DESIGN AND IMPLEMENTATION OF 6 DOF ROBOTIC ARM SYSTEM

A thesis
Submitted By

FAROKUL ISLAM
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ASHIK HOSSAIN
TONMOY HASAN ABIR
ABU HENA MOSTAFA KAMAL

In partial fulfillment of the requirements for the award of the degree of
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY (SU)

JANUARY 2024

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Abstract

The aim of this project is to make a 6 Degree of Freedom robotic arm which is work with the instruction of anybody using Blynk app. In this system there have 6 servo motor is used to control the arm. Each servo have their personal duty at his position. We used here Nude MCU to control this arm using arduino program. Arduino program are designed by arduino IDE software. The Robotic arms are mechanical products that are manufactured and marketed the world at a very high rate. There are thousands of types of arms are available on the market developed by different companies. Industrial use robot arm cannot be used at this time even more than the domestic robot can do the job. It is always use specific objectives and some conditions in the industry where humans cannot work at high temperature, polluted air region, weightlifting and so on. Robot arms are also used for high accurate places where local error are allowed. Robot arm set one tasks, and accurate implementation in a variety of environments. A robotic arm means a group of rigidly connected bodies that can be taken different configurations, and move between these configurations with speed and speed restrictions. Industrial robot arms vary in size and some are fixed body, type of joint, joint sequence.

Acknowledgment

At first of all, I am grateful to almighty God. Then I would like to express my heartfelt thanks to the honorable Vice chancellor professor **Dr. Md. Abul Bashar** of SU for his guidance and Leadership. Secondly we sincerely acknowledge the contributions of the honorable chairman of the Department Of Mechanical Engineering, professor **Md. Mostofa hossain**. Finally special thanks to our project thesis supervisor **Khandoker Mohammad Faisal Karim**, Assistant course Co-ordinator, Department Of Mechanical Engineering, Sonargaon University (SU). He was so dedicated and supportive. He has inspired us and given us the right direction to complete the project. We have completed this project with his necessary advice and help. Also, we would like to thank the members of our group. They share their knowledge and help make this project a success. We thank our teachers and faculty members. They are like our family. We would like to express our deep love and gratitude to them for their great support. They encourage us in university life.

ABBREVIATIONS

SMPS	-	Switched Mode Power Supply
DOF	-	Degree of Freedom
IDE	-	Integrated Development Environment

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Chapter 1

Introduction

1.1 Introduction

The Robotic arms are mechanical products that are manufactured and marketed the world at a very high rate. There are thousands of types of arms are available on the market developed by different companies. Industrial use robot arm cannot be used at this time even more than the domestic robot can do the job. It is always use specific objectives and some conditions in the industry where humans cannot work at high temperature, polluted air region, weightlifting and so on. Robot arms are also used for high accurate places where local error are allowed. Robot arm set one tasks, and accurate implementation in a variety of environments.[4] A robotic arm means a group of rigidly connected bodies that can be taken different configurations, and move between these configurations with speed and speed restrictions. Industrial robot arms vary in size and some are fixed body, type of joint, joint sequence. The range of motion to be connected and acceptable at each joint and individual fixtures are called links. Robot arm is made using different parameters such as quantity axis, degrees of freedom, working area and working space that arm cover, kinematics, payload, speed and acceleration, accuracy and repeatability, motion control and arm drive this survey summarizes a developing issue robot arm. People like to shop online rather than buy things and getting them online manually is now everywhere, comparing the last few decades into the Internet only wired, as well as people need to be in front of the computer to access the Internet.[5] Now, the internet is just at your fingertips.We can bring the advantages of robotics into the homeworks. The mechanical and electrical construction are the components used to build the robot arm. Internet controlled robots will connect these wired robotsandhas some space limitations. So in order to avoid this restriction robot control is wirelessly controlled through online. Wireless also means using Bluetooth, however the advancements used here are the most extensive so the WI-FI comes in to picture. 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. 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. 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. 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.[15]

1.2 Objectives

The objective of controlling a 6 Degree of Freedom (6 DOF) robotic arm using NodeMCU and the Blynk app can vary based on specific project goals and requirements. However, here are some common objectives and features that you might consider when developing such a control system:

- To enable users to control the 6 DOF robotic arm remotely using the Blynk app on their smartphones or tablets. Establish a reliable wireless communication link between the NodeMCU and the Blynk app.

- To implement real-time feedback from the robotic arm to the Blynk app. This feedback can include the current joint angles, end-effector position, or any other relevant sensor data from the 6 DOF robotic arm.
- To design an intuitive and user-friendly interface on the Blynk app for controlling the robotic arm. Use graphical elements such as sliders, buttons, or joysticks to allow users to control each joint's movement easily.
- To implement controls that allow users to specify the desired position and orientation of the robotic arm's end-effector. This may involve forward and inverse kinematics calculations to translate user inputs into joint movements.
- To incorporate path planning algorithms to allow the robotic arm to move smoothly and efficiently between different positions. This is particularly important when dealing with tasks that require precise and coordinated movements.
- To if the robotic arm includes a gripper or end-effector with grasping capabilities, implement controls for opening, closing, and manipulating the gripper. This can be essential for tasks such as picking and placing objects.
- To integrate sensors such as encoders, accelerometers, or force sensors if available on the robotic arm. Utilize this sensor data for feedback, collision detection, or to enhance the overall control system.
- To implement safety features in the control system. This could include emergency stop functionalities or collision detection mechanisms to ensure the robotic arm operates safely.
- To allow users to customize control parameters through the Blynk app. This might include adjusting speed, acceleration, or other settings based on the specific application or user preferences.
- To provide a programming interface that allows users to define and execute custom sequences of movements or tasks for the robotic arm. This can be beneficial for automation and more advanced applications.
- To explore the possibility of integrating the robotic arm control system with other IoT devices or systems. This could involve communication with other smart devices or triggering actions based on external inputs.

