

Homework 2

Intro to Robotics

Due Date: March 31st, 2023

1 Frames, translations and rotations

Given frames: Frame {A} = universe,

$$\text{Frame \{B\}} = \{{}^A_B R_{Z'Y'X'}(45^\circ, 100^\circ, 75^\circ), {}^A P_{Borg} = \begin{bmatrix} 1 \\ -2 \\ 5 \end{bmatrix}\},$$

$$\text{Frame \{C\}} = \{{}^B_C R_{Z'Y'X'}(90^\circ, 0^\circ, 15^\circ), {}^B P_{Corg} = \begin{bmatrix} -4 \\ 4 \\ 4 \end{bmatrix}\}$$

$$\text{Given points: } {}^A P_1 = \begin{bmatrix} 1 \\ 2 \\ -3 \end{bmatrix}, {}^C P_2 = \begin{bmatrix} -5 \\ 7 \\ 2 \end{bmatrix}, {}^B P_3 = \begin{bmatrix} 3.14 \\ -7.77 \\ 2.718 \end{bmatrix}$$

1. Find ${}^C_B T$.
2. Find ${}^A P_2$.
3. Find ${}^B P_1$.
4. Find ${}^C P_3$.
5. Given ${}^A P_1$ rotate the point by ${}^A_B R_{Z'Y'X'}(50^\circ, 150^\circ, 200^\circ)$ and translate by vector $\begin{bmatrix} -2 \\ -3 \\ -4 \end{bmatrix}$.

2 Solve for angles

Given frames: Frame {A} = universe,

$$\text{Frame \{B\}} = \{{}^A_B R = \begin{bmatrix} .15 & .18 & -.97 \\ .09 & -.98 & -.16 \\ -.98 & -.06 & -.16 \end{bmatrix}, {}^A P_{Borg} = \begin{bmatrix} 2 \\ 4 \\ -6 \end{bmatrix}\}$$

1. Find the eulerian angles for ${}^A_B R_{Z'Y'X'}$.
2. Solve for the angle between $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$ and $\begin{bmatrix} .5 \\ .5 \\ .71 \end{bmatrix}$

3 Complex

1. rotate the 2d vector $P_1 = \begin{bmatrix} 8 \\ -2 \end{bmatrix}$ by 110° using a complex rotation.

4 Coding Portion

- 1.) Modify your frame class from homework 1, to also create 3d frames then check your answers for part 1.
- 2.) Write a function that takes a rotation matrix as input and solves for the angles in $R_{z'y'x'}(\alpha, \beta, \gamma)$
- 3.) Write a function to solve for the angle between two 3d vectors.