12/
febrero
/2019

Parámetros Denavit-Hartenberg (Robots 1-6)

Tarea 5

8°B T/M

ASIGNATURA: CINEMÁTICA DE ROBOTS

PROFESOR: ENRIQUE MORÁN GARABITO

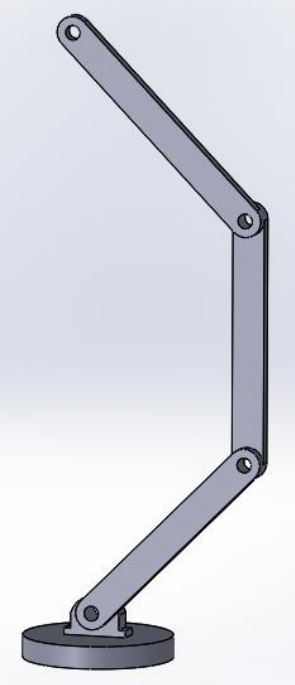
ALUMNO: MARCO ANTONIO LOZANO OCHOA

UNIVERSIDAD POLITÉCNICA DE LA ZONA METROPOLITANA
DE GUADALAJARA | **Ingeniería mecatrónica**

Matriz homogénea

$$T_i^{\,i-1} = \begin{bmatrix} C\theta_i & -S\theta_i & 0 & a_{i-1} \\ S\theta_i C \propto_{i-1} & C\theta_i C \propto_{i-1} & -S \propto_{i-1} & -d_i S \propto_{i-1} \\ S\theta_i S \propto_{i-1} & C\theta_i S \propto_{i-1} & C \propto_{i-1} & d_i C \propto_{i-1} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Robot 1



i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	-90	0	θ_1
2	L_1	0	0	θ_2
3	L_2	0	0	θ_3

$$T_1^{\,0} = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -S\theta_1 & -C\theta_1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^{\,1} = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & L_1 \\ S\theta_2 & C\theta_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^{\,2} = \begin{bmatrix} C\theta_3 & -S\theta_3 & 0 & L_2 \\ S\theta_3 & C\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3{}^0 = T_1{}^0 T_2{}^1 T_3{}^2 =$$

[

```
cos(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)) - sin(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1)), - cos(t3)*(cos(t1)*sin(t2) +
                                                                                                                        0,
cos(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1)) - sin(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)),   sin(t3)*(cos(t1)*sin(t2) +
                                                                                                                        0,


cos(t2)*sin(t1)) - sin(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)), 0,   L2*(cos(t1)*cos(t2) - sin(t1)*sin(t2)) + L1*cos(t1)]
                                                                0, 1,                                                    0]
cos(t2)*sin(t1)) - cos(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)), 0, - L2*(cos(t1)*sin(t2) + cos(t2)*sin(t1)) - L1*sin(t1)]
                                                                0, 0,                                                    1]
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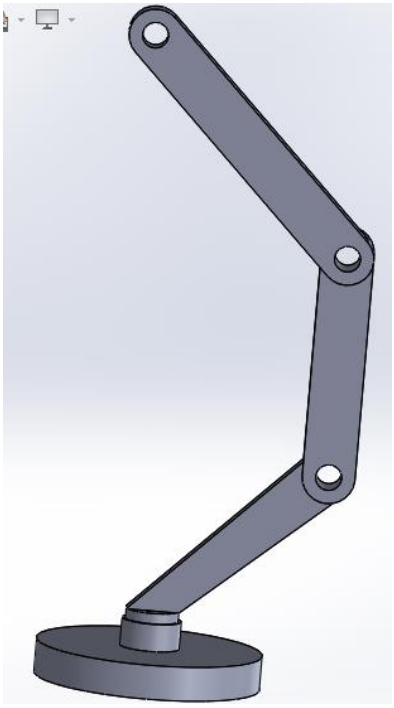
]

Robot 2



i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	-90	0	θ_1
2	L_1	0	0	θ_2
3	L_2	0	0	θ_3

$$T_1{}^0 = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ S\theta_1 & C\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2{}^1 = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & L_1 \\ 0 & 0 & 1 & 0 \\ -S\theta_2 & -C\theta_2 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^2 = \begin{bmatrix} C\theta_3 & -S\theta_3 & 0 & L_2 \\ S\theta_3 & C\theta_3 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

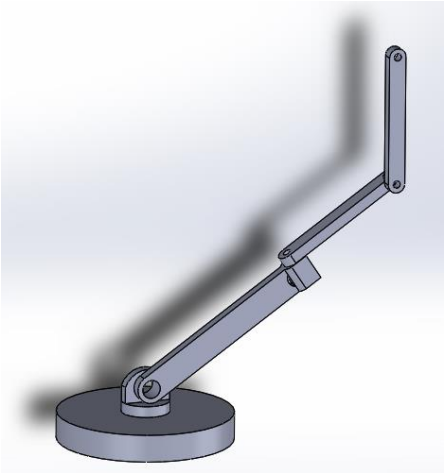
$$T_3^0 = T_1^0 T_2^1 T_3^2 =$$

[