- To develop comprehensive documentation and user guides for setting up and using the 6 DOF robotic arm control system. This ensures that users can effectively operate the system and understand its capabilities.

Always consider the specific requirements of your project and the intended application of the robotic arm when defining your objectives. Testing and iterating on your design are crucial steps to ensure a functional and reliable control system.[7]

Chapter 2
Literature Review
& Methodology

2.1 Literature Review

A survey on Arduino Controlled Robotic Arm by Ankur Bhargava. In this paper a 5 Degree of Freedom (DOF) robotic arm have been developed. It is controlled by an Arduino Uno microcontroller which accepts input signals from a user by means of a set of potentiometers. The arm is made from four rotary joints andend effector also, where rotary motion is provided by a servomotor. Each link has been first designed using Solid works Sheet Metal Working Toolbox and then fabricated using a 2mm thick Aluminium sheet. The servomotors and links thus produced assembled with fasteners produced the final shape of the arm. The Arduino has been programmed to provide rotation to each servo motor corresponding to the amount of rotation of the potentiometer shaft. A robot can be defined according to the nature ofthe relative movements between the links that constituteit.[12]

Review on development of industrial robotic arm by Rahul Gautam This selective operation robotic control method is need to be overcome the problem such as placing or picking object that at distant from the worker.[3] The robotic arm has been developed successfully as the movement of the robot can be controls precisely. It is expensive to change the cable and therefore the designing to reduce the friction on table, is crucial to increase time between maintenance.

Survey on Design and Development of competitive low cost Robot Arm With Four Degrees of Freedom by Ashraf Elfasahany In this paper the representation of the design, development and implementation of robot arm is done, which has the ability to perform simple tasks, such as light material handling. The robotic arm is designed and made from acrylic material where servo motors are used to perform links between arms. The servo motors consist of encoder so that no need to use controller. However, the rotation range of the motor is less than 180º span, which greatly decreases the region reached by the arm and the possible positions. The design of the robot arm was for four degrees of freedom. The end effector is not considered while designing because a readily available gripper is used as it is much easier and economical to use a commercial.[7]

2.2 Methodology

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.[14]

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 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. 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 aRobotic Crane or we can convert it into a Crane by easy ways.[9]

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.

Chapter 3
Hardware and Software Description

3.1 Introduction

One of the noteworthy developments in the technological revolution is how robots replace people in risky systems that could threaten human life. Explosive ordnance disposal (EOD) is one application in which technology has played an important role in saving people from possible explosive hazards. Suspect items can be very risky to touch humans at airports; for instance unexplained baggage can contain bombs that can detonate when the package is removed.[7] So a Unmanned Ground Vehicle (UGV), equipped with a robotic arm and camera, may be used instead of a person having to check the suspected object and thus endanger his life. Therefore, a healthy human operator may examine the item, only repairable parts and equipment on the track. In fact, the rotating robotic arm can be used to deal with the terrible consequences of war; landmines that is placed in the war but can trigger casualties even after planting them, hundreds of years. This leads to huge areas of land that are not safe and inaccessible for the human population even if they are crossed. The EOD system is generally made up of a UGV and is fitted with the robot arm. The UGV moves the robotic arm to the object of interest where the arm tests the component. The device can be controlled and treated using the appropriate means mounted on the end effectors, such as the wire cuttings, or by the disarming of explosives in a suitable vessel to detonate it. The above listed activities can be accomplished by various types of robotic arms. Depending on exactly the program and the operating environment, each arm has requirements. In fact, many factors are needed in order to determine the design characteristics of the final design, the total number of DOF, the maximum weight necessary, and the exactness expected measurements of the arm when stored and definitely the overall cost. In this paper we introduce the design and analysis to gain a six DOF robotic arm with a maximum payload of 10 kg and wireless control of the PlayStation III controller with a total cost of below US$ 3,000 that is much cheaper than the available robotic arms on the market, while corresponding to their specification. This paper presents the process and analysis.[12] 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. Servo can rotate approximately 180.[9]

Figure 3.1: Robotic Arm

3.2 Mechanical Gripper

A mechanical gripper is used to grip the objects and hold it while transferring it from its location to the destination the gripper has its inbuilt mini servo in it so it can open or close its jaws to grip the objects.

Figure 3.2: Mechanical gripper

The gripper is made from the acrylic by the LASER cutting operation .the shaft of the servo is fixed to the end of first jaw which meshes with the gear on the second jaw . as the motor rotates the gear rotates and this in turn rotates the gear in mesh and the jaws open or close to release or hold the objects. A gear link is attached to a servomoter which is meshes with another geared link to provide a smooth action of gripping of different objects according to there sizes the movement of both of figures of the grippers is synchrinize well to hold the object.[6]

3.3 Base with Bearing

The base is made so strong so that it can support the whole assembly and balance the centre of gravity of whole arm .the base let the arm do movements in the require directions flawlessly and the arm can cover the hemispherical volume.[11] Bearing fixed in the base and complete load of the base is taken by the bearing, the bearing also provides the rotational movement from the base to the robotic arm.

