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FIXED STATION ROBOT: DESIGN AND REALIZATION OF A ROBOT FOR TEACHING PURPOSES

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Abstract: *In this paper we used a robotic arm kit that we assembled and programmed for didactic purposes. Laboratory works can be carried out in order to put into practice the theoretical knowledge presented in this paper and also we discussed the kinematics of the robotic arm, such as the setting of the coordinate systems for each couple and the direct kinematics calculation. It followed the design of kit elements in Catia, kit description and physical assembly of the robotic arm.*
Keywords: *robot, arm, manipulator, ARDUINO*

1. INTRODUCTION

The science that deals with the study of technology, the design and manufacture of robots and manipulators is called Robotics. For this, knowledge such as: programming, design, mechanics and electronics must be acquired.[1]
The first robotic arm was installed in the General Motors factory in 1962 and was named "Unimate", created by George Devol as you can see in figure 1. He had the task of lifting and placing hot metal parts.

Figure 1: First industrial robotic arm

Depending on the use of robots, they are divided into 2 categories:

- Fixed robots are found in the field of industry, being able to replace the human operators in heavy or medium toxic operations.[2]
- Mobile robots are used for multiple operations that require increased attention and cover a wide range of repetitive activities.

Objectives
In this paper we used the theoretical knowledge acquired in order to perform practical simulations. We achieved the objective of designing manipulators in a commercial software suite multiplatform CAD / CAM / CAE and also programming the data transfer board.
Also, we achieved the objective of the actual assembly of a manipulator.
The objectives of this paper were to use theoretical knowledge in their transposition in a practical way, for performing simulations of the behavior of a robotic arm, as well as ways to design them.

2. ROBOT DESIGN AND ASSEMBLY

For the design of a manipulator, its dynamics and kinematics will be calculated.
In order to calculate the moments and forces, reference systems specific to each component are used with specific indicators, eg: center of mass, center of gravity and its orientation.
CATIA (Computer Aided Three Dimensional Interactive Application) is a software unit with 3D design, manufacturing (CAM) and CAE analysis modules developed by Dassault Systémes.[3]
For the design of the robot we used from Catia the Sketcher module for creating the sketch in two dimensions, the Part Design to transpose the sketch from 2D to 3D. The assembly design was used to assemble with the help of the constraints for their positioning and contact, in order to obtain a final product and in Drafting module the execution drawings are obtained.
In figure 2 the final assembling from Catia can be seen.

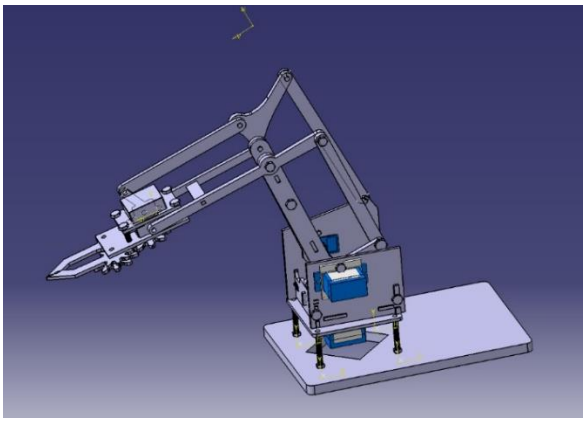

Figure 2: CAD model of robotic arm

On the market there exist different type of robotic kits that can be purchased. In figure 3 are the robotic kit components used for this paper. Following the acrylic components that were used:

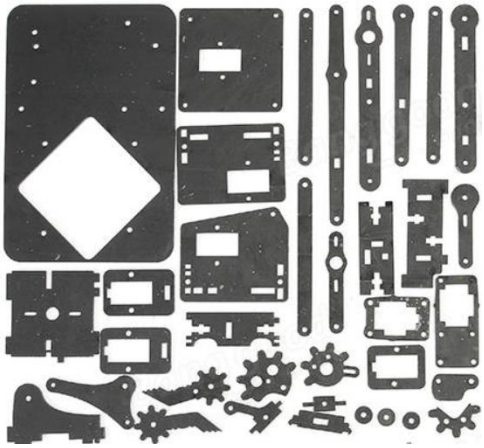

Figure 3: Acrylic components of the kit

After assembling the kit and calibrating the servo motors used for the arms to move, in figure 4 can be seen the final product.

