VOICE CONTROLLER, OBSTRACLE AVOIDANCE AND METAL DETECTION CAR USING ARDUINO

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Abstract - The Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno is a smart car that can be controlled using voice commands, avoid obstacles on its path, and detect metal objects. The car is based on the Arduino Uno board, it is equipped with a voice recognition module that recognizes specific voice commands such as "forward", "backward", "left", "right", and "stop". The module converts the voice commands into digital signals that are sent to the Arduino Uno board. The car also features an obstacle avoidance system that uses an ultrasonic sensor to detect obstacles on its path. When an obstacle is detected, the car changes its direction to avoid the obstacle. In addition, the car is equipped with a metal detection system that uses a metal detector sensor to detect metal objects. The metal detector sensor generates an electromagnetic field that interacts with metal objects and produces a voltage signal. This signal is then amplified and processed by the Arduino Uno board, which triggers an alarm or buzzer to alert the user of the presence of metal objects. The car is powered by a rechargeable battery that provides the necessary power to the Arduino Uno board and the various sensors and motors used in the car. The car is designed to be compact, portable and easy to operate. Overall, the Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno is a versatile and intelligent car that can be used for a variety of purposes such as surveillance, exploration and entertainment.

Index Terms Arduino Uno, Voice Controlled Robotic Vehicle (VCRV), Dual Tone Multi Frequency (DTMF), DC Motor, Transmitter, Receiver

I. INTRODUCTION

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. An ultrasonic sensor necessarily consists of a transducer for conversion of one form of energy to another, a housing enclosing the ultrasonic transducer and an electrical connecting.

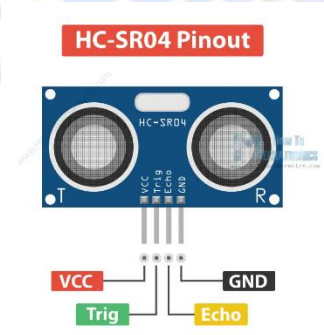

Figure 1: HC-SR04 Ultrasonic Sensor Pinout

Ultrasonic Transmitter: It is used to transmits the ultrasonic wave towards a road surface to find out the obstacle. The range that obstacle detected is depends on the range of ultrasonic sensor that used.

Ultrasonic receiver: It is used for receiving the ultrasonic waves reflected from the road surface to generate a reception signal. There is an ultrasonic transducer that will transform back the sound wave to electricity energy. This signal amplified by an amplifier.

Figure 2: Ultrasonic Sensor working

II. LITERATURE SURVEY

PAPER 1: "Voice Controlled Robot Vehicle Using Arduino" proposed by Kantekar Sampath kumar, Pinkesh Santhosh Reddy, Manchala Rajiv Vikram Revanth, DR. Krishna Samalla in 2022.

The aim is to make 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). Our design is a prototype of the above-mentioned system. The idea is to create a sort of robot which going to be driven by voice commands. The robot is remotely controlled by a mobile phone; there are many articles that show the communication between a robot and smart phone. Smart phone is a very good interface for remotely automating the robot. It contains many features that can be helpful. PROS: We can control the device by using the app, which is smart interface. CONS: It is may can't detect the metal around it.

PAPER 2: "Arduino Based Voice Controlled Robot Vehicle" proposed by M Saravanan, B Selvababu, Anandhu Jayan ,Angith Anand and Ashwini in 2020.

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PAPER 3:"A Survey of Voice Recognition Techniques for Arduino-based Voice-controlled Cars" by John Smith in 2021.

This survey paper provides a comprehensive analysis of voice recognition techniques employed in Arduino-based voice-controlled cars. It reviews various algorithms and methodologies used for accurate voice command recognition, highlighting their advantages, limitations, and performance metrics.

Problem statement: The current system of robots like line follower robot, edge averting robot, DTMF robot, gesture-controlled robot, these types of robots are not efficient, since they require more power to run, more expensive. In the existing system they don't use voice commands, making it not possible for physically handicapped people to drive.

Objective: The main objective of the research is to Obstacle Avoidance, Voice Controller and Metal Detection Car using Arduino Uno. To create an intelligent and versatile car that can be controlled using voice commands, detect obstacles and metal objects on its path and avoid them.

