ARM REPORT

Updated and Structured for GitHub Documentation

This document has been updated with a professional structure for showcasing on GitHub.
It includes all the essential information about the 'Robotic Arm' project, with enhancements
to readability and content organization.

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BUNDELKHAND UNIVERSITY, JHANSI

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INSTITUTE OF ENGINEERING OF TECHNOLOGY(IET)

ELECTRONICS AND COMMUNICATION ENGINEERING (ECE)

A PROJECT REPORT ON:

"ROBOTIC ARM"

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CANDIDATE'S DECLARATION

I hearby declare that the work which is being presented entitled as **"ROBOTIC ARM" ,** towards the partial fulfillment for the award of Degree of bachelor of Technology in Electronics & Communication Engineering, Institute of Engineering & Technology, Bundelkhand University, Jhansi, is an Authentic record of my work, under the kind guidance of **Er. SAIYED TAZEN,** Lecturer, Department of Electronics & Communication Engineering, Institute of Engineering & Technology, Bundelkhand University, Jhansi.

I have not submitted the matter embodied here for the award of any other degree.

Date : July 2022

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CERTIFICATE

Certified that Group carried out the project work presented in this report entitled **“ROBOTIC ARM” for** the partial fulfillment for the the partial fulfillment for for the award of degree of **Bachelor of Technology** from **Bundelkhand University**, **Jhansi**. The work is carried out by students themselves and the content of the work do not from the basis for the award of any other degree to the candidate or to anybody else

Date 16 JUNE 2022

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It would never be possible for us to take this level without innovative Idea and his relentless support and encouragement.

CONTENT

ABSTRACT

A Robotic Arm is one type of mechanical arm which is similar to a human and do most of the work that a human arm Can do most of the works that a human arm can do. It can do various works which is very risky for human. A robotic Arm is a programmable and can do the works through instructions. In today's world robotic arm are used in industries, Rescue purpose and various research works. Considering the facts, we thought of designing and making some improvement in robotic arm. Our robotic arm is an Arduino controlled five-degree freedom robot arm which can move 360 Degree and in five directions, it can do almost all the works of gripping.

First of all the unique part of our robotic arm is, a counter weight is used here to balance the arm while some object is Gripped. secondly, it is able to move to a specific point of its work space through X, Y and Z axis balance automatically If the points are given. For given command we are using the Bluetooth module communication system through an Application. This work presents a five-degree robotic arm with a gripper, controlled with an android application and Arduino UNO via Bluetooth to carry or load materials, here the app searches for the Bluetooth connections, if the Bluetooth device connected with the robot is open for connection, the mobile app connects with it. Then the app Send command to the Arduino UNO connected with the robot which is the brain of the robot, this command is fetch By the Arduino UNO and according to the command it moves the robot forward, backward, left turn, right turn, stop And it expands the gripper to pick a material, squeezes the gripper when a material is picked and it can also move The gripper in left or right direction according the lead.

CHAPTER 1: INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replacement humans especially, to perform the repetitive task. In general, robotics can divide into two areas, industrial and service robotics. These are currently used in many fields of applications including office, military tasks, hospitals operations, Dangerous environment and Agriculture. Besides, it might be Difficult or dangerous for human to do some specific tasks like picking up explosive Chemicals, defusing Bombs or in worst case scenario to pick and place action in industries.

Therefore, a robot can be replaced to do work.

ROBOTIC ARM DEFINATION

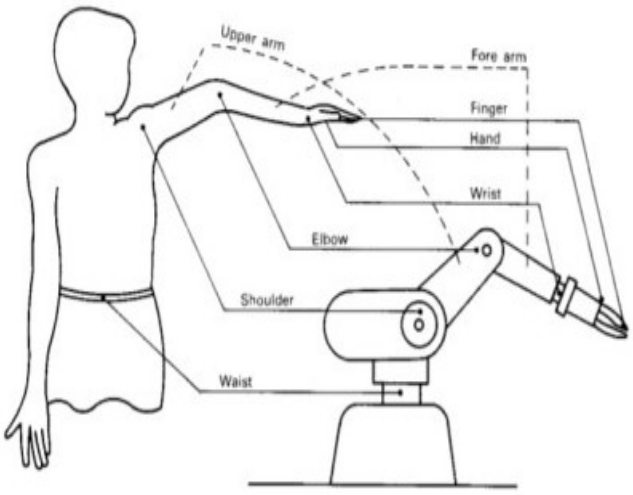
A Robotic Arm is a robot manipulator and a mechanical arm, usually programmable, with similar functions To a human Arm. The links such a manipulator is connected by joints allowing either Rotational motion Or Linear displacement. The link of the manipulator can be considered to form a kinematic chain. The Links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain Of the manipulator is called yhe end effectors and it is analogous of the human hand. The end effectors an can Be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. The Robotic ARM can be autonomous or controlled manually and can be used to perform a variety of tasks with Great accuracy. The robotic arm can be fixed or mobile and can be designed for industrial or home applications.

