EECE 5552-Assistive Robotics
Assignment 2

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***Due by 9:50 AM Eastern Time, Tuesday, September 29**

Problem 1

(a) Consider the following sequence of rotations.

A: Rotate by ϕ about the world x-axis.

B: Rotate by θ about the current z-axis.

C: Rotate by ψ about the world y-axis.

What is the resulting rotation matrix?

(b) Consider the following sequence of rotations.

A: Rotate by ϕ about the world x-axis.

B: Rotate by θ about the world z-axis.

C: Rotate by ψ about the current x-axis.

What is the resulting rotation matrix?

Problem 2

(a) A group is a set $\mathbf{X}$ together with an operation $*$ defined on that set such that

a) $x_1 * x_2 \in \mathbf{X}$ for all $x_1, x_2 \in \mathbf{X}$,

b) $(x_1 * x_2) * x_3 = x_1 * (x_2 * x_3)$,

c) There exists an element $I \in \mathbf{X}$ such that $I * x = x * I = x$ for all $x \in \mathbf{X}$,

d) For every $x \in \mathbf{X}$, there exists some $y \in \mathbf{X}$ such that $x * y = y * x = I$.

Now, demonstrate that $SO(3)$ with the operation of matrix multiplication is a group.

(b) Suppose $A \in SO(2)$. This implies that $A^T A = \mathbb{I} \in \mathbb{R}^{2\times 2}$ and $\det\{A\} = 1$. Show that there exists a unique θ such that A is of the form:

$$A = \begin{bmatrix} c_\theta & -s_\theta \\ s_\theta & c_\theta \end{bmatrix}$$

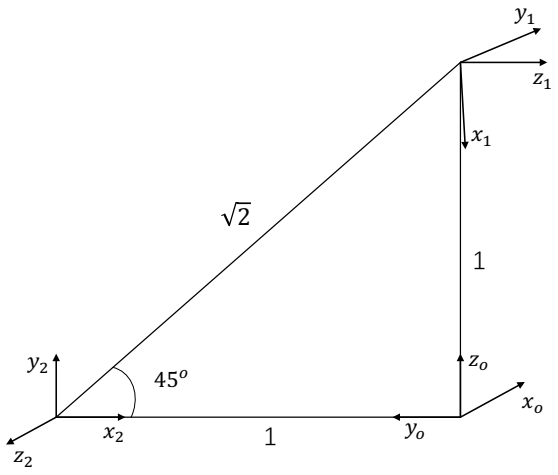

Figure 1: Problem 3-a.

Problem 3

(a) According to Fig. 1, what are the homogeneous transformations H_1^0, H_2^0, H_2^1? How H_2^1 is compared to H_1^2?

(b) Drive the forward kinematic solution for the robot shown in Fig. 2 (apply Danvit-Hartenberg convention after choosing the coordinate frames).

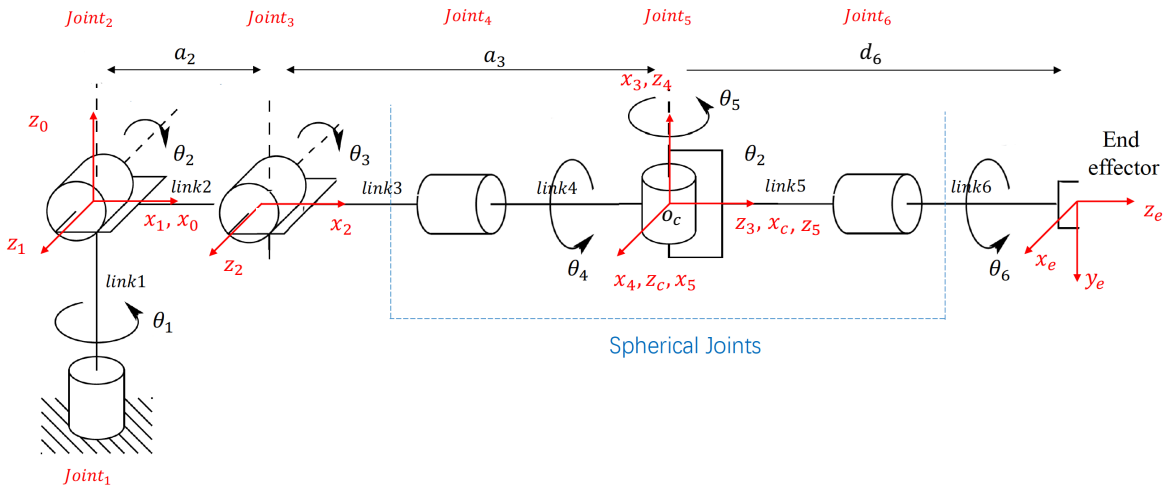

Figure 2: Problem 3-b.