3.4 Servo Motor

The three major servo motors are used in the robotic arm, one for the base movements and two on the side of the base plate two transmit the motion through the various links to the arm. The servo motor is bolted to the base plate it keeps it fixed and it avoids vibrations during the actual operations. A rotary actuator is consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Figure 3.3: Servo Motor

3.5 Controller

By sending a servo signals a servo control can be obtained, a series of repeating pulses of variable width where either the width of the pulse (most common modern hobby servos) or the duty cycle of a pulse train (less common today) determines the position to be achieved by the servo. Controller integrate the digital command signal into the analouge parameter like movement of the servo motor shaft.with the help of controller we can upload the programme regarding the movements of the servos.[13]by using the controller we can control the number of servos at a time and syncronise the operation of the servo for

-operation of any servo in any sequence and

-to syncronise actuation of four servos sequentially in a loop programme.

Figure 3.4: Node MCU

3.6 Connectors

The device that used to join electrical terminations and create an electrical circuit is called as an electrical connectors. These are an electro-mechanical devicesconsist of plugs called male ended and jacks called female ended. The connection may be temporary, as for portable equipment, require a tool for assembly and removal, or serve as a permanent electrical joint between two wires or device.In our project we used only the male to male connectors or the plugs for the connections.[1]

3.7 Software Design:

Blynk is an IoT platform that allows us to quickly build projects for controlling and monitoring the data using Android and iOS devices. We can create project dashboard and add widgets like button, display, sliders, etc. for controlling microcontrollers and other peripherals. Using these widgets we can control the devices and can monitor the sensor data on the phone screen. Follow the below steps to install Blynk and create dashboard for robotic arm control.

1. In your mobile phone Install the blynk application from the Google Play Store.

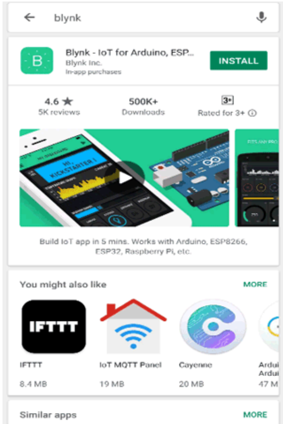

Figure 3.5: Install Blynk App

2. Next sign up for the Blynk application using the email id.

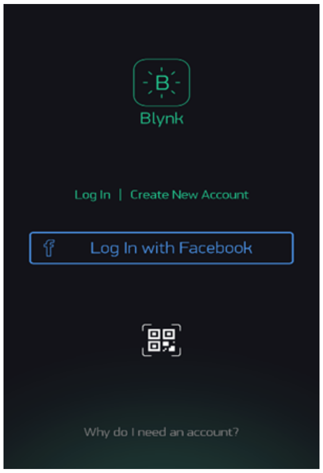

Figure 3.6: Log-In Blynk App

3. After signing up login the Blynk application.

4. After login, click on ***New Project***.

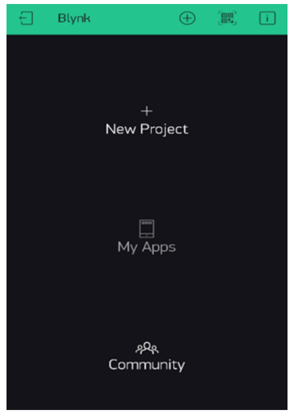

Figure 3.7: Create New Project

5. Next Project Name is given as per required and Board we use is "***NodeMCU***" is selected and connection type is given as "***WiFi***"

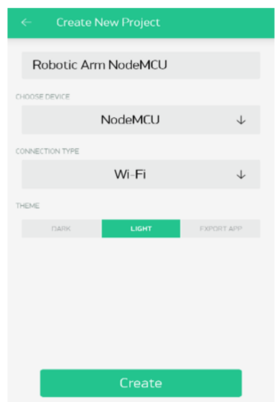

Figure 3.8: Chose NodeMCU

6. After that click ***Create***. And an Auth Token code is sent to your mail ID.

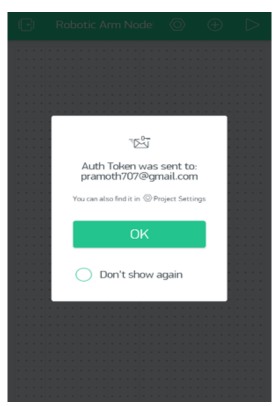

Figure 3.9: Send Auth Token

7. Copy the Auth Token Code sent to your mail ID we will use it in our NodeMCU coding.

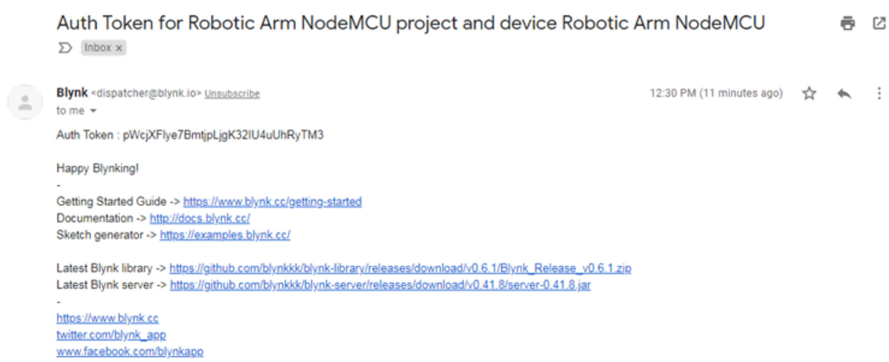

Figure 3.10: Check Inbox to find Auth Token

8. Next we have to create our own application for our Robotic ARM Control by adding the widgets in the widgets box. As we have four servo motor control, I have added four sliders.

