INDERPRASTHA ENGINEERING COLLEGE

Department of Electronics & Communication Engineering

PROJECT REPORT

on

APP CONTROLLED PICK AND PLACE ROBOTIC VEHICLE

Under the guidance of: **Dr. Swati Vaid**

By

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INTRODUCTION

In this rapidly changing world, inefficient use of time and labor are major obstacles to completing tasks on a wide scale. In the majority of routine and frequently performed tasks, robots play a significant role in reducing the need for human labor. Robots are intelligent machines that can be programmed and employed in a variety of settings, including business, manufacturing, assembly lines, healthcare and many more. These robots labor diligently, accurately, and in a hazardous environment to make human lives easier. They can work nonstop for 24 hours, and their performance is more efficient and precise than that of humans. Picking and arranging objects from source to destination is one of the main and most often done tasks.

A pick and place robot is a microcontroller-based mechatronic device that moves an object from one location to another. Pick and place robots automate the process of selecting an item and putting it in another location. By automating this process, production rates can be increased. Pick and place robots complete tedious tasks, freeing up human workers to focus on more difficult tasks. These have become widely used in a variety of industries for moving tasks.

Simple tasks such as lifting objects or moving them do not require a lot of thought processes. Therefore, using human workers on these tasks can be wasteful, as the workforce can be used for other tasks that require higher mental abilities. These repetitive tasks are handled by pick and place robots. These robots are often equipped with sensors and vision systems to lift objects from moving conveyor belt.

Every day, people with disabilities encounter situations where they need to lift something but are unable to do so and must enlist someone else's assistance. Industries are seeing a lot of stockpiling, necessitating the development of technology that can pick the ideal material at the ideal time with the least amount of danger and effort. In order to better utilize human potential, industries aspire to replace humans doing less productive work with robots. Robots have been produced in the past for a variety of tasks, but there still seems to be an opportunity for advancement.

The pick and place robots used for monotonous tasks in the food packaging industry nowadays are based on the Delta robots. Delta robots were designed in the early 1980s by a research team led by Professor Reymond Clavel at EPFL, Switzerland. The mass-scale production of packaging pick and place robots started in 1987 when a Swiss company called Demaurex purchased the license to create these robots. The field of pick and place robots is still developing, with researchers optimizing these robots for picking even smaller items for computer processors, or for higher speed repetitive tasks and precision.

COMPOSITION

(1)Structure

A robot's structure is typically primarily mechanical and is referred to as a kinematic chain. Links, actuators, and joints make up the chain, each of which can accommodate one or more degrees of freedom. The majority of modern robots work via open serial chains, where each link links to the one before and after. Serial robots are the name for these machines, which frequently resemble human arms.

(2)Power Source

Currently, (lead-acid) batteries predominate, but other potential power sources include:

 Pneumatic (compressed gases)

 Hydraulics (compressed liquids)

 Flywheel energy storage

 Organic garbage (through anaerobic digestion)

 Still untested energy sources (e.g., Nuclear Fusion reactors)

(3)Actuation

Actuators are the components that turn stored energy into movement, similar to the "muscles" of a robot. Electric motors that spin a wheel or gear and linear actuators that regulate industrial robots in factors are by far the two types of actuators that are most widely used. However, new developments in different forms of actuators that are powered by electricity, chemicals, or compressed air have recently emerged.

(4)Vision

The science and technology of computer vision can assist machines in seeing. Computer vision is a field of study that focuses on the theory underlying artificial systems that extract data from images. The image data can be in many different formats, including video clips and camera views.

Computer vision systems rely on image sensors to detect electromagnetic radiation, which is frequently present as either visible light or infrared light. Quantum mechanics is necessary for sophisticated image sensors to provide a thorough understanding of the image formation process.

(5)Manipulation

Robots that operate in the actual world need to be able to pick up, alter, destroy, or otherwise affect objects. This is why a robot's "hands" are frequently referred to as end effectors and its arm as a manipulator.

The gripper is one of the most prevalent effectors. It can be described as having just two fingers that can open and close to pick up and release a variety of little objects.

DEGREE OF FREEDOM

A joint on the arm represents each degree of freedom; this joint allows the arm to bend, spin, or translate. The quantity of actuators on the robot arm may often be used to determine the number of degrees of freedom. The amount of independent relative motions a robot is capable of doing is known as its DOF**.**

A smartphone is a mobile phone built on a mobile computing platform, with more advanced computing ability and connectivity than a feature phone. Smartphones are a more affordable and efficient hand-held devices which can be used to support collaborative activities in a community. It is a result of a huge advancement in mobile phones technology. Humans are anxiously working on finding new ways of interacting with machines. However, a major breakthrough was observed when gestures were used for this interaction.

Smartphone, a small yet powerful device is rapidly changing the traditional ways of human-machine interaction. Modern smartphones are embedded with accelerometer sensor, Bluetooth module and are powered by different operating systems such as Symbian, Bada, Android OS etc. Among all available mobile operating systems Android OS has gained significant popularity after being launched in 2008, overtaking all previous competitors due to its open architecture. Android platform has revolutionized the application development field for cellphone, opening new doors for technical exploration. The smartphone can be freely rotated in space, temporarily varying 3-dimensional signal data is obtained from the phone's 3-axis acceleration sensor. This data is transmitted to a robot via Bluetooth module of smartphone using an android app. Further, it is processed by a microcontroller embedded on the robot for its desirable motions.

For past two decades, researchers from around the world have shown keen interest in gesture technology and its possibilities in various fields making it a powerful tool for humans. Smartphones have proved to be of much more aid than being a device just for making calls. The large world is merging together into the palms of humans in the form of a smartphone.

LITERATURE SURVEY

[1] Design and Analysis of Pick and Place Robot by S. Mohanavelan[1] , M. Madhan Kumar[2] , K. Mohanprabhu[3] , M. Narendhiran[4] , B. Om Adhavan[5]

The design and implementation of a 5-DOF pick and place robotic arm is the main topic of this paper. The SOLIDWORKS18 design and 3D printing technologies were used to create this pick and place robotic arm. Servo motors are used to construct 3D-printed models, and an Arduino board and Bluetooth module are used to connect them. Arm is controlled by smartphone using Bluetooth module. Analysis of the final CAD model is done on ANSYS WORKBENCH 14.0. There are two most common materials used in this process are plastics called Acrylonitrile Butadiene Styrene (ABS) and Polylactic Acid (PLA). This paper focuses on designing a robotic arm which is soft, light weight and cheap using 3D modelling technique.

