Maestría en Ingeniería en Automatización de Procesos Industriales

Title

Design and Simulation of a robot of 4 degree of freedom for machining of Printed Circuit

Author

Felipe de Jesús Diez Ramírez

Contributor

Fernando Osvaldo Manzanilla,

Bernardino Benito Salmerón Quiroz

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Design and Simulation of a robot of 4 degree of freedom for machining of Printed Circuit Board PCB

Felipe de Jesús Díez Ramírez

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ABSTRACT

The next poster has as objective to present the advance of the thesis named "**Design and Simulation of a robot of 4 degree of freedom for machining Printed Circuit Board PCB** ". The proposed system will be a prototype system for students and teachers of the Universidad Politécnica de Puebla whose function is the machining of their printed circuits in according to their needs. The design staff through a software as Proteus, Multisim will send data to the robot, and as response the robot will be positioned at a specific point of the printed circuit board and using a drill machine as end effector, the printed circuit board will be drilled. The poster is formed by 4 parts. The first part is the introduction, which presents one of the needs of engineering students in the process of machining printed circuit and describes the proposed system to solve it. The second part is the objectives, which presents the 5 objectives that have to cover for the acceptance of the thesis. The third part are the results, which presents the graphical evaluation or equations of each objective and the fourth part are the reference.

1. INTRODUCTION

In different courses in the Departments of Electronics and Mechatronics at the Universidad Politécnica de Puebla are generated and manufactured printed circuit boards. For its manufacture, the students must use manual operations for realizing the processes, because it does not have specialized machinery for manufacturing thereof. One of the problems that students have in the mentioned process is drill the printed circuit. If drilling is not done correctly, the rework on the printed circuit is necessary and to apply more resources (money, time, etc).

To solve the mentioned need, is proposed to design a robot of 4 degree of freedom for machining the printed circuit board of automatic form.

2. OBJECTIVES

1. Implement the methods conventionally used for the design of control orientation and position for generate the trajectory applied to a robot of 4 degree of freedom.
2. Generate and model the forward and inverse dynamics to define paths for machining the Printed circuits.
3. Designing the Mechanical system of the robot taking into account rules and parameters obteined by calculating the kinematics and dynamics.
4. Designing electronics and control according to the requeriments of the Mechanical system.
5. Simulate the mechanical, electronic and control system of the robot.

3. RESULTS

3.1 FORWARD KINEMATICS

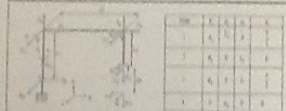


Fig 1. Conceptual Design and Table D-H.

$$T_4^0 = \begin{bmatrix} \cos(\theta_1) & \sin(\theta_1) & 0 & 500\cos(\theta_1)\cos(\theta_2) \\ \sin(\theta_1) & -\cos(\theta_1) & 0 & 500\sin(\theta_1)\cos(\theta_2) \\ 0 & 0 & -1 & 378.45 - d_3 + 500\sin(\theta_2) \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Eq 1. Equations of forward kinematics.

$$\begin{bmatrix} X_0 \\ Y_0 \\ Z_0 \end{bmatrix} = \begin{bmatrix} 500\cos(\theta_1)\cos(\theta_2) \\ 500\,sen(\theta_1)\cos(\theta_2) \\ 378.45 - d_3 + 500\,sen(\theta_2) \end{bmatrix}$$

Eq 2. Equation of cartesian coordinates of end effector.

Fig 2. Simulation of forward kinematics.

3.2 INVERSE KINEMATICS

[illegible] [illegible]

[illegible] $d_3 = L_2 sen(\theta_2) - P_z + L_1$

Eq. 3 Equations of inverse kinematics.

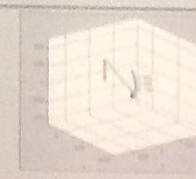


Fig 3. Simulation of forward kinematics.

3.3. INVERSE DINAMYCS

$\tau_1 = A\ddot{\theta}_1 + B\ddot{\theta}_2 + C\ddot{\theta}_3 + J + M + N_1 R$

Eq 4. Torque of joint 1.

[illegible]

$\tau_2 = D\ddot{\theta}_1 + E\ddot{\theta}_2 + F\ddot{\theta}_3 + K + N$

Eq 5. Torque of joint 2.

[illegible]

$\tau_3 = G\ddot{\theta}_1 + H\ddot{\theta}_2 + I\ddot{\theta}_3 + P + O$

Eq 6. Torque of joint 3.

[illegible]

3.4 FORWARD DYNAMICS

[illegible]

Eq 7. Equations of forward Dynamics.

3.5 MECHANICAL DESIGN

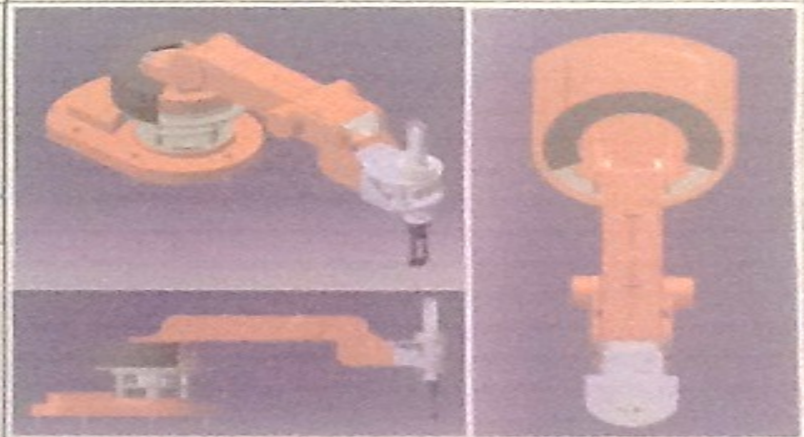


Fig 4. Robot of 4 degree of freedom.

3.6 CONTROL

The motor used for drilling has the next transfer function:

$$\frac{0.0452}{2.84e\text{-}8s^2+8.536e\text{-}05s+0.06189}$$

Función de Transferencia del Sistema

Fig 5. Transfer function

The diagram of blocks used for controlling the motor is:

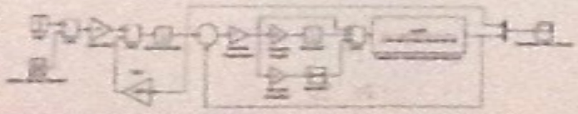
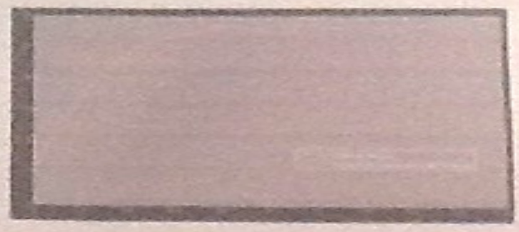


Fig 6. Diagram of block of control

The response of the system is the following:



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