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Design and Fabrication of Pick and Place Robot for Static Application

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***Abstract*— In this modern world robot plays a vital role in industrial automation. The aim of our project is to design and fabricate a pick and place robot. The function of the robot is to pick and place the objects. The design of mechanical structure of robotic arm has been developed by using CATIA V5 software. In our prototype model acrylic sheet material has been used. Arduino UNO controller is used for controlling servomotors. Servo motors are used to control robots base, arm, elbow, and gripper. The major components used in our project are of less cost and readily available. The advantage of our robot is to handle the things efficiently and it is also easily adoptable in small scale industries.**

Keywords*— Robotic arm; Arduino UNO; Servo motor;

I. INTRODUCTION

A pick and place robot is a microcontroller based mechatronic system that detects the object, which is used to pick an object and place in the desired location. It provides one rotational axis and two other linear movements. It is open or closed kinematic chain which consists of rigid links to interconnect the movable joints.

It might be a difficult task for the worker to perform pick and place function that may affect them. For example, things like chemistry that cannot be picked by human and for the military such as defuse bomb that needed robot to pick and place the bomb to somewhere and for user that needed robot to do pick and place item while sitting and much more.

II. WORKING

The Pick and place robot is controlled using the Arduino Uno microcontroller, which receives signal from the Arduino IDE software to generates PWM (pulse width modulation) signals to control the degree of movement of the robot. An adapter of 5 volt is used to provide power to actuate the servo motor. Bread board is an interfacing part in which the connections required for connecting the Arduino controller to actuate Servo motors is provided. After connecting all the components, supply for Arduino and Servo motor via adapter is given.

Then with the help of Arduino IDE software the program is decoded to actuate the robot arm. Which in turn provides rotation to the servo motor and controls the robot to pick an object from one place and place it in the given position according to the degree coded in the program.

III. PROBLEM DEFINITION

Handling delicate things without any damage and to ensure the pick and place process at hazardous environment has been a serious problem faced by the industries for the last decade. Several methods to pick and place object have been developed by various firms in order to combat the process of material handling in peril environment. However they are not of low cost and cannot be implemented in small scale industries. The high cost of the pick and place robot have made impossible to be implemented in such industries and so, the handling of things may cause a serious damage for both humans and atmosphere.

IV. METHODOLOGY

In this project, the robot consists of both hardware and software functions, which are combined to make the system reliable. The Arduino Uno will be the interfacing system for the robot and control the movement of the robotic arm. The project overview in block diagram form is shown in (Fig 1).

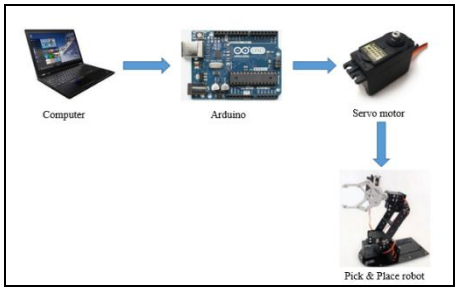

Fig. 1. Block diagram of the system.

V. Mechanical Design

The robotic arm is constructed using acrylic sheet, because it is lightweight but stiff to mimic the bone structure of a human arm. Our pick and place robot is entirely made up of acrylic sheet. It is used because, it is easy to be formed, cheap, strong and can bear the motor weight and movement. The robots arm length is 220 mm and the height is 450 mm. The robots mechanism is directly powered by servo motors. The robots base is made up wood because it holds the structure firmly.

VI. Electrical Design

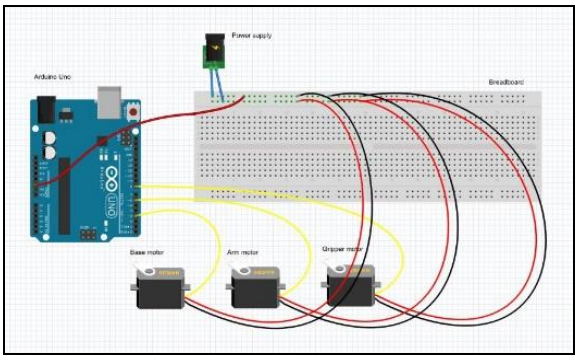

Fig. 2. Circiut Diagram.

The above circuit is designed using fritzing software (Fig 2). This circuit consists of various components, which are arranged in such a way that the process of picking an object from start point and placing the object in a destination point is performed. The components of the circuit is connected using jumper. These jumpers are capable of transferring power, PWM signals and also for making ground connection in a system. The various components used in this circuit are stated below.

