International Journal on Recent Researches In Science, Engineering & Technology
(Division of Electronic & Communication Engineering)
A Journal Established in early 2000 as National journal and upgraded to International journal in 2013 and is in existence for the last 10 years. It is run by Retired Professors from NIT, Trichy.
It is an absolutely free (No processing charges, No publishing charges etc) Journal Indexed in JIR, DIIF and SJIF.
Research Paper Available online at: www.jrrset.com

ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105
Volume 5, Issue 5, May 2017
JIR IF : 2.54
DIIF IF :1.46
SJIF IF: 1.329

DEVELOPMENT OF ROBOTIC ARM USING ARDUINO UNO

[1]Priyambada Mishra, [2]Riki Patel,[2]Trushit Upadhyaya, [2]Arpan Desai

[1]B.Tech Student,Department of Electronics & Communication,

[2,]Department of Electronics & Communication, Charotar University of Science & Technology, Changa, Gujarat, India. rikipatel.ec@charusat.ac.in

ABSTRACT

This proposed work is an overview of how we can make use of servo motor to make joints of a robotic arm and control it using potentiometer. Arduino UNO board is programmed to control the servo motors and arduino's analog input is given to potentiometer. This modelling resembles like a robotic crane or we can convert it into robotic crane using some tweaks. Robotic arm is one of the major projects in today automation industries. Robotic arm is part of the mechatronic industry today's fast growing industry. This project is apick and place robotic arm. On large scale it can be used as in environment, which is either hazardous (e.g. radiation) or not accessible. As the size of the robots scale down, the physics that governs the mode of operation, power delivery, and control change dramatically, restricting how these devices operate This also include it's characteristics like its extension, positioning, orientation, tools and object it can carry. This paper is on how we can make robotic arm with non useful materials and its application for small purposes. This paper also says about its advantages, disadvantages, methodology. I conclude this paper by future enhancement.

I. INTRODUCTION

The term robot comes from the Czech word robota, generally translated as "forced labour", this describes the majority of robots fairly well. Most robots in the world are designed for heavy, difficult to manufacture in work. They handle tasks that are difficulty, dangerous or boring to human beings. The most common robot is the robotic arm. This robotic arm is type of mechanical model arm, it is usually programmed, like of a human arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or linear displacement [1] .

An industrial arm with six joints similar to a human arm it has equivalent of a shoulder, an elbow and a wrist. Typically, the shoulder is mounted on a stationary base structure rather than to a movable body. This type of robot has six degree of freedom, meaning it can pivot in six different ways. A human arm by comparison have seven degrees of freedom [2].

Like as we have our arm whose job is to move your hand from place to place. Similarly job of robotic arm's is to move an object from one place to other that is what is a pick and place robotic arm. Industrial robots are designed to do exactly in an controlled environment, over and over again. For example, a robot might twist the caps of peanut butter jars coming down an assembly line. To each a robot how to do its job, the programmer guides the arm through the motions using a handheld controller. The robot stores the exact sequence of movements in its memory, and does it again and again every time a new unit comes down the assembly line [5] .

Most industrial robots work in auto assembly lines putting cars together. Robots can do a lot of this work more

efficiently than human beings because they are so precise, They always drill in the exactly the same place, and they always tighten bolts with the same amount of force, no matter how many hours, they've been working. Manufacturing of robots are very important in the computer industry. It takes precise hand to put together in tiny microstrip[4].

5. Speed: How fast the robot can position the end of its arm, angular linear speed of each axis or as a compound speed.
6. Acceleration: How quickly an axis can accelerate.
7. Accuracy: How closely a robot can reach a commanded position.
8. Repeatability: How well the robot will return to a programmed position.
9. Power source
10. Drive: Some robots connect electric motors to the joints via gears, others connect to the motor to joint directly.
11. Compliance

Types of robotic arm:

1. **Cartesian robot** : Used for pick and place work, , handling machine tools and arc welding application in various purposes like in assembly operations
2. **Cylindrical robot**: It is mostly used for assembly purpose operations, handling of machine tools, spot welding. It is a robot which has axes form of a cylindrical coordinate systemshows fig.4 [11].
3. **Spherical robot:** Used for handling machine tools, spot welding, fettling machines, gas welding and arc welding. It is a robot which has axes as form a polar coordinate system shows fig.2.
4. **Articulated robot**shows fig.3.
5. **Parallel robot**
6. **SCARA robot**shows fig.1
7. **Anthropomorphic robot**: It is shaped in a way that resembles a human hand, i.e. with independent fingers and thumbs.