CHAPTER 2: DESIGNING PORTION

2.1 Design of Robotic ARM:

The Robotic Arm is designed using the Microcontroller i.e., Arduino. Micro-controller using Arduino programming. This process works on the principle of interfacing servos and Bluetooth. This task is achieved by using Arduino board.

Robot arm of 5 degrees of freedom is commonly used for both education and industrial uses. This robot works with 5 motors for the joint, in the following picture you can see the shape of the robot with 5 degrees of freedom.



For the first 3 axis, the waist, the shoulder and the elbow, I used the MG996R servos, and for the other 2 axis, the wrist roll and wrist pitch, as well as the gripper I used the smaller SG90 micro servos.

The 5 DOF Arm makes use of 5 servo motors controlled by an Arduino Uno Controller. The controller is interfaced with a Bluetooth receiver that is used to receive commands via android App.

2.2. Five Degree of Freedom

Robotic arm includes a drive assembly and an articulated arm assembly pivotally connected to the drive assembly. The articulated arm includes a pivoting base link system, a wrist link system, and a first elbow link system rotatable connected to the base link system by a pair of upper arms and connected to the wrist link system by a pair of forearms, a second elbow link system rotatable connected to the base link system by another at least one upper arm and connected to the wrist link system by another at least one forearm, wherein the drive assembly is connected to at least one of the upper arms and the base link system to provide three degrees of freedom by driving the at least one of the upper arms and pivoting the pivoting base link system to position the wrist link system at a given location with a predetermined skew relative to an axis of translation

Positive and Negative on Robotic ARM

2.3.1 The Positive:

Increase productivity

Use equipment effectively

Reduce working costs

Flexibility at work

Get the job done in the shortest time

Provide good returns on investment

Better accuracy in performance

Ability to work in risky ways and make it more safe

2.3.2 The negative:

Cause unemployment for manual workers

High initial cost

designed Arm to perform specific tasks and not comparable to the human hand

Difficulty programmed to perform Accurate tasks

Needed a large number of sensors and high accuracy to perform the Complex tasks

And other technical problems, "especially in the fields of artificial intelligence and Machine vision" .

When the Robotic arm break down the production line will go off in the factories

CHAPTER 3: THEORETICAL PORTION

3.1 Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

Specification

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P)
	of which 0.5 KB used by bootloade*r
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

3.3 Programming

The Arduino Uno can be programmed with the (Arduino Software (IDE)).The ATmega328 on the Arduino UNO preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

3.4 Power

The Arduino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wallwart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

3.6 Arduino development "IDE"

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit make files or run programs on a command-line interface

Arduino programs are written in C or C++ The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output.

Operations much easier.

Users only need define two functions. To make a runnable cyclic executive program:

