})$$

$$l^2_{\check{p}} = R_2 [t]_\times \check{p}$$

$$\hat{q} \cdot l^2_{\check{p}} = 0$$

$$\rightarrow \hat{q}^T [R_2 [t_2]_\times] \check{p} =$$

Aside: Cross Product → Matrix Multiply

$t \times p$

$\downarrow$

$[t]_\times \vec{p}$

$\uparrow$

$\begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}_{3\times3}$

Epipolar Constraint: $\check{q}^T E \check{p} = 0$

↖ The Essential Matrix

camera ↓ pixel ↓

Let $\check{p} = K_1^{-1} p$

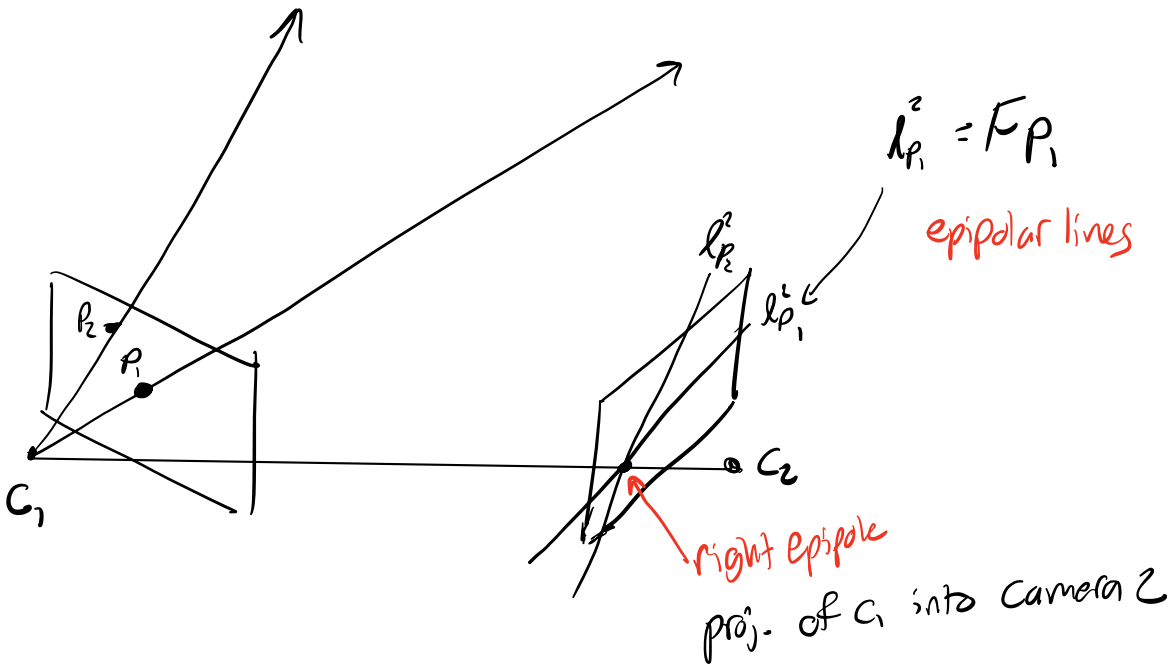
$\check{q} = K_2^{-1} q$

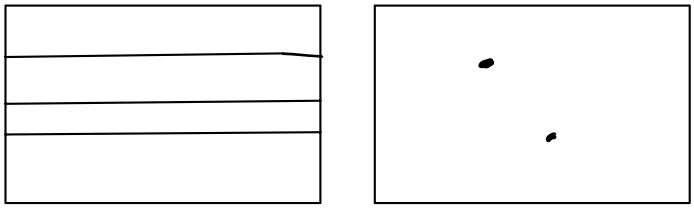
$\check{q}^T$

$q^T [K_2^{-T} \; R_2 [t_2]_\times \; K_1^{-1}] p$

$$q^T F p = 0$$

↖ The Fundamental Matrix





	"Structure" (3D scene points)	"Motion" (camera poses)	Measurements Needed
Pose Estimation	known	?	3D-2D Corr
Triangulation	?	known	2D-2D Corr
Structure from Motion	?	?	

Reprojection Error residuals:

$$\left(p_{20}X_i + p_{21}Y_i + p_{22}Z_i + p_{23}W_i\right)x_i - \left(p_{00}X_i + p_{01}Y_i + p_{02}Z_i + p_{03}W_i\right)$$

$$\left(p_{20}X_i + p_{21}Y_i + p_{22}Z_i + p_{23}W_i\right)y_i - \left(p_{10}X_i + p_{11}Y_i + p_{12}Z_i + p_{13}W_i\right)$$