CAR ROBOT USING ARDUINO BOARD

A PROJECT REPORT
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ABSTRACT

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux.It can be used to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics.

In this project, we're using an Arduino board to create a car robot that can avoid obstacles and be controlled via Bluetooth. Real-time obstacle detection and avoidance are major problems for robotic cars. The development and application of a robotic vehicle have been discussed in relation to communication environments, hardware, and software that allow for real-time obstacle avoidance and detection. The system has been implemented using Bluetooth technology, the Arduino platform, and Android applications. This paper presents the design and application of robotic cars that use sensor programming on a platform. This robotic device was created in collaboration with an Android-based device.The Arduino Uno has served as the brain of the robot.

The robot is equipped with numerous hardware parts, including an ultrasonic sensor, a PIR sensor, and a Bluetooth module. It also includes the mobile application-using software component. The user of the robotic car can choose the desired direction or mode via a mobile application to control the vehicle's movement. The robot can be programmed to move in tandem with the user's intelligent device, or it can be left in autonomous mode, allowing the vehicle to follow its own course. As a result, the robot is able to both detect live objects and escape from the obstacle. This article's goal is to warn military and civilian personnel about possible terrorist attacks.

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CHAPTER 1

INTRODUCTION

With the advancement of technology over the past ten years, sensors coupled with electronic devices have found widespread application to improve quality of life. Sensors are tools that energy forms into electrical energy conversion. The sensors act as a link between different electronic devices and the surrounding environment. Any physical setting, including airports, factories, hospitals, shopping centers, and military zones, can be considered the environment. Electronic devices that can be found there include smartphones, tablets, robots, and smart clocks. These devices can be used in many different industrial processes for image, identification, control, and protection. Hundreds of different kinds of sensors, including those that detect pressure, heat, obstacles, and people, are available today thanks to technological advancements. These days, algorithms for artificial intelligence are used in the development of robot systems. Among them is the field of robotics. The robot's perception system is its most crucial component. A robot's ability to perceive its surroundings will be crucial to its design. For example, it's critical that robots recognize explosives in order to use sensors to identify terrorists in the military.

This article presents a robotic car that is remotely controlled and autonomous, with the ability to detect and avoid obstacles through the use of sensors. Bluetooth has been used to establish the connection between the Android device and the robot. Robot action can be carried out based on the user's input value after the Arduino Uno processes the incoming data. The Android application on a mobile phone can operate the robotic car in two primary modes. The two modes are automatic and user control. To choose the actions, a menu with buttons has appeared on the screen. The robotic car can be moved with these buttons in the following directions: forward, backward, right, and left. It can also be stopped and put in automatic mode.

When the user chooses automatic mode, they surrender control over the robot, allowing it to navigate its path without colliding with any obstructions. When it comes across living things, the robot recognizes them and warns. The robot navigates without hitting any obstacles, recognizing them and stopping when they are encountered. Simultaneously, it uses a distance sensor to make live detection and calculate distance of the obstacle.This piece of work is as follows.

In this sense, related works are covered in Section 2. The principles of operation and system architecture of the robotic car are explained in Section 3.

The materials and specifications for the robotic car are displayed in Section 4. The robotic car's design and implementation are covered in Section 5. The paper's conclusion is given in Section 6.

CHAPTER 2

LITERATURE REVIEW

This section examines previous research on this topic and provides a summary of some of the techniques and guiding ideas.

For working families, S. S. Pujari et al. [1] created a robot that could watch over kids from a distance and interact with a camera. The robot is equipped with a Raspberry Pi 3, a camera module, and Bluetooth and WiFi technology.
The Robot was the heart of the Raspberry Pi, and it was programmed using the Python language.

A robotic car was created by D. Chakraborty et al. [2] utilizing Bluetooth technology and sensors. They had made contact between the smart device and the automated system. They had seen the living things because of the phone's camera. The ultrasonic ranging sensor avoided collisions with the obstacles facing the opposite direction. The camera captured images, which were then stored in the database and examined.

An autonomous robotic car was designed by S. J. Lee et al. [3] using an Arduino Uno R3 as the robot's brain. Additionally, an ultrasonic sensor and a Bluetooth module were utilized in this document. Thanks to the QR codes, the robot that scanned the placed ones was able to travel the road autonomously. Moreover, it offered text-to-speech voice communication with the Android device. With the aid of an ultrasonic sensor, it was also able to move without colliding with its surroundings. Data on range was gathered in this view. The PID algorithm minimized the deviation to ensure smooth motion for the robot.