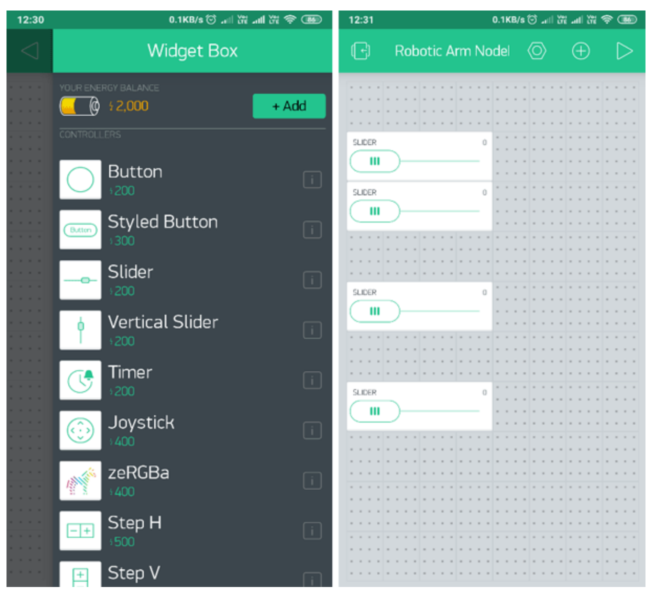

Figure 3.11: Add Slider

9. After Adding the Sliders. You can change each sliders name and Slider value and then the Slider settings.

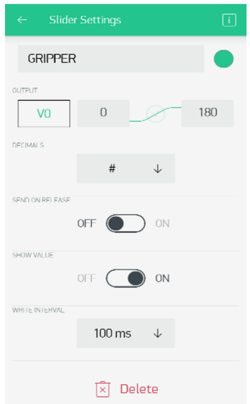

Figure 3.12: Slider Settings

Slider 1 as GRIPPER with settings as OUTPUT V0 from 0 to 180.

Slider 2 as LEFT/RIGHT with settings as OUTPUT V1 from 0 to 180.

Slider 3 as UP/DOWN with settings as OUTPUT V2 from 0 to 90.

Slider 4 as FORWARD/REVERSE with settings as OUTPUT V3 from 0 to 60.

For ALL Sliders I have turned OFF the SEND ON RELEASE. So that we can keep a Write Delay of 100ms between the values.

10. After Adding all the sliders with above settings, the application looks like this. After that you can run the application by clicking Play Button.

Figure 3.13: Run the system

11. Now our application is ready. Next thing is to make the circuit connections and upload code to the NodeMCU. After that we can control our Robotic ARM using the Blynk Application.

Chapter 4

System Design

4.1 Block Diagram

The robotic arm works on the principle of electrical input energy to perform some mechanical works effectively with the help of some automation and program based operations. The pick and place robotic arm consist of major hardware components such as strips & motors and arm gripper, switches, battery, piece of metal, and other discrete mechanical and electrical components.[9] This project is designed for developing a pick and place robotic arm with a soft catching gripper.

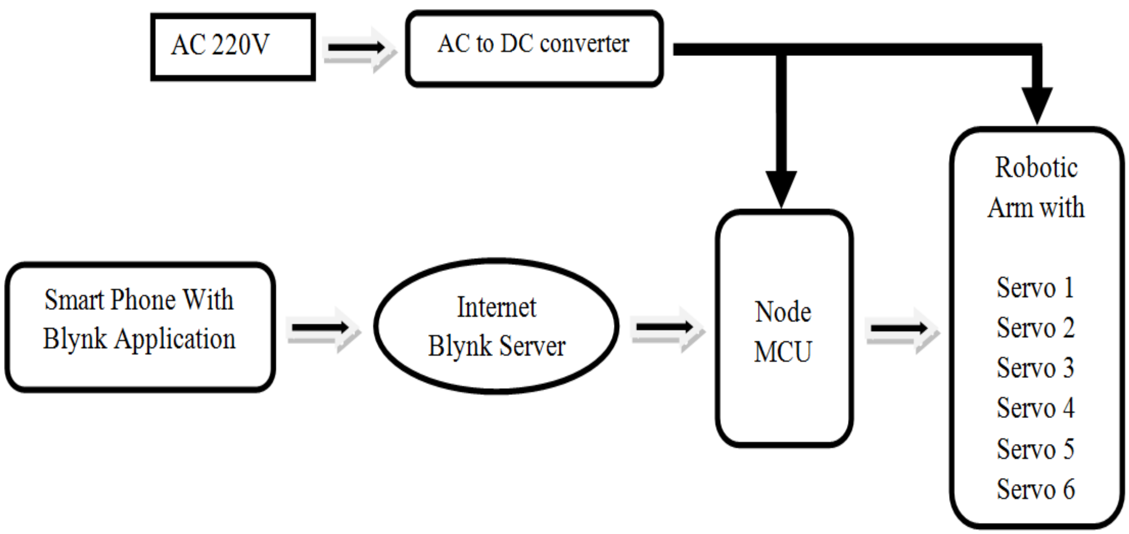

Figure 4.1: Block Diagram

This soft catching gripper is used for safely handling an object carefully while Catching and placing. The robotic arm consists of servo motor which is used for angular rotations of the arm for catching items (to hold items, to release, to rotate, to place). This servomotor used is works on the principle of Fleming's left-hand rule and is controlled using Arduino circuit board. In this system we try to make a internet based robotic arm and show the system control usign a smart phone with nodeMCU. To connect the robotic arm with the smart phone we use here Blynk app which is works on a Arduino IDE software program. We used hare mobile hotspot to supply the wi-fi signal to run the system on time. NodeMCU is a smart IoT programed device which is most used module in IoT platform.[17]

