Design of Automated Robotic Arm Mechanism using Arduino

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ABSTRACT

As we are living in 21st century, where industries are using "Industry 4.0" revolution, automation is one of the important part of industry. The pick and place robotic arm is one of the technology in manufacturing industries or any other industry which is designed to perform pick and place operations as per requirement. In our project, we have mainly focus to make a robotic arm whose primary function is to do pick and place operation. We have designed a system which eliminates the human error and human intervention to get more precise and efficient work. The project deals with implementing of an pick and place robotic arm using Arduino and NodeMCU microcontroller. The main focus of our project was to design and develop the mechanism for robotic arm for lifting. We have designed a robotic arm which is having four degree of freedom and we programmed to complete accurately simple light material lifting task which may be assist in the production line or assembly line in any industry. Our robotic arm is equipped with 4 servo motors to link the parts and bring arm movement. It is controlled by an NodeMCU microcontroller which accepts input signals from a mobile application named Blynk.

Keyword: *Robotic Arm, Arduino, Pick and Place, NodeMCU, Blynk application.*

1. INTRODUCTION

In the industry, automation is one of the most important part. It avails to reduce the need for humans by creating additional help systems that can increase efficiency and productivity of the work. One of the most widely used components of automation systems is robots, and the most common type in the market is the robotic arm which is commonly used in industrial purposes.

A robotic arm is a mechanical arm, usually programmable, with similar functions that a human arm do. It is connected by joints allowing either rotational motion or linear displacement. Akin to the purpose of a human arm, robotic arms are designed to fulfill tasks determined in a controlled environment in accordance with predetermined commands (by giving programming).

Robotic arm has wide application in industries, it can be used for many functions in industry as they can be used for welding, product inspection, material handling, packaging, etc. Also in computer related industries, robotic arm plays an important role as placing small parts as it becomes very difficult when we use manual method.

In the project, firstly we determine what should be the main funcation of our robotic arm and also we decided what materials will be suitable for this purpose, according we have design our robotic arm. It is controlled by an NodeMCU microcontroller which accepts input signals or instructions given by us through Blynk app. The servomotors and links thus produced assembled with fasteners produced the final shape of the arm. Arduino IDE

software is used to programmed this microcontroller using C++ language. We have design, developed and implement of robot arm which has the ability to perform simple tasks, such as light material handling.

1.1 Problem Definition

The Automated Robotic Arm works as pick and place robotic arm which is being implemented to ease the process of assembly complicated components, process of moving heavy materials etc. Usually the transfer process of the materials is being carried out, using man power and if the transfer process is repeated for a period of time, it can cause injuries to the operator. By using the particular robotic arm, the operator will no longer have to bent and lift up heavy loads thus preventing injuries and increasing the efficiency of the work. Operator will make mistakes whether small or big in a while. In the industries, as we know that the industry cannot afford to take any kind of mistakes, as every mistake in industry will be very costly whether in terms of money, time and material.

1.2 Objective Of Project

a) To develop a versatile and low cost robotic arm which can be utilized for Pick and Place operation.
b) To design, Modeling, Programming and Simulation of Pick and Place Mechanism.
c) To implement a robotic arm with four degree of freedom and which is not too bulky and also compatible to use.
d) To control the displacement and movement of robotic arm using NodeMCU through Wifi.
e) To control robotic arm from any corner of world using Blynk application.

2. DETAILS OF COMPONENTS USED, WORKING AND MECHANICAL PROCESSES

2.1 Details of components used

2.1.1 NodeMCU ESP8266

Figure-1 NodeMCU ESP8266

NodeMCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes code that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that relies on the ESP-12 module. In our project, we tend to used Arduino IDE computer code to program this NodeMCU board. The NodeMCU ESP8266 development board comes with the ESP-12E module. It contains ESP8266 chip having Tensilica Xtensa 32-bit LX106 reduced instruction set computing microchip. NodeMCU has 4MB of non-volatile storage and 128K RAM, whereas 4MB non-volatile storage is employed to store information and programs. Its high process power with in-built Wi-Fi and Deep Sleep operational options build it ideal for IoT comes. It contains different pins as an input. We have connected wires according to our circuit to NodeMCU

2.2.2 MG995 Servo Motor (metalic gear) with its Accessories

Figure-2 MG995 servo motor (metalic gear) with its accessories

This whole unit comes complete with 30cm wire and three pin 'S' kind feminine header instrumentality that matches most receivers. This high-speed servo that we've utilized in our project will rotate more or less one hundred twenty degrees (60 in every direction). We can use any library to manage these servos. A servomotor may be a rotory or linear actuator that enables for precise management of angular or linear position, speed and acceleration. It consists of an acceptable motor coupled to a device that is employed for position feedback.