M. R. Mishi and colleagues [4] created a robotic vehicle. In this project, a Raspberry Pi and Arduino Uno were combined to control a robot. The car was tracked using GPS, and measurements were made of the separations between the path and the obstacle.
One could use the cloud's data without needing to be online. The multi-motion system was thus managed.

Robotics experts E. Amareswar et al. [5] created the device for the military. The robot's ability to detect explosives was greatly enhanced by the metal detector, and the Android device's camera allowed it to view its surroundings. The components of this robot system included an Arduino Uno microcontroller, an Android device, a Bluetooth module, DC motors, a motor driver, a wireless camera, and a metal detector.

Premkumar et al. [6] created a Raspberry Pi-controlled robotic arm. This robot's primary goal was to equip its arm with human arm functionality. The code that enabled arm movement was written in Python and used the Raspberry Pi. The user was able to move the robot arm in the desired direction by using the Android application. In this way, control over the robotic arm was given. The Java code used to create the Android app. As a result, the Wi-Fi connection allowed for communication between the Raspberry Pi and the Android application. The robot arm moved left and right as a result of this communication.

This study uses an Android application to perform real-time obstacle avoidance and detection with a remote-controlled, autonomous robotic car based on the Arduino platform.

CHAPTER 3
COMPONENTS AND ITS CHARACTERISTICS

3.1 LIST OF COMPONENTS:

S.NO.	COMPONENTS	QUANTITY
1.	Arduino UNO board	1
2.	Arduino Mega Board	1
3.	L293D motor driver	1
4.	Ultrasonic sensor	1
5.	Bluetooth module	1
6.	Servo motor	1
7.	Gear motor	4
8.	Robot wheel	4
9.	Li-ion battery holder	1
10.	Li-ion battery	2
11.	Jumper wires	Sufficient amount
12.	Cardboard	1

Table 3.1: Table of Components

3.2 CHARACTERISTICS OF COMPONENTS

3.2.1.ARDUINO UNO BOARD

Arduino Uno serves as the robot's brain. Arduino has fourteen pins. The most popular Arduino card is the Arduino UNO. Figure 3.1 illustrates this. It can be easily programmed using Arduino libraries [7]. Other microprocessors have a significant advantage in their ease of programming. The Arduino Uno is programmed using the integrated development environment (IDE). The programming language is chosen as Embedded C. Sensor signals aid in the design of environmentally friendly robots and systems. Actions, such as sound and light, are specific to the project output.

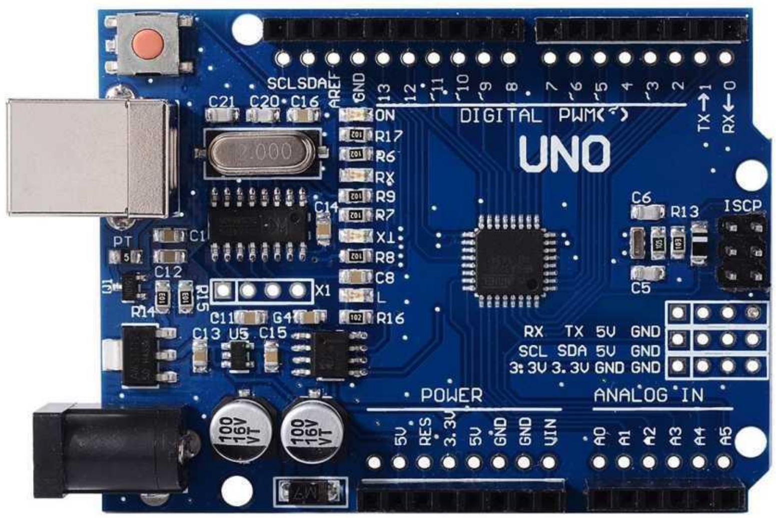

Fig 3.1: Arduino UNO Board

3.2.2 ARDUINO MEGA BOARD

Arduino Mega 2560 is a development board based on the Atmega2560 microcontroller. This board is ideal for projects that require more GPIO pins and memory space, as it has 16 analog pins and 54 digital I/O pins, 15 of which are used for PWM output. The board includes a DC power jack to power up the unit, and you can also turn it on using the VIN pin on the board. The unit also includes a USB interface, which allows you to connect the board to your computer using a USB cable. The Arduino Mega 2560 is similar to the Arduino UNO, but has more GPIO pins, memory space, and larger size. The unit also supports the ICSP header, which allows you to program the board without disconnecting it from the main circuitry.

