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CSCI - 677 Advanced Computer Vision

↳ HW #1

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Pb 1. ~~Let a point (x, y, z) be projected on a line given by (a, b, c) parameters, Then, point projected satisfies the given equation.~~

Please OMIT

$$\cancel{a\frac{x}{z} + b\frac{y}{z} + c = 0}$$

~~⇒ Equation of plane containing all points whose projections lie on a line given by parameters (a, b, c) is~~

$$\cancel{\boxed{ax + by + cz = 0.}}$$

Pb 1. Let a point (x, y, z) be projected on a line by (a, b, c) parameters, Then, projected point satisfies

$$a\left\{\alpha\frac{x}{z} - \alpha\cot\theta\frac{y}{z} + x_0\right\} + b\left\{\frac{\beta}{\sin\theta}\frac{y}{z} + y_0\right\} + c = 0$$

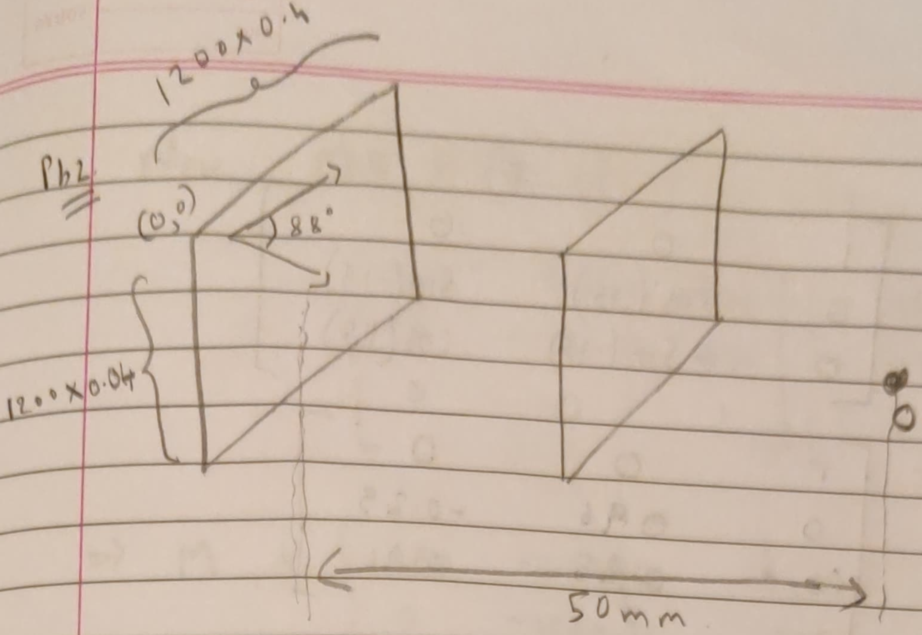
$$\Rightarrow x\left\{\frac{a\alpha}{z}\right\} + y\left\{-\frac{a\alpha\cot\theta}{z} + \frac{b\beta}{\sin\theta}\times\frac{1}{z}\right\} + \left\{ax_0 + by_0 + c\right\} = 0$$

$$\boxed{\Rightarrow x\{a\alpha\} + y\left\{-a\alpha\cot\theta + \frac{b\beta}{\sin\theta}\right\} + z\{ax_0 + by_0 + c\} = 0}$$

↑ (Given K, intrinsic parameters)

Equation of plane containing the 3-D line casting image on line $l(a,b,c)$

Pb2



a) $p = K\hat{p}$

$$\Rightarrow \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} \alpha & -\alpha\cot\theta & x_0 \\ 0 & \frac{\beta}{\sin\theta} & y_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \hat{x} \\ \hat{y} \\ 1 \end{bmatrix}$$

$x_0 = -600$
$y_0 = 600$
$\theta = -88°$
$\alpha = \beta = \frac{50}{0.04} = 1250$

$$\Rightarrow K = \begin{bmatrix} 1250 & -1250\cot(-88) & -600 \\ 0 & \frac{1250}{\sin(-88)} & 600 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1250 & 43.65 & -600 \\ 0 & -1250.76 & 600 \\ 0 & 0 & 1 \end{bmatrix}$$

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Pb2. b)

$$R_{\text{(about x-axis)}} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(-15) & \sin(-15) \\ 0 & -\sin(-15) & \cos(15) \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.96 & -0.25 \\ 0 & 0.25 & 0.96 \end{bmatrix}$$

$O_t = [4, -3, 2]$ (meter) ← In world coordinate system

$O_c = [0, 0, 0]$ ← In camera coordinate system

$$\Rightarrow \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} R & t \\ 0^T & 1 \end{bmatrix} \begin{bmatrix} 4000 \\ -3000 \\ 2000 \\ 1 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & t_1 \\ 0 & 0.96 & -0.25 & t_2 \\ 0 & 0.25 & 0.96 & t_3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4000 \\ -3000 \\ 2000 \\ 1 \end{bmatrix}$$

$\Rightarrow 0 = 4000 + t_1 \qquad \Rightarrow t_1 = -4000$

$\Rightarrow 0 = 0.96(-3000) - 0.25(2000) + t_2 \qquad \Rightarrow t_2 = 3380$

$\Rightarrow 0 = 0.25(-3000) + 0.96(2000) + t_3 \qquad \Rightarrow t_3 = -1170$

$\Rightarrow \vec{t} = (-4000, 3380, -1170)$

Now, $M = K[R \quad t]$

$$= \begin{bmatrix} 1250 & 43.65 & -600 \\ 0 & -1250.76 & 600 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -4000 \\ 0 & 0.96 & -0.25 & 3380 \\ 0 & 0.25 & 0.96 & -1170 \end{bmatrix}$$

$$\Rightarrow M = \begin{bmatrix} 1250 & -108.096 & -586.913 & -4150463 \\ 0 & -1050.73 & 888.69 & -4.92957 \times 10^6 \\ 0 & 0.25 & 0.96 & -1170 \end{bmatrix}$$

Pb.2 c)

Set of parallel Lines (in $X_w - Z_w$ plane)

→ The infinite point in direction of lines is given by

$$(x_0 \quad 0 \quad Z_0 \quad 0)^T$$

⇒ Homogenous coordinates of vanishing point

$$= M P_w$$

$$= \begin{bmatrix} 1250 & -108.096 & -586.913 & -4150463 \\ 0 & -1050.73 & 888.69 & -4.92957 \times 10^6 \\ 0 & 0.25 & 0.96 & -1170 \end{bmatrix} \begin{bmatrix} x_0 \\ 0 \\ Z_0 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} 1250x_0 - 586.913 Z_0 \\ 888.69 Z_0 \\ 0.96 Z_0 \end{bmatrix}$$

⇒ Vanishing point in image coordinate $= \left[\dfrac{1250x_0 - 586.913 Z_0}{0.96 Z_0}, \dfrac{888.69 Z_0}{0.96 Z_0} \right]$

$\Rightarrow$ Vanishing point = $\left[1302 \frac{x_0}{z_0} - 611.36 , 925.72 \right]$