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Voice Controlled Robotic Car using Arduino

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ABSTRACT

The project entitled "Voice Controlled Robotic Car" aims to build a car that reacts in accordance to the corresponding voice command of the user. Simple voice commands like left, right, forward, back, and stop is used for various movement of the car. The idea is to first design the hardware prototype and then develop the entire working code. At the heart of the car is Arduino UNO, which acts as the brain of the car. To the Arduino UNO are all the other hardware interfaced. The code is then developed, simulated, and fed to the Arduino UNO using the IDE. The car is then connected and controlled wirelessly via a smartphone. This wireless coordination is accomplished with the help of a HC-05 Bluetooth module. Voice commands are given to the robotic car via the android application installed in the smartphone Additionally, an HC-SR04 ultrasonic sensor is also interfaced, which when on detecting an obstacle stops the car, henceforth, preventing the collision.

Keywords: Arduino UNO, ASR, C++, IDE, Robotics

I. INTRODUCTION

Speech is an ideal means of communication in human beings. It is a form of voice that uses airflow coming out from the lungs. Air makes pressure over vocal folds which vibrate. Each and every person's speech is unique which therefore helps in determining one's personality and mood. To use our speech to drive a car is what our project demonstrates.

The project entitled "Voice Controlled Robot Car using Arduino" aims at creating a robot vehicle which can be controlled by the voice command of a person. Normally these types of systems are called as Speech Controlled Automation System (SCAS). The vision of our project is to recreate the driving technology thereby assisting the driver while driving the vehicle. At the heart of our project, sits Arduino Uno which acts as the brain of the voice-controlled robot car.

To establish a relation between the user and the microcontroller, a Bluetooth module is interfaced with the Arduino UNO. Bluetooth devices use 2.4 to 2.5 GHz frequency to communicate with each other. It has an approximate range of 2400–2483.5 MHz approximately. These devices generally use frequency-hopping spread spectrum communication technique to communicate with each other.

Therefore, in our project, we have interfaced an HC-05 Bluetooth module, which acts as a transceiver, thereby receiving the input voice commands from the user and delivering them to the microcontroller in order to move the car.

Smartphone has quite changed the traditional ways of human to machine interaction, thereby, making it a vital part of a person's life. Hence, to identify and process our speech as an input in order to deliver it to the system for the required output, is what's the main role of a smartphone here. Identification of speech is also called as "automatic speech recognition (ASR)". To run all such functions, an android application is used. Henceforth, with the help of an android application on a smartphone, a successful connection is established between the smartphone and the Arduino UNO, through the Bluetooth module. When connected, the vehicle will then be able to move in all the four directions; Forward, Backward, Right and Left as per the user's commands, that are received, respectively. To run the vehicle as per the user's command, the four DC motors connected to the wheels are synchronized accordingly to drive the car in that particular direction.

For instance: During forward motion, the motion of all four motors will be in the same direction. For backward motion, the motion of all the motors will be in opposite direction. Talking about the left and right motion, either of the motors will rotate and in order to stop the car all four motors will stop working. Therefore, for perfect synchronization and running of all the four DC motors, they are interfaced to the motor driver. The motor driver enacts as per the command received by the user to manipulate the velocity of the car.

To sense nearby objects for collision avoidance, an ultrasonic sensor is used. The sensor senses any object in the path of the car and sends a signal to the microcontroller which thereby automatically stops the car and changes its direction. Moreover, an IR sensor has also been interfaced as an additional feature to make the robotic car a line follower. The entire circuit sits on a chassis developed for the car. The system runs on two 4.2V battery. When developed, our project will then be able to successfully implement all the functions and work in the intended way.

II. LITERATURE SURVEY

Akshay Bhati et al. [1] authors developed a smartphone-controlled robot car. In this project, Arduino UNO is used as a central component, to which all the other components are interfaced. The designed vehicle is controlled wirelessly through a smartphone with the help of a Wi-Fi module. On detecting an obstacle, a notification is sent to the smartphone and the robot performs pick and place operation with the help of a robotic arm mounted onto the vehicle.

