

$u \vee w$

$$x_i = P X_i \quad x_i \times P X_i = [x]_i P X$$

1×4 3×4 4×1

$$\begin{bmatrix} 0 & -\omega & v \\ \omega & 0 & -u \\ -v & u & 0 \end{bmatrix} \begin{bmatrix} P_1^T & X \\ P_2^T & X \\ P_3^T & X \end{bmatrix} = 0$$

$$[x]_i P X$$

$$\begin{bmatrix} 0 & -\omega X^T & v X^T \\ \omega X^T & 0 & -u X^T \\ -v X^T & u X^T & 0 \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \end{bmatrix} = 0$$

$$\begin{bmatrix} 0 & -x & -y & -z & -1 & vx & vy & vz & v \\ 4x_1 & y & z & 1 & 0 & -ux & -uy & -uz & -u \end{bmatrix}_{2 \times 12}$$

A $P=0$ $2N \times 1$
 $2N \times 12$ 12×1

$$\omega = K^{-T} K^{-1} \xrightarrow{\text{Cholesky Decomposition}} LL^T$$

$$v_i^T \omega v_j = 0$$

$$K = L^{-T} \quad (\text{Normalized } K_{3,3}=1)$$

\hookrightarrow symmetric positive

$$K = \begin{bmatrix} f & 0 & x \\ 0 & f & y \\ 0 & 0 & 1 \end{bmatrix}$$

$$\omega = \begin{bmatrix} \omega_1 & 0 & \omega_2 \\ 0 & \omega_1 & \omega_3 \\ \omega_2 & \omega_3 & \omega_4 \end{bmatrix}$$

$\omega_1 : \omega_2 : \omega_3 : \omega_4$
3 DoF

$$v_1, v_2, v_3 \rightarrow (v_1, v_2), (v_1, v_3) \cdot (v_2, v_3)$$

$$v_i^T \omega v_j = 0 \quad \text{181}$$

$1 \times 3 \quad 3 \times 3 \quad 3 \times 1$

$$Ax = 0$$

$$\underbrace{x_i x_j + y_i y_j}_{\downarrow} \quad \underbrace{x_i + x_j}_{\text{blue}} \quad \underbrace{y_i + y_j}_{\text{orange}} \quad 1$$

$$\omega v_j = \begin{bmatrix} \omega_1 x_j + \omega_2 \\ \omega_1 y_j + \omega_3 \\ \omega_2 x_j + \omega_3 y_j + \omega_4 \end{bmatrix} \begin{bmatrix} x_j & y_j & 1 \end{bmatrix}$$

$$\underbrace{\omega_1 x_i x_j}_{\text{red}} + \underbrace{\omega_2 x_i}_{\text{blue}} + \underbrace{\omega_1 y_i y_j}_{\text{red}} + \underbrace{\omega_3 y_i}_{\text{orange}} + \underbrace{\omega_2 x_j}_{\text{blue}} + \underbrace{\omega_3 y_j}_{\text{orange}} + \underbrace{\omega_4}_{\text{green}}$$

$$x \equiv H \begin{matrix} x \\ \text{conic} \end{matrix} \quad \begin{matrix} 3 \times 1 \\ \downarrow \\ 3 \times 3 \end{matrix} \quad (0,0) (0,1) (1,0) (1,1)$$

$$\begin{matrix} 3 \times 3 \\ h_1^T \omega h_2 \\ 1 \times 3 \quad 3 \times 1 \end{matrix} = 0$$

$$\omega = \begin{bmatrix} a & b & d \\ b & c & e \\ d & e & f \end{bmatrix}$$

$$h_1^T \omega h_1 = h_2^T \omega h_2$$

$$\begin{matrix} 5 \times 5 \\ A \omega = 0 \\ 5 \times 1 \end{matrix}$$

UDV^T → last row

$$\begin{bmatrix} x_i \\ \vdots \\ 3 \times 3 \end{bmatrix} \times H \begin{matrix} x \\ \text{conic} \end{matrix} = 0$$

$$\begin{bmatrix} 0 & -1 & y \\ 1 & 0 & -x \\ -y & x & 0 \end{bmatrix} \begin{bmatrix} h_1 & x_c \\ h_2 & x_c \\ h_3 & x_c \end{bmatrix} = 0$$

$$Ah = 0$$

$$\begin{bmatrix} -h_2 x_c + x h_3 x_c \\ h_1 x_c - x h_3 x_c \\ -y h_1 x_c + x h_3 x_c \end{bmatrix} = 0$$

