Lecture 13 - Review MT 1 - 9/18/18

Announcements:

- HW 4 - IK, Due next Friday
- Friday: Test starts @ 8:20
  - One notes sheet (8.5 x 11)
  - No calculators
  - Content:

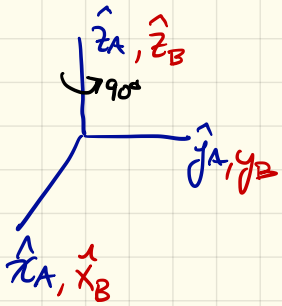
    HW 1 - 30%
    HW 2 - 30%
    HW 3 - 35%
    Challenge - 5%

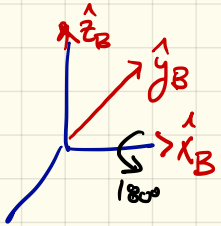
Representations of orientation:

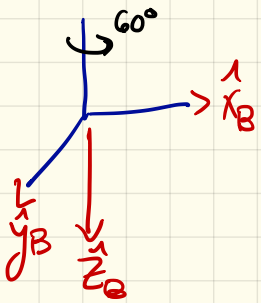
z-Y-Z

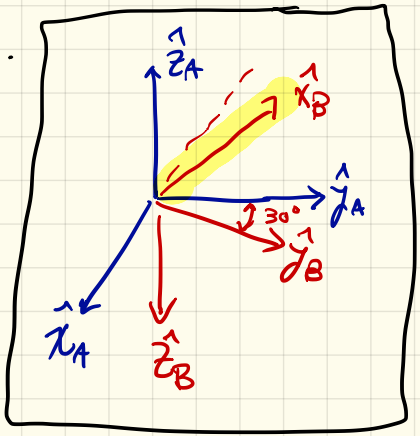
The orientation of $\{B\}$ is given relative to $\{A\}$ via fixed angles:

90°, 180°, 60° draw $\{B\}$ and give ${}^{A}R_{B}$.







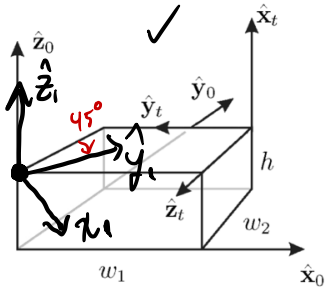


$$ {}^{A}R_{B} = \begin{bmatrix} {}^{A}\hat{x}_B & {}^{A}\hat{y}_B & {}^{A}\hat{z}_B \end{bmatrix} = \begin{bmatrix} -\sqrt{3}/2 & 1/2 & 0 \\ 1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & -1 \end{bmatrix} = \underbrace{R_z(60^\circ) R_y(180^\circ) R_z(90^\circ)}_{\text{body-fixed rotation sequence}} \quad \overleftarrow{\text{earth-fixed sequence}} $$

$$ {}^{A}R_{B} = R_z(\theta) \quad \text{solve for } \theta \quad \boxed{\text{No solution}} $$

Homogeneous Transformations:

$$ {}^1T_t = \begin{bmatrix} {}^1R_t & {}^1P_t \\ 0\,0\,0 & 1 \end{bmatrix} $$



$$ {}^1T_t = \begin{bmatrix} 0 & -\sqrt{2}/2 & \sqrt{2}/2 & w_1/\sqrt{2} - w_2/\sqrt{2} \\ 0 & -\sqrt{2}/2 & -\sqrt{2}/2 & w_1/\sqrt{2} + w_2/\sqrt{2} \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

(a) Draw and label the three axes of the 1 frame in the figure, indicate any angles that are not multiples of $\frac{\pi}{2}$.

(b) Give the homogeneous transformation ${}^0T_1$.

(c) Give the orientation of frame t relative to frame 1 in terms of Z-Y-X Euler angles

(d) What is ${}^0T_t$?

$$ {}^tT_1 = {}^1T_t^{-1} = \begin{bmatrix} {}^1R_t^T & -{}^1R_t^T\,{}^1P_t \\ 0\,0\,0 & 1 \end{bmatrix} $$

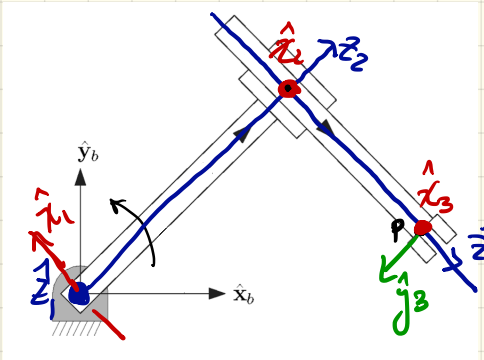
$$ = \begin{bmatrix} 0 & 0 & 1 & 0 \\ -\sqrt{2}/2 & -\sqrt{2}/2 & 0 & w_1 \\ \sqrt{2}/2 & -\sqrt{2}/2 & 0 & w_2 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

$$ \begin{bmatrix} {}^t\hat{x}_1 & {}^t\hat{y}_1 & {}^t\hat{z}_1 \end{bmatrix} \qquad {}^tP_1 $$

(b) $$ {}^0T_1 = \begin{bmatrix} \sqrt{2}/2 & \sqrt{2}/2 & 0 & 0 \\ -\sqrt{2}/2 & \sqrt{2}/2 & 0 & 0 \\ 0 & 0 & 1 & h \\ 0 & 0 & 0 & 0 \end{bmatrix} $$

(c) $135°, -90°, 0$

(d) ${}^0T_t = {}^0T_1 \, {}^1T_t$



1) Assign frames according to the DH convention. Assume {0} = {B} and place {3} at point p.
2) Complete a DH table for your assignment.
3) Compute ${}^0T_3$
4) Give approximate values for the configuration variables in the configuration shown.

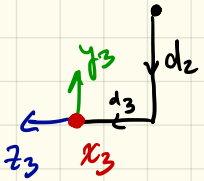
- $\hat{z}$ axes along joint axes
- $\hat{x}$ axes along common normals
- Draw Frames

$\hat{x}_i$ along common normal of joint axis i and axis i+1

② $\curvearrowleft \hat{x}_{i-1}$ $\curvearrowright \hat{x}_{i-1}$ $\uparrow z_i$ $\curvearrowleft z_i$

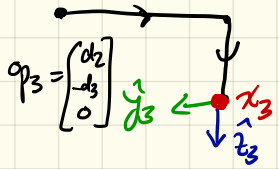
i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	θ_1
2	90°	0	d_2	90°
3	-90°	0	d_3	0

③ when $\theta_1 = 0°$



$${}^0p_3 = \begin{bmatrix} -d_3 \\ -d_2 \\ 0 \end{bmatrix}$$

when $\theta_1 = 90°$



$$q_{p_3} = \begin{bmatrix} d_2 \\ -d_3 \\ 0 \end{bmatrix}$$

$${}^0T_3 = \begin{bmatrix} 0 & -s_1 & -c_1 & -d_3c_1 + d_2s_1 \\ 0 & c_1 & -s_1 & -d_2c_1 - d_3s_1 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

④ $\theta_1 = 135°$, $L_1 = 2\,in$, $L_2 = 2\,in$