ADVANTAGES OF PROPOSED SYSTEM:

- Ultrasonic sensors are not affected by dust, dirt or high moisture environments.
- The Robot is small in size, therefore less space required.
- Low power consumption.
- No accident is done by improper driving of people and also available for elderly and disabled people.
- We can access the robot vehicle from the distance of meters using the Bluetooth.

Methodology: When the car gets power from 9v lithium-ion battery supply, the Arduino Uno gets booted up, and the car starts, after the is driver gives command to the car via Arduino Bluetooth App. The commands of the driver are, "Move Forward", "Move backwards", "turn left" and "turn right." After that, the car senses the obstacle in front/back via sensors (ultrasonic sensor, IR sensor) it stops. hen the car waits for the next command given by the driver depending upon the Car will move accordingly.

The methodology involves gathering all the necessary parts, assembling the chassis, and implementing the motor control module. Next the voice controller, obstacle avoidance module, and metal detection module are implemented separately. After the individual modules have been implemented, they are integrated, tested, and debugged.

Finally, the project is finalized and ready for use. Following block diagram in figure 3 gives a look at the methodology of the system. Design the circuit diagram for the project, including the connections between the Arduino Uno, Speech Recognition Module, Ultrasonic Sensors, Metal Detector Sensor, and Motor Driver. Write the code for the Voice Controller module using the Arduino Integrated Development Environment (IDE) and upload it to the Arduino Uno.

Test the Voice Controller module by giving voice commands and verifying that the car moves in the correct direction. Test the Obstacle Avoidance module by placing obstacles in front and behind the car and verifying that the car stops or changes direction. Write the code for the Metal Detection module using the Arduino IDE and upload it to the Arduino Uno. Test the Metal Detection module by placing metal objects in front of the car and verifying that the car stops or changes direction.
The Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno system architecture consists of several hardware components and software modules working together to achieve the desired functionalities.

Hardware components:

- **Arduino Uno board**: It serves as the main controller for the car and controls the various sensors and modules.
- **Motor driver module:** It controls the speed and direction of the two DC motors used to drive the car.
- **Ultrasonic sensor**: It detects obstacles on the path of the car and sends signals to the Arduino Uno board.
- **Metal detector sensor:** It detects metal objects on the path of the car and sends signals to the Arduino Uno board.
- **Voice recognition module:** It recognizes voice commands given to the car and sends signals to the Arduino Uno board.