[2] Design of Pick and Place Robot by S. Sentil Kumar

The introduction to robots, their characteristics, classification, benefits, drawbacks, and applications are the main topics of this paper. It focuses on pick-and-place robot specifications as well as the components needed to make an effective robot.

[3] Implementation of Pick and Place Robot by R.Neeraja[1], Dr. Sanjay Dubey[2], S.B.Arya[3], Neeraj Moota[4]

The goal of this paper is to create a Pick and Place Robot that can be operated by an Android phone. The XLR8 Development Board, an FPGA-based microcontroller that can be programmed using the Arduino IDE, a battery source, motor drivers, motors, and a Bluetooth module make up the prototype. Using the Bluetooth application named "Arduino Bluetooth controller," the user issues commands to the robot. The Google Play store offers this application for no cost. This paper's discussion of a robotic vehicle only provides one degree of freedom (DOF).

[4] Design and Fabrication of RF-Controlled Pick and Place Robotic Vehicle by Monsuru Abolade Adeagbo[1] , Ifeoluwa David Solomon[2] , Peter Olalekan Idowu[3] , John Adedapo Ojo[4]

This work proposes a design and fabrication process for RF-controlled pick and place robotic vehicles. RF transceiver modules, encoder and decoder ICs, microcontrollers, voltage regulators, servo motors, motor drivers, batteries, and other electrical materials are used in the fabrication. The vehicle can be smoothly operated (pick and place of tiny objects) at a maximum distance of 100 metres by the RF remote. The keypad is connected to the microcontroller via the keypad in the remote-control area, which also includes an RF transmitter module with an antenna, encoder, and 12V alkaline battery.

[5] Development of Pick and Place Robot in Agriculture by Srinivasa Nayaka K R[1] , Dr. Mallikarjuna.C [2]

This paper focuses on pick and place function in agricultural section which can benefit the farmers. The automatic seeding, water pumping, pick-and-place setup to remove the dried plant, and seed planting in the same location are all discussed in this paper. The Arduino Uno microcontroller has a Bluetooth module installed. Voice control is used to deliver all instructions through an Android mobile device. This robot uses an LCD, IR sensors, motor drivers, and motors in addition to an Arduino microcontroller. The project's hardware section consists of the components listed, while the software section consists of the programming language, Embedded C, and the platform on which it is run, Kiel software.

[6] Voice controlled Camera Assisted Pick and Place Robot Using Raspberry Pi by Muneera Altayeb[1] , Amani Al-Ghraibah[2]

The main objective of this system is to design and implement a robot that can recognise objects based on their characteristics, specifically their colour. The robot will analyse the video stream to detect coloured objects using artificial intelligence and image processing techniques, and it will then specify the object's location and issue commands to the raspberry pi based on its current position. A pocket arm is employed. In order to connect with a mobile application, the robot will also have a Wi-Fi modem. The robot will be controlled by the application in one of two modes: manual or automatic. Here, the robot begins to look for objects based on their qualities and strives to gather them.

[7] Android Phone Controlled Robot Using Bluetooth by Arpit Sharma[1] , Reetesh Verma[2] , Saurabh Gupta[3] and Sukhdeep Kaur Bhatia[4]

This paper analyses the motion technology used to capture gestures through an Android smartphone equipped with an integrated accelerometer and Bluetooth module. The microcontrollers regulate the Bluetooth Module's signals. The Bluetooth device (HC-05) is attached to the robot that receives the data from the mobile and also can transmit the data. The platform for developing the application is MIT Inventor. This paper mainly focuses on providing information on how to connect to the robot.

[8] ANDROID PHONE CONTROLLED BLUETOOTH ROBOTIC VEHICLE by Luv Sharma[1], Nidhi Mahawar[2], Nikita Meena[3], Nikhil Chopra[4], Ajay Bhardwaj[5], Abhishek Gupta[6]

This paper focuses on the designing of a computerised robotic vehicle that can move in the desired direction. Bluetooth is utilised to communicate with the microcontroller and an Android

application that uses RC control has been employed. Microcontroller ATMEGA328P-PU is used for the designing of robotic vehicle and the language of coding is C language.

[9] Generic Development of Bin Pick-and-Place System Based on Robot Operating System by CHING-CHANG WONG [1,2], CHI-YI TSAI [1,2], (Senior Member, IEEE), REN-JIE CHEN[2] , SHAO-YU CHIEN [2] , YI-HE YANG [2] , SHANG-WEN WONG [2] , AND CHUN-AN YEH [2]

The suggested system integrates a pick-and-place module and an object perception module using ROS. A YOLOv4 object detector is constructed to estimate the pose of the target item, and an object sorting mechanism is suggested to locate the target object in the image. The pose of the target object is then estimated using a process based on computer-aided design (CAD). A bin collision avoidance strategy based on link distance is suggested to prevent collisions. Finally, the outcome of the bin collision avoidance and the pose of the target object are used to determine the angle of the 1-DOF vacuum tool and the picking and placement postures of the robot manipulator.

[10] Voice-based direction control of a robotic vehicle through User commands by Mohammadibrahim Korti[1] , Girish B. Shettar[2] , Ganga A Hadagali[1] , Shashidhar Shettar[3] , Shailesh Shettar[3]

The goal of this article is to use speech recognition to operate a car. The end user speaks commands to the vehicle, which stops and moves in several directions like forward, backward, right, and left. To view the distance between the vehicle and the obstacles, a camera and LCD screen are attached on the vehicle. The application uses voice instructions within a 1 metre radius. GPS is integrated into the car. There are predefined commands. The microcontroller used is Arduino.

[11] Design Analysis of a Remote Controlled "Pick and Place" Robotic Vehicle by [1]B.O.Omijeh and [2]R.Uhunmwangho

This paper focuses on designing and analysing of a remote-controlled pick and place robotic vehicle. The microcontroller used is PIC 18F425 Microcontroller and for the communication, a transceiver is used. The robot designed has 5 DOF.