```
cos(t1)*cos(t2)*cos(t3) - cos(t1)*sin(t2)*sin(t3), - cos(t1)*cos(t2)*sin(t3) - cos(t1)*cos(t3)*sin(t2), -sin(t1), L1*cos(t1) + L2*cos(t1)*cos(t2)
cos(t2)*cos(t3)*sin(t1) - sin(t1)*sin(t2)*sin(t3), - cos(t2)*sin(t1)*sin(t3) - cos(t3)*sin(t1)*sin(t2),  cos(t1), L1*sin(t1) + L2*cos(t2)*sin(t1)
             - cos(t2)*sin(t3) - cos(t3)*sin(t2),                 sin(t2)*sin(t3) - cos(t2)*cos(t3),       0,                    -L2*sin(t2)
                                               0,                                                 0,       0,                             1
```

]

Robot 3



i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	-90	0	θ_1
2	L_1	90	d2	θ_2
3	L_2	-90	0	θ_3

$$T_1^0 = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -S\theta_1 & -C\theta_1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^1 = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & L_1 \\ 0 & 0 & -1 & -d2 \\ S\theta_2 & C\theta_2 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^2 = \begin{bmatrix} C\theta_3 & -S\theta_3 & 0 & L_2 \\ 0 & 0 & 1 & 0 \\ -S\theta_3 & -C\theta_3 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

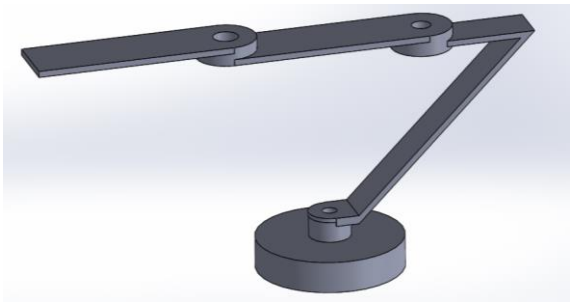
$$T_3{}^0 = T_1{}^0 T_2{}^1 T_3{}^2 =$$

[

