MCE4101 Introduction to Robotics
Quiz1 (5%) –SET 3 (ID end with 5,6)

Name……Todsavad T……**ID**…6114215……..
Date: 15 July 2021 (9.15-10.00)
Note:
1. OPEN BOOK.
2. There are 2 questions.
3. 50 Marks equivalent to 5%.

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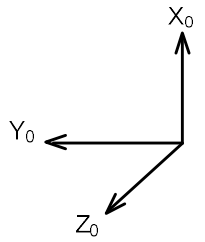
1. (25 Marks). The original frame is given. The following transformation steps for current frames are

i. Rotate -90° in the current y axis then
ii. Translate 2 in the current x axis then
iii. Rotate 90° in the current x axis then
iv. Rotate 90° in the current z axis then
v. Translate -2 in the current z axis

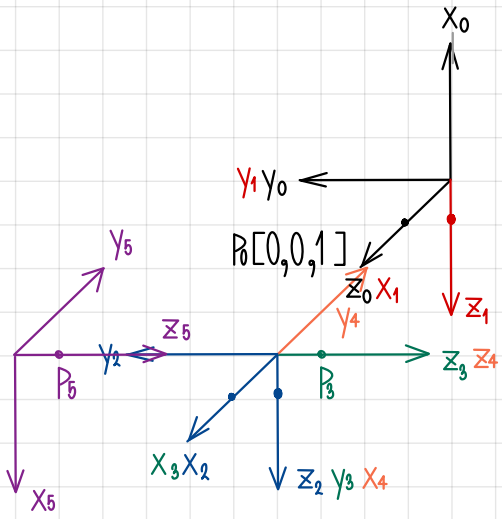
a. (10) List down the all the transformation steps. Find the T_5^0 transformation matrix values.

b. (5) If a point is fixed on the z axis at (0,0,1), obtain the coordinate P_5 with reference to original frame.

c. (10) Plot all the transformation frames and mark P_5 location with reference to origin frame.



Ans:



$$T_1^0 = Rot(y, -90^\circ)$$

$$T_2^1 = D(x, 2)$$

$$T_3^2 = Rot(x, 90^\circ)$$

$$T_4^3 = Rot(z, 90^\circ)$$

$$T_5^4 = D(z, -2)$$

$$T_{c5}^0 = T_1^0 T_2^1 T_3^2 T_4^3 T_5^4$$

$$= \begin{bmatrix} \cos(-90^\circ) & 0 & -\sin(-90^\circ) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(-90^\circ) & 0 & \cos(-90^\circ) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(90^\circ) & -\sin(90^\circ) & 0 \\ 0 & \sin(90^\circ) & \cos(90^\circ) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \cos(90^\circ) & -\sin(90^\circ) & 0 & 0 \\ \sin(90^\circ) & \cos(90^\circ) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 2 \\ 0 & -1 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P_{C5} = T_{c5}^0 P_0$$

$$= \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 2 \\ 0 & -1 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ 1 \\ 2 \\ 1 \end{bmatrix}$$

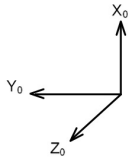
1. (25 Marks). The original frame is given. The following transformation steps for current frames are

   i. Rotate -90° in the current y axis then
   ii. Translate 2 in the current x axis then
   iii. Rotate 90° in the current x axis then
   iv. Rotate 90° in the current z axis then
   v. Translate -2 in the current z axis

   a. (10) List down the all the transformation steps. Find the T_5^0 transformation matrix values.

   b. (5) If a point is fixed on the z axis at (0,0,1), obtain the coordinate P_5 with reference to original frame.

   c. (10) Plot all the transformation frames and mark P_5 location with reference to origin frame.



Ans:

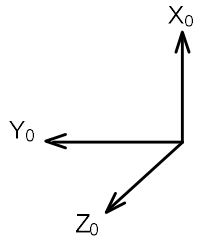
2. (25 Marks). The original frame is given. The following transformation steps for fixed frames are

i. Rotate -90° in the fixed y axis then
ii. Translate 2 in the fixed x axis then
iii. Rotate 90° in the fixed x axis then
iv. Rotate 90° in the fixed z axis then
v. Translate -2 in the fixed z axis

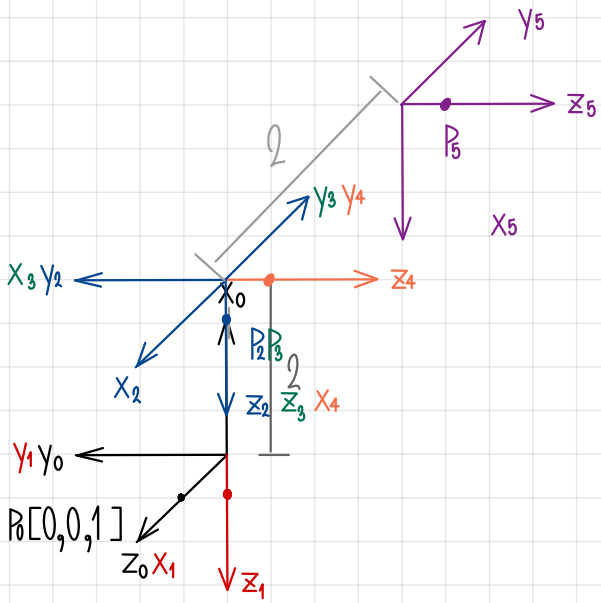
a. (10) List down the all the transformation steps. Find the T_5^0 transformation matrix values.

b. (5) If a point is fixed on the z axis at (0,0,1), obtain the coordinate P_5 with reference to original frame.

c. (10) Plot all the transformation frames and mark P_5 location with reference to origin frame.



Ans:



$$T_1^0 = Rot(y, -90^\circ)$$

$$T_2^1 = D(x, 2)$$

$$T_3^2 = Rot(x, 90^\circ)$$

$$T_4^3 = Rot(z, 90^\circ)$$

$$T_5^4 = D(z, -2)$$

$$T_{F5}^0 = T_5^4 T_1^0 T_4^3 T_3^2 T_2^1$$

$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-90^\circ) & 0 & -\sin(-90^\circ) & 0 \\ 0 & 1 & 0 & 0 \\ \sin(-90^\circ) & 0 & \cos(-90^\circ) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(90^\circ) & -\sin(90^\circ) & 0 & 0 \\ \sin(90^\circ) & \cos(90^\circ) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(90^\circ) & -\sin(90^\circ) & 0 \\ 0 & \sin(90^\circ) & \cos(90^\circ) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$P_{F5} = T_{F5}^0 P_0$$

$$= \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 \\ -1 \\ -2 \\ 1 \end{bmatrix}$$

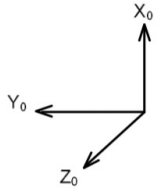
2. (25 Marks). The original frame is given. The following transformation steps for fixed frames are

i. Rotate -90° in the fixed y axis then
ii. Translate 2 in the fixed x axis then
iii. Rotate 90° in the fixed x axis then
iv. Rotate 90° in the fixed z axis then
v. Translate -2 in the fixed z axis

a. (10) List down the all the transformation steps. Find the T_5^0 transformation matrix values.

b. (5) If a point is fixed on the z axis at (0,0,1), obtain the coordinate P_5 with reference to original frame.

c. (10) Plot all the transformation frames and mark P_5 location with reference to origin frame.



Ans: