Contents

Certificate

DECLARATION

I declare that this project report titled **Robotic Arm** submitted in partial fulfillment of the degree of B. Tech in Electronics and Telecommunication Engineering is a record of original work carried out by me under the supervision of **Prof.S.S.Thorat** and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

Signature of Guide

ACKNOWLEDGEMENT

It is an incident of great pleasure for us submitting this Mini Project Report.We take this opportunity to express our deep sense of gratitude and great thanks to our Guide and Head of department **Prof.S.S.Thorat** Who has been a constant source of guidance and inspiration through this report work we shall ever be grateful to them for the encouragement and suggestion gives by them from time to time.

It is grateful to thank all the teaching member of electronic and telecommunication engineering department who always inspire us and their suggestions helped us to complete our micro project. We would also like to thanks our principal **DR.P.M.Khodke** who always inspire us and their suggestions helped us to complete our micro project.

We also thankful to our friends and library staff members whose encouragement Last but not the least, we thankful to our parents whose wishes are always with us.

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.

List of Figures

1 CHAPTER

1.1 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 . 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.

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

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
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
4. Articulated robotshows
5. Parallel robot
6. SCARA robotshows
7. Anthropomorphic robot: It is shaped in a way that resembles a human hand, i.e. with independent fingers and thumbs.

2 CHAPTER

2.1 LITERATURE SURVEY

2.1.1 Overview

Literature surveys play a crucial role in understanding the existing knowledge and research trends in a particular field. When it comes to robotic arms, there is a vast amount of literature available due to their widespread use in various industries and applications. Here is a brief literature survey highlighting some key research areas, trends, and notable papers related to robotic arms.

1. **Robotic Arm Kinematics and Dynamics:** Kinematics and dynamics form the foundation of robotic arm analysis. Numerous papers focus on modeling, control, and optimization of robotic arm movements. Notable works include "Robot Modeling and Control" by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, which provides a comprehensive overview of kinematic and dynamic modeling techniques.

2. **Robotic Arm Control:** Control algorithms play a crucial role in enabling precise and efficient movements of robotic arms. Classic control methods such as PID control and modern techniques like adaptive and learning-based control have been extensively studied. Prominent works in this area include "Feedback Control of Dynamic Bipedal Robot Locomotion" by Jessy W. Grizzle, et al., which presents control strategies for legged robots that can also be extended to robotic arms.

3. **Robotic Arm Grasping and Manipulation:**

   Grasping and manipulation are fundamental tasks for robotic arms, and research in this area aims to improve dexterity, object recognition, and grasp planning. Papers such as "GraspIt! – A Versatile Simulator for Robotic Grasping" by Andrew T. Miller, et al., present simulation tools and frameworks for grasp analysis and planning. Robotic Arm Perception:

   Perception plays a crucial role in robotic arm applications, enabling the arm to interact with the environment and objects. Object detection, recognition, and tracking are key research topics. Notable papers include "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks" by Shaoqing Ren, et al., which introduces a popular object detection algorithm.

4. **Robotic Arm Applications:**

   Robotic arms find applications in various fields, including manufacturing, healthcare, space exploration, and assistive robotics. Research papers in this area often focus on specific applications and domain-specific challenges. For example, "Robotics in Agriculture and Forestry" by M. Paulikas provides insights into the use of robotic arms in agriculture.

5. **Soft Robotic Arms:**

   Soft robotic arms have gained significant attention in recent years due to their flexibility and potential for safe human-robot interaction. Literature in this area explores soft materials, novel actuation mechanisms, and control strategies. "Soft Robotics: Biological Inspiration, State of the Art, and Future Research" by Robert F. Shepherd, et al., provides a comprehensive overview of soft robotics, including soft robotic arms.

   Please note that this literature survey only scratches the surface of the extensive research available on robotic arms. The field is continually evolving, and new research papers are published regularly. To delve deeper into a specific subtopic or find the latest advancements, it is recommended to explore academic databases, such as IEEE Xplore, ScienceDirect, or Google Scholar, using relevant keywords related to your area of interest.

3 CHAPTER

3.1 METHODOLOGY

Projects can be brought to a successful end in various ways. But the best and most popular project management methodologies, methods, and frameworks are always changing. New concepts appear all the time. An entire string of methods, tools, and techniques lies behind all successful projects. In fact, as a project management practitioner, you'll probably get to use more than just one of these during your life.

3.2 Hardware 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.

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.