4.2 Circuit Diagram

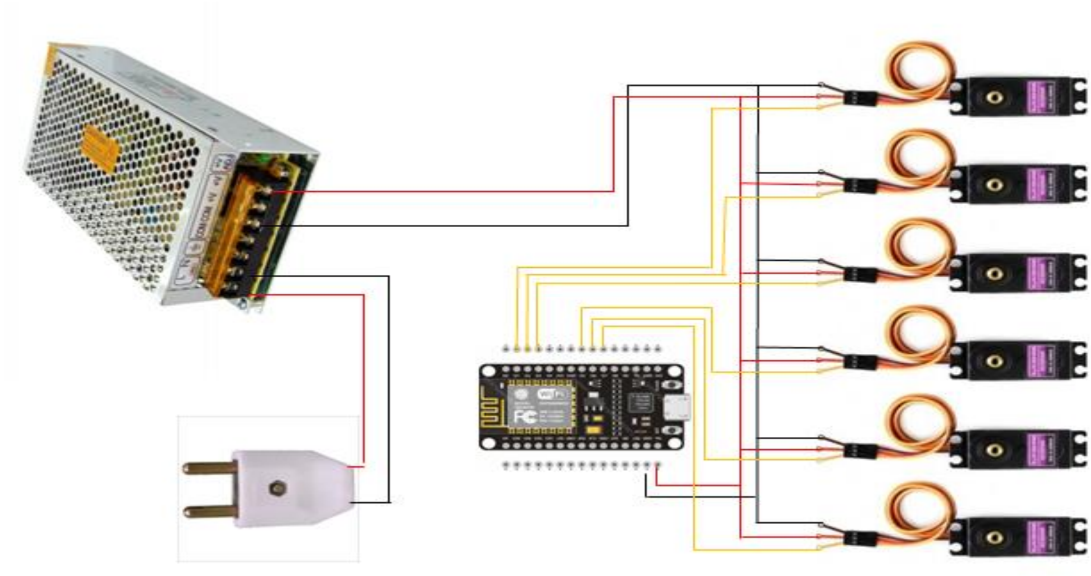

Figure 4.2: Circuit Diagram

As shown above we will need a total of 4 servo motor to operate our **robotic arm**, since these motors do not consume much power they are being driven directly by the 5V dc supply from our 1A adapter. I have used the breadboard to make the above connections; once the connections are done my set-up looks something like this.[9]

4.3 Robotic Arm Design

The main benefits of teleportation are that homo-sapiens are versatile and thus compliant with unstructured conditions. This project went through a range of design stages from the very first design which mainly focused on the necessary DOF, to the point that the design achieved its optimum stage and fulfilled all the criteria of the project based on complex assessments. In particular, we started by deciding the lengths of the arms connections to establish a practical configuration of six DOF and the ability to reach distances of 2 meters and the ability to fold the arm within the UGV surface dimension. The template of three connections was chosen because in conjunction with the revolving base and gripper it results in six DOF. The original lengths of the ties have been calculated from the 2 meter extension requirement. The first conceptual design was designed using computerized drawing software (CATIA) to ensure that the links are foldable over and above the UGV, and that their borders do not exceed. The following was the stage of determining the form of each link. The subsequent approach concentrated more on the usability of trying to maximize each joint with the available rotating angle. In addition, the length and stroke were chosen in order to meet the loading criterion for each linear actuator. This stage of development led to a change of the proportions of relations, which involved a compromise to achieve the best movement. Eventually, the gripper was applied to the design, and the connecting dimensions improved, which reduced the connecting measurements in particular to a smaller arm.[17]

4.4 Drive Circuit

After the design of the robotic arm is complete, a moving circuit must be applied. The linear actuators are the robotic arm components to be operated. Essentially such actuators are DC motors which are operated by adjusting the polarity on the terminals in the direction of rotation. The linear actuators were powered by H-bridges consisting of relays. In particular, for practicality, pre-welded relay modules have been used since they enable the control of engines using a microcontroller directly.

4.5 Remote Controller

The Arduino Mega microcontroller has been chosen because its own C-based programming language is easy to program. The code includes the library which enables the Arduino Mega to be interfaced with a Bluetooth dongle that can then be linked to a PlayStation wireless controller to wirelessly monitor relays with the PS3 controller. The relays control the current direction in which the DC motors of the linear actuators flow, which controls the extension and retraction of each connection of the robotic arm. The servo motors mounted on a base rotation and a gripper were controlled by analog buttons on the PS3 controller.

4.6 Machanical Analysis

The efficiency of the robotic arm has to be evaluated, so the measurements below are carried out to insure that the mechanical configuration satisfies the standard specifications.

4.7 Torque Calculation

Newton's second rule was changed to calculate the base rotational torque and the gripper engines. The law states that an object must be rotated in torque relative to its angular acceleration ($\tau = I\alpha$), i.e., that it must be torque equivalent to the moment of inertia of the body. In order to give the arm a smooth and steady motion, the angular acceleration of its robot arm and its gripper will be preferred for the most important parameter for torque control. The motors used have produced very high torques, as the rotary arm has a ratio of 7:1 that guarantees good torque and sluggish rotational speed.