Enlisting the industrial robotic arms parameter:

1. Number of axes
2. Degree of freedom
3. Working Freedom: The region of space a robot can reach
4. Carrying capacity or pay load: How much weight a robot can lift.

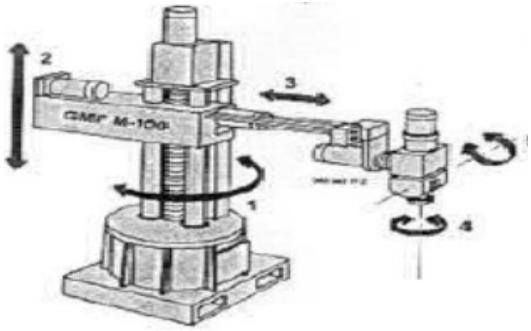
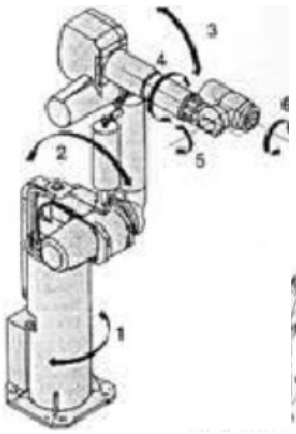


Fig 4 Cylindrical robotic arm



i **Fig** 1 Scara robotic arm **Fig 2** Spherical robotic

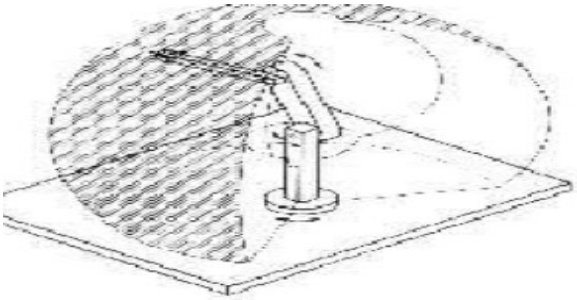


Fig 3 Articulated

This project is very much of a beginner level that is here i have used servo motors and potentiometer where potentiometers act as controller of servo motors and

servo motor act as a joint. the servo motors and potentiometer are controlled by Arduino Uno board. The Arduino Uno is a microcontroller board based on the ATmega328. It specification are 14 digital input/output pins of which 6 can be used as PWM outputs, , a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, 6 analog inputs and a reset button. Servo Motor (SG 90- four pieces): . Tiny and lightweight with high output power[12]. Servo can rotate approximately 180 degrees (90 in each direction), these are excessively used when there is a need for accurate shaft movement or position. These are not proposed for high speed applications. They are proposed for low speed, medium torque and accurate position application[6] [7].

The voltage across variable resistors is not linear; it will be bit noisy one. So to filter out this noise, capacitors of micro are placed across each resistor

II. METHODOLOGY

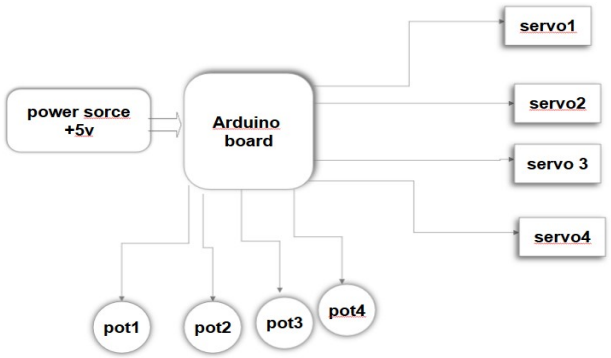


Fig 5 Block diagram representing the robotic arm

Fig 5 show the Block diagram representing the robotic arm , The components here used are arduino uno board, capacitors, servo SG90,10k pot variable resistor. Now talking about servo motors they are excessively used when there is a need for a accurate shaft movement or position. These are not proposed for a high sped applications. Servo motors are proposed for low speed, medium torque and accurate position application. So they are best for designing robotic arm. Servo motor are available at different shapes and sizes. We are going to use small servo motors (four) a servo motor will have mainly three wires positive voltage another is for ground and the last one is for position setting. The RED wire is connected to power, the brown wire is grounded and the orange wire is for signal.

