DESIGN AND IMPLEMENTATION OF A PROTOTYPE INDUSTRIAL ROBOT ARM FOR WELDING PROCESS

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ABSTRACT

The various advances in industrial production have generated strong demand on the handling systems, such as robotic arms. It has a variety of shapes and sizes because these are designed exclusively for specific and precise tasks. That is why for a greater understanding of this type of technology it has been chosen to design and build a miniature robotic manipulator. This contains the same concepts of an industrial robot, such as direct and inverse kinematics, control of position and tracking. Therefore, it has opted for a system electronic efficient also it has chosen the right servos according to duty in each degree of freedom, in addition to this, it was selected the Mega Arduino as a micro controller to manage the actuators and sensors.

Keywords: Arm robot, control, sensor, actuator and kinematics.

I. INTRODUCTION

In order to remain competitive in a globalized environment, manufacturing companies need to constantly evolve their production systems and accommodate the changing demands of markets. Currently, production is experiencing a paradigm shift from mass production to mass customization of products. The impact of this trend on production systems is that they should adapt to handle more product variation, Smaller life cycles, and smaller batch sizes – ideally batch size 1. Today, robot-based production is an essential part of the industrial manufacturing backbone. However, the concept of an industrial robot statically placed in a cell and continuously repeating a carefully predefined sequence of actions has remained practically unchanged for many decades. Not surprisingly, typical industrial robots are not flexible and thus such a degree of transformable production [1], [2] and [3] is beyond the capabilities of current systems. For all these reasons is necessary to create a miniature robot manipulator as an educational module to do a lot of experiments in order to analyze the results and errors, and then implement in an industrial robot, of course, with other considerations and conditions.

II. REPRESENTATION OF THE PROBLEM

The problem to solve with this project is to improve the skills and increase the knowledge in industrial robotics through an educational module which consists in miniature robotics manipulator because many students finished the university without it has implemented the theory.

III. OBJECTIVES

- Design and build a miniature robotic manipulator for emulate applications in the industry
- Improve the skills of students in robotics field
- Develop an educational module for doing experiments in the laboratory of control and automation

IV. DESCRIPTION OF THE SOLUTION

A. Direct Kinematics

In the design of the robotic arm it is considered this morphology, the relative location and the kinematics of the end-effector trajectory.

B. Model Kinematic Robot

To develop the robotic arm has 6 degrees of freedom of which the coordinate systems are analyzed as shown in Figure 1 .Since the coordinate origin in the robot base. Subsequently, taking as an idea procedure develop for these manipulators as these calculations are developed extensively in subsequent courses of our profession matrix homogeneous transformation T, which describes the sequence of rotations and translations develops about a previous coordinate system [4].

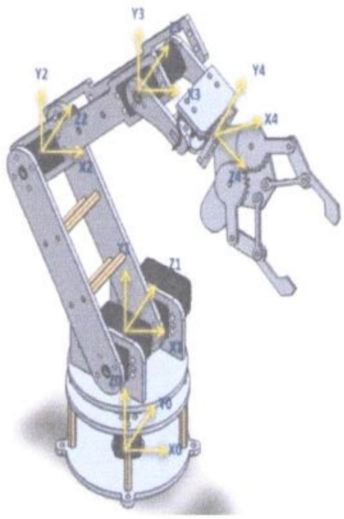

Figure 1. Representation of the coordinates of each freedom degree of arm robotic

C. Parameters of D-H

Denavit Hartenberg matrix [5] is a function of four parameters, two of which are constant parameters depending on the geometry of the robot (See figure 2) while the other two variables are parameters that depend on the relative movement thereof.

With these parameters the equations to determine the position of arm ends (x, y, z) and horizontal range (r) arise. With these equations the forward model, the simulation of the manipulator is to locate the joint from variable values.

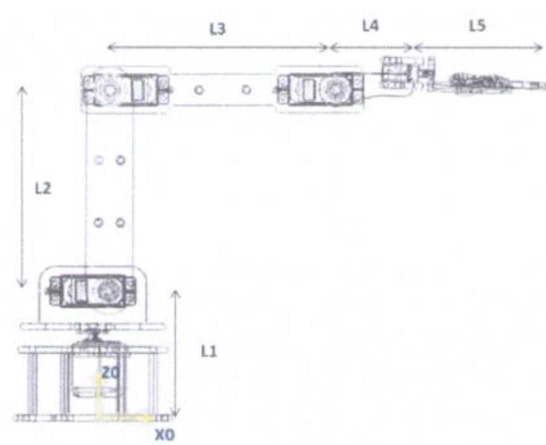

Figure 2. Dimensions of arm robotics

D. Inverse Kinematics

The inverse model, to find the values that should adopt the joint coordinates of the robot to its end position and orient according to a specific spatial location as it shows in the figure 3.The equations of this model are based on the length of the links and the coordinates of the point to be reached [6]. Applying geometric and trigonometric equations analysis for determining the angle to be rotated every joint, so it can reach a specific point given by the user (coordinates Px, Py, Pz) are obtained.