The board includes two voltage regulators that allow you to regulate the voltage as desired.Arduino Mega 2560 is programmed using Arduino IDE (Integrated Development Environment), which is the official software introduced by Arduino.cc.

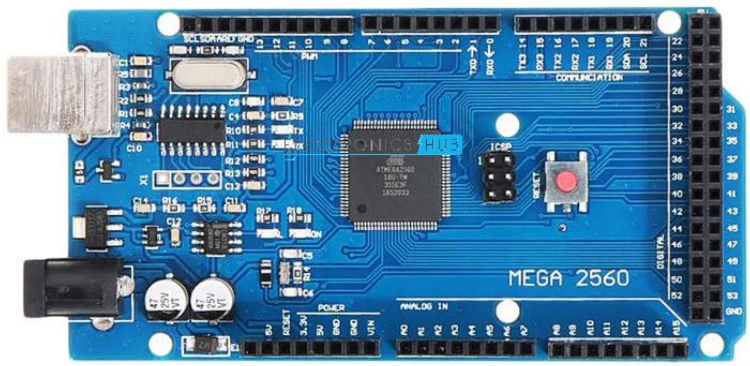

Fig 3.2: Arduino Mega Board

3.2.3. L293D MOTOR DRIVER

The L293D H-bridge driver is the most commonly used driver for bidirectional motor control applications. This L293D IC enables a DC motor to drive in either direction. The L293D is a 16-pin integrated circuit that can control two DC motors simultaneously in any direction. This means that you can control two DC motors using a single L293D IC. Because it contains two H-bridge circuits. The L293D can also drive small, quiet big motors. There are several methods for creating an H-bridge motor control circuit, including using transistors, relays, and L293D/L298.

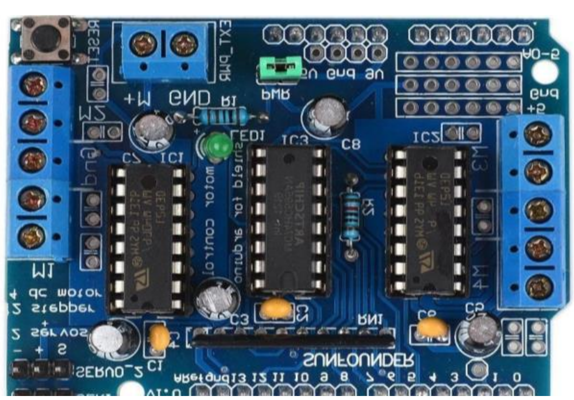

Fig 3.3: L293D Motor Driver

3.2.4. ULTRASONIC SENSOR

The Ultrasonic sensor uses Sonar (Sound Navigation and Variable) to determine the distance to an object. Using sonar, the distance between robots Obstacles are measured. The optimal measurement range is 2–400 cm. Ultrasonic sound waves have frequencies between 20 and 500 kHz. Ultrasonic sensors emit sound waves and measure distance by calculating the time it takes to strike obstacles. (Figure 3.4). Ultrasonic sensors have a sensing range of up to 30 meters under appropriate conditions. Ultrasonic sensors contain two transducers. One is an ultrasonic speaker, while the other is an ultrasonic microphone. The electronic circuit measures the time between sound propagation from the loudspeaker to obstacle detection and reflection by the ultrasonic microphone. The distance between the obstacle and the ultrasonic sensor is calculated by dividing this time by the sound speed.

Fig 3.4: Ultrasonic Sensor

3.2.5. BLUETOOTH MODULE

Figure 3.5 depicts the HC-06 Bluetooth module, which enables communication between devices within a 10 to 20 meter range. Connects to Arduino using serial communication (USART). The Bluetooth module can only respond to incoming connections and cannot send them to other Bluetooth modules. The Bluetooth module has four pins. The pins are VCC, GND, Rx, and Tx. The HC-06 Bluetooth Module requires VCC and GND from Arduino. Arduino provides the VCC and GND needed for the Bluetooth module. For the Bluetooth module to recognize commands from the Arduino, the Tx pin of the Arduino needs to be connected to the Rx portion of the module.