- Arduino Uno microcontroller
- Metal gear servo motor for arm, frame
- Mini servo motor for gripper end
- Power supply (Adapter)
- Jumper

VII. Software Design

The CATIA software offers different approaches to model generation like parts design, assembly design, surface design etc., allowing the user to employ the combination of methods to create a model. The modeling application also provides "features based" solid bodies by directing editing capabilities, which allow changing and updating solid bodies by directing editing the dimension of a solid feature or by other geometric construction techniques.

A. Design process

The various steps to create the model by using the CATIA software package are,

- Getting a 2-D sketch of the model.
- Operation carried out in CATIA software

The final model of the pick and place Robot (fig-1) is designed in order to make the prototype of the robot for static application.

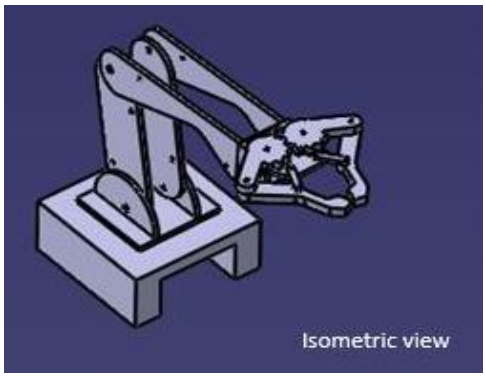

Fig. 3. Designed View.

VIII. Design Calculation

A. Calculation of Torque of Servomotor

Torque (**T**) is defined as a turning or twisting "force" and is calculated using the following relation:

$$\mathbf{T = F * L}$$

Where,

F = force acts at a length from a pivot

L = Length of the pivot

$$F = m * g$$

The force above is also considered the object's weight (**W**). The torque required to hold a mass at a given distance from a pivot is therefore:

$$T = (m * g) * L$$

By using the above equations the torque provided by the servo motors is stated in the TABLE I:

TABLE I TORQUE CALCULATION

L	[cm]	M	[kg]	A	[kg]	T	[kg-cm]
L1	15	M1	0.3	A1	0.09	T1	3.599
L2	22	M2	0.4	A2	0.55	T2	28.68
L3	15	M3	0.35	A3	0.55	T3	59.28

Where,

L1, L2, L3 – Length of links
M1, M2, M3 – Mass of the links
A1, A2, A3 – Actuators used for the links Servo motor)
T1, T2, T3 –Torque for the links

Here degrees of freedom of a mechanism is also called the mobility of the device. The mobility is the number of input parameters (usually pair variables) that must be independently controlled to bring the device into a particular position.

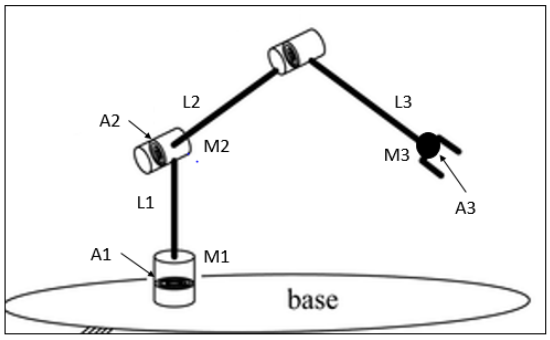

Fig. 4. Link Diagram of 3DOF robot.

B. Calculation of Degree of Freedom

The number of degrees of freedom of a mechanism is also called the mobility of the device. The Kutzbach criterion, which is similar to Gruebler's equation, calculates the mobility. Kutzbach's equation for planar mechanisms

$$M = 3 (L – 1) – 2J – H$$

Where,

M=degree of freedom or mobility
L=number of links
J=number of binary joints / lower pair
H=number of higher pairs

In this pick and place robot the calculation of Degree of freedom is performed as follows.

$$M = 3 (4-1) -2*3 – 0$$
$$M = 3$$

Hence the Pick and place Robotic system consists of 3 Degrees of freedom.

C. Calculation of Gripping Force Analysis

Gripping force is the maximum effort applicable by the end-effector. As robot grippers are not all alike, different terms exist. Grip force is normally used for claw-grippers, representing the force that the "fingers'' can apply on a part.

$$\mu\, n_f\, F_g = W$$

Where,

μ = Coefficient of friction
μ = 0.9 (Between asphalt)
n_f = Number of fingers (2)
F_g = Gripping force
W = Weight of the object (0.3 Kg approx.)

$$F_g = 6\ Kg$$

CONCLUSION

In today's world scenario, it is very difficult for an employee in small scale industries, to transfer objects from one place to another. With this in mind we put forth our idea of implementing a Robotic arm which would decrease the time consuming process. In this with the help of Arduino Uno controller and servo motor's required operation is performed. So that it is more efficient and much faster and smartest than other methods of robotic arm

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