[12] OBSTACLE AVOIDANCE ROBOTIC VEHICLE USING ULTRASONIC SENSOR, ARDUINO CONTROLLER by R.VAIRAVAN[1], S.AJITH KUMAR[2], L.SHABIN ASHIFF[3] , C.GODWIN JOSE [4]

This paper focuses on creating an ultrasonic sensor-controlled robot vehicle that can avoid obstacles. The robot is constructed with an ultrasonic sensor, and an Arduino microcontroller is used to operate it. This vehicle is employed for obstacle detection and collision avoidance. An android app has been used to operate the robotic car. The ultrasonic sensor used is HC-SR04.

[13] Remote Controlled Pick and Place Robot by Meenakshi Prabhakar[1]* , Valenteena Paulraj[1] , Dhusyant Arumukam Karthi Kannappan[1] , Joshuva Arockia Dhanraj[1] , Deenadayalan Ganapathy[1]

This paper focuses on designing a pick and place robotic arm which can be controlled using a smartphone. A microcontroller called Arduino is used, and Bluetooth HC-05 is used for connectivity. MIT App Inventor was used to construct the application. This paper uses 3D modelling to highlight the designing and analysis of a robotic arm.

[14] Robotic Arm Control Using Arduino by Rajashekar K[1] , Hanumantha Reddy[2] , Ruksar Begum T K[3] , Shaheena Begum[4] , Syeda Ziya Fathima[5] , Saba Kauser[6]

This paper focuses on introducing the technologies which can be used in order to design an effective and low-cost robotic arm which can be controlled using an android application. This paper also provides a review of works done by other authors which contributes to the successful designing of pick and place robot.

[15] SMART PHONE BASED ROBOTIC CONTROL FOR SURVEILLANCE APPLICATIONS by M. Selvam

This paper focuses on to develop a robotic system which has a wireless camera attached to the surveillance. Bluetooth was implemented in his project for providing connection between robot and smart phone. Wireless night vision camera was used for providing the robot surveillance. The video which is recorded by camera is then transmitted to TV unit through radio frequency signal. He used 8051 micro-controllers for the robotic unit.

[16] Android based robot implementation for pick and retain of objects by Ranjith Kumar Goud and B. Santosh Kumar.

This paper focuses on designing of pick and place robot for diffusing a bomb remotely with safety. For the robotic arm, they used a pair of motors and another pair as the wheels of the robot for controlling the movement. Connectivity is established using Bluetooth. The micro-controller used is LPC2148. They had also attached wireless camera for remote surveillance. They have worked on this project mainly for industrial and military applications.

[17] IoT developed Wi-Fi Controlled Rover with Robotic Arm Using NodeMCU by Gaurav Singh[1], Ashirwad Kumar Singh[2], Anurag Yadav[3], Indu Bhardwaj[4], Dr. Usha Chauhan[5]

In this paper, Wi-Fi controlled rover with a robotic arm has been discussed. The Wi-Fi module NodeMCU serves as the system's brain and the module is a microchip that combines a full TCP/IP stack with a microcontroller that is mostly based on the inexpensive Wi-Fi ESP8266. Motor drivers

are used to regulate Rover's motor motion and robotic arm rotation. Rover and the robotic arm are mechanically built to be able to pick up objects weighing between 250 and 350 grammes and place them at a distance. For the application, Blynk software is used and for the programming, Arduino IDE is used . The microcontroller used is Node MCU and the robot is Wi-Fi controlled.

COMPONENTS USED

The design of pick and place robot consist of :- Mechanical and Electrical components.

- **MECHANICAL COMPONENTS**

  The mechanical design of a robotic arm is based on a robotic manipulator with similar function like a human arm. In order to establish a generalized operating system and the technological systems for the analysis, design, integration and implementation of a humanoid robotic arm.

  The Mechanical parts consist of Mechanical arm, chassis.

- **ELECTRICAL COMPONENTS**

  The electrical components consist of -

  - L298 Motor Driver
  - MG995 Servo Motor x 6
  - 12V DC Gear Motor x 2
  - hc-05 Bluetooth Module
  - DC to DC Buck Converter

Fig : Mechanical Arm

***Robotic Arm:** This is the most important aspect of the system since it is responsible for picking up and dropping project tasks. The robotic arm is outfitted with a Gripper (for selecting and putting things) and an Arm (for raising and lowering objects and rotating). Both the Arm and the Gripper are outfitted with Servo Motors to control movement. These motions are coordinated with the user's hand gestures when controlling the Robotic Arm. The lowest point servo is mounted in such a way that it moves the top base horizontally from 0 to 180 degrees based on the RF module values.

***Servomotors**: Servo detects the operation error of a mechanism, provides feedback and corrects faults. The servo motor can have alternating current (AC), direct current (DC) or stepper motors. In addition to these, there are drive and control circuits. Servo motors are the kinds of motors that can fulfill the commands we want. They can operate steadily even at very small or very large speeds. The large moment can be obtained from the small size. Servo motors are used in control systems such as fast operation, excessive axis movement, condition control and so on. Servo motors are the last control element of a mechanism. Servo motors are mostly three cables. These are a red cable for power, black for grounding and yellow cables for control (data, data). One of the servo motors used in the production phase of the project.

***Power Supply**: It is basically consisting of transformer, rectifier filter and regulator circuits. A power supply takes the ac from the ac source and the step-down transformer which is connected to AC source decrease the voltage from 230V to 12V AC, and then it is converted to unregulated DC by rectifier unit. This rectified unregulated DC voltage is filtered by filter capacitor and regulated by electronic regulated i.e., ic7812, ic7809, ic7805.