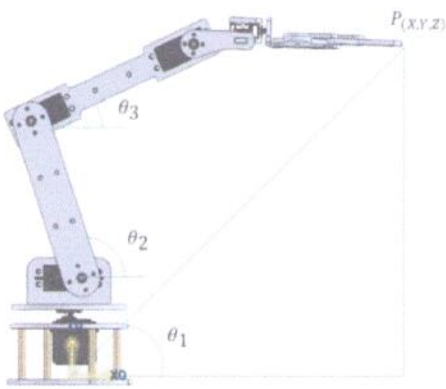

Figure 3. Location of the end position

V. STRUCTURE

Mechanically, a robot consists of a series of elements or links connected by joints that allow relative motion between two consecutive links. The physical constitution of the majority of industrial robots bears some similarity to the anatomy of the human arm. Possible movements to the joints are: a shift (prism type joint), a twist (rotation or articulation of revolution), or a combination of both. In our case, rotation joints are used, since the actuators have been selected for this type of joint.

When talking about the structure of a manipulator, it is important to comment on the number of modules that are part of the same. The number of modules directly affects the reach of the robot (manipulator operation zone) form, as well as to the different positions which can reach space.

VI. POSITIONING CONTROL OF ROBOT

Navigation is described as: "The ability of a robot to get from one point even point Y X through N intermediate points which are obtained from a planning process". For this project the planning process is about the control of the position of each actuator and as result the end position is the correct and planned. The implementation of this logic is showed in the figure 4.

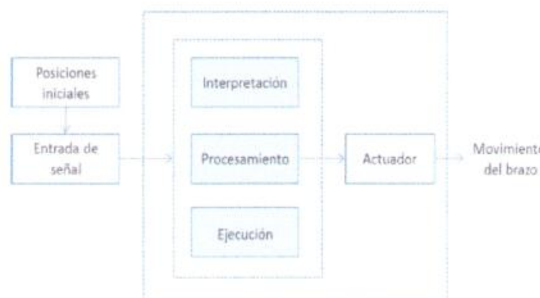

Figure 4. Block Diagram of project's working

Given the diagram, the system has to interpret the input data to be processed and then execute sending signals to servomotors who take charge of moving the robotic arm.

VII. ELECTRONIC DESIGN & COMMUNICATIONS

The electronic format is important for the project, because without movement actuators fulfill the functions for which it was designed.

For this project a number of actuators are used, which are described below:

Servo Motor, These are DC servo motors incorporate an electronic circuit that allows simple control of the direction and speed of their axes by electric impulses (PWM) in the project is used to control the movement of the robotic arm.

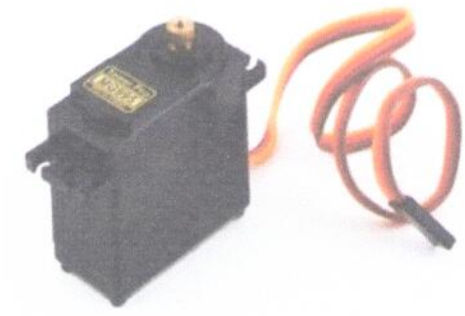

Figure 5. Actuator – Servomotor MG-995

The Arduino Mega is a microcontroller board that has single processor architecture, just a microcontroller on the board that communicates with your computer directly by USB.

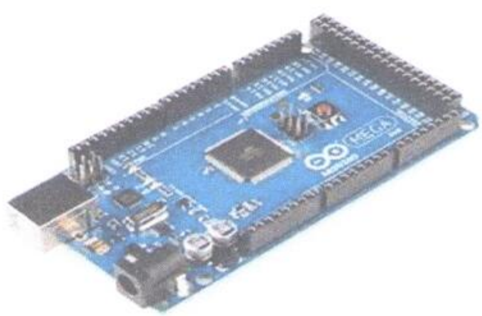

Figure 6. Microntroller ARDUINO MEGA 2560

VIII. RESULTS

Then of doing the design and the simulation of the arm robotic, it continues with the implementation in order to do test the movements of system. The results show a good performance, as for example, the end effector reached the target position with an error of +/- 10 %. Another positive result was that the robot (see figure 7) done almost the same trajectory that the planned.

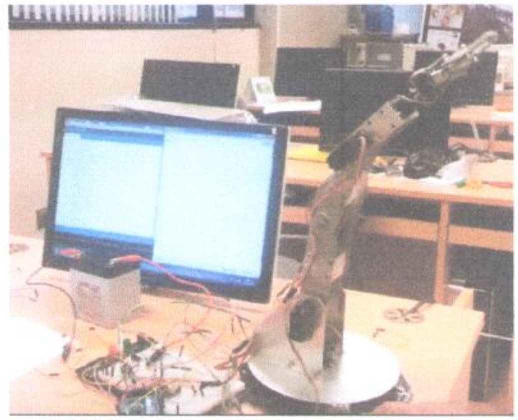

Figure 7. The implementation of the arm robotic

IX. CONCLUSIONS

As conclusions of this project is the increasing of knowledge in robotics and its application in the industry. Also, It is notice that it is necessary to improve the electronic design using a full board, besides it observed that the servomotor in the base has a limited force and for that there was certain vibration in some cases of movements.

For future works, it will improve the mechanical design; it will use servomotors with more quality, and also a better algorithm control. Finally, it will add two freedom degrees more using two more servomotors that it will simulate to be two tables gyratory and replicate a welding process like robots KUKA.

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