1. The arm has been built with cardboards and the individual parts have been locked to servo motors. Arduino Uno is programmed to control servo motors. Servos motors are acting as joints of Robotic arm here. This setup looks a like aRobotic Crane or we can convert it into a Crane by easy ways
2. This Robotic Arm is controlled by four Potentiometer with which we attach each with potentiometer that is used to control each servo. We can move these servos by rotating the potentiometer to pick some object, with some practice we can easily pick and move the object from one place to another. Here we use low torque servos here but we can use more powerful servos to pick heavy object.
3. Program done using Arduino 1.6.10.
4. We connect the circuit according to circuit diagram.
5. Now the voltage provided by these variable resistor voltage which represents position control into ADC channels of Arduino.
6. We are going to use four ADC channels of UNO from A0 to A3. After the ADC initialization, we will have digital value of pots representing the position needed by user.
7. We will take this value and match it with servo position.
8. The robotic arms takes a perfect scaling that is cardboard, foam board is cut using measuring a servo are fitted according so that position of one servo motor does not affect the position of other servo motor.
9. As we rotate the 10K pot the value changes accordingly and we get rotation in the output of servo motor.
10. The voltage across variable resistors is not completely linear; it will be a noisy one. So to filter out this noise, capacitors are placed across each resistor.

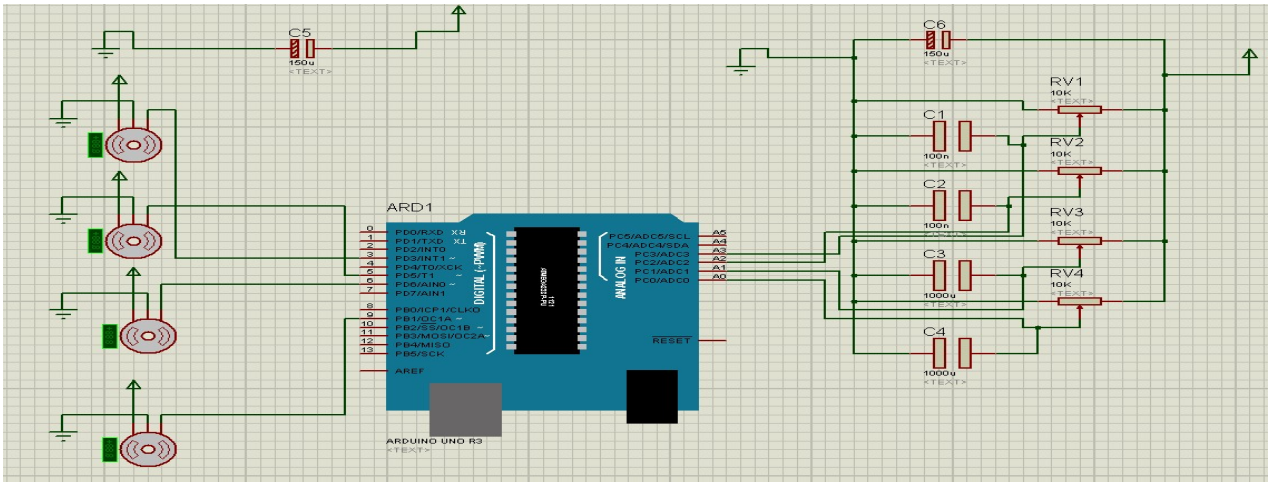


Fig 6 Proteus stimulation

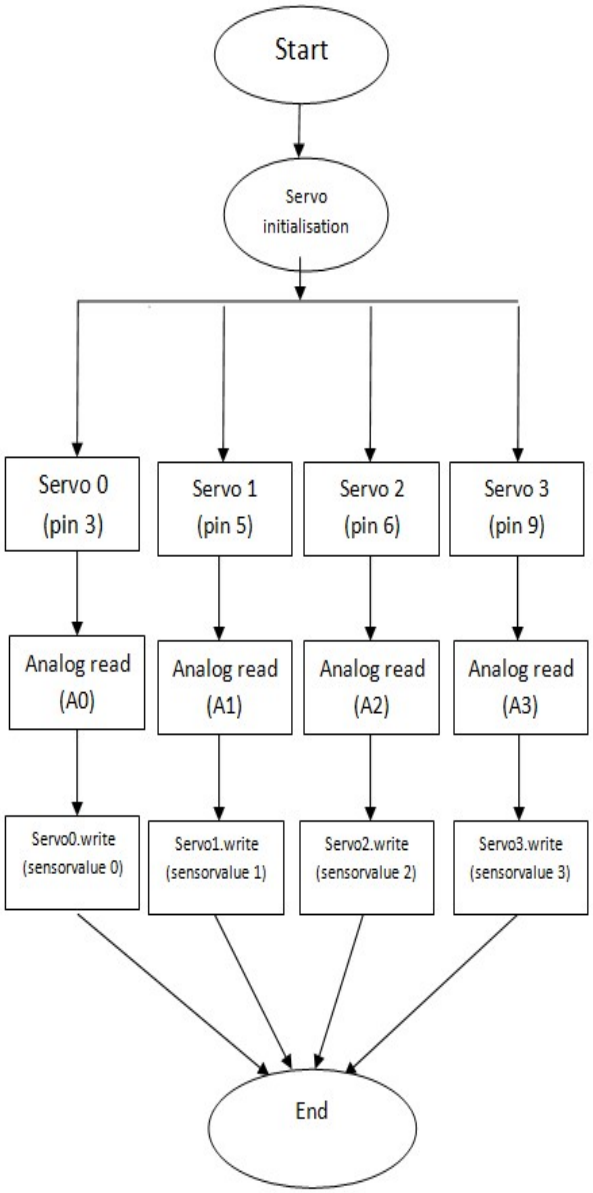


Fig 7 Flow chart of program

Arduino has six ADC channels. Here four are used for the robotic arm. The UNO ADC is of 10 bit resolution so the integer values ranging from 0-1023(2^10=1024). This means

that the input will map voltages from 0 and 5 volts into integer values between 0 and 1023. So for every (5/1024=4.9mv) per unit. As all the UNO ADC channels has a default reference of 5V for ADC conversion at any input channel. Since some sensors provide voltages from 0-2.5V, with a 5V reference we get lesser accuracy, so we have a instruction that enables us to change this reference value. So for changing the reference value we have ("analogReference();").

