Model and Control of a Robotic Arm

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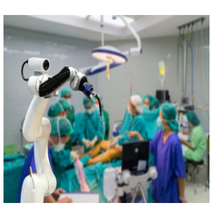
Abstract*– Nowadays, all views of life require the automation and repetition of jobs. The robot arm is used to achieve this and is used in many applications (spot welding, spray painting, assembly, ...etc.). In this paper, we show how to design a CAD model for a robot arm, Simulink model, control the model by Simulink, manufacture the arm, and control it using Arduino. It includes how to perform the forward kinematics to get the end-effector positing from the given angles, the DH parameter and invers kinematics to get the angle that each joint needs to reach to a certain position, using them to obtain the final effector position, and how to move to the desired position of the part. This operation can be done using mat lab. This robot arm can be used to do parts classification[2]. This can increase accuracy, security and save more money.

***Keywords*-- Robotic Arm, model, forward kinematics, invers kinematics, control.**

I. Introduction (Heading 1)

Robotic weapons are now being used to help companies reach new levels of productivity by enhancing speed, efficiency and accuracy across a variety of applications[3]. When we add machine vision and networking technologies, we allow robotic arms to see, analyze, and understand their environments. This intelligence helps the robotic arm to perform tasks flexibly, accurately and quickly while increasing quality and factory/warehouse safety. Android has many applications.



Hospitals

Assembly

Spot welding

Inspection

Arc welding

Cooking

We needed to make a model of the robot's arm and control it. At first, we have to make a design for a CAD model of the robot arm that has the same miniaturization of the real robot arm that we need to manufacture. And then we have to take the CAD model and make Simulink model and design control for that model using matlab [5]. The next step is to manufacture a real robot arm. The mathematical model is the most important thing that controls the robot arm, and it includes two main sections, the first is the forward kinematics, and is used to detect the position of the end effector of the arm, and the second, the inverted movement. , to get how to get to the desired position. We should try this final model for accuracy.

In our case, we use 6DOF robot arm, which has 6 revolutionary joints as shown in Figure 1

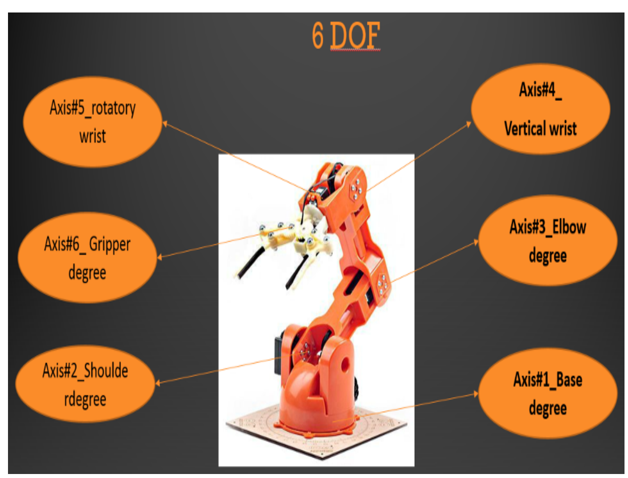


Fig. 1 6DOF Braccio Robotic Arm

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The control of the robot arm is based on the mathematical model of the robot arm. There is a step-by-step robot arm control scheme. In this scheme the next step cannot be skipped, and all these steps are very important without any step the robot arm cannot reach the desired position and achieve its goal. This diagram of the robot arm is designed to reach a specific desired point and by applying some extra steps this robot arm can do some functions like Bick and place and other functions