3.3 Circuit Components lists

Table 1: List Of Components

Sr.No	**Component**	**Specification**	**Quantity**
1	Arduino Uno	-	1
2	Servo Motor	-	3
3	Joy Sticks	-	2
4	Connecting Wires	-	As per Requirement
5	Arm Kit	-	1
6	SPST Switch	-	1

3.3.1 Arduino Uno

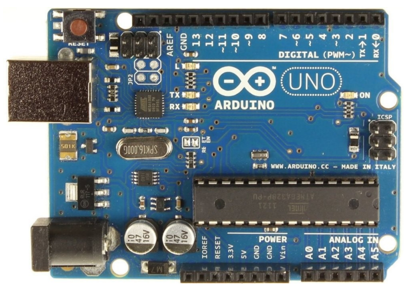

Figure 1: Arduino Uno

Arduino Uno is a popular microcontroller board based on the Atmega328P chip. It is a compact and user-friendly development board designed for beginners and experienced electronics enthusiasts. Arduino Uno provides an open-source platform for creating and prototyping a wide range of electronic projects.

With its easy-to-use interface and a large community of users, Arduino Uno allows you to write and upload code to control and interact with various electronic components such as sensors, motors, and displays. It has digital and analog input/output pins that can be easily programmed to perform different tasks.

Arduino Uno can be powered via USB or an external power source, making it versatile and portable. It supports a simplified programming language based on C/C++, making it accessible for beginners to start coding and experimenting with electronics.

The board can be connected to a computer through a USB cable, enabling seamless code uploading and real-time data monitoring. Arduino Uno also offers a wide range of shields and modules that expand its capabilities, allowing you to create complex projects with ease.

Overall, Arduino Uno is a versatile and user-friendly microcontroller board that serves as an excellent platform for learning, prototyping, and creating interactive electronic projects.

Arduinos contain a number of different parts and interfaces together on a single circuit board. The design has changed through the years, and some variations include other parts as well. But on a basic board, you're likely to find the following pieces.

- A number of pins, which are used to connect with various components you might want to use with the Arduino. These pins come in two varieties.
- Digital pins, which can read and write a single state, on or off. Most Arduinos have 14 digital I/O pins.Analog pins, which can read a range of values, and are useful for more fine-grained control. Most Arduinos have six of these analog pins.
- These pins are arranged in a specific pattern, so that if you buy an add-on board designed to fit into them, typically called a "shield," it should fit into most Arduino-compatible devices easily.
- A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low. The power connector can connect to either an AC adapter or a small battery.
- A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low. The power connector can connect to either an AC adapter or a small battery.
- A microcontroller, the primary chip, which allows you to program the Arduino in order for it to be able to execute commands and make decisions based on various input. The exact chip varies depending on what type of Arduino you buy, but they are generally Atmel controllers, usually a ATmega8, ATmega168, ATmega328, ATmega1280, or ATmega2560. The differences between these chips are subtle, but the biggest difference a beginner will notice is the different amounts of onboard memory.
- A serial connector, which on most newer boards is implemented through a standard USB port. This connector allows you to communicate to the board from your computer, as well as load new programs.
- Variety of other small components, like an oscillator and/or a voltage regulator, which provide important capabilities to the board, although you typically don't interact with these directly; just know that they are there.

3.3.2 Servo Motor

Figure 2: Servo Motor

The SG90 180-degree servo motor is a small and lightweight motor commonly used in robotics, it is a type of servo motor that can rotate up to 180 degrees. The SG90 servo motor operates on a control signal, typically a PWM (Pulse Width Modulation) signal, which determines the position of the motor's shaft. By varying the duration of the pulse signal, the motor's shaft can be positioned at different angles within its range of motion.

Applications for the SG90 180-degree servo motor include robotic arm movements, steering mechanisms in RC cars or boats, camera gimbal control, and various other projects that require controlled angular movement. It's important to note that while the SG90 servo motor can rotate up to 180 degrees, it does not offer continuous rotation like some other servo motors. It is limited to the specified range of motion.

3.3.3 Joy Stick

Figure 3: Joy Stick

The joystick in the picture is nothing but two potentiometers that allow us to measure the movement of the stick in 2-D.Potentiometers are variable resistors and, in a way, they act as sensors providing us with a variable voltage depending on the rotation of the devicearound its shaft .

3.3.4 SPST Switch

Figure 4: SPST Switch

A Single Pole Single Throw (SPST) switch is a switch that only has a single input and can connect only to one output. This means it only has one input terminal and only one output terminal. A Single Pole Single Throw switch serves in circuits as on-off switches. When the switch is closed, the circuit is on. When the switch is open, the circuit is off.