As default we get the maximum board ADC resolution which is 10 bits, this resolution can be changed by using instruction (”analogReadResolution(bits);"). This resolution change can come in some cases.Now if the above condition are set default, then we can read value from ADC of channel '0' by directly calling function "analogRead(pin);", here pin represents pin where we connect analog signal. The value from ADC can be taken into an integer as float voltage value=analogRead(A0); by this instruction the value after ADC gets stored in the integer "Voltage value".

Fig 6 show the Proteus stimulation and fig.7 for flow chart Now for the arduino UNO to convert analog signal into digital signal, we will have to use ADC channel of Arduino UNO with the help of above function:

a. analogRead(pin);
b. analogReference();
c. analogReadResolution(bits);

Now talking about servo, the arduino Uno has a feature which enables us to control the servo position by just giving the degree value. Say if we want the servo to be at 60, we can directly represent the value

in the program. The Servo header(Servo.h) file takes care of all the duty ratio calculations internally.

```
#include <servo.h>
 servo servo0;
servo0.attach(3);
servo0.write(degrees);
```

Here the first statement represents the header file for controlling the SERVO MOTOR. Second statement is for naming the servo. Here considering as servo0 as i have used four servo motor. Third statement states where the servo signal pin is connected this must be PWM pin here pin3 for first servo. Fourth statement gives command for positioning servo in degrees. If it is given 30, the servo motor rotates in 30 degrees.

Now we have SG90 servo position from 0 to 180 and the ADC values are from 0-1023. We will use a servovalue function function which matches both values automatically.

```
sensorvalue0=map(sensorvalue0, 0, 1023);
sensorvalue1=map(sensorvalue0, 1, 1023);
sensorvalue2=map(sensorvalue0, 2, 1023);
sensorvalue3=map(sensorvalue0, 3, 1023);
```

The above statement maps both values automatically and stores the result in integer 'sensorvalue0'.

The above statement maps both values automatically and stores the result in integer 'sensorvalue1'.