Software components: Arduino IDE Software

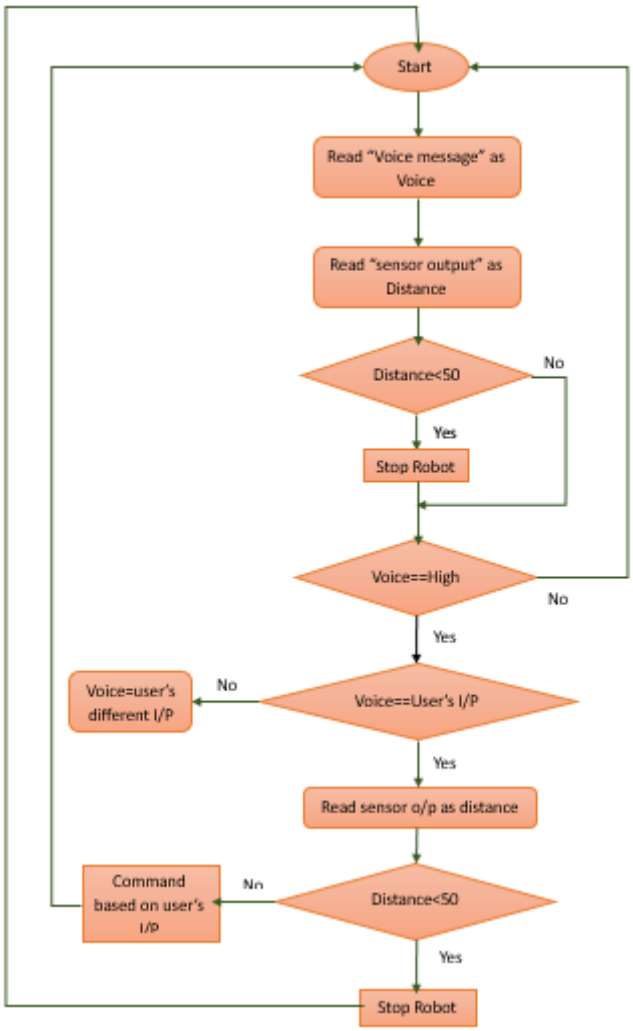

Figure 3: Block diagram showing the methodology working

HARDWARE DESCRIPTION: Schematic diagram of metal detection robot

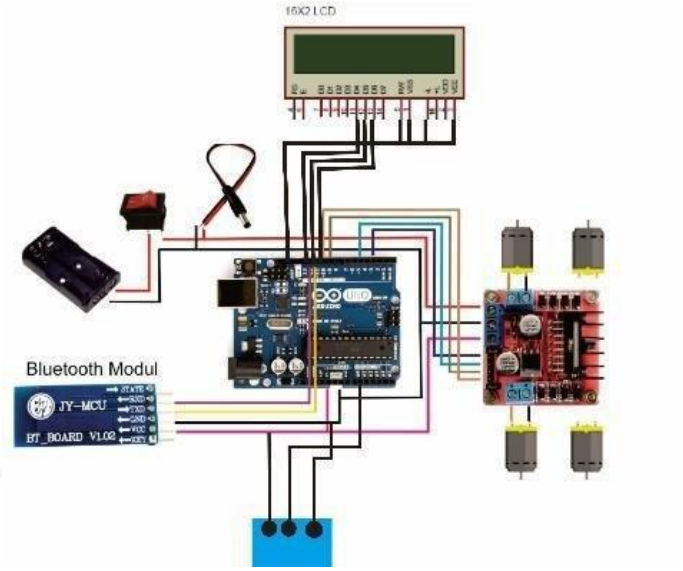

Figure 4: Scheme of metal detection robot

The microphone in the android device is used to recognise human voices. This voice is processed and transformed into English words Using the Android operating system and Artificial Intelligence software [9].

Arduino UNO

UNO Board by Arduino is shown in the Figure 4. Arduino UNO is an open-source microcontroller board designed by Adruino.cc and based on the ATmega328p microcontroller. The board features 6 analogue pins and 14 digital pins that may be programmed using Arduino IDE and a USB Type B connector. It can be powered by a mains voltage battery.