4.8 Force Analysis

A force study was carried out for the mechanical design in order to evaluate the appropriate proportions of the robotic arm connections. If the outcome of static analyzes and dynamic tests is negligible and because the arm is moving very slowly, static force analysis has been used. In addition, all the weight of the robotic arm components have been applied to the tip of the arm's gripper as a vertical force in the Y axis, including the strength weights and weights of the aluminum layer of the contact beams.[16] The robotic arm foundation had to be set, and the laws of Newton were used to perform a simple static force study. The measurement of static forces was carried out in different positions of the arm; the arm was slightly stretched, fully extended and bent down to take the target from a relatively close point in front of the UGV. The highest forces in the case of a full forward extension of the arm were the three positions. The analysis of the static force led to the reaction forces due to load and link weight. The pressures acting on the points of contact between the ties and pins linking the connected plates can be used to examine tension on each side of the head. The intensity measurement started from the gripper to the foundation joint. At each pin, weights of the previous parts were increased by the built-in charge.[12]

4.9 Stress Analysis

CATIA has been used to perform stress analysis on robotic arm components; CATIA provides stress and simulation methods that are specific to portions of different CAD drawing formats. The material to be checked must first be provided to the component to be tested; all the mechanical properties of the item must then be allocated the material using CATIA. Once the aluminum content has been allocated, forces can be positioned at various points of the component, which are dependent on the effects of the static force study. The component can be meshed and the algorithm will measure the tension. We have used the CATIA criterion for tension yield von mises. Depending on the actual stresses arising from von mises, we adjusted the measurements of the components to reduce stress, where a stress analysis protection factor was added.[14]

4.10 Tipping

Since safe operation of the arm during dangerous items is important, a tipping study has been performed for knowledge on load limitations in order to provide stabilization. The tipping equation was solved by MATLAB and the lifting load limiting graph was obtained. The study concluded that the pivot point is the car's bottom, and that the UGV runs on a flat surface. The arm will have a limited load range at each arm location (extension) that the user will learn in order to avoid device instability. The resulting time during load handling on different angels and extensions was calculated using MATLAB code, and was compared with the resulting time from the weight of the UGV. The point between equivalence of the two periods is the volatility to be prevented. The vehicle's weight is 200 Kg; 150 Kg in tipping calculations were taken into account for safety purposes. At full extension and half end, the capacity of the arm to fall over was measured. The UGV mass core is known as the UGV center 0.47 m away from the pivot. At the middle point of the component, the center of mass for every element was known.[9]

4.11 Robotic Arm Parameters

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.
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

4.12 Robotic Arm Types

- **Cartesian robot :** Used for pick and place work, , handling machine tools and arc welding application in various purposes like in assembly operations
- **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 system.
- **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.
- **Articulated robot**
- **Parallel robot**
- **SCARA robot**
- **Anthropomorphic robot:** It is shaped in a way that resembles a human hand, i.e. with independent fingers and thumbs.

Chapter 5
Results & Discussions

5.1 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)

5.2 Experimental Results

In this part of this proposal we discuss about our project output results. After a thorough testing of the robotic arm, the electrical wiring was found to be reliable for continuous operation. The operational output showing serially in bellow.