H.Rissanen et. al [2] has developed a planned vehicle that is controllable by utilizing a Bluetooth module. A mechanical knock sensor is connected on the facade of the vehicle to decide whether an impact has happened to it, and likewise, gives the specific time of crash.

S. Mandal et. al. [3] authors designed a Robot Vehicle to follow a black line path while accommodating various other features such as collision detection and avoidance or falling from a certain height with great stability and control. The design is incorporated with IR sensors, Bluetooth and Wi-Fi modules interfaced with a central Microcontroller Arduino UNO and is controlled by user through long range Wi-Fi connectivity. The path of the car can be changed by the user.

Ritika Pahuja et. al. [4] have elaborated how to control robot-controlled car using Wi-Fi module through android application of an android mobile phone. The robot has a smart phone attached to it. It captures the video of objects in front of the robot. Robot contains Bluetooth Compiler, Controllers, driver, IR, ADC.

Mrumal.K. Pathak et.al. [5] motivation behind their paper is to furnish amazing computational android stages with less difficult robot equipment design. This paper depicts how to control a robot utilizing portable through Bluetooth communication, a few highlights about Bluetooth innovation, segments of the versatile and robot.

S R Madkar (Assistant Professor), Vipul Mehta, et.al [6] authors provide powerful computational android platforms with simpler robot hardware architecture. It describes how to control a robot using mobile through Bluetooth communication, some features about Bluetooth technology, components of the mobile and robot.

Aniket R. Yeole, et.al [7] The authors have designed a robot that can be controlled using an application running on an android phone. It sends control command via Bluetooth which has certain features like controlling the speed of the motor, sensing and sharing the information with phone about the direction and distance of the robot from the nearest obstacle.

T. L. Chien, H. Guo, et.al [8] Authors describes a robot that extinguishes fire in real time is designed to extinguish the fire in the event of a fire disaster. It consists of two fire sensors that sense fire and then relay the signal to the module for motion control. The robot is then designated using a modern GSM to communicate using an RS232 interface and move to the fire location and extinguish the fire and also alarm the customer via a cell phone. To ease the movement of the robot, sets of IR sensors are used to facilitate the movement in free space and to avoid obstacles.

Vito M. Guardi [9] The author has evolved the method of Bluetooth technology by developing an android app for a robot which is driven by a microcontroller.
The central idea of his work is to show that one android app can be operated using totally different electronic devices.

Arpit Sharma et.al [10] The authors designed the robot vehicle in which phone uses motion sensors and records the gestures sent via an android mobile phone. It also has an inbuilt accelerometer and Bluetooth module for controlling the movements of a robot.

Zhao Wang, Eng Gee Lim, et.al [11] designed a mechanical vehicle that is structured with the assistance of a Microcontroller Arduino UNO. The vehicle is wirelessly controlled with the help of a Bluetooth module. On detecting any object within a threshold distance, the car stops and analyses all directions. Whichever provides more clearance, the car moves in that direction.

N. Firthous Begum, et.al [12] Authors talks about a pick and place robotic car which is designed with a purpose of picking the obstacle in front of it and placing aside. The car is controlled via Java programmed application and is equipped with a camera, placed on the car for surveillance.

Xiao Lu, et.al [13] The authors developed a model in which the smartphone is capable of IFLYTEK voice as well as handwritten input. The design is therefore robust, suitable, and practical for use and it also ensures the reliability of the full system. Wi-Fi serves as the mode for connectivity between the smartphone and robot and it makes it easy and absolutely convenient for controlling the robot so that it can act according to the commands.

Zhenjun He, et.al [14] Authors describes a mine detection robot with the help of different sensors. For detection purposes, a combination of ultrasonic sensor, gas sensor, temperature sensor, humidity sensor is used. The system is designed to assist the military in places where mine detection is highly probable. Further, the designed car is accompanied with a camera for video surveillance and an alert is sent to a smartphone with the help of IOT whenever a mine is detected.

M. Selvam [15] has projected design to develop a robotic system which has a wireless camera and night vision camera attached to it for surveillance. Bluetooth is implemented in the project for providing connection between robot and smartphone.

R. M. Narayana, et.al [16] Authors develop the remote buttons in the android app which control the robot motion with them. Adding to it, Bluetooth communication is used to interface controller and android. Controller is interfaced to the Bluetooth module though UART protocol.

In [17][18][19], the author describes the need of modern progression through the robotic systems for underground sewer infrastructure and also highlighted the existing methodologies, their applications, limitations and impact on realistic scenarios. The use of On-board processing with computer vision algorithms is proposed for better results.

In [20], the author presented the energy efficient system to clean the PV panels/solar panels to remove the accumulation of dust particles and other debris on the solar panels. The presented solar panel cleaning robot equipped with two rough sponges and a water pump system to clean sequence using the Arduino Uno board platform.

III. PROPOSED SYSTEM

A. Methodology

- Install any Bluetooth Application for Arduino.
- When the app is operating in the system, the microphone on the mobile is used to identify user voice commands.
- Pair the HC-05 Bluetooth module with the smartphone using the security key “1234” or “0000”.
- Click on the “MIC” icon in the app to speak the desired command to the robot.

Voice Commands	Functions
FORWARD	Car moves Forward
BACKWARD	Car moves Backwards
RIGHT	Car turns right
LEFT	Car turns left
STOP	Car stops moving

Figure 1: Basic Voice Commands

- Commands are interpreted and the program utilizes Google's speech recognition software to translate voice to text within the app.
- The text will then be sent with the aid of smartphone’s Bluetooth to the receiver part.
- These commands are received on the robotic device with the help of Bluetooth module set integrated in it.
- The Bluetooth Module receives the string, decodes it and compares it with the Instructions that are described in the program and moves the robot as per the command.
- The L298N motor driver circuit is used to run the DC motors and manipulate the velocity of the car.
- The ultrasonic sensor detects any object in the path of the vehicle.
- The complete circuitry is powered by a 12V rechargeable battery.
- Table above displays the basic voice commands used to control and monitor the robot and its functions.