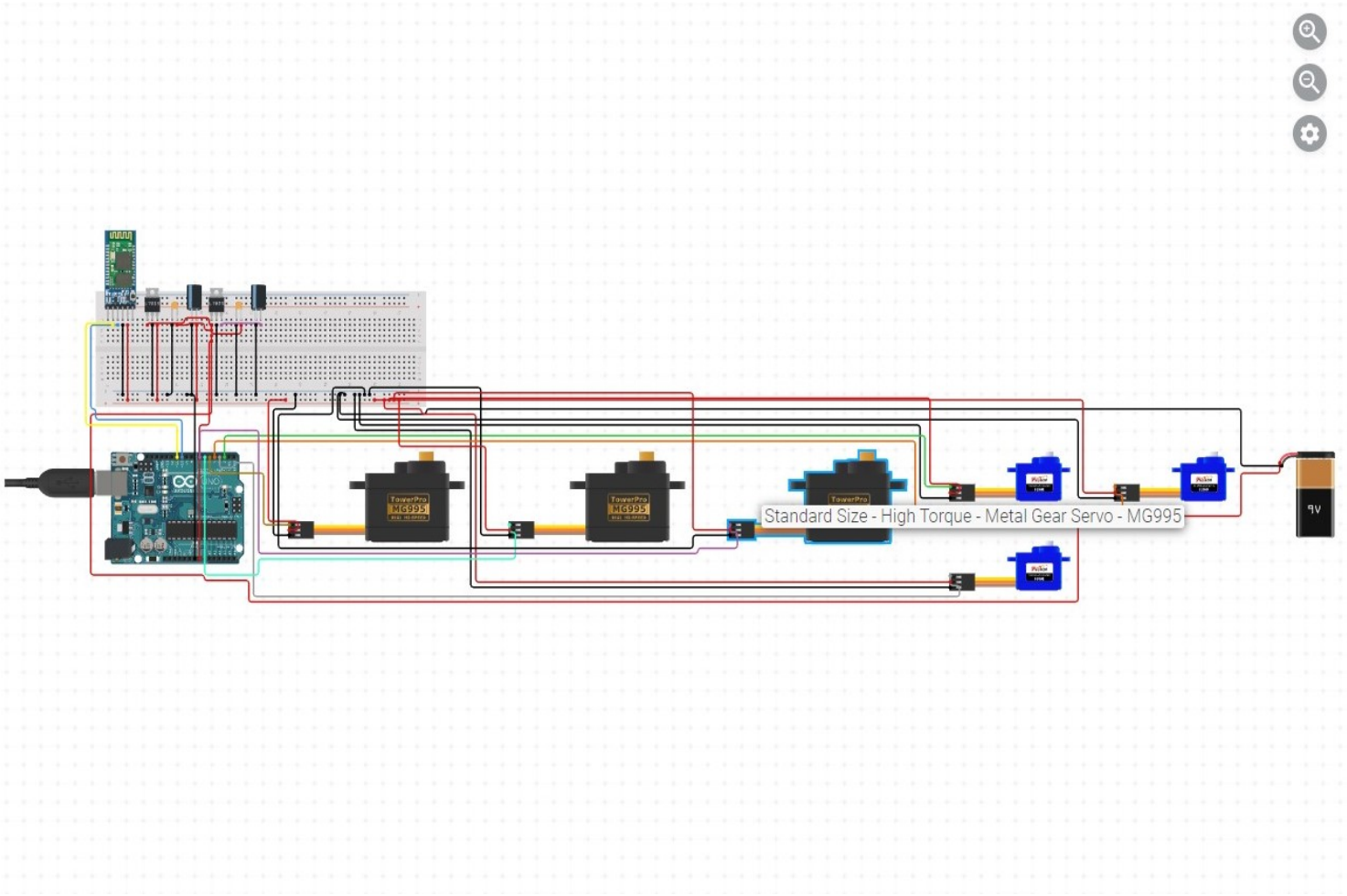
Setup (): a function run once at the start of a program that can initialize settings.

Loop (): a function called repeatedly until the board powers off

2.4. Circuit Diagram (Above Board)

Circuit; Servo inputs, Arduino pin inputs, and Bluetooth module inputs. Servo motors are activated in this way, Bluetooth module Arduino Nano connections.

And power supply connections are shown. Thanks to this circuit we use, it is possible to distribute the 5V from the power supply to the servo motors.



CHAPTER 4: PRACTICAL PORTION

4.1 Servo Motors

Servo refers to an error sensing feedback control which is used to correct the performance of a system. Servo or RC Servo Motors are DC motors equipped with a servo mechanism for precise control of angular position. The RC servo motors usually have a rotation limit from 90° to 180°. But servos do not rotate continually. Their rotation is restricted in between the fixed angles. The Servos are used for precision positioning. They are used in robotic arms and legs, sensor scanners and in RC toys like RC helicopter, airplanes and cars.

The specifications for big Servomotor used are as follows:

Weight- 55g

Dimension- 40.7*19.7*42.9mm

Stall torque- 10kg/cm

Operating speed-0.20sec/60degree(4.8v)

Operating voltage 4.8-7.2V.

Temperature range 0-55 degrees.

The specifications for small Servomotor G9 used are as follows:

Weight: 9 g

Dimension: 22.2 x 11.8 x 31 mm approx.