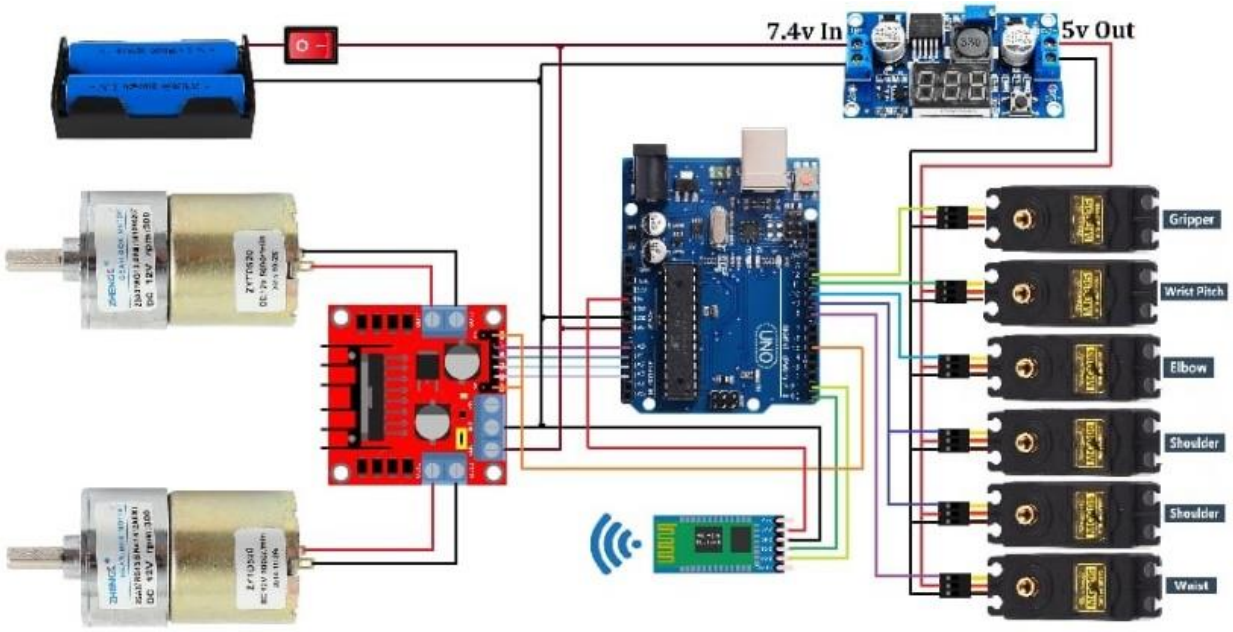
***Manipulator**: The manipulator is the entire mechanism of the robot that provides movement of any degree of freedom. The joints to the robotic manipulator are the movable components, which enables relative motion between adjoining links. Further they consist of base, arm and gripper

***Arduino UNO**: Although microcontroller type PIC is usually used in programming and software fields, Arduino UNO is an open-source microcontroller word based on the microchip ATmega328P microcontroller and developed by arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. Arduino has become very popular in the world in recent times. It is based on Arduino's past wiring and processing projects. Processing is written for nonprogramming users. Arduino wiring is produced on the basis of programming language.

***HC-05 Bluetooth**: This module is used to communicate between two microcontrollers like Arduino or communicate with any device via Bluetooth. This module communicates with the help of USART at 9600 baud rates. The HC-05 has two operating modes, 1 is the data mode in which it can send and receive data from other Bluetooth devices and the other is AT command mode where the default device setting can be changed.

***L298N Motor Driver**: The L298N is a dual H-bridge motor driver which allows speed and direction control of two dc motors at the same time. The module can drive dc motors that have voltages between 5 and 35 volts with a peak current up to 2amps. The driver module can drive two motors. The enabled terminals ENA and ENB are effective at high level. ENA and ENB pins are speed control pins for motor A and motor B, the enable A pin must be high to turn on the motor to drive motor to A direction say, clockwise, the pin input 1 must be high while pin input 2 must be low, to drive a motor to a direction say counter clockwise the pin input 1 must be low while pin input 2 must be high. Although we need to do is to apply signal to input and make motor to certain direction.

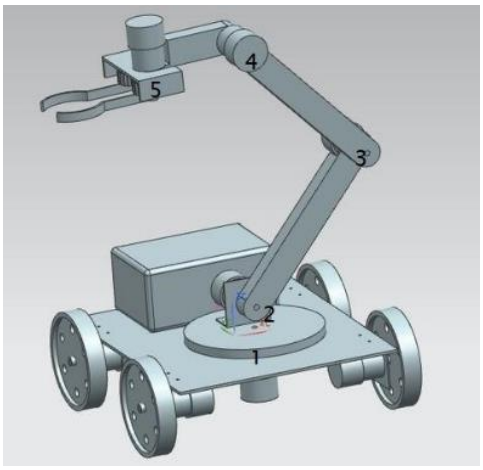
CIRCUIT DIAGRAM



SPECIFICATIONS

The specifications for pick and place robot are mentioned below-

- Degrees of freedom: 5
- Payload capacity: 180gm
- Joint speed (approximate): 40-60 rpm
- Base spin: 180 degrees
- Shoulder base spin: 180 degrees
- Elbow pitch: 180 degrees
- Finger opening (Max): 10cm



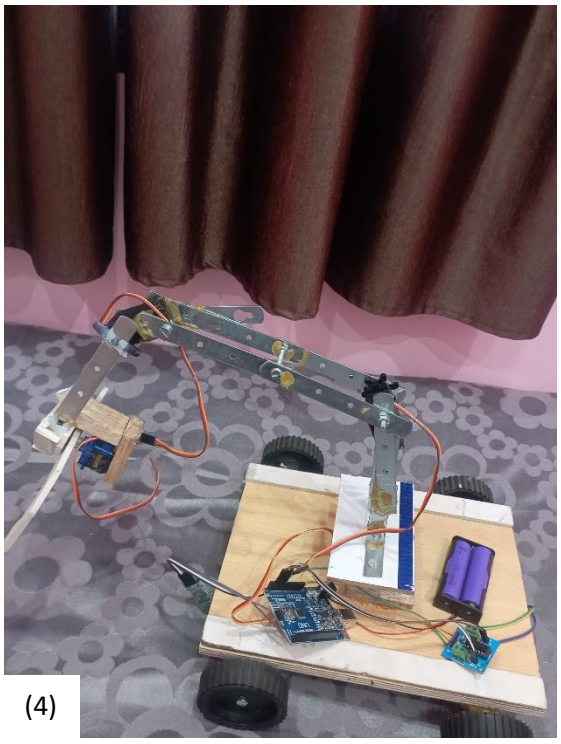
IMAGES

Here are the images showing the different DOF of robotic arm.