B. **Flow Chart**

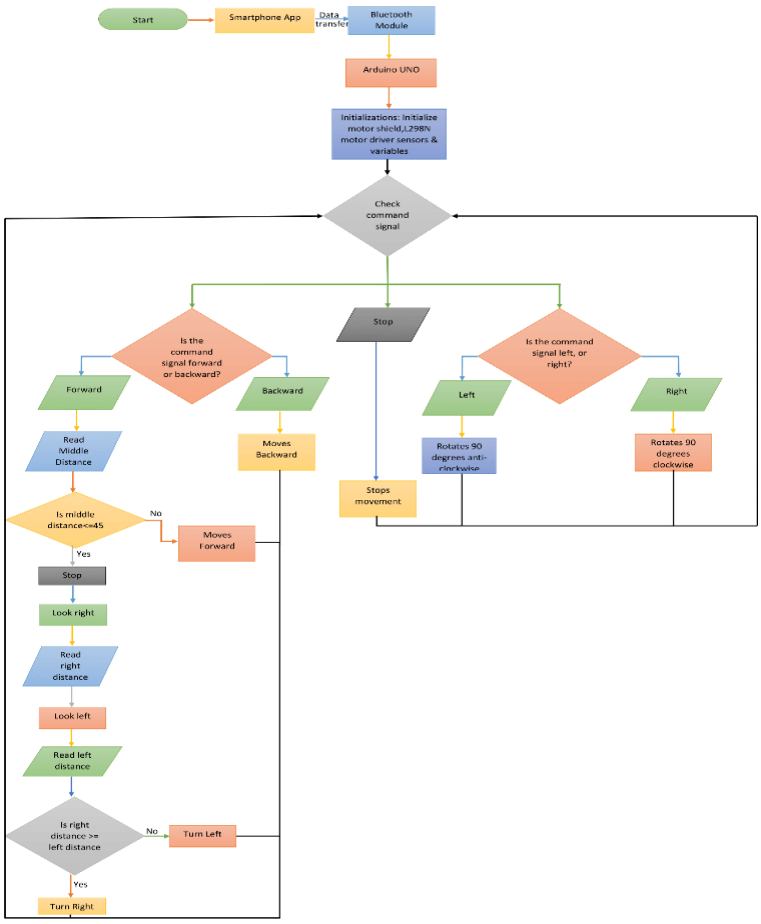

Figure 2: Flow Chart of the system

C. **Block Diagram**

Figure 3: Block Diagram of the system

1) Arduino UNO: Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

Figure 4: Arduino UNO

2) L298N Motor Driver: The L298N is an integrated monolithic circuit in a 15- lead Milliwatt and PowerSO20 package. It is a high voltage, high current, dual full-bridge driver designed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping motors.

Figure 5: L298N Driver

3) Sensor Shield: Sensor shield allows to connect various modules like sensors, servos, relays, buttons, drivers, and so on, directly to the Arduino.

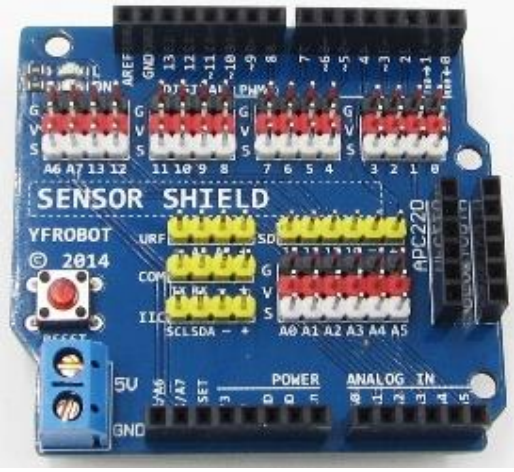

Figure 6: Sensor Shield

4) HC-05 Bluetooth Module: The HC-05 Bluetooth Module has range up <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.

Figure 7: Bluetooth Module

5) HC-SR04 Ultrasonic Sensor: The HC-SR04 ultrasonic sensor provides 2cm to 400cm (0.8 inches – 157 inches) of noncontact measurement functionality with a ranging accuracy that can reach up to 3mm (0.1 inches).

Figure 8: Ultrasonic Sensor

6) SG90 Servo Motor: The Servo motor is equipped with sophisticated internal circuitry and carbon fibre gears which makes it much lighter than the metal gear motor. The Servo Motor rotates 90° in each direction making it 180° servo motor.

Figure 9: Servo Motor

7) IR Sensor: The IR sensor can detect the white lines in black and black lines in white with the help of built-in LED indicator lights that uses infrared light detection and anti-interference ability to detect the line.

Figure 10: IR Sensor

8) DC Motors: A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy.

Figure 11: DC Motor

9) Arduino Bluetooth Controller: The Arduino Bluetooth Controller is a smartphone app that makes any android device a remote control for any microcontroller equipped with a Bluetooth module.

