MIE 466 HW 4:

1. $FoV = \alpha = 270^\circ$ where $\theta_{min} = -\frac{3\pi}{4}$ $\theta_{max} = \frac{3\pi}{4}$ $N = 136$

a) $= \beta = \frac{\alpha}{N-1} = \underline{1.985^\circ}$

b) $d_{36} = 2m$. $\theta_n = \theta_{min} + \beta(n-1) = -135 + 1.985(37-1)$
$= -63.529^\circ$

$$\rightarrow \begin{bmatrix} x_n \\ y_n \end{bmatrix} = \begin{bmatrix} \cos(\theta_n) d_n \\ \sin(\theta_n) d_n \end{bmatrix} = \begin{bmatrix} \cos(-63.529)2 \\ \sin(-63.529)2 \end{bmatrix} = \underline{\begin{bmatrix} 0.891 \\ -1.790 \end{bmatrix}}$$

c) $O_R^W = \begin{bmatrix} 3 \\ 2 \\ 1 \end{bmatrix}$ & $R,P,Y = \theta, \alpha, \beta = 0, \frac{\pi}{4}, 0$

$$\rightarrow \theta \,\&\, \beta = 0 \rightarrow R_R^W = \begin{bmatrix} c\alpha & 0 & s\alpha \\ 0 & 1 & 0 \\ -s\alpha & 0 & c\alpha \end{bmatrix} = \begin{bmatrix} .707 & 0 & .707 \\ 0 & 1 & 0 \\ -.707 & 0 & .707 \end{bmatrix}$$

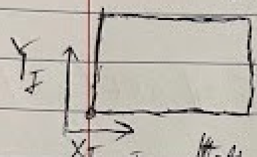
$$\rightarrow H_R^W = \begin{bmatrix} R_R^W & O_R^W \\ 0\,0\,0 & 1 \end{bmatrix} = \begin{bmatrix} .707 & 0 & .707 & 3 \\ 0 & 1 & 0 & 2 \\ -.707 & 0 & .707 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\tilde{P}^W = H_R^W \tilde{P}^R = H_R^W \begin{bmatrix} 0.841 \\ -1.740 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 3.63 \\ 0.21 \\ 0.37 \\ 1 \end{bmatrix}$$

$$\boxed{\rightarrow \begin{bmatrix} x_W \\ y_W \\ z_W \end{bmatrix} = \begin{bmatrix} 3.63 \\ 0.21 \\ 0.37 \end{bmatrix} = P^W}$$

2) $FL = 50\,mm \quad Res = 640 \times 480 \quad \alpha_x = \alpha_y = 8000\ pixel/m$

a) $p_1^C = \begin{bmatrix} 0 \\ 0 \\ 8 \end{bmatrix} m, \quad p_2^C = \begin{bmatrix} 1 \\ 1 \\ 8.5 \end{bmatrix} m, \quad p_3^C = \begin{bmatrix} -2 \\ 4 \\ 7.6 \end{bmatrix}$



$\rightarrow W = 640 \quad H = 480 \quad \ell = 50 \cdot 10^{-3}$

$$p_1^I = \begin{bmatrix} \alpha_x \ell \, p_{1x}^C / p_{1z}^C + \frac{W}{2} \\ \alpha_y \ell \, p_{1y}^C / p_{1z}^C + \frac{H}{2} \\ 0 \end{bmatrix} = \begin{bmatrix} W/2 \\ H/2 \\ 0 \end{bmatrix} = \begin{bmatrix} 320 \\ 240 \\ 0 \end{bmatrix} = p_1^I$$

$$p_2^I = \begin{bmatrix} (8 \cdot 10^3)(\frac{1}{8.5})(50 \cdot 10^{-3}) + 320 \\ (8 \cdot 10^3)(\frac{1}{8.5})(50 \cdot 10^{-3}) + 240 \\ 0 \end{bmatrix} = \begin{bmatrix} 367 \\ 287 \\ 0 \end{bmatrix} = p_2^I$$

$$p_3^I = \begin{bmatrix} (8 \cdot 10^3)(\frac{-2}{7.6})(50 \cdot 10^{-3}) + 320 \\ (8 \cdot 10^3)(\frac{4}{7.6})(50 \cdot 10^{-3}) + 240 \\ 0 \end{bmatrix} = \begin{bmatrix} 213 \\ 453 \\ 0 \end{bmatrix} = p_3^I$$

b) $B^I = \begin{bmatrix} 30 \\ 50 \end{bmatrix} p_x \quad dist: 10\,m$

$$p_B^C = \begin{bmatrix} (30-320)(\frac{10}{400}) \\ (50-240)(\frac{10}{400}) \\ 10 \end{bmatrix} = \begin{bmatrix} -7.25 \\ -4.75 \\ 10 \end{bmatrix} = p_B^C$$

c) $R_C^R = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} \ \& \ O_C^R = \begin{matrix} 0 \\ 0 \\ 0 \end{matrix}, \quad O_R^W = \begin{bmatrix} -3 \\ -2 \\ 0 \end{bmatrix} \ \& \ (RY) = 0, 0, \frac{\pi}{3}$

$$\tilde{B}^W = H_R^W H_C^R \tilde{B}^C \Rightarrow H_C^R = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \ \& \ H_R^W = \begin{bmatrix} .5 & -.866 & 0 & -3 \\ .866 & .5 & 0 & -2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\Rightarrow \tilde{B}^W = \begin{bmatrix} -11 \\ .880 \\ -7.3 \\ 0 \end{bmatrix}$$