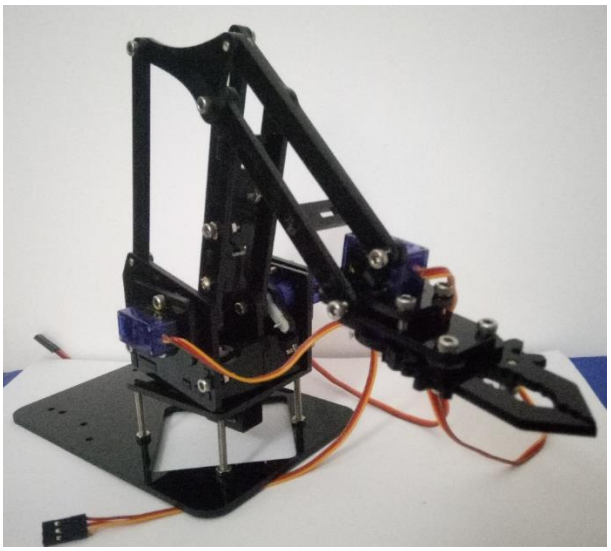

Figure 4: Final mounting of the kit

3. ROBOTIC ARM PROGRAMMING IN ARDUINO IDE

In order to program this manipulator, an Arduino Uno board was used, which has an ATmega328P microcontroller. This board has both digital and analog inputs and outputs to make different connections as needed. It is programmed with Arduino IDE (Integrated Development Environment) and its connection to a PC is done with a USB cable.
The ATmega328P microcontroller is produced pre-programmed with a program that allows the loading of a new code, using the STK500 protocol, in order to use the Arduino board.[4]
The library used to program this robotic arm is Sweep, which allows the rotation of each controlled servo motor, a certain angle through certain functions.

Figure 5: Arduino UNO R3 Board

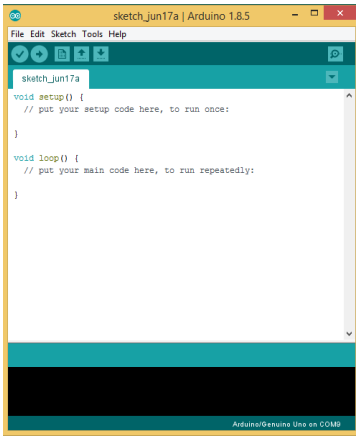

Figure 6: Arduino IDE

4. TESTS OF THE ROBOTIC ARM FOR SERVO MOTORS FUNCTIONALITY

To program the servo motor correctly, attach its bracket, then rotate maximum left and maximum right to delimit the rotation limits. Once delimited, the support will be fixed in the direction of the servo motor axis.
In figure 7 using TinkerCad, before testing the servo motors and testing them practically, I simulated the electrical circuits in order to be sure of the right voltage and conexions.

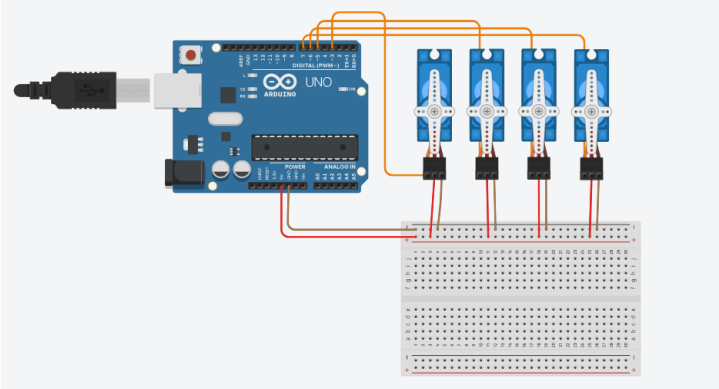

Figure 7: Arduino UNO Circuit with breadboard and 4 servo motors[5]

It has a 3D Design module, with an object library, the circuit module, which was used in this paper and a lesson module, which allows the user to see examples and models.[6]
To test the functionality of the servo motors, an Arduino Uno, a USB cable, an SG90S servo motor and 3 jumper wires were used.
In figure 8 the circuit needed for testing one of the servo motor can be seen. After testing the minimum and maximum distance of displacement of the robotic arm that is dependent of the servo motor, we proceeded in entering the parameters in Arduino program.

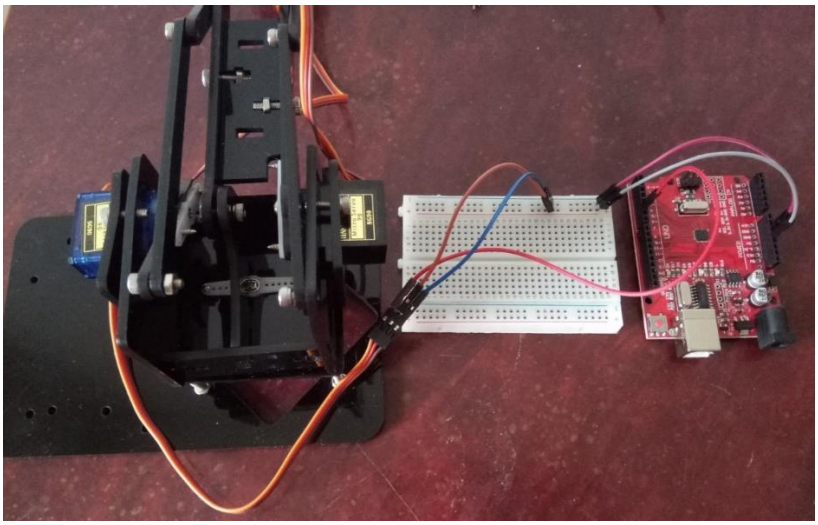

Figure 8: Testing the left servo motor

5. CONCLUSIONS

In this papers all the objectives were achieved. For performing practical simulations we used the theoretical knowledge and for robot design a CAD multiplatform was used.
We managed to program the data transfer board in order to move the robotic arms for the desired angles.
My own contribution in this paper was designing of assembly parts in catia and also making the drawings of the elements and the execution drawings.
I managed to succeed in physical assembly of the robotic arm along with the calibration and installation of servo motors and also to create the code execution and servo motor programming in order to use the robotic arm.

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