To access Arduino, Bluetooth messages must be plugged into the Arduino's Rx pin Bluetooth module's Tx pin. It takes a password in order to connect the Bluetooth module to the Android device.

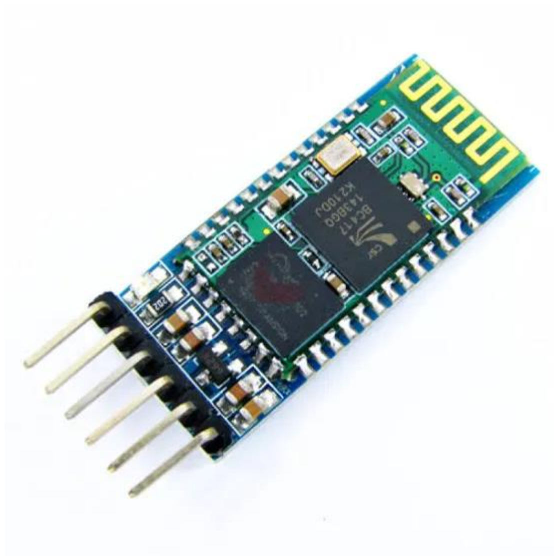

Fig 3.5: Bluetooth Module

3.2.6. SERVO MOTOR

The servo motor, control circuit, shaft, potentiometer, drive gears, amplifier, and either an encoder or resolver are the components that make up a closed-loop system. A servo motor is an independent electrical apparatus that precisely and efficiently rotates machine parts.This motor's output shaft can be adjusted to a specific angle, position, and velocity that a conventional motor cannot. For positional feedback, the servo motor combines a standard motor with a sensor.The most crucial component of the servo motor used for this purpose is the controller, which is made especially for it.

Fig 3.6: Servo Motor

3.2.7. GEAR MOTOR

A motor that has an integrated gearbox is called a gear motor. Because gear motors double as speed reducers and torque multipliers, they use less energy to move a given load. The performance of a gearbox is influenced by its design, type of gears, lubrication, and coupling. Depending on the load and duration of operation, the gear motor's structure determines whether it is appropriate for light, medium, or heavy loads. The gear motor adjusts the output shaft's speed based on the internal gear structure and the reduction stages. One of the most crucial gearbox characteristic values is the reduction ratio, which is the ratio of the input speed to the output speed.

Fig 3.7: Gear Motor

Thus, these are the components that play a major role in the working of robotic car.

CHAPTER 4
METHODOLOGY

4.1. EXPERIMENTAL SET-UP

- Firstly, we will identify the required components. Then we will take the cardboard and glue the four gear motors to it.
- After that, the motor shield is glued to the robot chassis and affix it to the Arduino board.
- The gear motor wire should then be inserted through the two holes that we dug on either side of the Arduino board.
- Next, the motor driver shield should be attached to the motors. The circuit diagram below is used to accomplish this.