The above statement maps both values automatically and stores the result in integer 'sensorvalue2'.

The above statement maps both values automatically and stores the result in integer 'sensorvalue3'.

Thus by using the pot means by rotating the pot which changing its voltage value will change the servo angular rotation.

III. RESULT AND DISCUSSION

Construction of the robotic arm

The four servo are connected by the help of glue gun and foam board, cardboard. These are connected by scaling and angular rotation of servo motor.
On a flat surface like a table a hard cardboard a servo is placed in the middle and glued in place. The degree of rotation is 0 to 180 degrees, which forms the base of the arm. This base forms the main joint on this servo the whole load of other servo was made. So there was a problem initially but then it was fixed tightly with screws and made it. Fig 8 shows how the base forms the bottom part of the robotic arm.

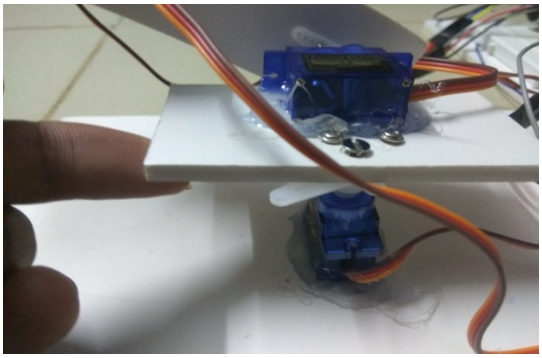


Fig8 Step 1

Then a small piece of cardboard is placed on the top of the first servo and above it a second servo is placed on this piece and glued it in the place. The servo rotation m just be again 0 to 180 degree rotation. This servo forms the another joint of the arm thus forming the second base of robotic arm. This is shown in the Fig 9 that is how the second servo is placed on the second servo. Each Servo is necessary for another servo joint forming a scaled hand so that arms remains stable and we can use pick and place the object easily.

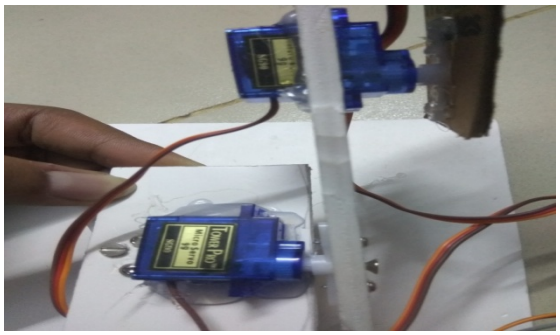


Fig 9 Step 2

Then for the joint we take few cardboards and cut them into 3cm*11cm pieces. Making sure the piece is not softened otherwise it will not able to support the servo motor and would fall easily. Cutting a small rectangular hole at one end (leaving 0.8cm from bottom) that is just enough to fit another servo in it which would form the another base of the fourth servo. The third servo is fitted and gear tightly with screws and by glue. then fitting the third servo in the first hole [10].

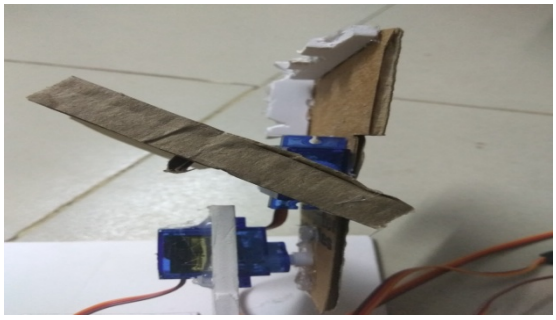


Fig 10 Step 3

Now the fourth and the last servo is glued at the edge of another piece that is made of another cardboard piece with length 8cm,3cm,4cm,1cm. With this we connect the third and fourth respectively together and hence we set up as of Fig 11 and this servo forms the main to pick and place device. Now we make a hook so that we can easily pick the objects so for that we cut two pieces of cardboard of length 1cm*7cm and 4cm*5cm gluing them together making it a final grab and then all the joints are glued together and we get a robotic arm ready to connect to the digital pins of arduino and which can be controlled by the use of the 10k pot. Fig 8 to fig12 show for the one by one step move for arm.