Mechanism

A servomotor may be a closed-loop control system that uses position feedback to manage its motion and final position. This motor is paired with some variety of position encoder to supply position and speed feedback. as an example, we've to measured solely position, the measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that needed, a slip-up signal is generated which ends up that the motor is rotate in any direction, as required to bring the output shaft to the acceptable position.

2.2.3 Mechanical Gripper

Figure-3 Mechanical Gripper

A mechanical gripper is employed as an finish effector in our robotic arm for holding or lifting the objects with its automatically operated fingers. In industries, 2 fingers square measure enough for holding functions, thus we've chosen a gripper that has 2 fingers. Over 3 fingers may be used supported the opposite application. These fingers square measure simple to get rid of and assemble to its main body. Its needs either electrical, hydraulic, or gas drive system to make the input power. Here we tend to used electric to work this gripper. The ability created is shipped to the gripper for creating the fingers react. It conjointly permits the fingers to perform open and shut actions (it is controlled by mobile application). in a very mechanical gripper, the holding of an object is done by 2 totally different ways like:

- Using soft material finger pads.
- Using the finger pads as just like the form of the work half.

2.1.4 7805 Regulator IC

Figure-4 7805 Regulator IC

An IC transformer is an computer circuit that haves a basic purpose to manage the unregulated input voltage and supply with a relentless, regulated output voltage as we tend to needed. 7805 may be a 3 terminal linear transformer IC with a hard and fast output voltage of 5V that is employed to convert 12V into 5V that is then passed to robotic arm. We used it as a result of it acts as a super part against input voltage fluctuations for circuits, and adds an extra safety to our electronic equipment. It will take most 35Vas AN input. A transformer IC maintains the output voltage at a relentless price. 7805 transformer that we've used is a member of 78 series of mounted linear voltage regulators accustomed maintain such fluctuations, may be a well-liked transformer computer circuit (IC).

2.1.5 12v Adapter and Power Jack

Figure-5 12v Adapter and Power Jack

Power connectors devices that enables an electrical current to tolerate it for the exclusive purpose of providing power to our device. In our case, it's accustomed power our robotic arm. Here, we tend to use 12V Power provide Adapter. The 12V Power Adapter is additionally referred to as a "Brick", "Desk Wart" and "Floor" provide, offer a regulated twelve Volts DC output. the most purpose that we tend to use this adapter that it permits offer and supply a gradual supply of electricity. External power provides square measure used each with instrumentality with no different supply of power and with powered instrumentality, wherever the availability, once obstructed in, will generally charge the battery additionally to powering the instrumentality. It conjointly provides a bonus that use of an external power provide permits movableness of apparatus steam-powered either by mains or battery while not the further bulk of internal power elements. Another advantage of those device is that it is accumulated safety; since the venturesome 120V or 240V mains power is reworked to a lower, safer voltage at the wall outlet and also the appliance that's handled by the user is steam-powered by this lower voltage.

2.2 Working

The working of the project is so simple, we are just controlling the Robotic Arm's four servo motor from an application named Blynk using the internet. This requires continuous internet connectivity. The NodeMCU has an inbuilt ESP8266 Wi-Fi Module so that we can connect the NodeMCU to the internet. Next using the Blynk application in the mobile we have created an application to send values via internet to control the PWM values for the four-servo motor that are connected with the NodeMCU.

In the Blynk application 3 sliders are usedand we have given 2 tasks to the robotic arm to perform. The Servo motor is controlled according to the slider movement.

Setting Up Blynk & NodeMCU (ESP8266) Library for Arduino IDE

The coding for this Robotic Arm project is simple. First, we need the Blynk library for Arduino IDE. Following are the steps to follow for doing coding-

1. Download the Blynk library from the playstore.

2. After that install the Blynk Library for Arduino.

So, after setting up the Blynk library for Arduino IDE. Second, we need the NodeMCU library for Arduino IDE.