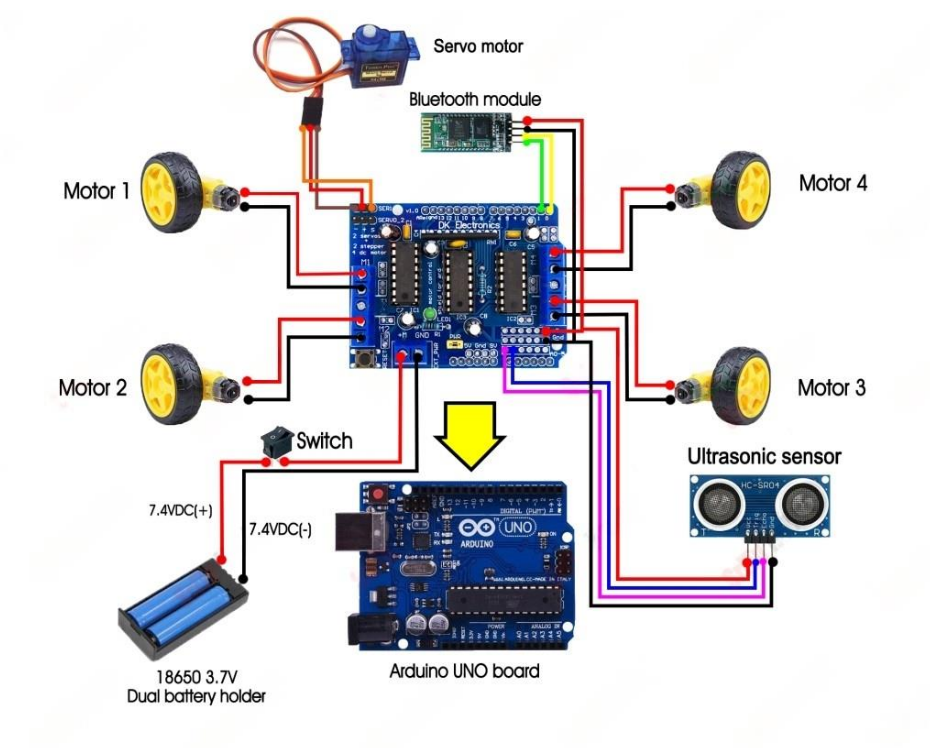

Fig 4.1:Circuit Diagram

- The servo motor should then be attached, followed by the ultrasonic sensor on top of it.

- The servo motor and ultrasonic sensor should then be connected (GND -> GND).
- After that, attach the motor driver shield to the robot chassis by attaching the Bluetooth module to it.(TXD1 -> RXD1).
- Next, attach the battery holder to the driver shield using glue.
- Put the batteries in the battery holder and attach the robot wheels.