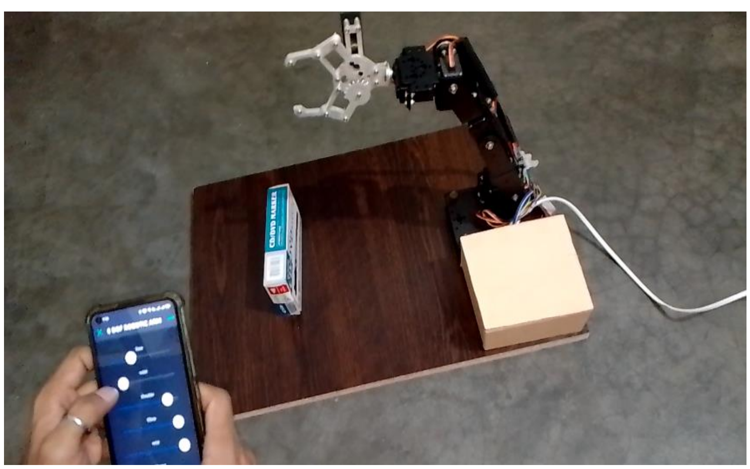

Figure 5.1: Control Robotic Arm Using Smart Phone with Blynk App

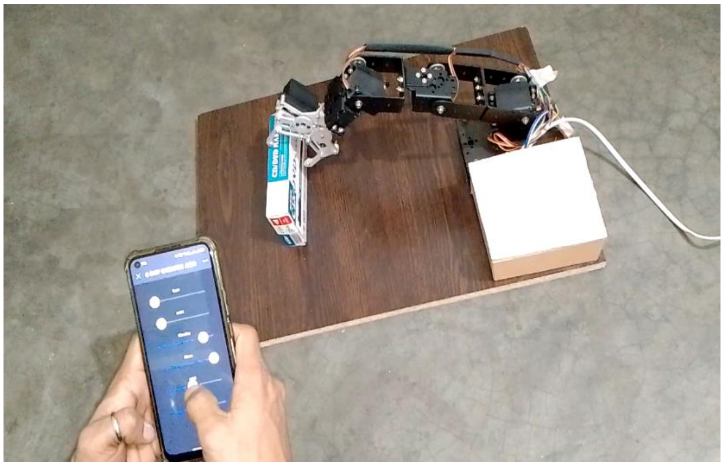

Figure 5.2: Catching Load using gripper

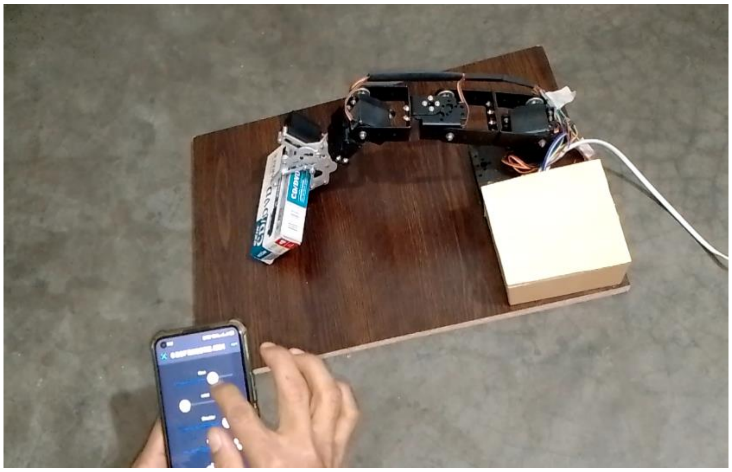

Figure 5.3: Load hold to shift another place

Figure 5.4: Hold the load to up side

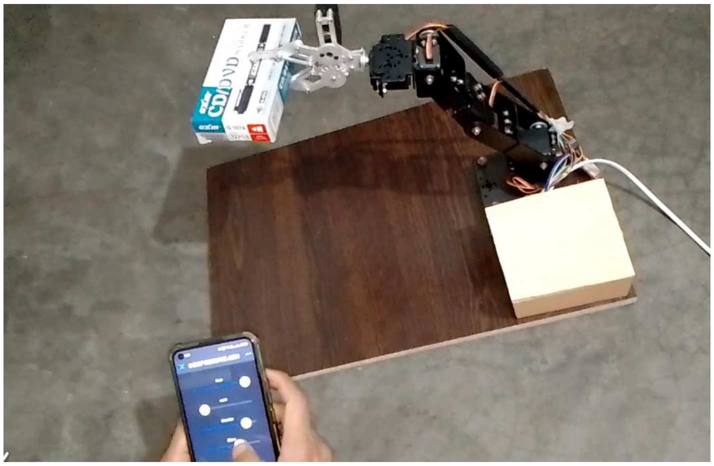

Figure 5.5: Shift Arm body to Right Side

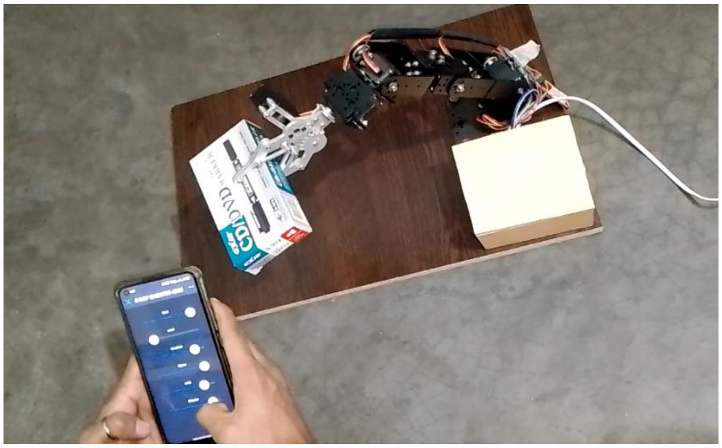

Figure 5.6: Shift Arm body to Left Side

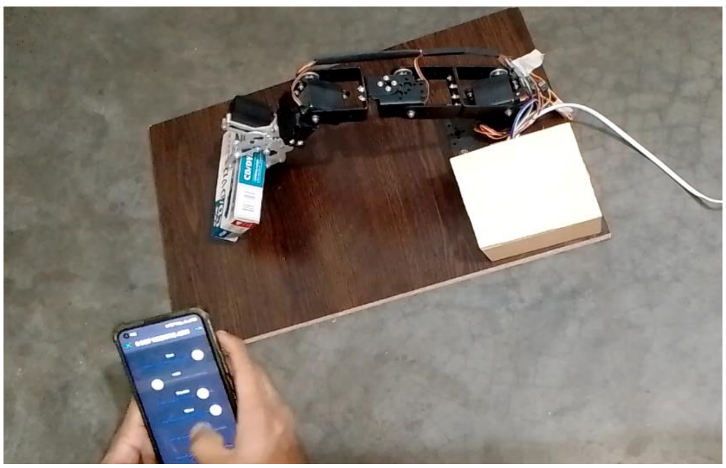

Figure 5.7: Again take it down

Figure 5.8: Its releasing the load from its gripper.