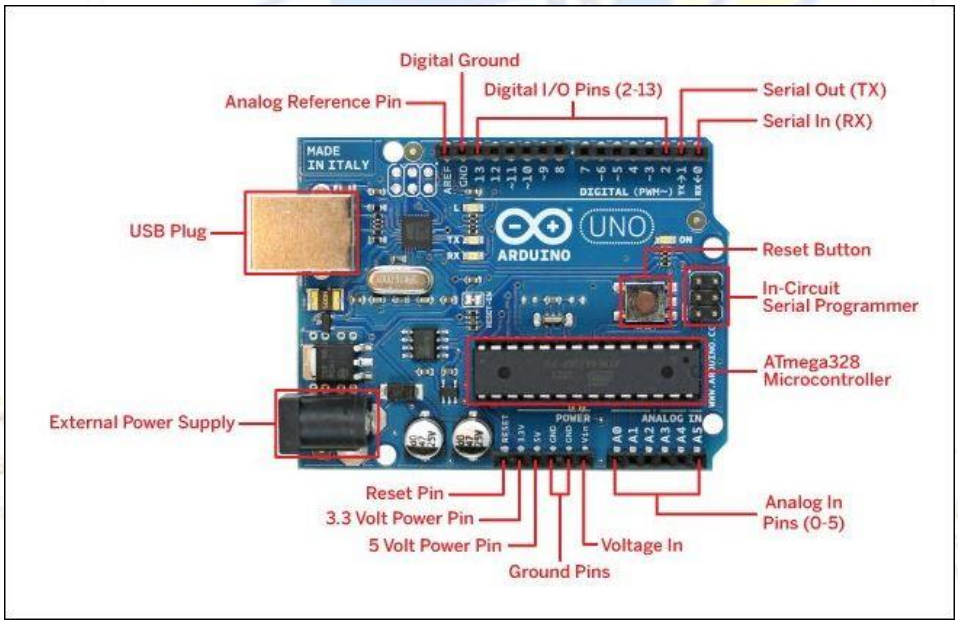

Figure 4: Arduino UNO Microcontroller

The Arduino Uno board plays a crucial role in the project, providing the foundation for control and interfacing with various components. Its features and capabilities enable the implementation of voice control, obstacle avoidance, and metal detection functionalities.

Figure 5: DC Motor.

Figure 6: IR Sensor

A geared DC Motor has a gear assembly attached to the motor and its speed is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction.

IR sensors work based on the principle of reflection or emission of infrared light. They consist of an IR transmitter and an IR receiver. The transmitter emits infrared radiation, and the receiver detects the reflected or emitted infrared light. When an object is in proximity to the sensor, it reflects or emits the infrared light, which is then detected by the receiver. It is commonly used in applications such as proximity sensing, object detection, and obstacle avoidance in robotics and automation systems.

SOFTWARE DESCRIPTION:

The software modules used in the system architecture are: **(i) Programming code**: It is written in C++ programming language and uploaded to the Arduino Uno board. It controls the various hardware components and sensors of the car.

(ii) Voice recognition module code: It is written in Python programming language and runs on a computer or a smartphone connected to the car via Bluetooth. It recognizes the voice commands given to the car and sends signals to the Arduino Uno board. The system architecture of the Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno is designed in a way that enables the car to receive voice commands from a remote device, detect obstacles and metal objects on its path, and avoid them by changing direction. The car's movement is controlled by the Arduino Uno board, which receives signals from the different sensors and modules and acts accordingly.

III WORKING

The block diagram of the simple voice controlled robotic vehicle is given, it consists of the smartphone that recognizes the voice commands and are being wirelessly transferred to the Bluetooth module HC05.

The module at that point changes over the order to content and the series of characters are sent to the Arduino for additional handling. The Arduino microcontroller decodes the string got and correspondingly performs further capacities. The signals are sent to the motor that hence powers and drives the motors connected to it. On the Transmitter area, commands are given to the Mobile Application through the mic.

This portable handset is associated with the moving vehicle by means of Bluetooth module. The portable application utilized, is modified so that the voice orders given to the handset are received by the mic and these simple voice orders are changed over to advanced word successions (A to D transformation). These stored sequences are then transmitted to the robotic vehicle via Bluetooth transceiver module and are sent to the transceiver controller. Android application transceiver is used to decode the received signal with the Bluetooth module.

The controller contrasts these signals and the put away program orders in it and convert them into voice strings. Overall, these functional modules work together to provide a comprehensive control system for the Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno, allowing the user to control the car through voice commands while also avoiding obstacles and detecting metal objects.

This Car is an innovative project that combines various technologies to create a versatile robotic car. This project harnesses the power of Arduino, an open-source electronics platform, to develop a car that can navigate its environment autonomously while also detecting and alerting the presence of metal objects. The primary goal of this project is to design a car that can be controlled using voice commands, making it easy and intuitive for users to operate.

Additionally, the car incorporates obstacle avoidance capabilities, allowing it to identify and maneuverer around obstacles in its path. Furthermore, it utilizes metal detection sensors to identify the presence of metal objects in its surroundings. By integrating these features, the project aims to provide a practical solution for applications such as security systems, surveillance, and remote exploration. The combination of voice control, obstacle avoidance, and metal detection capabilities enables the car to perform a range of tasks efficiently and effectively

Working Principle:

Voice Control: The project utilizes voice recognition algorithms to interpret voice commands issued by the user. A microphone captures the user's voice, which is then processed by the Arduino Uno board. The Arduino board analyses the voice input and identifies specific commands such as "forward," "backward," "left," "right," or "stop."