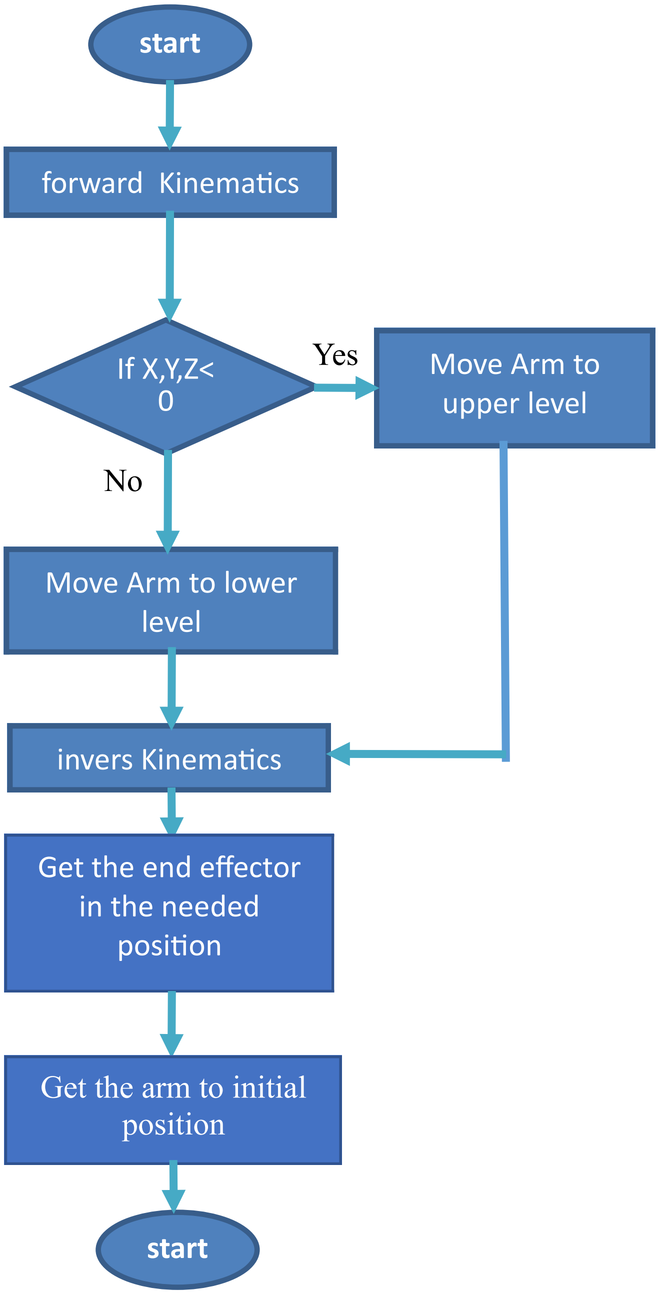

Fig. 2 Control chart

II. CAD MODEL

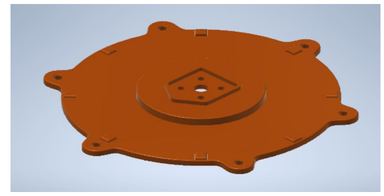

Fig. 3 Base of the robot arm

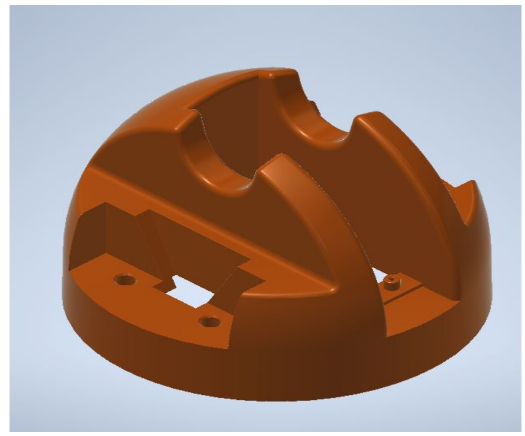

Fig. 4 Link 1 of the robot arm

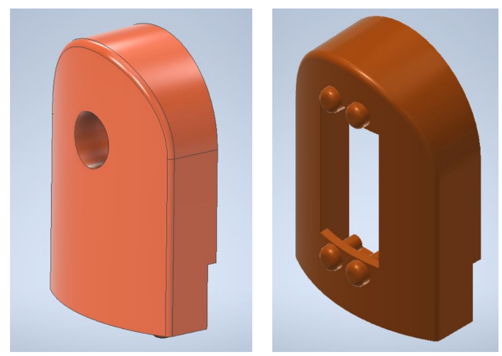

Fig. 5 Joint 2 holder

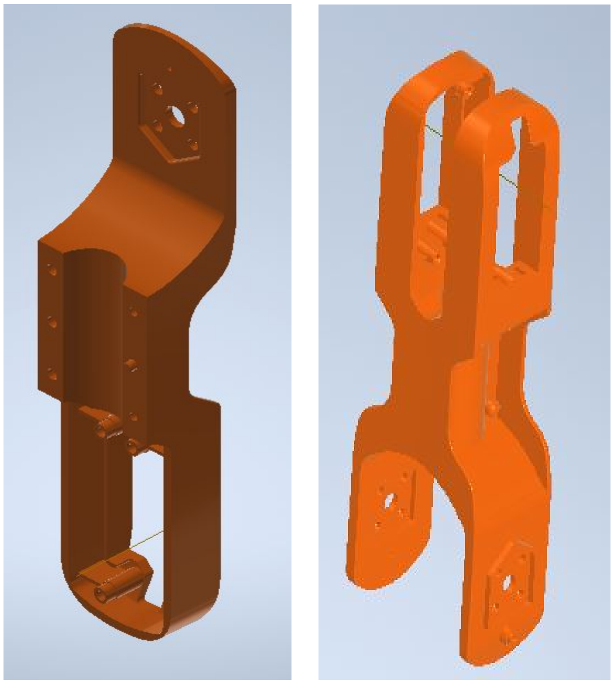

Fig. 6 Link 2&3 of the robot arm

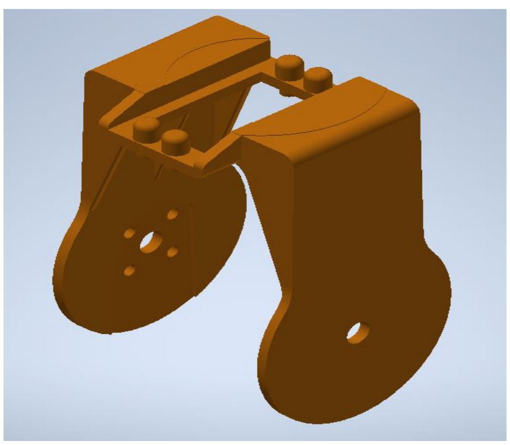

Fig. 7 Link 4 of the robot arm