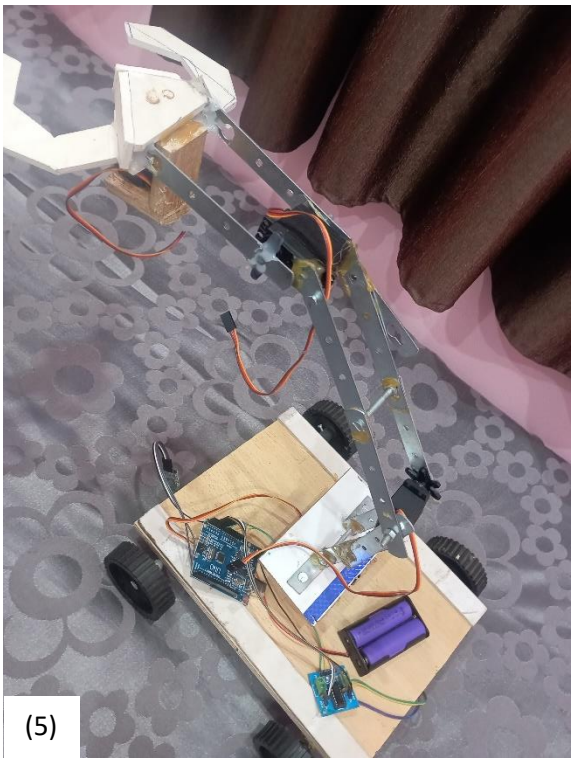
(1)

(2)

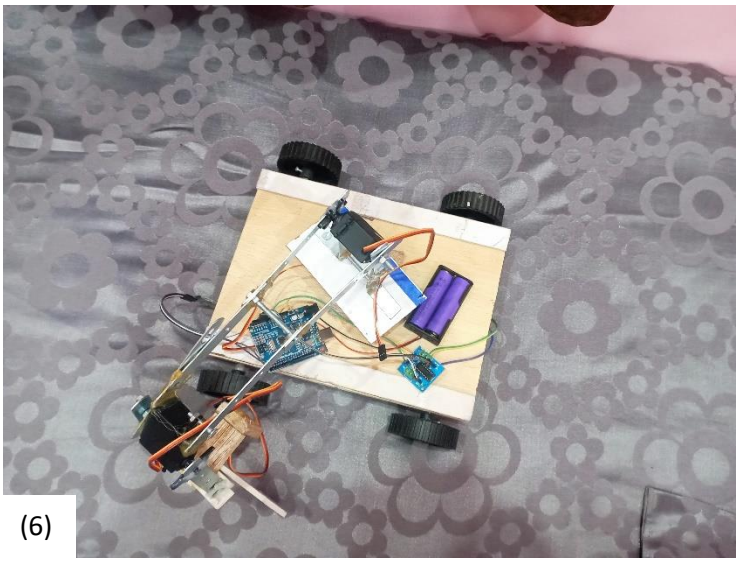
(3)



(4)



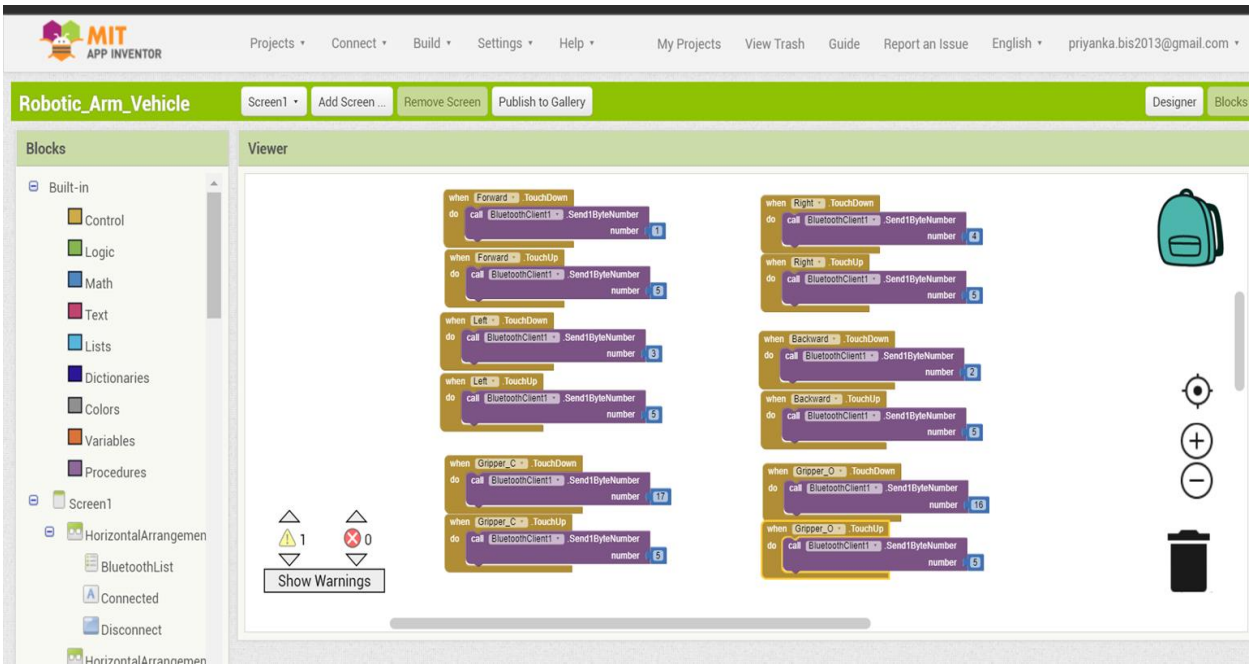
(5)



(6)

APPLICATION INTERFACE

Android devices are powerful mobile computers and they become more and more popular smart phones used worldwide. They become more and more popular for software developers because of its powerful capabilities and open architecture, also it's based on the java programming language. Android devices provide numerous communication interfaces like USB, Wi-Fi and Bluetooth, that can be used to connect to the robot. We use android platform because it is the widest used in the word and runs the largest number of smartphones worldwide.



This app is developed using the MIT App Inventor. This app inventor brings out the revolution in the Embedded Systems & Robotics. The app invented search for the Bluetooth devices along with their MAC addresses. The user just has to select the particular MAC Address. When a particular MAC is selected , the status shown on the screen is "Connected". Now all the buttons are active and the app is now connected with the robot and mobile phone can control the robot.