Stall torque: 1.8 kgf·cm • Operating speed: 0.1 s/60 degree

Operating voltage: 4.8 V (~5V)

Dead band width: 10 µs

Servomotors are the electromechanical energy conversion devices. In other words, a *Servomotors* is a rotary actuator or linear actuator which is used for precise control of linear or angular position, velocity and acceleration

A servomotor consists of an electric motor coupled with a sensor for position feedback. Servomotors are used in feedback control systems as the output actuators. Hence, servomotors are also called as **control motors**.

Servomotors are not used for continuous energy conversion. The power ratings of servomotors vary from a fraction of a watt to a few hundred watts. The servomotors have low rotor inertia and hence they have a high speed of response.

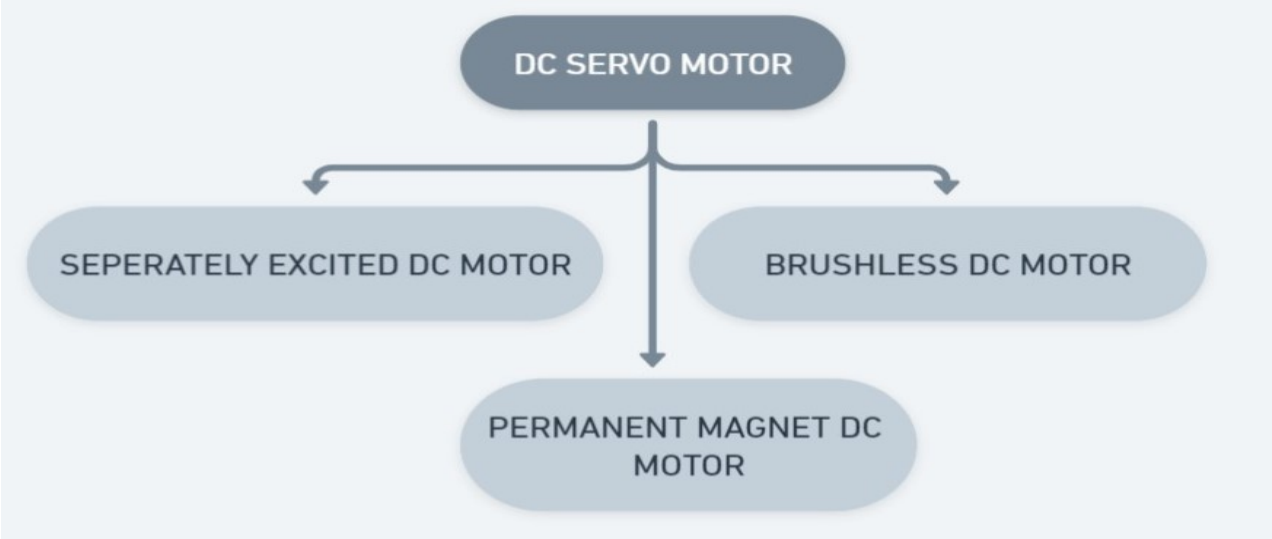
Practically, the rotors of servomotors are designed with long rotor length and smaller diameters. A servomotor has larger size as compared to a conventional motor of same rating. The servomotors generally operate at very low speeds and sometimes zero speed.

Applications of Servomotors

The servomotors are widely used in –

- Radars and communication devices
- Computers
- Robots and other automation systems
- Machine tools
- In-line manufacturing
- Pharmaceutics and food services
- Remote controlled toy cars
- Tracking and guidance systems
- Process controllers, etc.

As we know that any electrical motor can be utilized as servo motor if it is controlled by servomechanism. Likewise, if we control a DC motor by means of servomechanism, it would be referred as DC servo motor. There are different types of DC motor, such shunt wound DC motor, series DC motor, Separately excited DC motor, permanent magnet DC motor, Brushless DC motor etc. Among all mainly separately excited DC motor, permanent magnet DC motor and brush less DC motor are used as servo.