```
cos(t1)*cos(t2)*cos(t3) - sin(t1)*sin(t3), - cos(t3)*sin(t1) - cos(t1)*cos(t2)*sin(t3), -cos(t1)*sin(t2), L1*cos(t1) + d2*sin(t1) + L2*cos(t1)*cos(t2)
                          cos(t3)*sin(t2),                           -sin(t2)*sin(t3),          cos(t2),                                 L2*sin(t2)
- cos(t1)*sin(t3) - cos(t2)*cos(t3)*sin(t1),   cos(t2)*sin(t1)*sin(t3) - cos(t1)*cos(t3),  sin(t1)*sin(t2), d2*cos(t1) - L1*sin(t1) - L2*cos(t2)*sin(t1)
                                          0,                                           0,               0,                                         1
```

]

Robot 4



i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	-90	0	θ_1
2	$\frac{3}{4}L$	0	d3	θ_2
3	L	0	d2	θ_3

$$T_1{}^0 = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -S\theta_1 & -C\theta_1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2{}^1 = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & \frac{3}{4}L \\ S\theta_2 & C\theta_2 & 0 & 0 \\ 0 & 0 & 1 & d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3{}^2 = \begin{bmatrix} C\theta_3 & -S\theta_3 & 0 & L \\ S\theta_3 & C\theta_3 & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3{}^0 = T_1{}^0 T_2{}^1 T_3{}^2 =$$

[

```
cos(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)) - sin(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1)), - cos(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1))
                                                                                        0,
- cos(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1)) - sin(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)),   sin(t3)*(cos(t1)*sin(t2) + cos(t2)*sin(t1))
                                                                                        0,


      - sin(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)), 0,   L*(cos(t1)*cos(t2) - sin(t1)*sin(t2)) + (3*L*cos(t1))/4
                                                  0, 1,                                                  d2 + d3
      - cos(t3)*(cos(t1)*cos(t2) - sin(t1)*sin(t2)), 0, - L*(cos(t1)*sin(t2) + cos(t2)*sin(t1)) - (3*L*sin(t1))/4
                                                  0, 0,                                                         1
```

]

Robot 5

i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	0	0	θ_1
2	0	0	d1	0
3	L_1	-90	d2	0

$$T_1{}^0 = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ S\theta_1 & C\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2{}^1 = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3{}^2 = \begin{bmatrix} 0 & 0 & 0 & L \\ 0 & 0 & -1 & d_2 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\boldsymbol{T_3}^{\mathbf{0}} = \boldsymbol{T_1}^{\mathbf{0}}\boldsymbol{T_2}^{\mathbf{1}}\boldsymbol{T_3}^{\mathbf{2}} =$$

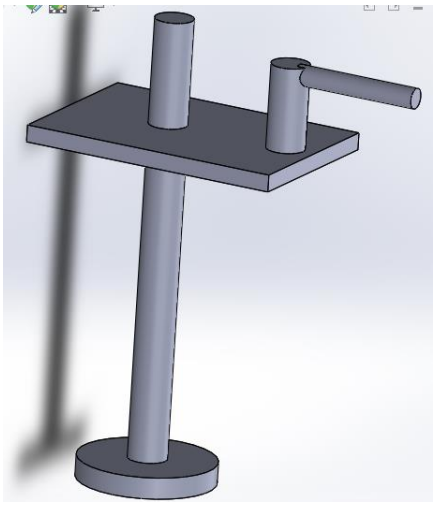
[0, 0, 0, 0

0, 0, 0, 0

0, 0, 0, d1

0, 0, 0, 1]

Robot 6



i	a_{i-1}	$\propto_{i-1}$	d_i	θ_i
1	0	0	0	θ_1
2	0	0	d1	0
3	L	0	d2	θ_2

$$\boldsymbol{T_1}^{\mathbf{0}} = \begin{bmatrix} C\theta_1 & -S\theta_1 & 0 & 0 \\ S\theta_1 & C\theta_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\boldsymbol{T_2}^{\mathbf{1}} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\boldsymbol{T_3}^{\mathbf{2}} = \begin{bmatrix} C\theta_2 & -S\theta_2 & 0 & L \\ S\theta_2 & C\theta_2 & 0 & 0 \\ 0 & 0 & 1 & d_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^0 = T_1^0 T_2^1 T_3^2 =$$

[0, 0, 0, 0]

[0, 0, 0, 0]

[0, 0, 1, d1 + d2]

[0, 0, 0, 1]

Evidencia (firma)