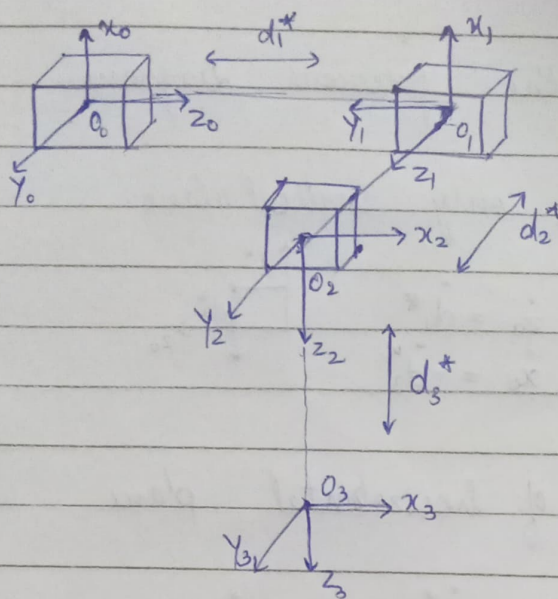


## ASSIGNMENT - 4

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7.



link	$a_i$	$\alpha_i$	$d_i^*$	$\theta_i$
1	0	$-90^\circ$	$d_1^*$	$0^\circ$
2	0	$90^\circ$	$d_2^*$	$-90^\circ$
3	0	$0^\circ$	$d_3^*$	$0^\circ$

Input :-(i)  $d_1^* = 5$      $d_2^* = 5$      $d_3^* = 5$   
 $(x, y, z) = (-5, 5, 5)$

(ii)  $d_1^* = 6$      $d_2^* = 8$      $d_3^* = 4$   
 $(x, y, z) = (-4, 8, 6)$

For velocities

Input: (i)  $\dot{d}_1^* = 0.1$      $\dot{d}_2^* = 0.5$      $\dot{d}_3^* = 0.2$   
 $(\dot{x}, \dot{y}, \dot{z}) = (-0.2, 0.5, 0.1)$

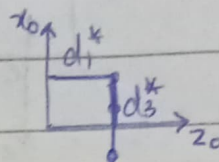
(ii)  $\dot{d}_1^* = 1$      $\dot{d}_2^* = 3$      $\dot{d}_3^* = 7$   
 $(\dot{x}, \dot{y}, \dot{z}) = (-7, 3, 1)$

8. Referring to the previous diagram.

6 Projection of only vertical plane:

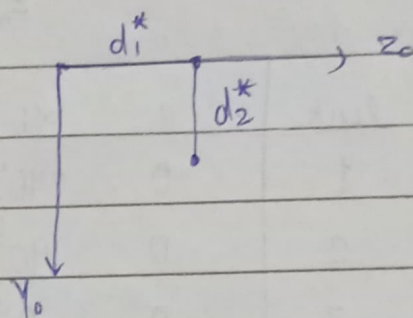
$$z_0 = d_1^*, \quad \dot{z}_0 = \dot{d}_1^*$$

$$x_0 = -d_3^*, \quad \dot{x}_0 = -\dot{d}_3^*$$



Projection of horizontal plane.

$$y_0 = d_2^*, \quad \dot{y}_0 = \dot{d}_2^*$$



joint positions

$$\begin{bmatrix} d_1^* \\ d_2^* \\ d_3^* \end{bmatrix} = \begin{bmatrix} z_0 \\ y_0 \\ -x_0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_0 \\ y_0 \\ z_0 \end{bmatrix}$$

joint velocities

$$\begin{bmatrix} \dot{d}_1^* \\ \dot{d}_2^* \\ \dot{d}_3^* \end{bmatrix} = \begin{bmatrix} \dot{z}_0 \\ \dot{y}_0 \\ -\dot{x}_0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} \dot{x}_0 \\ \dot{y}_0 \\ \dot{z}_0 \end{bmatrix}$$



1.

$$R = \begin{bmatrix} 0.2 & 0.3 & 0.4 \\ 0.6 & 0.7 & 0.8 \\ 0.1 & 0.5 & 0.9 \end{bmatrix}$$

$$d = (1, 2, 3)$$

It gives  $p = (0.2, 0.4, 1.2)$

and output  $\theta_1 = 26.56^\circ$   $\theta_4 = -10.68^\circ$

$$\theta_2 = -60.79^\circ$$

$$\theta_5 = 64.68^\circ$$

$$\theta_3 = 0$$

$$\theta_6 = 127.64^\circ$$

$$d_3 = -3.08^\circ$$

The values are close to the ones calculated.

2. Same values for  $R$  and  $d$  were input as above.  
~~are close to~~ ~~are close to~~

$$a_1 = 1, \quad a_2 = 1.5, \quad d_4 = 1.5$$

Output:  $\theta_1 = -0.68$

$$\theta_2 = 0.7$$

$$\theta_3 = 0$$

$$\theta_4 = -0.96$$

$$d_3 = 4.5$$

The values are close to calculated ones.