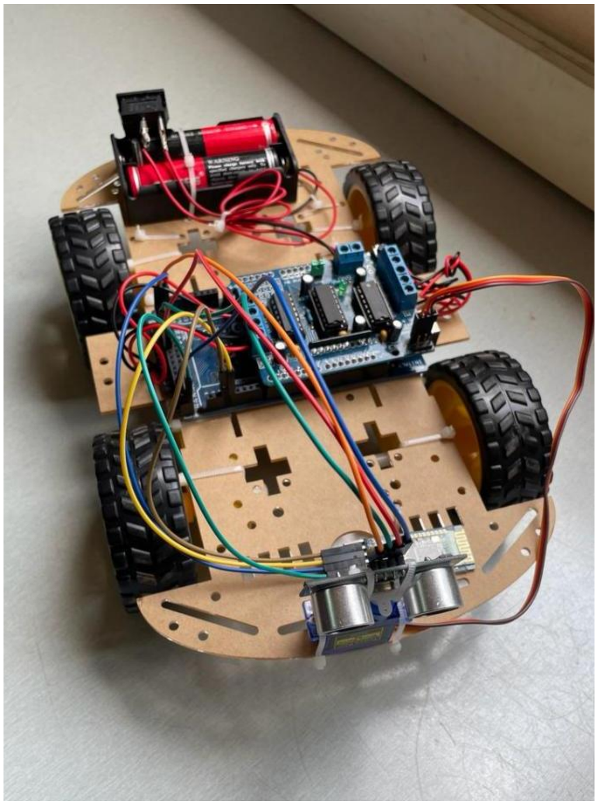

Fig 4.2: Final Product

4.2. SOURCE CODE

The following source code is loaded to the Arduino IDE platform after downloading the AF motor library.

```
#include <Servo.h>
#include <AFMotor.h>
#define Echo 47
#define Trig 41
#define motor 9
#define Speed 170
#define spoint 103
char value;
int distance;
int Left;
int Right;
int L = 0;
int R = 0;
int L1 = 0;
int R1 = 0;
```

```
Servo servo;
AF_DCMotor M1(1);
AF_DCMotor M2(2);
AF_DCMotor M3(3);
AF_DCMotor M4(4);
```

```
void setup() {
  Serial1.begin(9600);
  pinMode(Trig, OUTPUT);
  pinMode(Echo, INPUT);
  servo.attach(motor);
  M1.setSpeed(Speed);
  M2.setSpeed(Speed);
  M3.setSpeed(Speed);
  M4.setSpeed(Speed);
}
void loop() {
  Obstacle();
  Bluetoothcontrol();
}
//Bluetooth control
void Bluetoothcontrol() {
  if (Serial1.available() > 0) {
    value = Serial1.read();
    Serial1.println(value);
```

```
  }
  if (value == 'F') {
    forward();
  } else if (value == 'B') {
    backward();
  } else if (value == 'L') {
    left();
  } else if (value == 'R') {
    right();
  } else if (value == 'S') {
    Stop();
  }
}
//Obstacle Avoidance
void Obstacle() {
  distance = ultrasonic();
  //Serial1.print("distance:");
  //Serial1.println(distance);
  if (distance <= 12) {
    Stop();
    backward();
    delay(100);
    Stop();
    L = leftsee();
    servo.write(spoint);
    delay(800);
    R = rightsee();
    servo.write(spoint);
    if (L < R) {
      right();
      delay(500);
      Stop();
      delay(200);
    }
   else if (L > R) {
      left();
      delay(500);
      Stop();
      delay(200);
    }
  }
  else {
    forward();
  }
}
```

```
int ultrasonic() {
  digitalWrite(Trig, LOW);
  delayMicroseconds(4);
  digitalWrite(Trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(Trig, LOW);
  long t = pulseIn(Echo, HIGH);
  long cm = t / 29 / 2; //time convert distance
  return cm;
}
void forward() {
  M1.run(FORWARD);
  M2.run(FORWARD);
  M3.run(FORWARD);
  M4.run(FORWARD);
}
void backward() {
  M1.run(BACKWARD);
  M2.run(BACKWARD);
  M3.run(BACKWARD);
  M4.run(BACKWARD);
}
void right() {
  M1.run(BACKWARD);
  M2.run(BACKWARD);
  M3.run(FORWARD);
  M4.run(FORWARD);
}
void left() {
  M1.run(FORWARD);
  M2.run(FORWARD);
  M3.run(BACKWARD);
  M4.run(BACKWARD);
}
void Stop() {
  M1.run(RELEASE);
  M2.run(RELEASE);
  M3.run(RELEASE);
  M4.run(RELEASE);
}
int rightsee() {
  servo.write(20);
  delay(1200);
  Left = ultrasonic();
  return Left;
```

```
}
int leftsee() {
  servo.write(180);
  delay(1200);
  Right = ultrasonic();
  return Right;
}
```

This code is then uploaded to the robot using a cable.

4.3. IMPLEMENTATION

The user must first download the "Arduino Bluetooth Controller" from Google Play in order to begin the implementation process. Following the application's download, make confirm that there is an open Bluetooth connection. Once the application has been opened, the "1234" password needs to be used to connect it to the Bluetooth module (HC-06). The user must assign values to the desired keys after establishing a connection to the application. After completing the task, the robots are now able to transmit input values. Data is transmitted to the Arduino Uno via Bluetooth module from the Android application. The Arduino Uno manages incoming signals and selects which ones the motor driver should receive. As a result, the robot moves in a specific order based on the inputs made. The robot's basic movements are controllable by the user.

From their own intelligent device, the user can control the robot's basic movements, such as back and forth, rotation from right to left, and stop motion. Additionally, the user has the option to put the robot in autopilot and let the vehicle go where it pleases. The autonomous vehicle is capable of identifying whether the impediments in its path are human. The robot's red led illuminates, and the shortest path that can be taken is determined and taken if there is an obstacle present. The robot calculates the shortest path it can take to avoid an inanimate object and moves in that direction when it encounters one. In addition, the robot recognizes the cliff and comes to a stop on its own