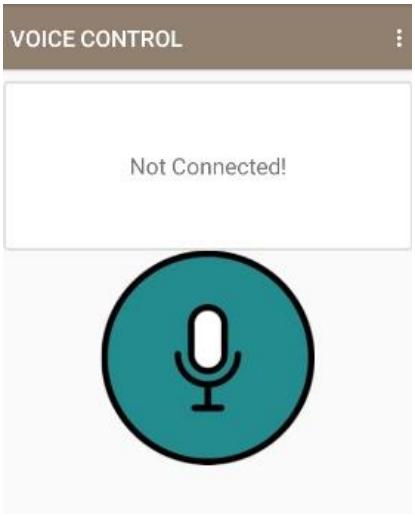

Figure 12: Android App

D. **Circuit Diagram**

The circuit comprises of Arduino UNO Board, Sensor Shield, an HC-05 Bluetooth Module, L298N Motor Driver, an HC-SR04 Ultrasonic Sensor, an SG90 servo motor, a 3-module line tracking IR Sensor, 4 DC Geared Motors, and two 4.2V Battery. UNO pins D5, D6, D7, D8, D9, and D11 are associated with the shield's S5, S6, S7, S8, S9, and S11 pins, respectively. These pins are henceforth associated with ENA, ENB, N1, N2, N3, and N4 pins of the L298N Motor driver, respectively. Fundamentally, pins D0 and D1 of UNO which acts as the TX and RX pins, respectively, are associated with the Rx and Tx pins of sensor shield. These pins are hence associated with Tx and Rx pins of Bluetooth Module, in accordance with the + and - of sensor shield for VCC and GND of the Bluetooth Module.

A5 and A4 pins of the Arduino UNO is wired with the pins A5 and A4 of the sensor shield. These pins along with the shield's V and G pins are connected to the Vcc, Trig, Echo, and Gnd of the Ultrasonic sensor, respectively. Additionally, pin D3 of the UNO is connected with the S3 pin of the shield, which in turn is associated with the servo motor, along with the G and V pins.

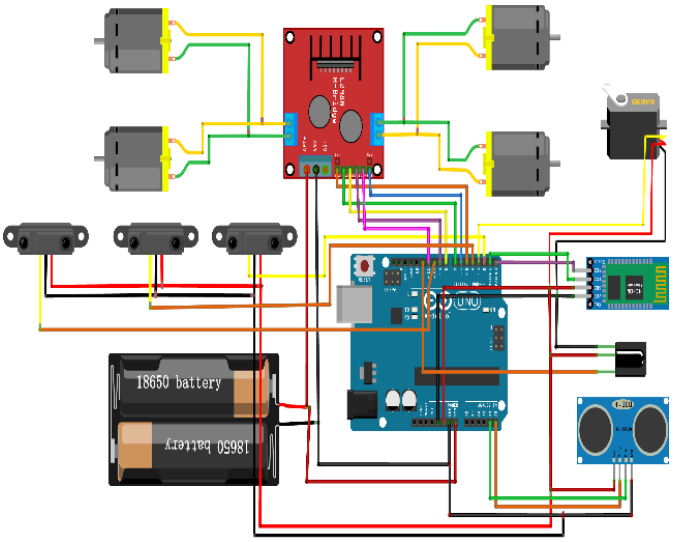

Figure 13: Circuit Diagram of the system

Essentially, DC motors 1, 2, 3, and 4 connected to control pins N1, N2, N3, and N4, of the L298N motor driver, respectively. Moreover, pins D10, D4, D2 are associated with pins S10, S4, and S2 of the sensor shield, respectively. These sensors shield pins are in turn connected with the 3-module line tracking IR sensor. Lastly, pin Vin and Gnd of sensor shield is straightforwardly provided with the power supply.

