Kinamatic Modeling and Simulaation of a SCARA robot by using solid dynamics and verification by MATLAB/Simulink

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Introdution

- **SCARA**
- Simulation using softwares(**MATLAB**, **Simulink**)
- Kinematic Modeling(**Inverse Kinematics**)
- Equations (**Actuador Modeling, Transmission Equations**)

Introdution

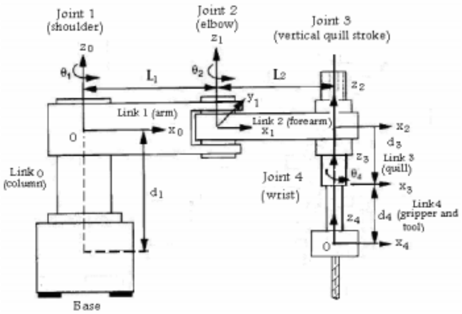

Figura 1: Robot SCARA.

Development

- Robot Kinematics

i	θ_i	d_i	a_i	α_i
1	θ_1	0	L_1	0
2	θ_2	0	L_2	0
3	0	d_3	0	0
4	θ_4	d_4	0	0

Tabela 1: D-H parameters of the robot

Development

- Inverse solution for position:

$$\theta_1 = \tan^{-1}(\frac{s_1}{c_1}) = \tan^{-1}\frac{(L_1 + L_2c_2)\cdot\rho_y - L_2\cdot s_2\cdot p_x}{(L_1 + L_2c_2)\cdot\rho_x + L_2\cdot s_2\cdot p_y}$$

$$\theta_2 = \tan^{-1}\frac{s_2}{c_2}$$

$$\theta_3 = 0$$

$$\theta_4 = \tan^{-1}\frac{-n_x\cdot\sin(\theta_1+\theta_2) + n_x\cdot\cos(\theta_1+\theta_2)}{n_x\cdot\cos(\theta_1+\theta_2) + n_y\cdot\sin(\theta_1+\theta_2)}$$

Development

- Inverse solution for velocity:

$$\theta_1 = \frac{\rho_x \cdot c_{12} + \rho_y \cdot s_{12}}{L_1 \cdot s_2}$$

$$\theta_2 = \frac{-\rho_y \cdot (L_1 \cdot s_1 + L_2 \cdot s_{12}) - \rho_x \cdot (L_1 \cdot c_1 + L_2 \cdot c_{12})}{L_1 \cdot L_2 \cdot s_2}$$

$$d_3 = -\rho_z$$

$$\theta_4 = \frac{c_{12} \cdot n_y - s_{12} \cdot n_x - (n_x \cdot c_{12} + n_y \cdot s_{12}) \cdot \theta_{12}}{c_4}$$

Development

- Torques exerted on the robot joint:

$$T_1 = (b_{11} \cdot \theta_1 - b_{12} \cdot \theta_2 - b_{13} \cdot d_3 - b_{14} \cdot \theta_1 \cdot \theta_2 + b_{15} \cdot \theta_2^2)$$

$$T_2 = (-b_{21} \cdot \theta_1 + b_{22} \cdot \theta_2 + b_{23} \cdot d_3 + b_{24} \cdot \theta_1^2)$$

$$T_3 = (-b_{31} \cdot \theta_1 + b_{32} \cdot \theta_2 + b_{33} \cdot d_3 - b_{34})$$

Results

- The main arm has $\theta_1 = 1.649rad, \theta_2 = 1.475 - 2.617rad$.

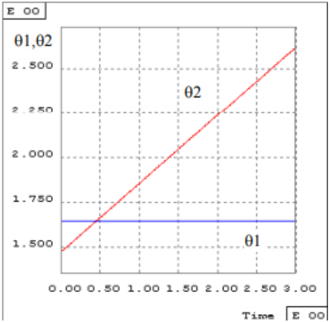

Figura 2: Input angles.

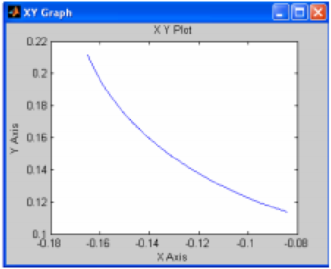

Figura 3: Output variables(final position).

Results

- The main arm has $\theta_1 = 3.0142 - 0.794 rad, \theta_2 = 2.449 rad$.

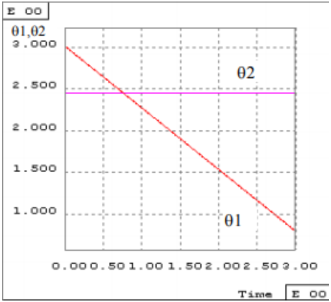

Figura 4: Input angles.

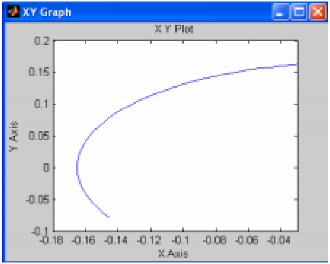

Figura 5: Output variables(final position).

Results

- The main arm has $\theta_1 = 0.232 - 2.469rad, \theta_2 = 1.352 - 2.094rad.$

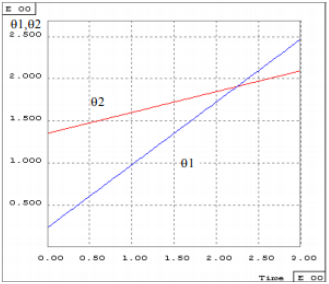

Figura 6: Input angles.

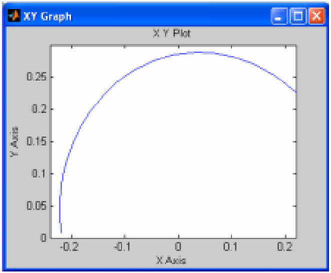

Figura 7: Output variables(final position).

Conclusion

- A complete mathematical model of **SCARA** robot is developed.
- Using **Solid Dynamics** program, struture for SCARA was built.
- Shows a union between **SD** and **MATLAB**.

Acknowledgement

Thank you all !

References