4.3.1 DC Servo Motor Theory:

The which are utilized as DC servo motors, generally have separate DC source for field winding and armature winding. The control can be archived either by controlling the field current or armature current. Field control has some specific advantages over armature control and on the other hand armature control has also some specific advantages over field control. Which type of control should be applied to the DC 16 servo motor, is being decided depending upon its specific applications. Let's discus DC servo motor working principle for field control and armature control one by one motor

4.6 Bluetooth HC-06 module

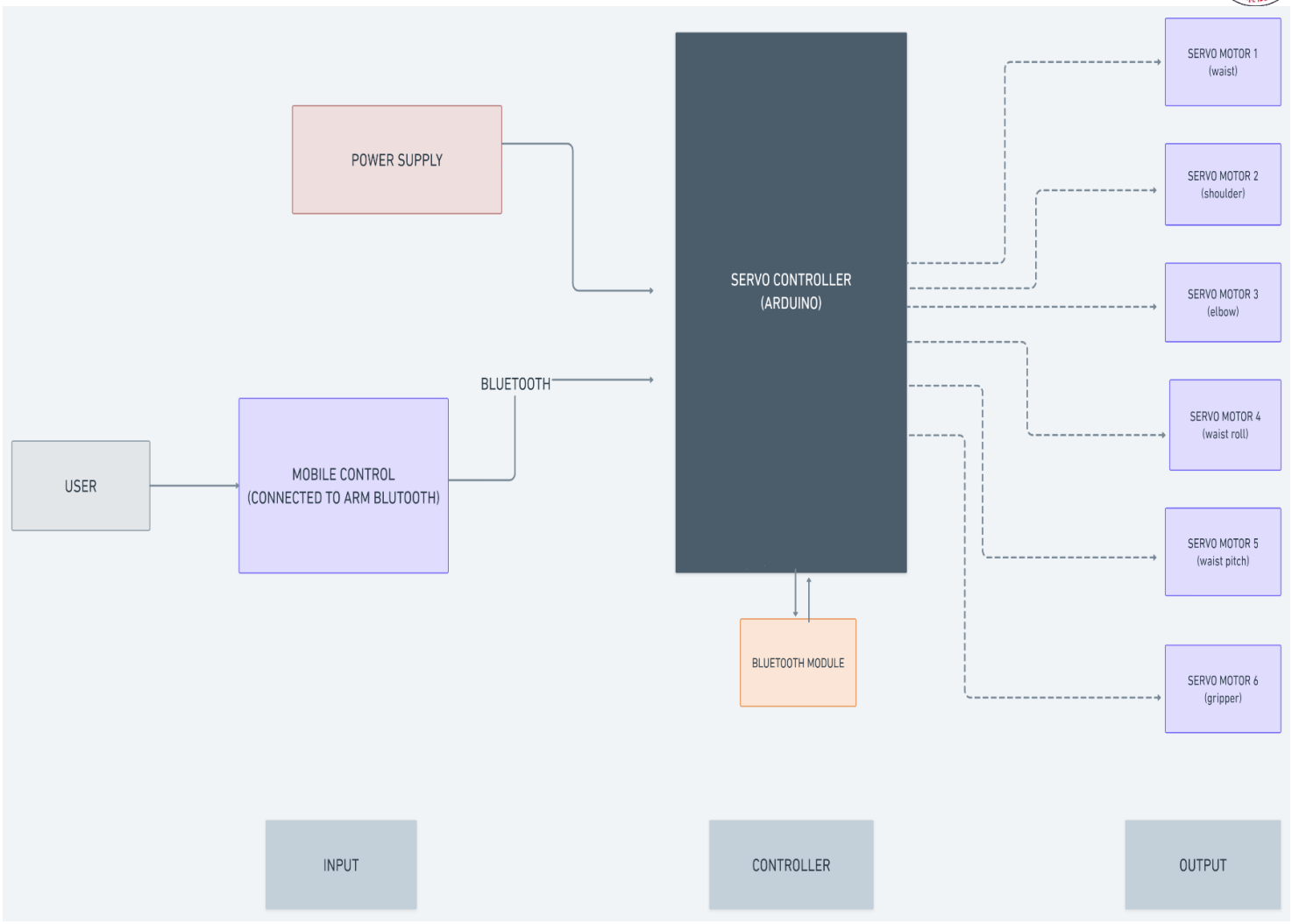
HC.06 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04.External singl

Pin Description

- **EN:** It is the enable pin. When this pin is floating or connected to 3.3V, the module is enabled. If this pin is connected to GND, the module is disabled.
- **+5V:** This is the supply pin for connecting +5V. As the Module has on-board 3.3V regulator, you can provide +5V supply.
- **GND:** It is the ground pin.
- **TX:** It is the Transmitter pin of the UART Communication.
- **RX:** It is the Receive Pin of UART.
- **STATE:** This is a status indicator pin. This pin goes LOW when the module is not connected to any device. When the module is paired with any device, this pin goes HIGH

HC-05 module Information

- HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.
- This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.
- As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.