SYSTEM ARCHITECTURE

This figure shows the overall architecture of the system, and with which components the different types of users will interact.

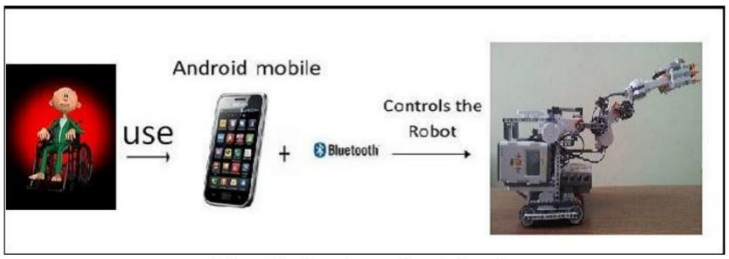
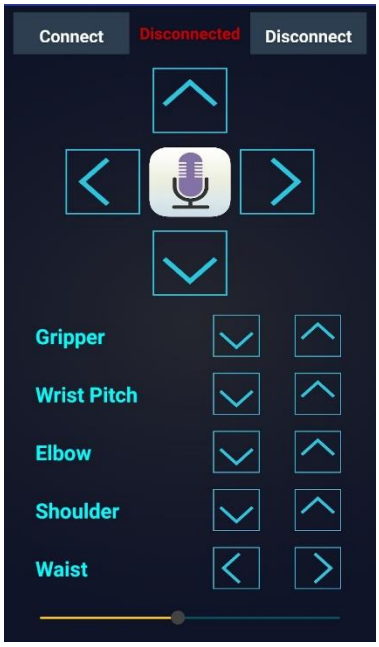


Fig. 2: System Architecture.

MOBILE APPLICATION

The Mobile application consists of 4 buttons viz. Right, Left, Forward, Reverse. This also consists of movement of Gripper, Wrist Pitch, Elbow, Shoulder and Waist.

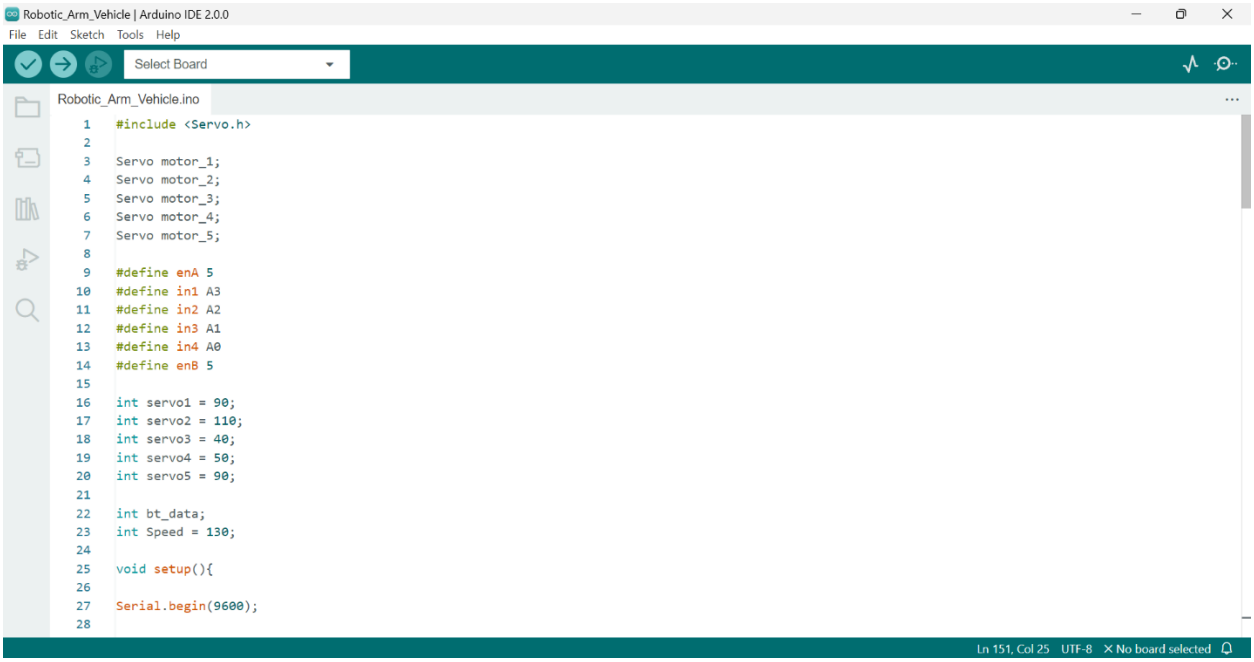


The screen consists of an overlook of the mobile application. The sliding option is to adjust the speed of the robot.

The first phase of application design goes through App Inventor Designer. Designer is accessible through the web page and all the ingredients for the app are available on the left side of the window. The ingredients include elements like a screen for the app, buttons for tapping, text boxes, images, labels, animations and many more. The right side of the designer allows users to view the screen and components added to the screen. Additionally, the properties section of the window allows users to modify the properties of components.

In this apps development the App Inventor provides a versatile opportunity to develop a customized application starts with establish a Bluetooth connection by searching the available Bluetooth devices and make pair with them.

