

3D Reconstruction

Epipolar Lines

$$p_R^T E p_L = 0 \quad u_L = E p_L p_R^T u_L = x_R u_{L1} + y_R u_{L2} + f u_{L3} = 0 \quad = \text{Epipolar Line}$$

Pixel Coordinates

S_x, S_y = Width and height of each pixel (\hat{x}, \hat{y}) = Pixel Coordinate (\hat{o}_x, \hat{o}_y) = Principal Point (Where the principal axis intersects the image plane)

Fundamental Matrix:

$$p_L = \begin{bmatrix} x_L \\ y_L \\ f \end{bmatrix} = M_L \begin{bmatrix} \hat{x}_L \\ \hat{y}_L \\ f \end{bmatrix} = M_L \hat{p}_L$$

$$p_R^T E p_L = 0 \implies \hat{p}_R^T M_R^T E M_L \hat{p}_L = 0 \implies \hat{p}_R^T F \hat{p}_L = 0 \quad F = M_R^T E M_L = \text{The fundamental matrix}$$

In order to find the actual point P in the scene we can find the intersection of the epipolar lines, however they will usually never intersect so we can pick the closest point on each line and take the average of those points:

$a p_L$ = Closest point to right epipolar line on left line $b p_R$ = vice versa $b R^T p_R + T$ is $b p_R$ wrt left camera $c(p_L \times R^T p_R + T)$ is the distance from the left camera to the line $b p_R$

Given corresponding points, we know: $\$ p_L, p_R \$$

Given calibrated views, we know: $\$ R, T \$$

$$\hat{p} = \frac{(a p_L + b R^T p_R + T)}{2} = \text{Point in the scene at the average of the closest points}$$

A diagram of a circle with a horizontal radius extending to the right. A red chord is drawn parallel to the radius, starting from the left edge of the circle and ending at a point on the radius. A vertical green line segment extends upwards from the center of the circle.

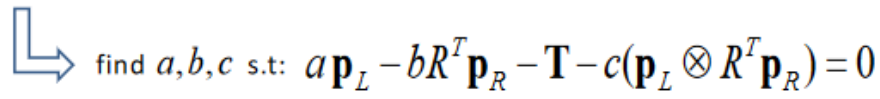


Figure 1: Untitled

$$a \begin{bmatrix} \bullet \\ \mathbf{p}_L \\ \bullet \end{bmatrix}_{3 \times 1} - b \begin{bmatrix} R^T \mathbf{p}_R \end{bmatrix}_{3 \times 1} - c \begin{bmatrix} \mathbf{p}_L \otimes R^T \mathbf{p}_R \end{bmatrix}_{3 \times 1} = \begin{bmatrix} \mathbf{T} \end{bmatrix}_{3 \times 1}$$

$$\Rightarrow H \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \mathbf{T} \Rightarrow \begin{bmatrix} a \\ b \\ c \end{bmatrix} = H^{-1} \mathbf{T}$$

Figure 2: Untitled