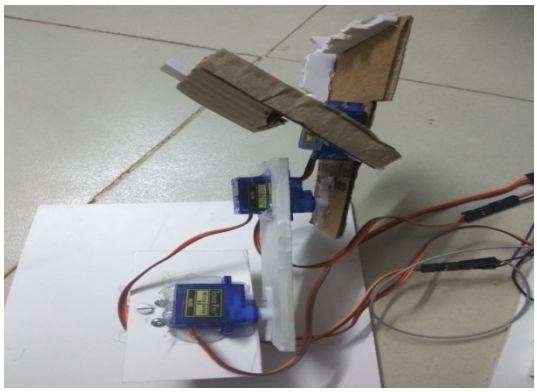


Fig 11 Step 4

RESULT AND DISCUSSION

How to operate the robotic arm

Here we are having four pots provided to the user that is by rotating these four pots, we supply variable voltage at the ADC channels of UNO. So the digital values of Arduino are under control of user. These digital values are to adjust the servo motor position, thus the servo position is in control of user and by rotating these pots we can move the joints of Robotic arm and we can pick or grab or place any object**.** The voltage across variable resistors is not completely linear it will be a noisy one [9]. So to filter out this noise, capacitors are placed across each resistor.Robotic Arm is controlled by four Potentiometer, and we control it with the help of servo motor, We can move these servos by rotating the potentiometer to pick objects, with some practice we can easily pick and move the object from one place to another. We have used low torque servos here but we can use more powerful servos to pick heavy object. The given three figures shows the complete working of the robotic arm that is how each potentiometer is fixed and how each individual pot controls the rotation of the servo motors. The below figure shows how four potentiometer are fixed [8].

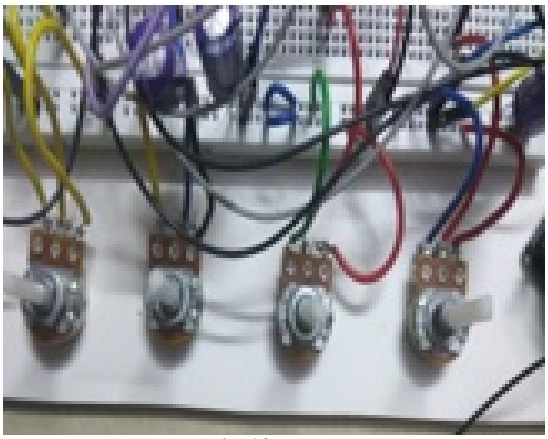


Fig 12 Step 5

Practice is required for rotating the pots accordingly and thus by when the ADC values are from 0-1023 it will match the servo degree of rotation that is from 0 to 180 degree and we get an appropriate output. Thought there was many vibration in the system still. I made use of capacitor 1000micro farad (4) and 100 nano farad do that we can use of it and block the noise and improve the stability of the robotic arm. Remaining two figures shows the individual Robotic arm and the whole circuit it works accordingly when we apply a 5V supply to the system and we get a suitable output. Thus representing how it works accordingly. Still there is a problem of vibration in the system that can reduce in the future enhancement that is maybe we can use high power servo motor and by the help of it vibration can be reduced even the grabbing power is less that it can pick a very heavy object just a lighter object. In future this structure can be modified and made of heavier materials and power servo or either accelerometer or simple ac, dc motors thus we will get a structure that would be able to pick object easily and grab heavy object easily and act like a perfect crane.**Fig 13**show the representing whole robotic arm and fig.14 show the connections with arduino.

