Maestría en Ingeniería en Automatización de Procesos Industriales

Title

Teleoperation of a robot of five degrees of freedom by means of instrumentation the human arm for the handling objects in restricted áreas

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1. Introduction

Human operator intervention is essential in many robotics applications, especially in unstructured and dynamic environments, where problems of perception and automatic planning are very complex.

It is understood by teleoperation to the extension of sensory and human to a remote effector dexterity skills, the terms of tele-action to refer to specific aspects of the generation of orders to actuators and tele-detection to capture and also They use sensory information display.

Telerobotics is considered as an evolved form of teleoperation, characterized by increased autonomy on a remote system while maintaining a significant intervention of human operator supervision or direct teleoperation.

2. Objectives

2.1. General objective

Developing the teleoperation system of a robot of five degrees of freedom by means of instrumentation the human arm for handling objects in restricted areas for man

2.2. Particular objectives

- To get the kinematic model of the manipulator to determine their range of mobility and the necessary restrictions on its architecture.
- To program of the algorithms of locomotion of the robot to mimic the movement of the human arm.
- To develop the instrumentation of the human arm for the motion sensing.

3. Methodology

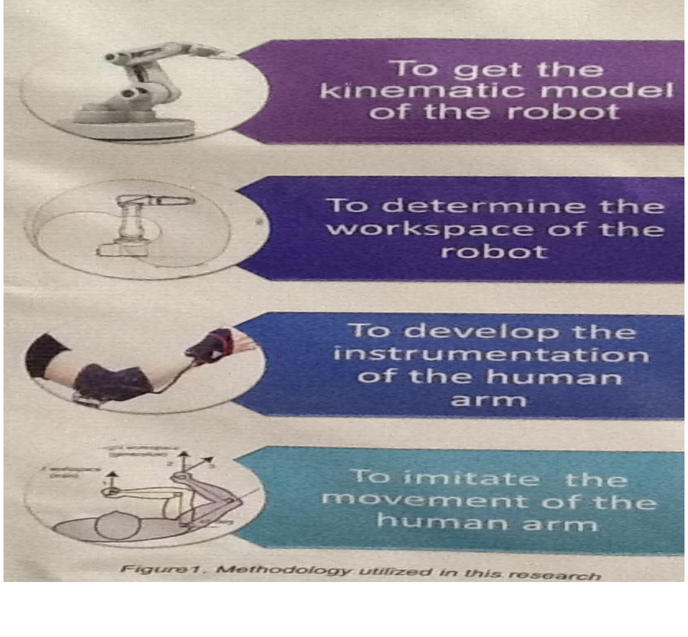

Figure1. Methodology utilized in this research

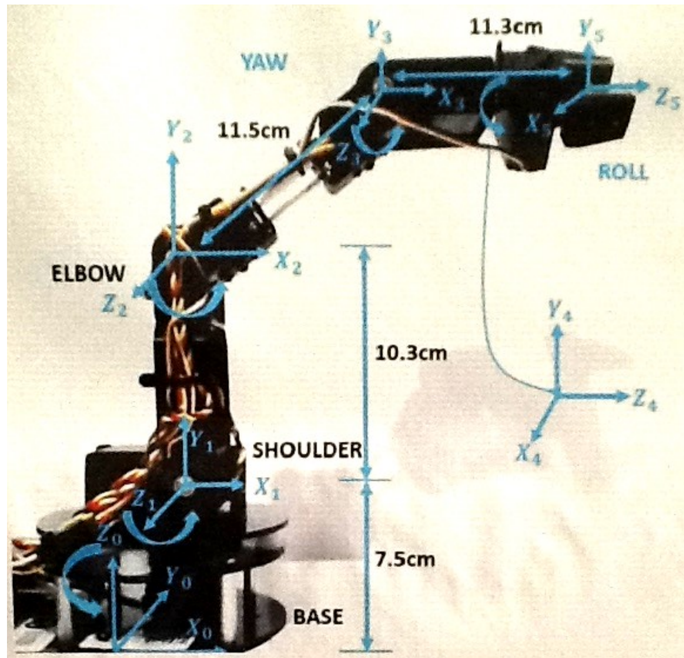

Figure 2. Get the kinematic model by means of Denavit-Hartenberg algorithm

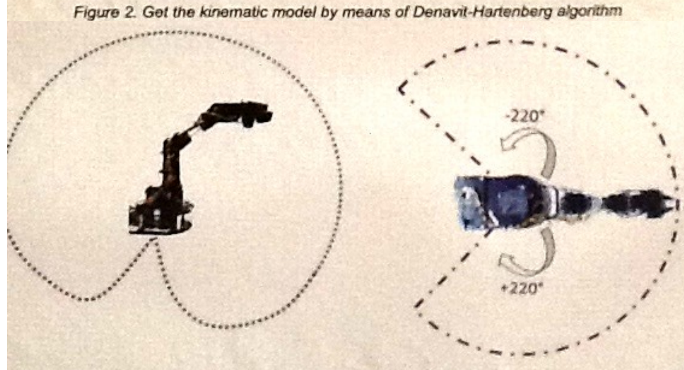

Figure 3. Workspace of this robot

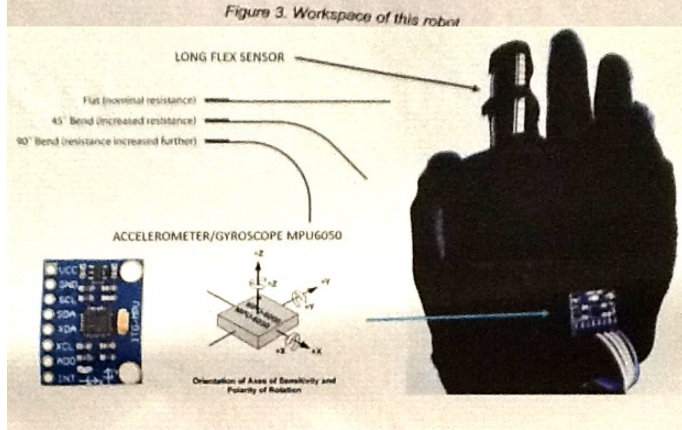