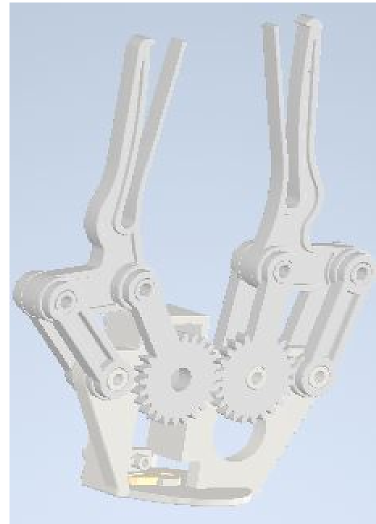

Fig. 8 the end effector or gripper of the robot arm

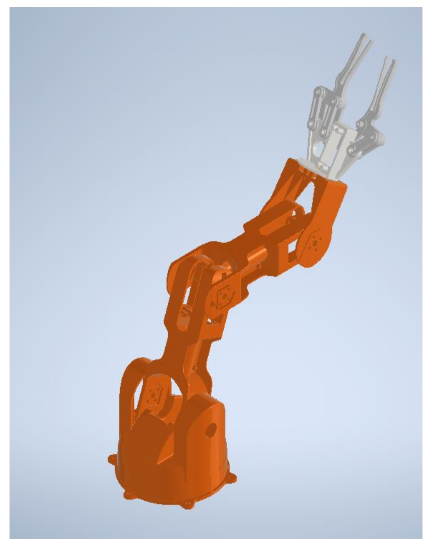

Fig. 9 the robot arm (CAD Model)

III. SIMULINK MODEL

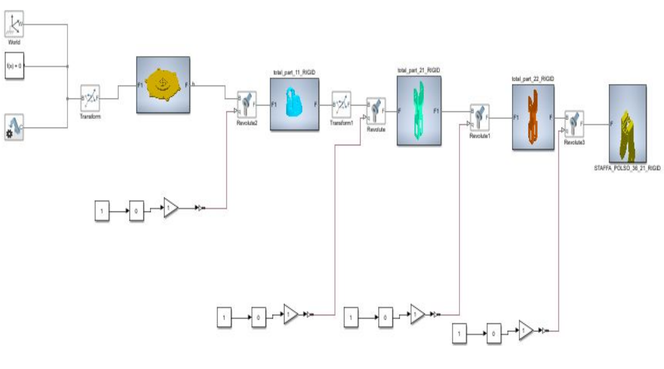

Fig. 10 the Simulink model of robotic arm

In this model we can control and control the covariate of each joint to simulate the movement of the robot arm in these cases [7] .