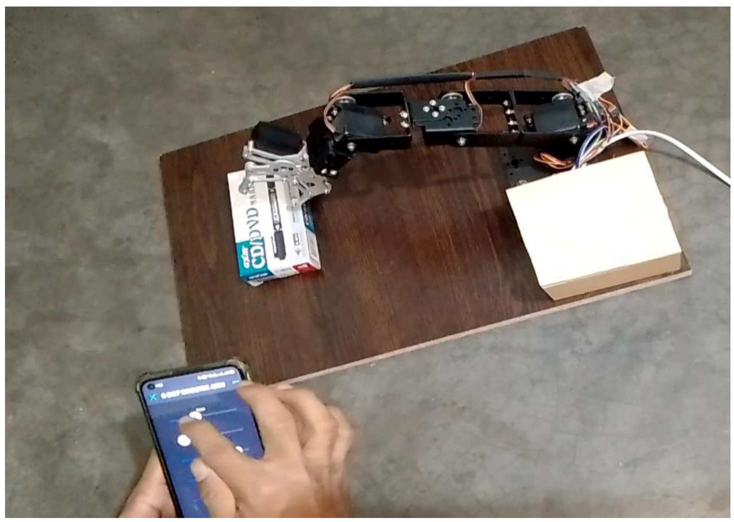

Figure 5.9: Load is released now.

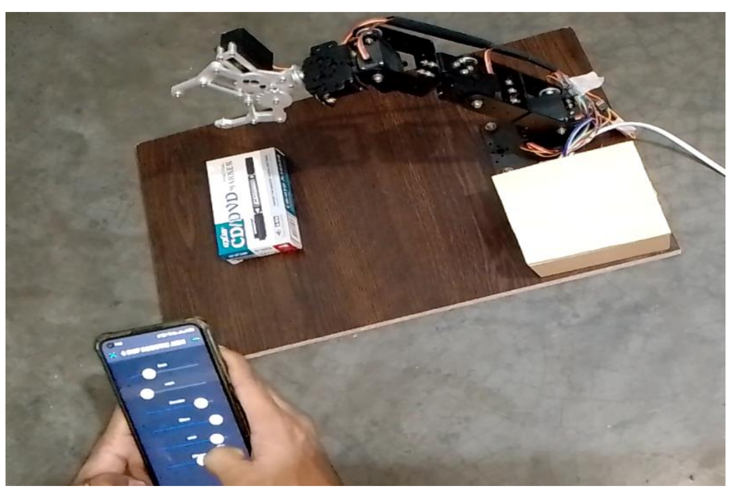

Figure 5.9: Robotic Arm is ready to do another job.

Chapter 6
Conclusion

RESULTS & DISCUSSION

Table 4.3: Performance Test

Parameter	Specification	Description
Kinematics	No. of DOF	6
	Range of Motion (ROM)	Waist: 90° Shoulder : 90° Elbow: 172° Wrist: 90° Effector: 180°
Physical	Actuation	6 DC Servo Motor
	Weight	5 Kg
	Dimension	Base: 550×250×50mm
		Arm Length: 380mm
Performance	Position Precision	± 2mm
	Movement Time Required	2 Sec. (Depend on Internet Speed)
	Payload	50 Gr
	Gripper Length	50mm (Max)
	Load Capacity	200 gr (Max)

6.1 Discussion

The Robotic arms are mechanical products that are manufactured and marketed the world at a very high rate. There are thousands of types of arms are available on the market developed by different companies. Industrial use robot arm cannot be used at this time even more than the domestic robot can do the job. It is always use specific objectives and some conditions in the industry where humans cannot work at high temperature, polluted air region, weightlifting and so on. Robot arms are also used for high accurate places where local error are allowed. Robot arm set one tasks, and accurate implementation in a variety of environments. A robotic arm means a group of rigidly connected bodies that can be taken different configurations, and move between these configurations with speed and speed restrictions. Industrial robot arms vary in size and some are fixed body, type of joint, joint sequence.[11]

6.2 Conclusion

This report presents the design and the development of robotic arm, which has the ability to perform simple tasks, such as light material handling. The robotic arm is designed and built from aircraft grade aluminium material where servo motors were used to perform arm movements. The design of the robotic arm limited to the four degrees of freedom The design of a Robotic arm has been complete.[12] A prototype was built and confirmed functional. This system would make it easier for man to unrivalled the risk of handling suspicious objects which could be hazardous in its present environment and workplace. Complex and complicated duties would be achieved faster and more accurately with this design. A device that is applicable to EOD implementations with regard to the control distance and stability will effectively replace the current control system.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. This Due to the growing demand for natural Human Machine Interfaces and automaton intuitive programming platforms, a robotic system that permits users to manage AN industrial automation using arm gestures and postures was planned. Two 3-axis accelerometers were selected to be the input devices of this system, capturing the human arms behaviors. When compared with alternative common input devices, particularly the teach pendant, this approach mistreatment accelerometer is additional intuitive and straightforward to figure, besides giving the likelihood to control a automaton by wireless suggests that. mistreatment this technique, a no expert robot applied scientist will management an automaton quickly and during a natural method. The low worth and short set-up time area unit alternative advantages of the system. still, the irresponsibleness of the system is a vital limitation to think about. The ANN′s shown to be an honest option to acknowledge gestures and postures, presenting a mean of ninety-two of correctly recognized gestures and postures.[14] The system has a very good response time is another necessary issue. Future work can devolve on the ndevelopment of the average of properly recognized gestures. One approach might be the implementation of a gyro into the system, in order to separate the acceleration because of gravity from the inertial acceleration. The employment of additional accelerometers attached to the arms is another chance. The Arduino has a very good response time and later the same system can be up graded to raspberry pi in future and the same is implemented on proteus design tool. Finally, the system was first build on a bread board and the values area calculated the same values were used in the code to see the difference in the operation of the robotic arm.[13]

6.3 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

6.4 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.

6.5 Future Scope

- 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.

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