

HW3

1)

$$T_1 = {}^w T_c = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 10 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

$$T_2 = {}^w T_c = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 45 & -\sin 45 & 0 \\ 0 & \sin 45 & \cos 45 & 0 \end{bmatrix}$$

$${}^w T_c = T_2 T_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 10 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 45 & -\sin 45 & 0 \\ 0 & \sin 45 & \cos 45 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$${}^w T_c = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -\sin 45 & -\cos 45 & 10 \\ 0 & \cos 45 & -\sin 45 & 0 \end{bmatrix}$$

$${}^c T_w = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -\sin 45 & \cos 45 & 10 \sin 45 \\ 0 & -\cos 45 & -\sin 45 & 10 \cos 45 \end{bmatrix}$$

2) ${}^w P = {}^w T_c {}^c P$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -\sin 45 & -\cos 45 & 10 \\ 0 & \cos 45 & -\sin 45 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \\ 1 \end{bmatrix}$$

$${}^w P = \begin{bmatrix} 1 \\ -\cos 45 + 10 \\ -\sin 45 \end{bmatrix}$$

3)

$${}^w T_c = \begin{bmatrix} \cos 45 & 0 & -\sin 45 & 2 \\ -\sin 45 & 0 & -\cos 45 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

$${}^c T_w = \begin{bmatrix} \cos 45 & -\sin 45 & 0 & -2\cos 45 + \sin 45 \\ 0 & 0 & 1 & 0 \\ -\sin 45 & -\cos 45 & 0 & 2\sin 45 + \cos 45 \end{bmatrix}$$

4)

$$\begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ 0 & 0 & 1 \\ -\sin 45 & -\cos 45 & 0 \end{bmatrix}$$

 $R_2 \leftrightarrow R_3$

$$\begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ -\sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

 $R_1 + R_2 \rightarrow R_2$

$$\begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ 0 & -\sin 45 - \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Since the three vectors are linearly independent and there are three vectors, the columns of ${}^c R_w$ form a basis for \mathbb{R}^3 . we can see linearly independence because there are no free variables.

$$5) \quad {}^cP = \begin{bmatrix} 0 \\ 0 \\ 5 \end{bmatrix}$$

$${}^wP = {}^wT_c {}^cP$$

$${}^wP = \begin{matrix} & 3 \times 4 & & 4 \times 1 & = & 3 \times 1 \end{matrix} \begin{bmatrix} \cos 45 & 0 & -\sin 45 & 2 \\ -\sin 45 & 0 & -\cos 45 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 5 \\ 1 \end{bmatrix}$$

$${}^wP = \begin{bmatrix} -5\sin 45 + 2 \\ -5\cos 45 + 1 \\ 0 \end{bmatrix}$$

The point is in front of the camera

6)

$${}^wt_c = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$$