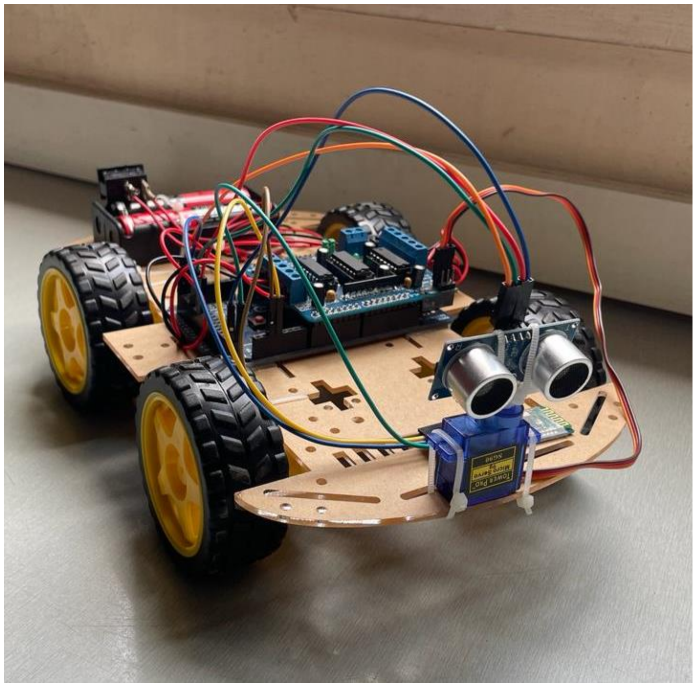

Fig 4.3: Lateral view of robotic car

4.3.1. USER MODE

The user's Android device needs to have Google Play installed before they can install the app. The user must download the Serial Bluetooth Terminal application if they have Google Play installed. Bluetooth needs to be enabled in order to establish a connection with the application. The user needs to connect the Bluetooth Module (HC-06) with the password "1234" after downloading the application. After that, the user will see a few options after selecting the HC-06.The robot car is then connected to the Android Device. The app displays a message to approve the connection.

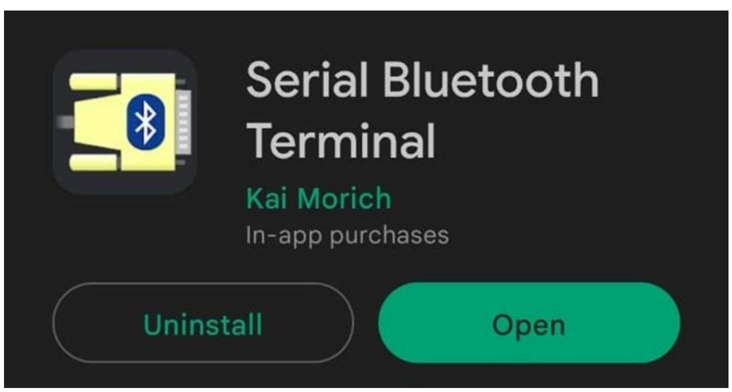

Fig 4.4: The app from Google Play

In this mode, the application will allow the user to control the robot's basic movements. Bluetooth technology will be used to transfer user input to the robot. The robot will take inputs from the device, process them on the Arduino Uno processor, and then release the inputs to move in the order specified by the user. The robot can move in four basic directions: forward, backward, right, and left. The user can also halt the robot at any moment. The modes include:

MODES	MOVEMENTS
F	Forward
B	Backward
L	Left
R	Right
S	Stop

Table 4.1: Modes and Movements

4.3.2. AUTOMATIC MODE

By selecting the automatic mode key displayed in the application's user interface, the user can switch the robot into the second (automatic) mode. The robot will be able to control its fundamental movements in this mode. The robot uses an ultrasonic sensor to detect obstacles up to 25 cm away. The robot stops itself and retreats two centimeters upon detecting the obstruction.

In the event that the obstacle is a living thing, the robot will overcome it and carry on. In the event that it detects an inanimate object as an obstacle, it calculates the distance to the point that is furthest from the obstacle and proceeds, dodging obstacles in that direction. Until the user stops the robot and closes the application, this process keeps going.