IV. RESULTS

A. **Simulation Results**

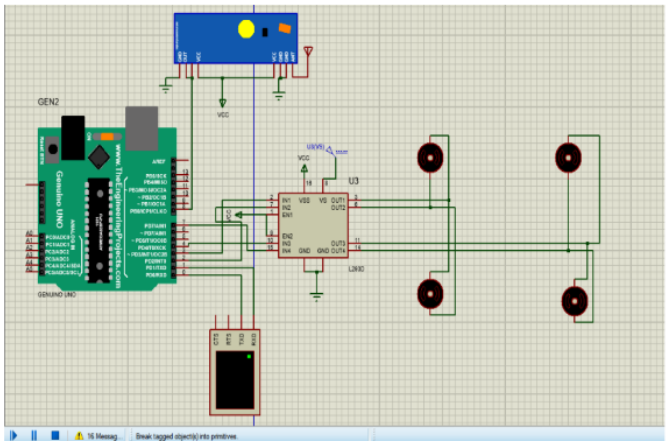

Figure 14: Simulation circuit of the system

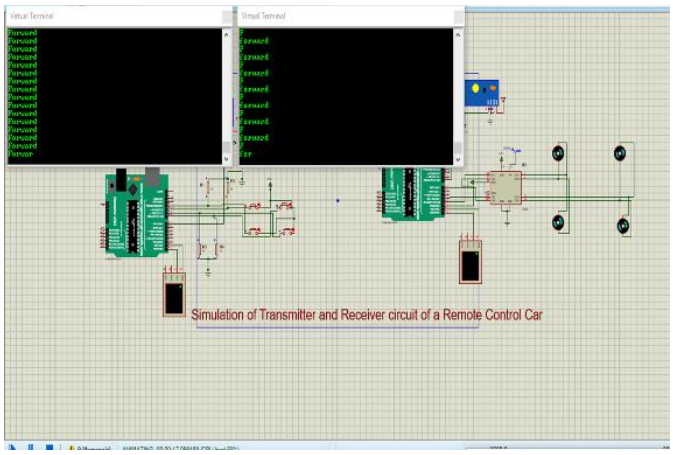

Figure 15: Motion simulation result of the system

B. Command Results

TABLE I
FORWARD COMMAND RESULT

Command: Move forward/Forward			
Sr. No.	**Conditions**	**Presence of Obstacles**	**Vehicle movement**
1.	Distance<45cm	Yes	Stop Check for distance>45cm in left or right direction and turn in that direction Wait for next voice command
2.	Distance>45cm	Yes	Moves ahead
		No	

TABLE II
LEFTWARD COMMAND RESULT

Command: Turn left/Left	
Vehicle movement	**Angle of rotation**
Turns to the left side	Rotates 90 degrees anti-clockwise

TABLE III
RIGHTWARD COMMAND RESULT

Command: Turn right/Right	
Vehicle movement	**Angle of rotation**
Turns to the right side	Rotates 90 degrees clockwise

TABLE IV
BACKWARD COMMAND RESULT

Command: Move backward/Backward	
Vehicle movement	**Angle of rotation**
Turns back and moves ahead	Rotates 180 degrees clockwise

TABLE V
REVERSE COMMAND RESULT

Command: Reverse
Moves backward in reverse position

TABLE VI
STOP COMMAND RESULT

Command: Stop
Stops the movement of the vehicle

C. Response Time Tabulated Result

Voice Commands	Response Time(in sec)	Distance(in m)
Forward	1.40	100
Reverse	1.34	100
Stop	1.33	100
Turn Left	1.59	100
Turn Right	1.26	100
Go Left	1.48	100
Go Right	1.80	100
Stop	1.63	100