FLOW CHART OF ROBOTIC ARM

CHAPTER 5: MECHANICAL PORTION

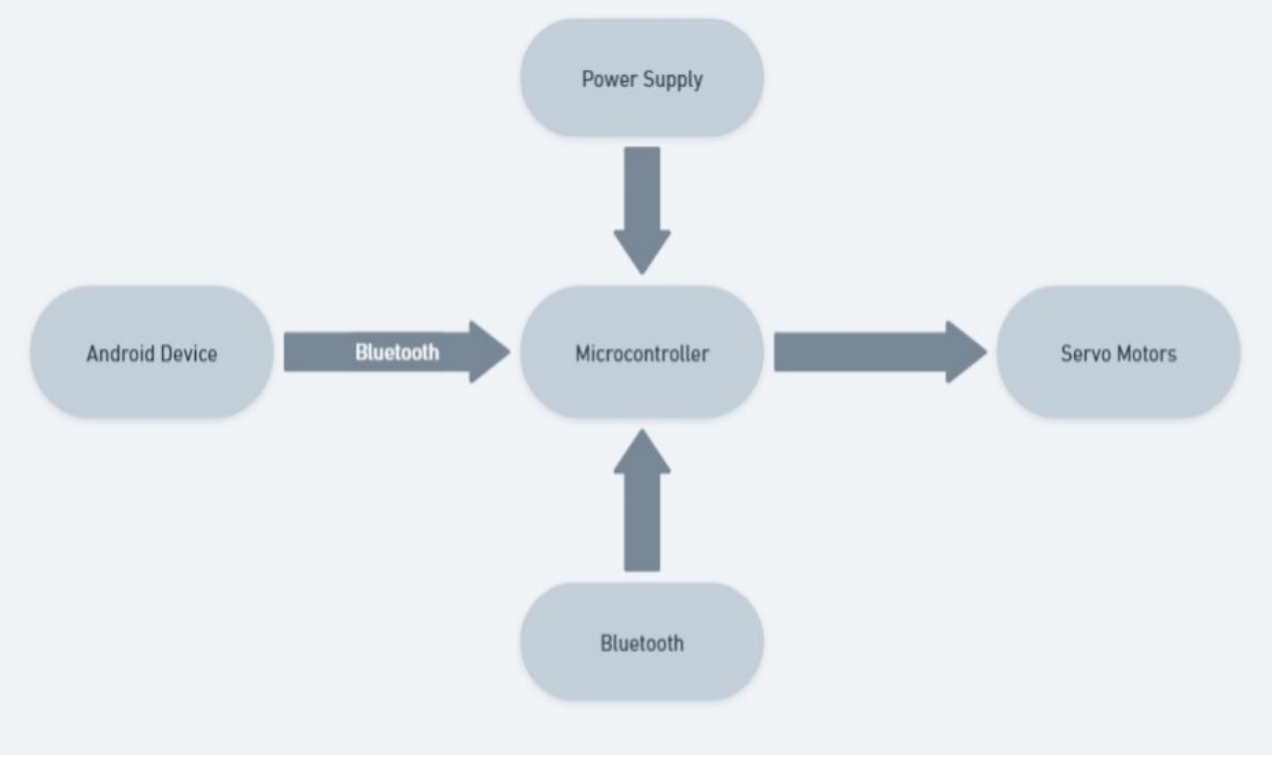
5.1Mechanical Design

The mechanical design of the robot arm is based on a robot manipulator with similar functions to a human arm . The links of such a manipulator are connected by joints allowing rotational motion and the links of the manipulator is considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is called the end effector or end of arm tooling and it is analogous to the human hand. Figure 5.1 shows the Free Body Diagram for mechanical design of the robotic arm.

