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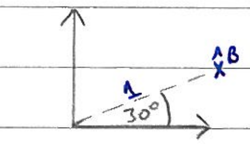
$$\begin{bmatrix} \text{Rotation } 3\times 3 & \text{Translation } 3\times 1 \\ \text{Perspective } 1\times 3 & \text{Scaling } 1\times 1 \end{bmatrix}$$

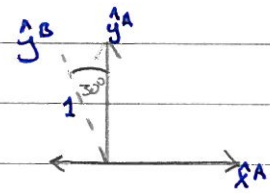
out of page $\odot$ $\otimes$ into page

Example 2.1 → See diagram on p.6, section 2 of notes.

$$(\hat{x}^B)^A = \begin{bmatrix} \cos 30° \\ \sin 30° \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \\ 0 \end{bmatrix}$$



$$(\hat{y}^B)^A = \begin{bmatrix} -\sin 30° \\ \cos 30° \\ 0 \end{bmatrix} = \begin{bmatrix} -\frac{1}{2} \\ \frac{\sqrt{3}}{2} \\ 0 \end{bmatrix}$$



$$(\hat{z}^B)^A = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\Rightarrow \text{Rotation} = \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad \text{Translation} = \begin{bmatrix} 10 \\ 5 \\ 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} & 0 & 10 \\ \frac{1}{2} & \frac{\sqrt{3}}{2} & 0 & 5 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = T_A^B$$

$$p^B = \begin{bmatrix} 3 \\ 7 \\ 0 \end{bmatrix} \Rightarrow p^A = \begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} & 0 & 10 \\ \frac{1}{2} & \frac{\sqrt{3}}{2} & 0 & 5 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 7 \\ 0 \\ 1 \end{bmatrix}$$

$$\Rightarrow p^A = \begin{bmatrix} \begin{matrix} 9.098 \\ \cancel{7366} \end{matrix} \\ 12.562 \\ 0 \\ 1 \end{bmatrix}$$

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Example 2.7

T_{base}^{tool}, $T_{base}^{station}$, $T_{STATION}^{BOX}$ are all known.

Where is the box relative to the tool?

$\Rightarrow T_{TOOL}^{BOX}$?

$$= T_{TOOL}^{base} \, T_{base}^{box}$$

$$= T_{TOOL}^{base} \, T_{BASE}^{STATION} \, T_{STATION}^{BOX}$$

$$= \left(T_{BASE}^{TOOL}\right)^{-1} T_{BASE}^{STATION} \, T_{STATION}^{BOX}$$

$$T_A^B = \begin{bmatrix} 0.866 & -0.5 & 0 & 4 \\ 0.5 & 0.866 & 0 & 3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad R_A^B$$

$$\Rightarrow T_B^A = \begin{bmatrix} 0.866 & 0.5 & 0 & \\ -0.5 & 0.866 & 0 & -(R_A^B)^T (p_{Borg}) \\ 0 & 0 & 1 & \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$-(R_A^B)^T (p_{Borg})^A = -\begin{bmatrix} 0.866 & 0.5 & 0 \\ -0.5 & 0.866 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 3 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} -4.964 \\ 0.598 \\ 0 \end{bmatrix}$$

$$\Rightarrow T_B^A \begin{bmatrix} 0.866 & 0.5 & 0 & -4.964 \\ -0.5 & 0.866 & 0 & 0.598 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$