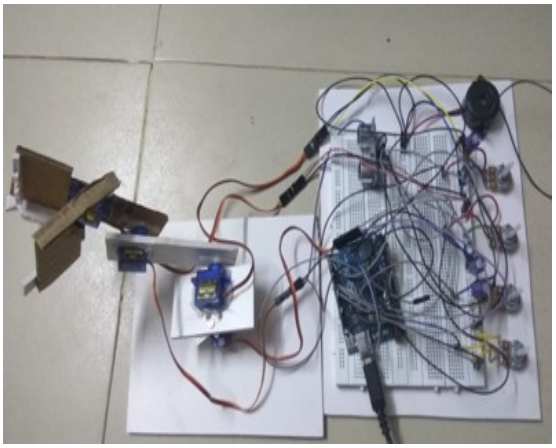


Fig 13 representing whole robotic arm

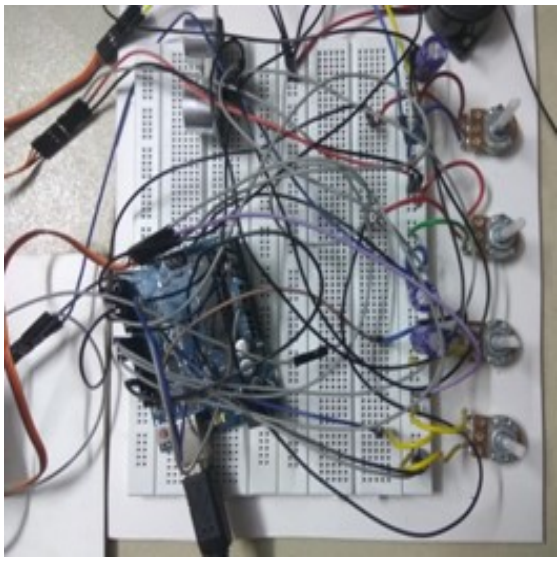


Fig 14 representing the connections with arduino

IV. ADVANTAGESAND DISADVANTAGES

ADVANTAGES:

- Grasping and holding objects and then move them to a new location, or mixing with other fluids. (used in laboratories that trust such arms to work within a toxic environment and so do not endanger the researcher. Building cars.
- Retrieving suspicious objects without endangering humans.
- Dig trenches.
- A source of entertainment and education.
- An appendage of an anthropocentric robot.
- Used in surgery.
- Used in farming.

Fig.15 show the arm are using for the architecture drawing part and fig 16 agricultural purpose also we can use ad pick and place .

DISADVANTAGES:

- This project is a small scale production it can pick up only small and lighter objects.
- On large scale this project may become costly and its circuit complexity increases.
- On large scale may become hazardous due to uncontrollable robotic arm it can harm physically.

V. APPLICATIONS:

- The characteristics of a robotic arm are:
  - its extension: how far from its base it can operate
  - its positioning: can it control its wrist position, orientation, with what precision, what speed
  - the tools and objects it can carry
- Therefore they can be used as:
  Painting (cars)
  - soldering (cars)
  - access unevenly placed parts (for scanning, selecting...)
  - pick and place (most industries, a lot for food industry).
  - act in a human-designed environment: send the arm on a mobile base to a damaged/radioactive building and use the arm to open the door and manipulate the tools (by itself or remote controlled)

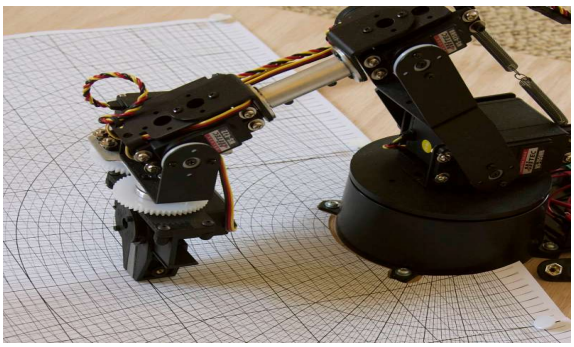


Fig 15arm design for architectural drawing

Fig 16 arm for agricultural purpose**.**

Fig 17 arm for pick and place

The above three figures represent how we can use the robotic arm on large scale production that in industry ho it is helping humans and making our life easier thus by several industrial parameters we defined the robotic arms based on characteristics thus which satisfy how we can make use of these characteristics and make pure developed hand that it used for many purposes. Thus not only the large scale robotic arm have complex structure but even it is difficult to make. Circuit complexity is more compared to the small scale production where we can supply less voltage and get a desired output but in this we need a large power supply to get a desired output.

VI. FUTURE ENHANCEMENT AND CONCLUSION

FUTURE ENHANCEMENT

- Future enhancement can include further improvement that is by adding 360 degree rotary servo motor and making it more stable. Setup can be modified that will pick more weight compared to present model.
- Ultrasonic sensor can even be placed on the arm so that it can detect and simultaneously pick the object and keep it on other place.

Conclusion:

This proposed work is an overview of how we can make use of servo motor to make joints of a robotic arm and control it using potentiometer and arduino UNO. Also used for high loaded industrial application work.

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