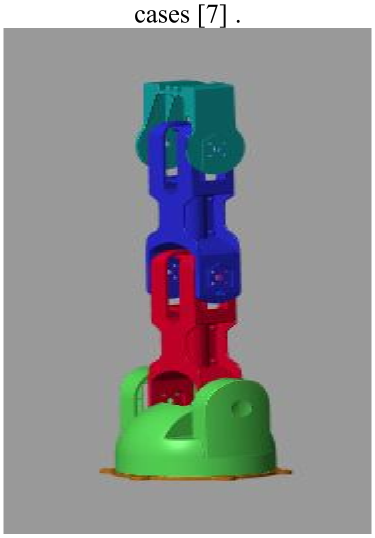

Fig. 11 Simulation of the Simulink model of robotic arm

IV. FABRICATION

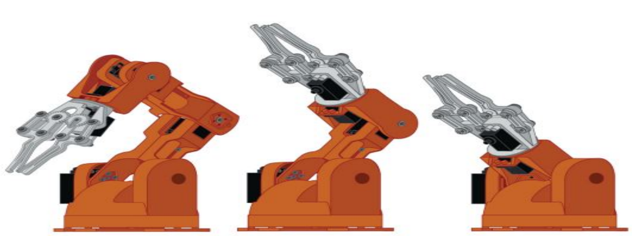

Fig. 12 different shape of this robot arm

The manufacturing step is one of the most important steps in our project in this step we will assemble the robot arm and we can make many different robotic arms from braccio robot arm depending on the required use of this robot arm.

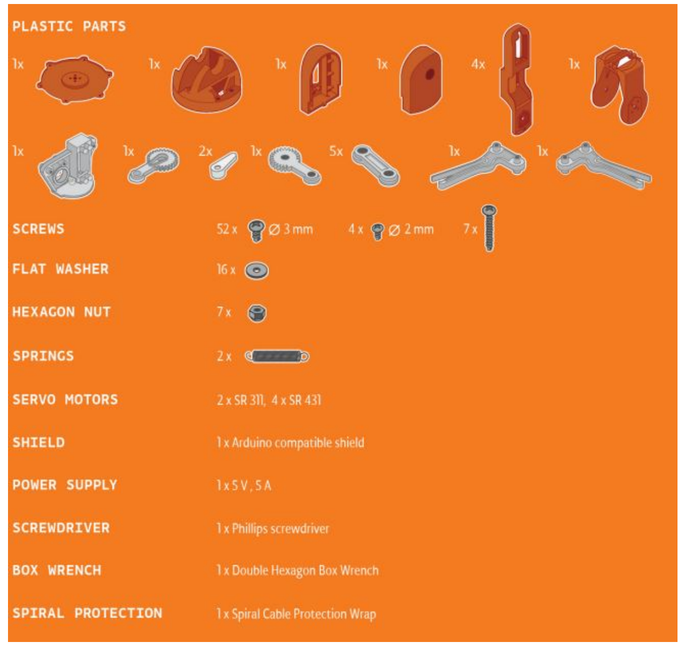

Fig. 13 part list of robot arm component

Fig. 14 real parts

In our case, we needed to use 6 DOF robot arm to help us achieve the required tasks for this robot arm [8] .

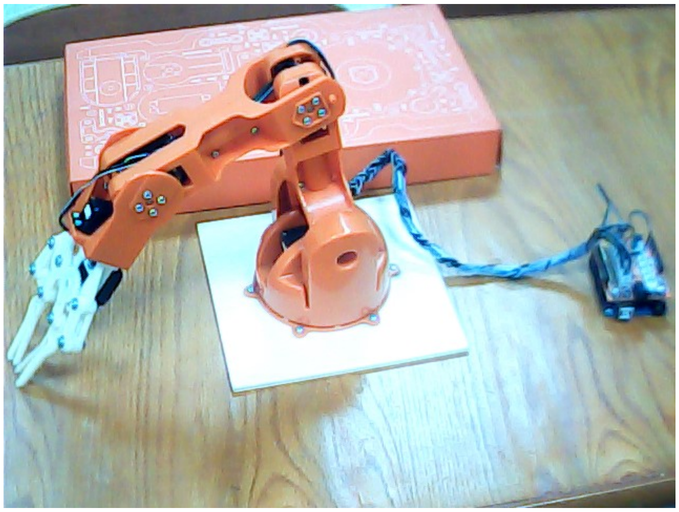

Fig. 15 the final robot arm

1- Forward kinematics

For doing the forward kinematics we should to apply the frames to the joints[6] .