SPST switches are, thus, very simple in nature. SPST switches are commonly used in a variety of electrical circuits and applications, such as turning on and off lights, fans, and other appliances. They can also be used to control the flow of electricity to different parts of a circuit, or to switch between different circuits altogether.

3.4 Software Methodology

To accomplish the project, we had to go through various software methodologies, so that we could get the one which is best to fulfil the requirements in an efficient manner. In the market,there are many software tools that are available, and even that could be different in its own way according to the purpose of using. So, in our case after careful analysis, we have chosen Aurdino/Aurdinodroid App, because of its some specific advantages. There is some other software'that we could possibly use, but we have decided to use Aurdino IDE/AurdinoDroid App for our project

3.4.1 Procedure to Upload Program in Arduino

1. The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.
2. Download and install the Arduino Software IDE:
3. Arduino IDE 1.x.x (Windows, Mac OS, Linux, Portable IDE for Windows and Linux, ChromeOS).
4. Arduino IDE 2.x
5. Connect your Arduino board to your device.
6. Open the Arduino Software (IDE).
7. Write the program.
8. Compile the program.
9. Upload the program to the Board.

3.5 program Code

```
#include <Servo.h>

Servo s1;
Servo s2;
Servo s3;
Servo s4;

int pos1;
int pos2;
int pos3;
int x1;
int y1;
int y2;
int sw;
void setup() {
  // put your setup code here, to run once:
 Serial.begin(9600);
  s1.attach(2);
  s2.attach(3);
  s3.attach(4);
  s4.attach(5);
  pinMode(A0,INPUT);
  pinMode(A1,INPUT);
  pinMode(A2,INPUT);
  pinMode(6,INPUT_PULLUP);
}

void loop() {
  // put your main code here, to run repeatedly:

x1 = analogRead(A0);
y1 = analogRead(A1);
y2 = analogRead(A2);
sw = digitalRead(6);
```

```
if (x1>600){
  pos1 = s1.read();
  if(pos1<180){
    pos1+=1;
    s1.write(pos1);
    delay(10);
  }
}

if (x1<400){
  pos1 = s1.read();
  if(pos1>0){
    pos1-=1;
    s1.write(pos1);
    delay(10);
  }
}


if (y1>600){
  pos2 = s2.read();
  if(pos2<180){
    pos2+=1;
    s2.write(pos2);
    delay(12);
  }
}

if (y1<400){
  pos2 = s2.read();
  if(pos2>0){
    pos2-=1;
    s2.write(pos2);
    delay(12);
  }
```

```
}


if (y2>600){
  pos3 = s3.read();
  if(pos3<180){
    pos3+=1;
    s3.write(pos3);
    delay(12);
  }
}

if (y2<400){
  pos3 = s3.read();
  if(pos3>0){
    pos3-=1;
    s3.write(pos3);
    delay(12);
  }
}


if (sw == 0){
  s4.write(0);
}

if (sw == 1){
  s4.write(180);
}

Serial.println(pos1);
}
```

3.6 System Development

In this project, we are combining two things together, hardware and software. So, according to this, we need to be aware of each step that is required to follow. As we are coding in the microcontroller, and for the software, we need to be aware of the developing process of the application and of course the hardware which is linked to it.

4 CHAPTER

4.1 WORKING

4.1.1 Circuit Diagram

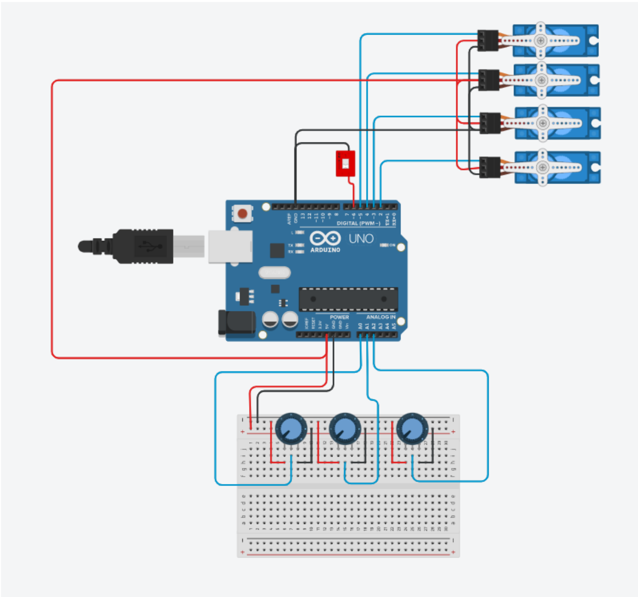

Figure 5: Circuit Diagram

4.1.2 Working Principal

Here we are having three pots provided to the user that is by rotating these three 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 . So to filter out this noise, capacitors are placed across each resistor.Robotic Arm is controlled by three 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.

