

Problem 3.

a)

$$P = KR[I_{3 \times 3}] - C$$

Intrinsic matrix

$$K = \begin{bmatrix} 1072 & 0 & 500 \\ 0 & 1072 & 330 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{now } K = \begin{bmatrix} f_x & 0 & o_x \\ 0 & f_y & o_y \\ 0 & 0 & 1 \end{bmatrix}$$

Focal lengths

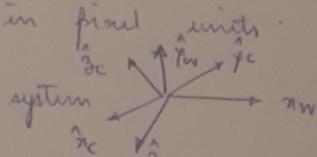
$$f_x = 1072 \quad f_y = 1072$$

in pixel units.

Image center

$$o_x = 500 \quad o_y = 330$$

in pixel units.

- b) consider the world co-ordinate system
- 
- $$R = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$$
- direction of  $\hat{x}_c$  in world co-ord frame  
→ direction of  $\hat{y}_c$  in world co-ord frame  
→ direction of  $\hat{z}_c$  in world co-ord frame.
- $$C = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix}$$
- Camera center locations  
in world co-ordinate system.

∴ The camera appears to be centered at  
 $(25, 50, 0)$  in the world coordinate frame  
and rotated at an angle of  $45^\circ$  along

For a rotation around world x axis

$$x_{wc} = R(x_w - c_w)$$

where  $x_c$  is the world coordinate

when the world coordinate is rotated  
along x axis by  $10^\circ$

$$x'_c = R_{10} x_c$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos 10 & -\sin 10 \\ 0 & \sin 10 & \cos 10 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.9848 & -0.1736 \\ 0 & 0.1736 & 0.9848 \end{bmatrix}$$

$$\therefore x'_c = R_{10} R (x_w - c_w)$$

combined this should be a rotation  
matrix of angle  $45 + 10 = 55^\circ$  around x axis

$$R' = R_{10} R_c = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5735 & -0.8191 \\ 0 & 0.8191 & 0.5735 \end{bmatrix}$$

The camera is translated by 10 units along x axis (+ve)

$$x''_c = x'_c + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} = R' (x_w - c'_w)$$

$$\begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} = -R' c_w \quad \therefore c = -R'^{-1} \begin{bmatrix} 25 \\ 50 \\ 0 \end{bmatrix}$$
$$= \begin{bmatrix} -25 \\ -28.68 \\ 40.96 \end{bmatrix}$$