ARDUINO CODE



Robotic_Arm_Vehicle.ino

```
#include <Servo.h>

Servo motor_1;
Servo motor_2;
Servo motor_3;
Servo motor_4;
Servo motor_5;

#define enA 5
#define in1 A3
#define in2 A2
#define in3 A1
#define in4 A0
#define enB 5

int servo1 = 90;
int servo2 = 110;
int servo3 = 40;
int servo4 = 50;
int servo5 = 90;

int bt_data;
int Speed = 130;

void setup(){

Serial.begin(9600);

```

Robotic_Arm_Vehicle.ino

```
29  motor_1.attach(8);
30  motor_2.attach(9);
31  motor_3.attach(10);
32  motor_4.attach(11);
33  motor_5.attach(12);
34
35  motor_1.write(servo1);
36  motor_2.write(servo2);
37  motor_3.write(servo3);
38  motor_4.write(servo4);
39  motor_5.write(servo5);
40
41  pinMode(enA, OUTPUT);
42  pinMode(in1, OUTPUT);
43  pinMode(in2, OUTPUT);
44  pinMode(in3, OUTPUT);
45  pinMode(in4, OUTPUT);
46  pinMode(enB, OUTPUT);
47
48  delay(1000);
49  }
```

Robotic_Arm_Vehicle.ino

```
50
51  void loop(){
52
53
54  if(Serial.available() > 0){
55  bt_data = Serial.read();
56  Serial.println(bt_data);
57  if(bt_data > 20){Speed = bt_data;}
58  }
59
60  analogWrite(enA, Speed);
61  analogWrite(enB, Speed);
62
63
64      if(bt_data == 1){forword(); }
65  else if(bt_data == 2){backword();}
66  else if(bt_data == 3){turnLeft();}
67  else if(bt_data == 4){turnRight();}
68  else if(bt_data == 5){Stop(); }
69
70  else if(bt_data == 6){turnLeft();  delay(400);  bt_data = 5;}
71  else if(bt_data == 7){turnRight(); delay(400);  bt_data = 5;}
72
73  else if (bt_data == 8){
74  if(servo1<180){servo1 = servo1+1;}
75  motor_1.write(servo1);
76  }
```

Robotic_Arm_Vehicle.ino

```
77   else if (bt_data == 9){
78   if(servo1>0){servo1 = servo1-1;}
79   motor_1.write(servo1);
80   }
81
82   else if (bt_data == 10){
83   if(servo2>0){servo2 = servo2-1;}
84   motor_2.write(servo2);
85   }
86   else if (bt_data == 11){
87   if(servo2<180){servo2 = servo2+1;}
88   motor_2.write(servo2);
89   }
90
91   else if(bt_data == 12){
92   if(servo3>0){servo3 = servo3-1;}
93   motor_3.write(servo3);
94   }
95   else if (bt_data == 13){
96   if(servo3<180){servo3 = servo3+1;}
97   motor_3.write(servo3);
98   }
99
100  else if (bt_data == 14){
101  if(servo4<180){servo4 = servo4+1;}
102  motor_4.write(servo4);
103  }
```

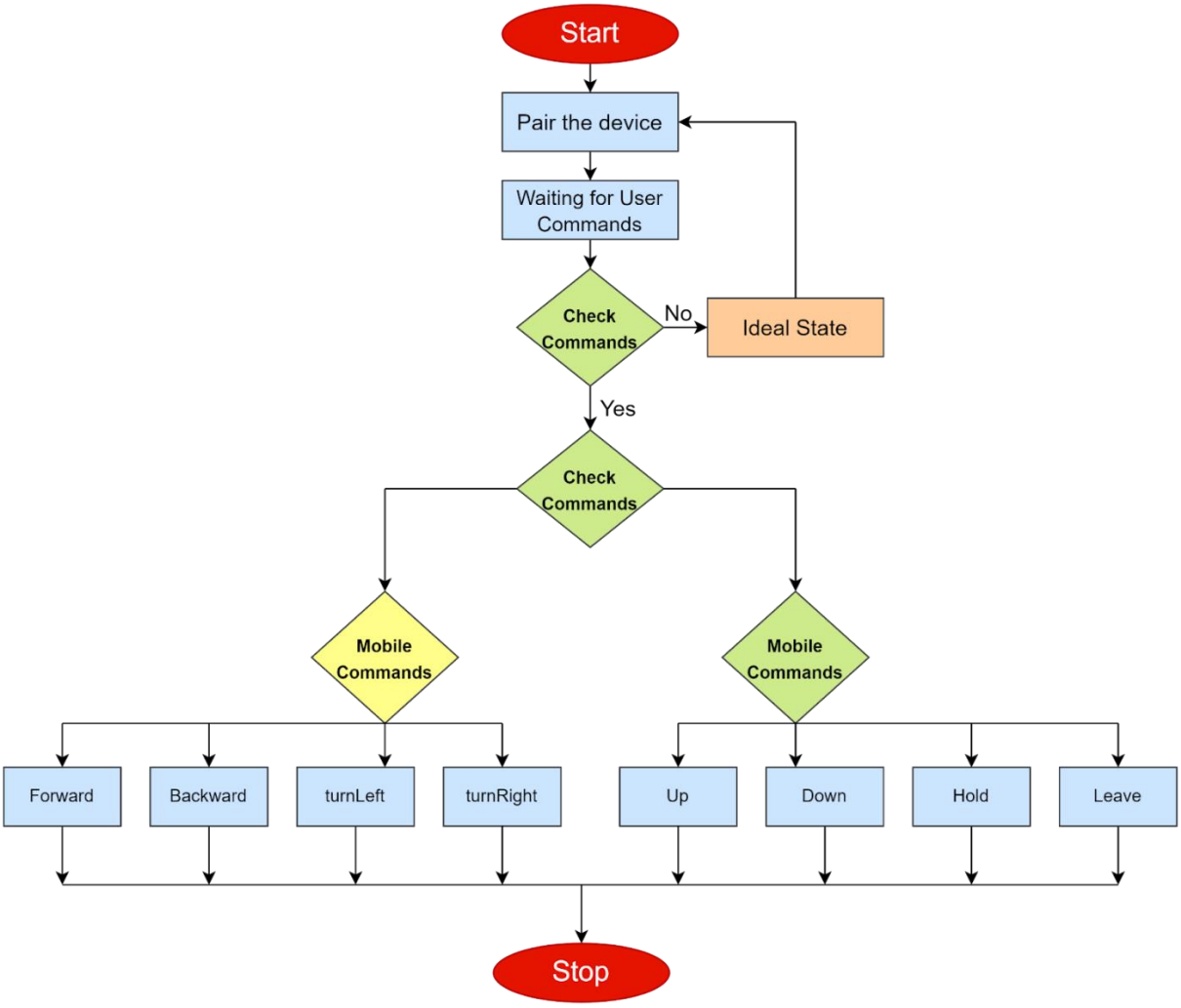
Robotic_Arm_Vehicle.ino

```
104  else if(bt_data == 15){
105  if(servo4>0){servo4 = servo4-1;}
106  motor_4.write(servo4);
107  }
108
109  else if (bt_data == 16){
110  if(servo5>90){servo5 = servo5-1;}
111  motor_5.write(servo5);
112  }
113  else if (bt_data == 17){
114  if(servo5<150){servo5 = servo5+1;}
115  motor_5.write(servo5);
116  }
117
118  delay(30);
119  }
120
```