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 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.

4.2 Actual Circuit

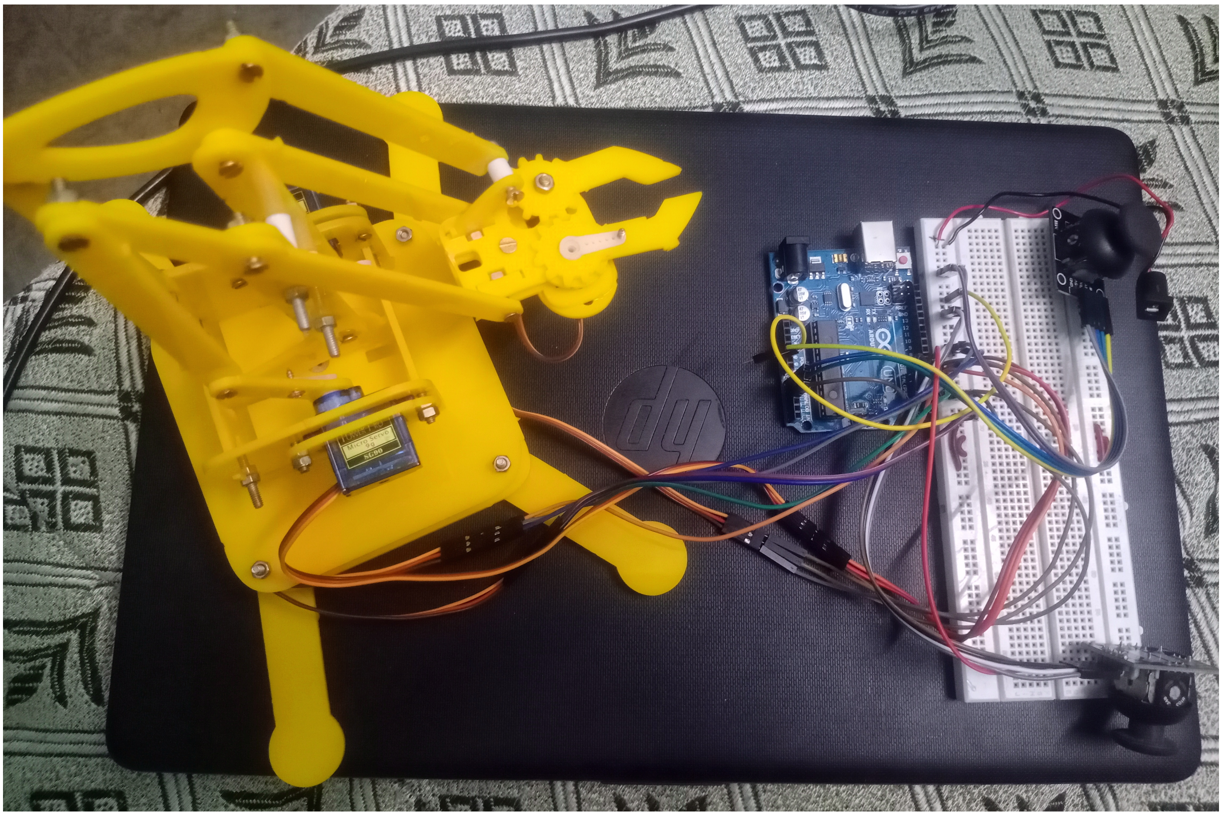

Figure 6: Circuit Diagram

5 CHAPTER

5.1 RESULT AND ANALYSIS

5.1.1 Applications

- Public Internet access using existing LED lighting.
- Auto-piloted cars that communicate through their LED based headlights.
- Connecting with specialists across the globe from the operation theater.
- Since it uses just the light, it can be used safely in locations or areas where the presence of radio waves raises concerns of security.

5.1.2 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.

5.1.3 Limtation

- This project is a small scale production it can pick up only small and lighter objects.
- 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 CHAPTER

6.1 CONCLUSION AND FUTURE SCOPE

6.1.1 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.

6.1.2 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.

- The machine will be of great use to perform repetitive task of picking of small part in industrial production line.

- Its use can be extended and exploited by few modifications to dodifficult and hazardous tasks for industrial applications.

- It can be used to do small assembly work effectively due to its greatadded accuracy for placement of parts, which is further extended scope.

7 CHAPTER

7.1 References

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APPENDIX-1

Hex Code

```
:100000000C9462000C948A000C948A000C948A0070
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