$$-h_4 x_c + -h_5 y_c - h_6 + y (h_2 x_c + h_3 y_c + h_5) = 0$$

$$0 \quad 0 \quad \dots \quad 0 \quad -x_c \quad -y_c \quad -1 \quad y x_c \quad y y_c \quad y = 0$$

$$\omega = K^{-T} K^{-1}$$

$$\begin{matrix} 8 \times 9 & 9 \times 1 \\ 8 \times 1 \\ h_9 = 1 \end{matrix}$$

$$h_1^T \omega h_2 = 0$$

$$\begin{bmatrix} h_1 & h_4 & h_7 \\ \end{bmatrix}_{3 \times 3} \begin{bmatrix} w_1 & w_2 & w_3 \\ w_4 & w_5 & w_6 \\ w_7 & w_8 & w_9 \\ \end{bmatrix}_{3 \times 3} \begin{bmatrix} h_2 \\ h_5 \\ h_8 \\ \end{bmatrix}_{3 \times 1}$$

$$\begin{bmatrix} w_1 h_2 + w_2 h_5 + w_3 h_8 \\ w_4 h_2 + w_5 h_5 + w_6 h_8 \\ w_7 h_2 + w_8 h_5 + w_9 h_8 \\ \end{bmatrix}_{3 \times 1}$$

$$h_1 [w_1 h_2 + w_2 h_5 + w_3 h_8] + h_4 [w_4 h_2 + w_5 h_5 + w_6 h_8] + h_7 [w_7 h_2 + w_8 h_5 + w_9 h_8] = 0$$

$$h_1 h_2 \rightarrow w_1$$

$$h_1 h_5 \rightarrow w_2$$

$$h_1 h_8 \rightarrow w_4$$

$$h_4 h_2 \rightarrow w_2$$

$$h_4 h_5 \rightarrow w_3$$

$$h_4 h_8 \rightarrow w_5$$

$$h_7 h_2 \rightarrow w_4$$

$$h_7 h_5 \rightarrow w_5$$

$$h_7 h_8 \rightarrow w_6$$

$$\begin{matrix} w_1 & w_2 & w_4 \\ w_2 & w_3 & w_5 \\ w_4 & w_5 & w_6 \end{matrix}$$

$$h_1 h_2$$

$$h_1 h_5 + h_4 h_2$$

$$h_4 h_2$$

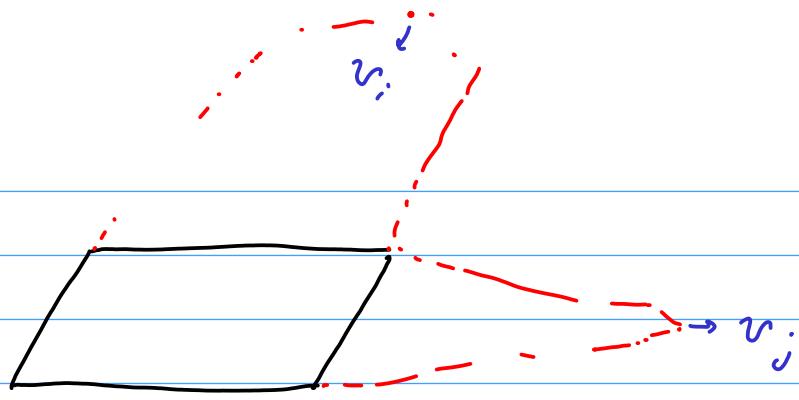
$$h_1 h_8 + h_7 h_2$$

$$h_4 h_8 + h_7 h_5$$

$$h_7 h_8$$

Normalize $\mathbf{n} = \mathbf{d}_i \times \mathbf{d}_j$
so that
 $\|\mathbf{n}\| = 1$

$$\mathbf{d} = K^{-1} \mathbf{v}$$



$$\mathbf{n}^T \mathbf{X} + a = 0$$

\curvearrowleft normal \curvearrowright distance

We should get ref point and assign depth to it

$$\mathbf{X}_{\text{ref}} = \lambda K^{-1} \mathbf{x}_{\text{ref}} \rightarrow a = -\mathbf{n}^T \mathbf{X}_{\text{ref}}$$

$$\text{To reconstruct } \mathbf{n}^T \mathbf{X} + a = 0 \rightarrow \lambda (\mathbf{n}^T K^{-1} \mathbf{x}) + a = 0$$

\downarrow
 $\lambda K^{-1} \mathbf{x}$

$$\lambda = \frac{-a}{\mathbf{n}^T K^{-1} \mathbf{x}}$$

for Connected Plans \mathbf{x} will come from the Shared Corner
or and point in the Shared Edge