Figure 4. instrumentation of the hand with the flex sensor and accelerometer & gyroscope MPU6050

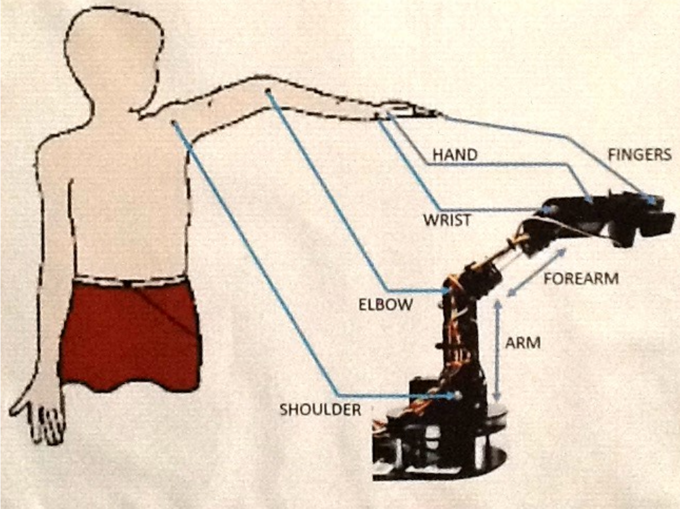

Figure 5. Comparison between the robot and the human arm

4. Results

The application of the Denavit-Hartenberg method allows homogeneous transformation matrices, these allow the calculation of the matrix robot which take only the parameters p_x, p_y and p_z.

$$T_0^1(\theta_1) = \begin{vmatrix} C_1 & 0 & S_1 & 0 \\ S_1 & 0 & -C_1 & 0 \\ 0 & 1 & 0 & 7.5 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

$$T_1^2(\theta_2) = \begin{vmatrix} C_2 & -S_2 & 0 & 10.3C_2 \\ S_2 & C_2 & 0 & 10.3S_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

$$T_2^3(\theta_3) = \begin{vmatrix} C_3 & -S_3 & 0 & 11.5C_3 \\ S_3 & C_3 & 0 & 11.5S_3 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

$$T_3^4(\theta_4) = \begin{vmatrix} C_4 & 0 & S_4 & 0 \\ S_4 & 0 & -C_4 & 0 \\ 0 & 1 & 0 & 5.6 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

$$T_4^5(\theta_5) = \begin{vmatrix} C_5 & -S_5 & 0 & 5.6C_5 \\ S_5 & C_5 & 0 & 5.6S_5 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

Figure 6. The homogeneous transformation matrices

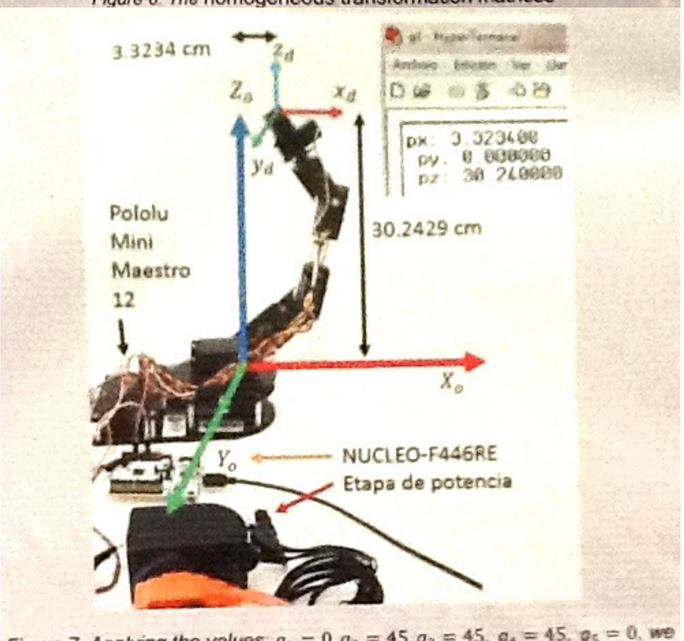

Figure 7. Applying the values: $q_1 = 0, q_2 = 45, q_3 = 45, q_4 = 45, q_5 = 0$, we obtain the position $p_x = 3.3234\ cm$, $p_y = 0\ cm$, $p_z = 30.24\ cm$

Figure 8. Mimic the movement of the wrist

5. Conclusion

According to preliminary results we can conclude that:

We have been able to obtain the forward kinematics, which was programmed in the embedded system with the software online MBED, define the workspace of the robot manipulator and developing the instrumentation of a glove for the teleoperation of the wrist of the robot.

The gripper is controlling by flex sensor and the fourth and fifth joint is controlling with a accelerometer / gyroscope sensor (MPU6050).

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