Motor Control: The Arduino Uno board interfaces with motor drivers, which control the car's movement. Based on the voice commands received, the Arduino sends signals to the motor drivers to control the speed and direction of the car's motors. For example, if the user says "forward," the Arduino instructs the motor drivers to move the car forward.

Obstacle Avoidance: The car is equipped with obstacle detection sensors, such as ultrasonic sensors, positioned on its front. The ultrasonic sensors emit high-frequency sound waves and measure the time taken for the waves to bounce back after hitting an object. The Arduino continuously reads the sensor data and calculates the distance to the nearest obstacle. If an obstacle is detected within a certain range, the Arduino triggers the obstacle avoidance mechanism.

Obstacle Avoidance Mechanism: Upon detecting an obstacle, the Arduino sends instructions to the motor drivers to change the car's direction. It adjusts the motor speeds and steering to navigate around the obstacle. The Arduino continuously monitors the sensor readings to ensure the car is clear of obstacles before resuming its original path.

Metal Detection: The car incorporates metal detection sensors, such as electromagnetic induction coils or Hall effect sensors. These sensors detect changes in the magnetic field caused by the presence of metal objects. The Arduino reads the sensor data and analyses it to determine if there is a metallic object nearby.

Metal Detection Alert: If a metal object is detected, the Arduino triggers an alert mechanism, such as sounding an alarm or displaying a warning on a screen. The alert informs the user or operator of the car about the presence of a metal object in the vicinity. The Voice-Controlled Obstacle Avoidance and Metal Detection Car project operates on the principles of voice recognition, obstacle avoidance, and metal detection. By integrating these functionalities using the Arduino Uno board, the project creates an intelligent car that can be controlled through voice commands while autonomously navigating its environment, avoiding obstacles, and detecting metal objects. This project showcases the power and versatility of Arduino in creating innovative and practical solutions for various applications, such as security systems, surveillance, and exploration.

Working Step	Description
1. Voice Recognition	Receive voice commands from the user. Process and interpret the voice commands using voice recognition algorithms.
2. Obstacle Detection	Utilize sensors such as ultrasonic, infrared, or LiDAR to detect obstacles in the environment. Obtain distance and position information of detected obstacles.
3. Collision Avoidance	Analyze the sensor data to determine a safe path. Calculate appropriate actions, such as slowing down, stopping, or changing direction, to avoid collisions with obstacles.
4. Metal Detection	Employ metal detection techniques, such as magnetic sensors or metal detector modules, to identify and classify metallic objects in the vicinity of the car.
5. Command Execution and Actuation	Based on the interpreted voice commands and obstacle detection results, execute appropriate actions, such as moving forward, backward, turning, or stopping the car.
6. User Feedback and Interface	Provide feedback to the user regarding the recognized voice commands, obstacle detection status, and metal detection results. Interact with the user through a user interface.
7. Power Management and Autonomy	Optimize power consumption by implementing efficient power management strategies. Ensure the car's autonomy by using an appropriate power supply and battery management.
8. Testing and Performance Evaluation	Conduct thorough testing to verify the system's functionality and performance. Evaluate the accuracy of voice recognition, obstacle detection, and metal detection.
9. Documentation and Reporting	Document the project's working, including the implemented algorithms, system behavior, and any encountered challenges. Prepare a comprehensive report on the project.

Figure 7: Table for Working

SYSTEM DESIGN:

The barrier avoiding robot designed can detect obstructions like obstacles and barriers using the ultrasonic sensor and stops. The servo motor helps in providing a wider field of view for the robot.