Here are the Programming Codes used for working our robotic arm:

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#include <Servo.h>

Servo servo1, servo2, servo3, servo4;

int pos1,  pos2, pos3, pos4, x;

char auth[] = "pw5xAYgPaogulMyXEWNBXSfyDgtEowr7";

char ssid[] = "servoarm";   // your ssid

char pass[] = "11111111"; // your pass



void setup()

{

  Serial.begin(9600);

  Blynk.begin(auth, ssid, pass);

  servo1.attach(D0);
```

```
  servo2.attach(D1);
  servo3.attach(D3);
  servo4.attach(D2);
  servo1.write(175);
  servo2.write(180);
  servo3.write(90);
  servo4.write(90);
}

void loop()
{
  Blynk.run();
}




BLYNK_WRITE(V0)
{
  servo1.write(param.asInt());
}
BLYNK_WRITE(V1)
{
  servo2.write(param.asInt());
}
BLYNK_WRITE(V2)
```

```
{
  servo4.write(param.asInt());
}
BLYNK_WRITE(V3)
{
  servo3.write(param.asInt());
}



BLYNK_WRITE(V4)
{
  servo2.write(140);
  delay(1000);
  servo1.write(95);
  delay(1000);
  servo3.write(35);
  delay(1000);
  servo4.write(175);
  delay(1000);
  servo3.write(0);
  delay(1000);
  servo2.write(165);
  delay(1000);
  servo1.write(160);
  delay(1000);
```

```
 servo2.write(120);
 delay(1000);
 servo4.write(0);
 delay(1000);
 servo2.write(165);
 delay(1000);
 servo1.write(95);
 delay(1000);

 delay(2000);
}
```

```
BLYNK_WRITE(V5)
{

 servo1.write(175);
 delay(1000);
 servo3.write(30);
 delay(1000);
 servo2.write(145);
 delay(1000);
 servo4.write(120);
 delay(1000);
```

```
   for (pos4 = 120; pos4 >= 60; pos4 -= 1)
  {
   servo4.write(pos4);
   delay(50);
  }

  for (pos3 = 30; pos3 >= 0; pos3 -= 1)
  {
   servo3.write(pos3);
   delay(50);
  }

   for (pos4 = 60; pos4 <= 120; pos4 += 1)
  {
   servo4.write(pos4);
   delay(50);
  }

     for (pos3 = 0; pos3 <= 30; pos3 += 1)
  {
   servo3.write(pos3);
   delay(50);
  }
}
```

```
BLYNK_WRITE(V6)

{

 servo1.write(175);

 servo2.write(180);

 servo3.write(90);