As shown, the end effector is not included in the design because a commercially available gripper is used. This is because that the end effector is one of the most complex parts of the system and, in turn, it is much easier and economical to use a commercial one than build it. Figure 5.17 shows the work region of the robotic arm. This is the typical workspace of a robot arm with four degree of freedom (6 DOF). The mechanical design 27 was limited to 6 DOF mainly because that such a design allows most of the necessary movements and keeps the costs and the complexity of the robot competitively Accordingly, rotational motion of the joints is restricted where rotation is done around two axis in the shoulder and around only one in the elbow and the wrist, see Figure 5.18. The robot arm joints are typically actuated by electrical motors. The servo motors were chosen, since they include encoders which automatically provide feedback to the motor.

Robot Arm Control

The robot arms can be autonomous or controlled manually. In manual mode, a trained operator (programmer) typically uses a portable control device (a teach pendant) to teach a robot to do its task manually. Robot speeds during these programming sessions are slow. In the current work we enclosed the both modes. The control for the presented robot arm consists basically of three levels: a microcontroller, a driver, and a computer-based user interface. This system has unique characteristics that allow flexibility in programming and controlling method, which was implemented using inverse kinematics; besides it could also be implemented in a full manual mode. The electronic design of control is shown in Figure 11. The microcontroller used is an Atmega 368p which comes with a development/programming board named —Arduino‖, as shown in Figure 12. The programming language is very similar to C but includes several libraries that help in the 33 control of the I/O ports, timers, and serial communication. This microcontroller was chosen because it has a low price, it is very easy to reprogram, the programming language is simple, and interrupts are available for this particular chip. The driver used is a eight .channel for servo controller board. It supports tow control methods: Bluetooth for direct connection to an android device or direct control using variable resistors. This controller as shown in figure.



Electronic Scheme of Control

5.4 End-Effector Selection

The end effector is probably one of the most important and most complex parts of the system. The end effector varies mainly according to the application and the task that 34 the robot arm accomplishes for; it can be pneumatic, electric or hydraulic. Since our robot arm is based on an electric system, we may choose electric basis of end effector. Besides, the main application of our system is handling, accordingly, the recommended type of our end effector is a gripper, as shown in Figure and Figurer 5.23. Please note that the end effector is controlled by a servo motor .

5.5 MIT App Inventor

MIT App Inventor is a blocks based programming tool that allows everyone, even novices, to start programming and build fully functional apps for Android devices. Newcomers to App Inventor can have their first app up and running in an hour or less, and can program more complex apps in significantly less time than with more traditional, text based languages. Google's Mark Friedman and MIT Professor Hal Abelson co-led the development of App Inventor while Hal was on sabbatical at Google. Other early Google engineer contributors were Sharon Perl, Liz Looney, and Ellen Spertus . App Inventor runs as a Web service administered by staff at MIT's Center for Mobile Learning. A collaboration of MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and the MIT Media Lab. MIT App Inventor supports a worldwide community of nearly 3 million users representing 195 countries worldwide. The tool's more than 100 thousand active weekly users have built more than 7 million android apps. An open source tool that seeks to make both programming and app creation accessible to a wide range of audience

Formal and informal educators who have used MIT App Inventor to introduce programming to their Computer Science students, science club members, after school programs attendees, and summer campers. Many educators have also started to use MIT Inventor to develop apps in support of their own instructional objectives.

Government and civic employees and volunteers who have harnessed the power of MIT App Inventor to develop custom, often hyper local apps in response to natural disasters and community based needs Designers and product managers who have seen the potential that MIT App Inventor has to support the iterative design process via rapid prototyping, testing and iteration.

Researchers who use MIT App Inventor to create custom app in support to meet their data collection and analysis requirements in support of their research in a wide variety of fields from medical to social.

Hobbyists and Entrepreneurs who have an idea they want to quickly turn into an app without the cost or learning curve that more traditional app creation entails.

Future scope on Robotic ARM

- The machine will be of great use to perform repetitive tasks of picking and placing of small parts (up to 500 gms) in an industrial production line

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

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

CONCLUSION

The main focus of this work was to design, and programme robotic arm the robot arm was designed with five degrees of freedom and talented to accomplish accurately simple tasks, such as light material handling the robot arm is equipped with several servo 40 motors which do links between arms and perform arm movements. A microcontroller that drives the servo motors with the capability of modifying position The programming is done on ATMEGA-328p Microcontroller using Arduino programming. The potentiometers are also used to detect the angle of rotation and the signals are then sent to the microcontroller. And you can control the robotic arm also using android device, in today's world, this Robotic arm has turned out very benevolent. Besides Robotics and Automation, these kinds of arms have applications in other fields also.