Robotic_Arm_Vehicle.ino

```
121
122   void forword(){
123   digitalWrite(in1, HIGH);
124   digitalWrite(in2, LOW);
125   digitalWrite(in3, LOW);
126   digitalWrite(in4, HIGH);
127   }
128
129   void backword(){ //backword
130   digitalWrite(in1, LOW);
131   digitalWrite(in2, HIGH);
132   digitalWrite(in3, HIGH);
133   digitalWrite(in4, LOW);
134   }
135
136   void turnRight(){ //turnRight
137   digitalWrite(in1, LOW);
138   digitalWrite(in2, HIGH);
139   digitalWrite(in3, LOW);
140   digitalWrite(in4, HIGH);
141   }
142
143   void turnLeft(){ //turnLeft
144   digitalWrite(in1, HIGH);
145   digitalWrite(in2, LOW);
146   digitalWrite(in3, HIGH);
147   digitalWrite(in4, LOW);
148   }
149
150   void Stop(){ //stop
151   digitalWrite(in1, LOW);
152   digitalWrite(in2, LOW);
153   digitalWrite(in3, LOW);
154   digitalWrite(in4, LOW);
155   }
156
```

FLOW CHART


Start
Pair the device
Waiting for User Commands
Check Commands
No
Ideal State
Yes
Check Commands
Mobile Commands
Mobile Commands
Forward
Backward
turnLeft
turnRight
Up
Down
Hold
Leave
Stop

MERITS, DEMERITS AND APPLICATIONS

MERITS

- **FASTER**: Hardware-accelerated functions run in a fraction of the clock cycles required to execute the same function in software. This results in faster overall application speed.
- **HIGH-PERFORMANCE**: Shorter times to complete complex tasks in hardware result in more clock cycles available for additional software functions. This effectively improves overall computational performance.
- **SCALABLE**: The functionality and capabilities accelerated in the FPGA hardware can be expanded and scaled for many different applications. We are just scratching the surface of what is possible to accelerate.

LIMITATIONS

- The vehicle can be operated only within the range of Bluetooth. A Wi-Fi module can be replaced with Bluetooth to get the more operational range.
- The vehicle is not able to pick up heavy loads, as the prototype is a simple one. To lift up heavy objects, the prototype can be implemented with heavy mechanical machinery. This is more useful in manufacturing industries.
- Objects having smooth surfaces are difficult to handle, to avoid this problem the surface of the hand gripper can be made rougher so that it is capable of holding objects.

APPLICATIONS

- Mainly focuses on helping old and disabled people.
- Can be used by common people for certain day to day activity.
- Can be used in industries and offices with certain modifications according to needs.

FUTURE SCOPE

With high budget, the project has potential of enhancement in various ways-

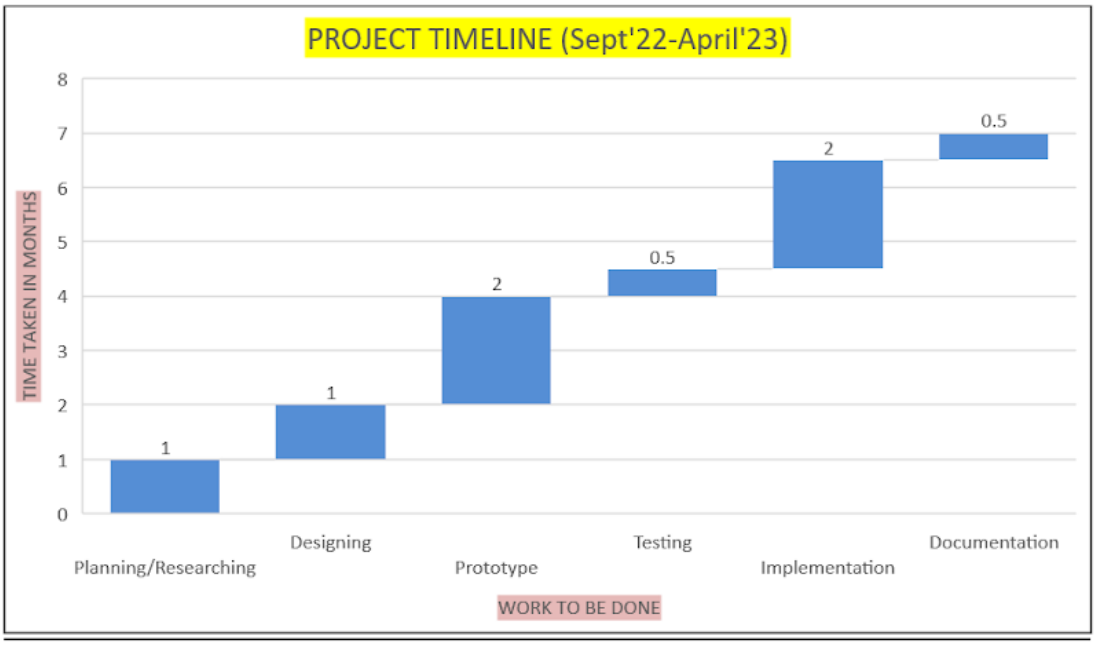
- Use of strong and expensive material to increase the limit of weight it can pick and hold.
- More accuracy and range.
- Advanced features can be introduced according to requirements.
- Surface to height movement can be achieved.
- Sensors for obstacle tackling and movement on its own.
- Can introduce an AI.

With some modifications, it can also be utilized as-

- **Industrial Robot**: An Industrial Robot that can be used to pick heavy machinery which can be operated using an Android application or controller. A Wi-Fi Module can be included for a better range of operational area.
- **Bomb Defuse Robot**: Bomb Defuse Robot can be made using this prototype by interfacing camera. A person can defuse a bomb using this robot even by staying far from the bomb. A camera is used for the user visibility of the bomb.

MILESTONES

TIMELINE OF COMPLETION OF PROJECT



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