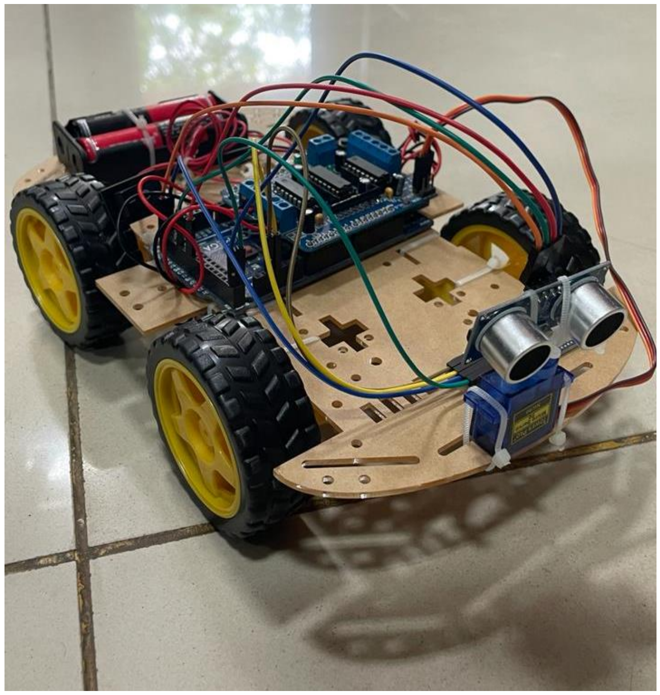

Fig 4.5: Robotic Car in Automatic Mode

In this study, the user or the automated mode can determine the tracking path. Depending on the option chosen, the robotic car can either: 1-move in response to user commands while avoiding obstacles in real time; or 2-move until it detects obstacles using autonomous mode.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1. CONCLUSION

Numerous articles focus on robotic vehicles that use the Android, Raspberry Pi, and Arduino Uno platforms. This article's goal is to use an Android application to notify the user of any potential terrorist attacks on military property. The robot's fundamental movements are supplied by receiving commands from the Android application. The HC-06 Bluetooth module facilitates communication between the robot and application. The HC-SR04 ultrasonic sensor is employed to keep the robot from collapsing. The robot is able to avoid the obstacles because of this sensor.

Furthermore, the robot detects the cliff as it approaches and prevents itself from falling.
The use of an ultrasonic sensor to measure an obstacle's distance from the robot, steer clear of obstacles in front of inanimate objects, and identify human simultaneous detection is what makes this research novel. Therefore, commissioning such a robot can enhance its efficiency and enable wireless and remotely controlled tasks, potentially leading to an attack. By employing more skilled materials, this study can be enhanced even more. The Bluetooth module may be swapped out for the Wi-Fi module. In this sense, WiFi is more widely applicable than Bluetooth and cannot be disrupted as quickly.

5.2. FUTURE SCOPE

- **PIR Motion Sensor:** The Passive Infrared sensor is a type of thermal infrared sensor that uses environmental variations in infrared radiation to detect motion. The PIR sensor is used by the human detection system to identify human presence, which then sounds an alarm to notify the driver.
- **Temperature Sensor:** Temperature Sensors like LM35 can be attached to check the temperature changes of the environment around the robotic car.
- **Control Speed of the Car:** The speed of the car can be controlled by using speed sensors like L298N. Two DC motors can be simultaneously controlled for both speed and direction thanks to the dual H-Bridge motor driver L298N. DC motors with a peak current of up to 2A and a voltage between 5 and 35V can be driven by this module.
- **Other Features:** The project can be enhanced more by adding another feature , Voice Control. The car can be used through voice commands received via android application.

REFERENCES

[1] S. S. Pujari, M. S. Patil, and S. S. Ingleshwar, “Remotely controlled autonomous robot using Android application”, 2017 IEEE International Conference on I-SMAC (IoT in Social, Mobile, Analytics, and Cloud) (I-SMAC), 2017.

[2] M. R. Mishi, R. Bibi, and T. Ahsan, “Multiple motion control systems of the robotic car based on IoT to produce cloud service,” 2017 IEEE International Conference on Electrical, Computer and Communication Engineering (ECCE), 2017.

[3] D. Chakraborty, K. Sharma, R. K. Roy, H. Singh, and T. Bezboruah, “Android application based monitoring and controlling of movement of a remotely controlled robotic car mounted with various sensors via Bluetooth,” 2016 IEEE International Conference on Advances in Electrical, Electronic and Systems Engineering (ICAEES), 2016.

[4] S. J. Lee, J. Lim, G. Tewolde, and J. Kwon, “Autonomous tour guide robot by using ultrasonic range sensors and QR code recognition in an indoor environment,” IEEE International Conference on Electro/Information Technology, 2014

[5] E. Amareswar, G. S. S. K. Goud, K. R. Maheshwari, E.Akhil, S. Aashraya, and T. Naveen, “Multipurpose military service robot,” 2017 IEEE International Conference of Electronics, Communication, and Aerospace Technology (ICECA), 2017

[6] Premkumar, Keerthi, and K Gerard Joe Nigel. “Smart Phone-Based Robotic Arm Control Using Raspberry Pi, Android, and Wi-Fi.” 2015 IEEE International Conference on Innovations in Information, Embedded, and Communication Systems (ICIIECS), doi:10.1109/iciiecs. 2015.7192973, 2015