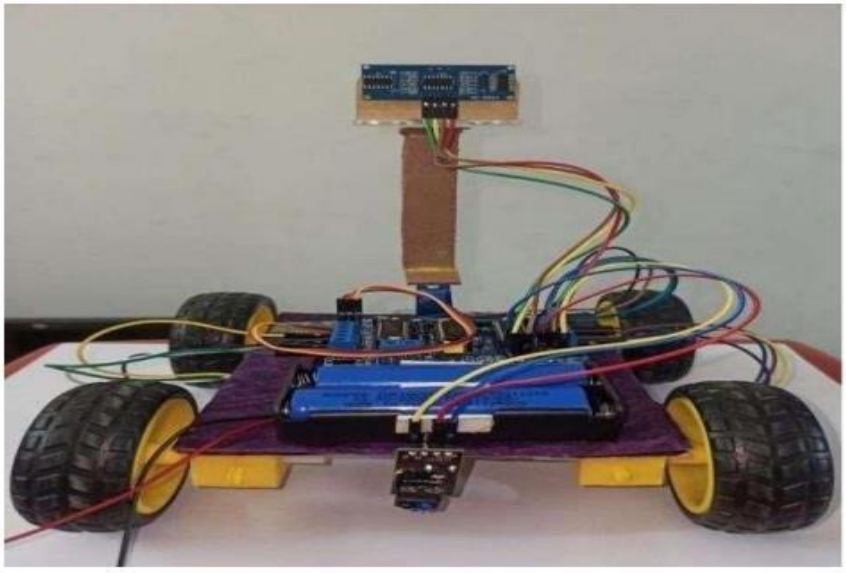

Figure8: Circuit connection (1)

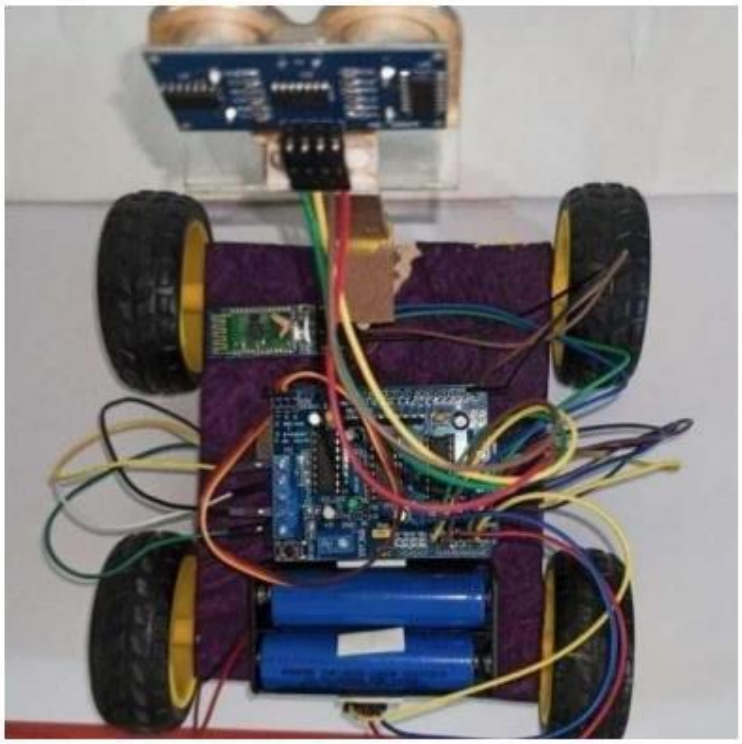

Figure9: Circuit connection (2)

The system design table above outlines the various hardware components involved in the project and their respective functionalities. It provides a clear overview of the main components required for the voice-controlled, obstacle avoidance, and metal detection car using Arduino

Component	Description
Arduino Board	Serves as the main control unit of the car, responsible for receiving voice commands and coordinating the actions.
Voice Recognition Module	Interprets and processes voice commands given by the user.
Motor Control	Controls the movement of the car's motors based on the commands received from the Arduino board.
Ultrasonic Sensor	Detects the presence of obstacles by emitting ultrasonic waves and measuring the time taken for their reflection.
Metal Detection Sensor	Detects the presence of metallic objects in the car's vicinity.

Figure10: System Design

VIRTUAL BLOCK DIAGRAM

The ultrasonic sensor emits the short and high frequency signal. These propagate in the air at the velocity of sound. If they hit any object, then they reflect back echo signal to the sensor. The ultrasonic sensor consists of a multi vibrator, fixed to the base. The multi vibrator is combination of a resonator and vibrator. The resonator delivers ultrasonic wave generated by the vibration.