Figure 16: Tabulated result of the system

D. Response Time Graphical Result

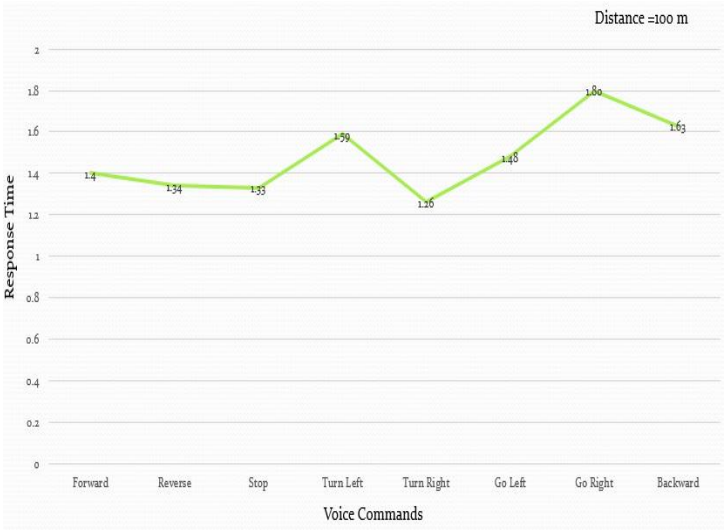

Figure 17: Graphical result of the system

E. Hardware Implementation

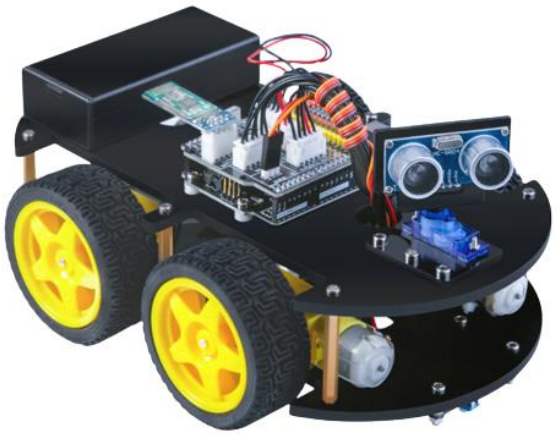

Figure 18: Top-end snapshot of the system

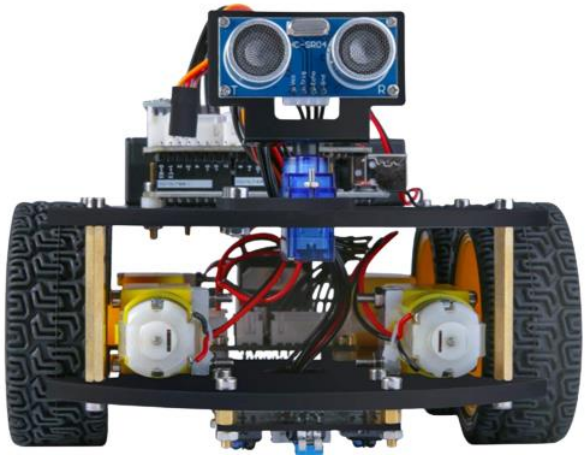

Figure 19: Front-end snapshot of the system

V. FUTURE SCOPE

The proposed project is just a small prototype of what's possible in this vast this sector. There's a lot of potential in this field. The vehicle works on simple voice command, so it is easy to use, and hence, is useful for those areas where humans can't reach. A variety of enhancements can be done in this proposed model to make it useful in wide variety of areas such as military, home security, rescue missions, industries, medical assistance etc. The system can be implemented on a wheel chair to make it voice-controlled wheel chair. A warm camera can be introduced to detect the warmth produced by bodies valuable in military purposes to distinguish foes on the lines. A web camera can be interfaced with the system for surveillance purposes. Furthermore, a proximity sensor can be interfaced with the system to make it useful for landmine detection. Obstacle avoidance can be interfaced with IR sensor to make it useful for line tracking purposes. The system can be implemented with the pick & place robot to make it operate via voice commands for certain actions. The vehicle can also be implemented with a gas sensor, fire sensor, and temperature sensor to make it an explosion sensing model which is controlled via voice commands.

VI. CONCLUSION

The field of Robotics has been vastly explored in this project which has led to the development of the proposed robotic vehicle. The entire coding has been done from the ground level to make the project run successfully. During the designing of the project, a complete working of Arduino UNO, a Bluetooth module, and ultrasonic sensor is executed and understood. Exposure to various software such as Arduino IDE and Proteus gave us a profound knowledge of how these software works. The voice recognition software has a high accuracy for identifying a voice command and it is also highly sensitive to the surrounding noise.

Different commands have been built in the code for different ways of the movement of vehicle. Henceforth, we were successful in implementing a simple model of voice controlled robotic vehicle which runs successfully on various voice commands given by the user. Additionally, the vehicle successfully detects any obstacle encountered in front of it and stops the movement thereby avoiding collision.

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