 servo4.write(90);}
```

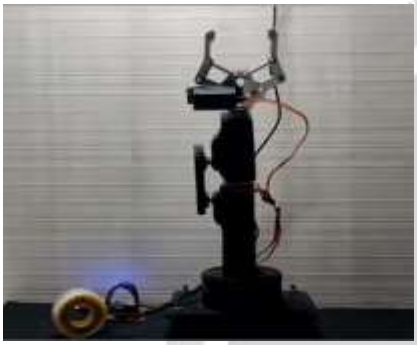

Figure-6 Actual Image of model

Figure-7 Actual Image of model

Figure-8 Actual Image of model

2.3 Mechanical Processes

2.3.1 Cutting

Cutting may be describe as a mechanical method wherever the piece of work or material is cut in different form. We use the cutting operation for cutting specific material like wood, cardboard etc. For obtaining good form for assembly, we've got cut the fabric into specific dimensions to fits the motor, circuit and alternative movable components. We have additionally used cardboard-cutting scissors to cut your cardboard. These scissors square measure arcuate and have a pointy blade to chop through cardboard with ease.

2.3.2 Soldering

Soldering may be called a connection method that is employed to hitch differing types of metal by melting solder. We tend to use fastening operation for connecting wires to the circuit for run the circuit in correct approach. It is a kind of permanent affiliation between elements particularly electronic. Here we've got used fastening operation to hitch totally different wires that square measure about to placed on our circuit that square measure about to hook up with NodeMCU microcontroller.

2.3.3 Drilling

Drilling may be define as a cutting method that uses a bit to drill a hole of circular cross-sectional in solid materials. The bit is ironed against the work-piece and turned at rates from lots of to thousands of revolutions per minute. Drilling could have an effect on the mechanical properties of the piece of work by making low residual stresses round the hole gap and a really skinny layer of extremely stressed and disturbed material on the freshly fashioned

surface. This causes the piece of work to become a lot of prone to corrosion and crack propagation at the stressed surface. A end operation is also done to avoid these harmful conditions. We used the drilling method to drill holes within the picket foundation and also the body of our arm, to repair screws within the desired location for attachment of varied components.

2.3.4 Screwing

Screw is a mechanism that converts rotory motion to linear motion, and a force (rotational force) to a linear force. it's one in every of the six classical straightforward machines. the foremost common type consists of a cylindrical shaft with turbinate grooves or ridges known as threads round the outside. The screw passes through a hole in another object or medium, with threads on the within of the outlet that mesh with the screw's threads. once the shaft of the screw is turned relative to the stationary threads. The screw moves on its axis relative to the medium close it; as an example rotating a wood screw forces it into wood. In screw mechanisms, either the screw shaft will rotate through a rib hole in an exceedingly stationary object, or a rib collar like a nut will rotate around a stationary screw shaft. Geometrically, a screw are often viewed as a slim machine wrapped around a cylinder. Uses of screws here square measure to carry objects along like wood and to position objects. Uses of screws here are to hold objects together such as wood and to position objects. We used the screwing process to attach the nut and the bolts together in the servomotors and other components. The body is also held in place by the help of screwing.

2.3.5 Gluing

The use of adhesives offers bound blessings over alternative binding techniques like stitching, mechanical fastenings, or welding. These embody the power to bind totally different materials along, the a lot of economical distribution of stress across a joint, the cost-effectiveness of Associate in Nursing simply mechanized method, and larger flexibility in style. Disadvantages of adhesive use embody attenuated stability at high temperatures, relative weakness in bonding giant objects with a little bonding expanse, and larger problem in separating objects throughout testing. Adhesives square measure generally organized by the tactic of adhesion followed by reactive or non-reactive, a term that refers as to whether the adhesive with chemicals reacts so as to harden. instead, they'll be organized either by their beginning physical part or whether or not their raw stock is of natural or artificial origin. A robotic arm are often helpful for electronic elements. The glue dispenser can apply protection to the element, thereby connection along metal and/or plastic components to form the assembly waterproof .The adhesive is applied to either one or each of the materials being warranted. The items square measure aligned and pressure is accessorial to help in adhesion and disembarrass the bond of air bubbles.

3. RESULTS AND DISCUSSION

A research on possible design and basic information about the robotic arm was initially made. Using 4 servo motors, the robotic arm could move in different directions and could hold or release things with its gripper. Working model of robotic arm using NodeMCU microcontroller has been developed by us. The program code was written in C++ language which is one of the most popular and fundamental programming language. By making all correct connections of microcontroller and considering the proper design, we are able to operate the robotic arm which can be used to lift maximum weight of 700 gram. Following are the observations that we got after the successful running the robotic arm,

Table-1 Observations

Sr. No.	Parameter	Observation	Units
01.	Vertical Reach	400	Mm
02.	Horizontal Reach	230	Mm
03.	Claw inner opening diameter	50	Mm
04.	Claw height	110	Mm
05.	Weight lifting capacity	700	Gram
06.	Power consumption	12	Watts

By the successful operating of robotic arm, we can conclude that the design and other factors that we consider during model making is correct and the arm operate and move in four axis without any problem. NodeMCU microcontroller was operated by wifi model which having advantages that it can be control by any place by connecting our mobile phone to it. All the results obtain was satisfactory**.** The maximum angle that the robotic arm can move per servo is shown below in table 2,

Table-2 The different maximum angle that each servo in the robotic arm can move

Sr. No.	Servo Arm	Maximum Angle (in degrees)
01.	Waist	170
02.	Shoulder	180
03.	Elbow	160
04.	Gripper	70

4. CONCLUSIONS

Designing of Robotic Arm using NodeMCU microcontroller has been successfully completed. We provided 4-DOF i.e it can move in right, left, up, and down direction with the help 4 servomotors. We use Arduino ide to program Arduino which uses C++ language and can be control by Wifi module. The experiments are conducted on the pick and place robot and the results obtained werevery satisfactory. We have collected all the necessary theoretical and practical information for this purpose has been obtained and the necessary infrastructure has been established for the project. During the process of making and developing our project, we make a lot of theoretical knowledge has to transferred to the practice and it has been ensured that it is suitable for the purpose of the project. As a robotic arm made by us is of prototype quality, it has a quality that can be improved for more robotic systems. Robotic arm will have more importance in near future.

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