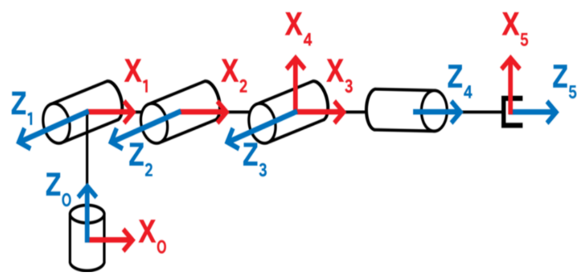

Fig. 17 model for robot arm with frames

V. CONTROLLING WITH ARDUINO

This robotic arm can be controlled using the Arduino Uno with the shield included with the kit [1]

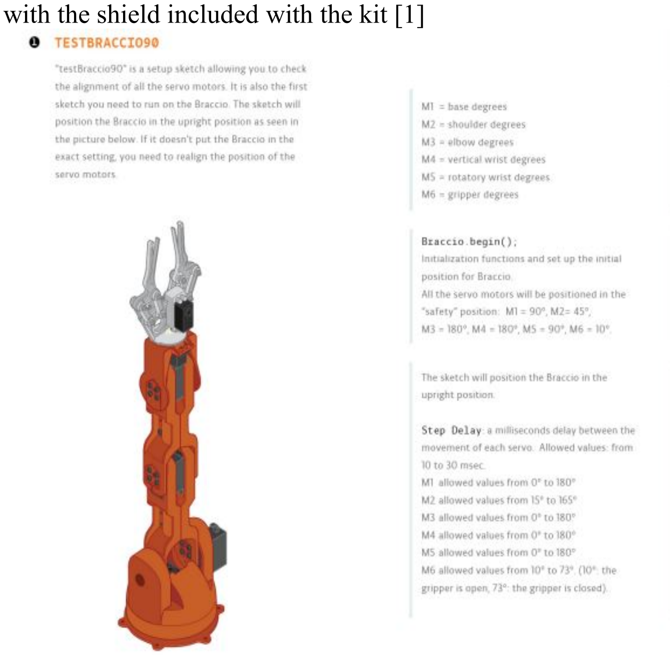

Fig. 16 control the robot arm with Arduino

Then we should to obtain DH parameter.

	Θ_i	d_i	a_i	α_i
1	Θ_1	L_1	0	90
2	Θ_2	0	L_2	0
3	Θ_3	0	L_3	0
4	Θ_4+90	0	0	90
5	Θ_5	L_4+L_5	0	0

Table. 1 DH parameters

Then we applied in this matrix

$$\begin{bmatrix} \cos(\Theta_i) & -\sin(\Theta_i).\cos(\alpha_i) & \sin(\Theta_i).\sin(\alpha_i) & a_i.\cos(\Theta_i) \\ \sin(\Theta_i) & \cos(\Theta_i).\cos(\alpha_i) & -\cos(\Theta_i).\sin(\alpha_i) & a_i.\sin(\Theta_i) \\ 0 & \sin(\alpha_i) & \cos(\alpha_i) & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

VI. MATHEMATICAL MODEL

The mathematical model is the important step in our project and this helps to know the geometry of the robot arm.

There are two main types of kinematics we are use

By applying in this matrix we get the transformation matrix for every joint. To get the transformation matrix from the base of the robot to the end effector we should substitute in this equation.

$$ {}^{0}T_5 = {}^{0}T_1 \cdot {}^{1}T_2 \cdot {}^{2}T_3 \cdot {}^{3}T_4 \cdot {}^{4}T_5 \quad \ldots (1) $$

Finally we can get how to reach to needed point of end effector to do the job of the robot arm.

VII. CONCLUSION

We can benefit from this study because we now have robot arm. It can be used in different directions and different uses depending on the job required of it in the end. He can perform the job required of him with high accuracy

IV. FUTURE WORK

In the next stage, we can add a camera, and then it can recognize the objects and can carry them and move them from one place to another according to the type of the object, shape or color. Increases the accuracy, performance and speed of work and saves manpower [7]

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