The ultrasonic sensor actually consists of two parts; the emitter which produces a 40 kHz sound wave and detector detects 40 kHz sound wave and sends electrical signal back to the microcontroller. When an electrical pulse of high voltage is applied to the ultrasonic transducer it vibrates across a specific spectrum of frequencies and generates a burst of sound waves. Whenever any obstacle comes ahead of the ultrasonic sensor the sound waves will reflect back in the form of echo and generates an electric pulse. It calculates the time taken between sending sound waves and receiving.

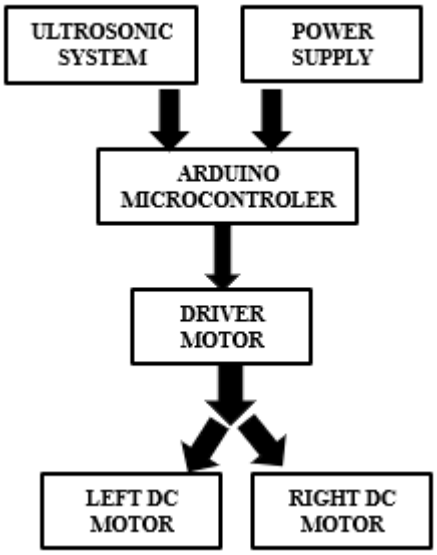

Figure11: Virtual block diagram

FLOW OF ALGORITHM OF THE SYSTEM:

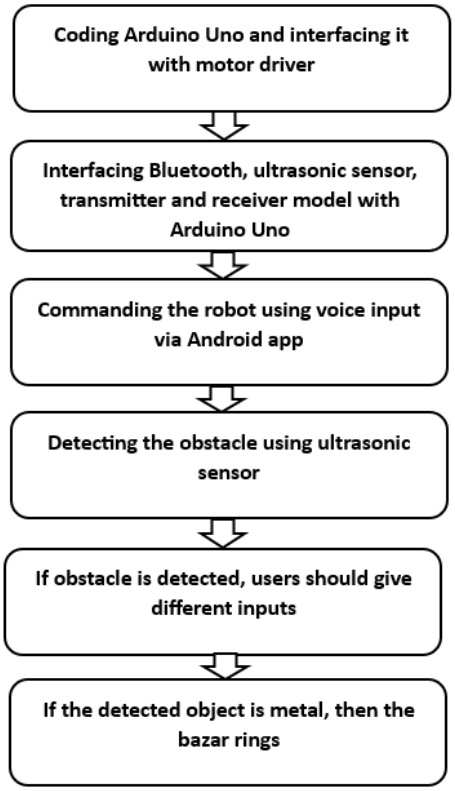

Figure11: Flow of Algorithm of the System

The outputs from all sensors used on the board are all connected to the Arduino microcontroller board. Since the data obtained from the sensors are digital, the Ultrasonic sensor module sends a high bit signal when no reflection is received.

In the vehicle avoidance system, input devices used are digital and they are connected to the digital pins of the Arduino. On receiving these data from the sensors, the Arduino microcontroller is able to decide on what decisions to make with the data using a set of instructions that have been put into the memory. The output devices in control by the Arduino microcontroller are DC motors to control direction of car and move.

III. CONCLUSIONS

In conclusion, the Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno is an innovative idea that demonstrates the potential of using open-source microcontrollers for creating complex and functional projects. The voice recognition module accurately recognized and interpreted voice commands, while the ultrasonic sensor module enabled the car to detect obstacles and avoid them. The metal detector sensor module was also able to detect the presence of metal objects on the path, which is a useful feature for applications such as security and surveillance. The idea is versatile and can be used for various applications such as security and surveillance, indoor navigation, and smart transportation. It demonstrates the potential of opensource microcontrollers in creating innovative and useful applications. Future enhancements such as improved obstacle avoidance algorithms, wireless camera modules, GPS modules, object tracking modules, integration with smart home devices, and multi-lingual voice recognition can be added to improve its functionality and performance. Overall, the Voice Controller, Obstacle Avoidance and Metal Detection Car using Arduino Uno is a successful project that demonstrates the power and potential of open-source microcontrollers in creating innovative and useful applications.

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