

# 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  $110^\circ$  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.