Voice Control Robot with Added Feature of Obstacle Avoidance and Remote Control

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***Abstract*—The roots of foundation of robotics belong back in 1950s; more than six decades has passed since then, and robotic evolution has been running unparalleled. Today we can feel the presence of robots everywhere and in every field whether it is medical, military, education or governance and so on. Robotics has become a helping hand for humans, and they are making our life easier, better and faster. Robotics is a boon for human kind, because robotic machines are giving alternatives, which is providing a great support to physically impaired people. This proposal focuses in the problems faced by specially abled people who wish to drive their vehicle on their own but they cannot because of the natural cause. In this proposed project, the emphasis is on voice control of robot with automatic braking, speed slow down and avoidance of obstacles automatically or manually (through voice command).In this model, we will use an android app to pass on the voice commands to the Arduino through Bluetooth communication using Bluetooth module. Ultrasonic sensor will act as the obstacle detector, which will act as a mediator for Arduino microcontroller (or the CPU) and the proximal environment, and it would eventually lead to slowing down the vehicle or to fully break its motion**

Index terms: arduino uno, motor shiled, servo motor, ultrasonic sensor, bluetooth module, voice control Etc.

I. Introduction

A. Background

The roots of foundation of robotics belong back in 1950s; more than six decades has passed since then, and robotic evolution has been running unparalleled. Today we can feel the presence of robots everywhere and in every field whether it is medical, military, education or governance and so on. Robotics has become a helping hand for humans, and they are making our life easier, better and faster. Robotics is a boon for human kind, because robotic machines are giving alternatives, which is providing a great support to physically impaired people.

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B. Problem Statement

This proposal focuses in the problems faced by specially abled people who wish to drive their vehicle on their own but they cannot because of the natural cause. In this proposed project, the emphasis is on voice control of robot with automatic braking, speed slow down and avoidance of obstacles automatically or manually (through voice command).

C. Motivation

Creating a voice-controlled robot with obstacle avoidance and remote control features offers convenience, accessibility for users with disabilities, interactivity, hands-free operation, enhanced safety through obstacle avoidance, and expanded utility with remote control capabilities.

D. Objectives

•To Build a robot that can be controlled using voice commands.

•To Incorporate obstacle avoidance capabilities to enable the robot to navigate autonomously without colliding with objects.
•To Implement a remote control feature that allows users to control the robot from a distance.

•To Develop a voice recognition system to convert spoken commands into actionable instructions for the robot.

•To Integrate ultrasonic sensors to detect and measure distances from obstacles.

•To Enable the robot to adjust its movements and path based on real-time obstacle detection.

•To Establish wireless communication between the robot and a remote control device.

•To Design a user-friendly interface for the remote control device, whether it's a mobile app, web interface, or physical remote.

•To Ensure seamless interaction between the voice control, obstacle avoidance, and remote control functionalities.

•To Test and optimize the system for accuracy, responsiveness, and reliability.

E. Organization

In this model, we will use an android app to pass on the voice commands to the Arduino through Bluetooth communication using Bluetooth module. Ultrasonic sensor will act as the obstacle detector, which will act as a mediator for Arduino microcontroller (or the CPU) and the proximal environment, and it would eventually lead to slowing down the vehicle or to fully break its motion.

II. Related Works

• Voice-Controlled Mobile Robot with Obstacle Avoidance" by Jitendra Baisla and Ravindra Kumar Yadav
• Remote-Controlled Robot with Voice Recognition and Obstacle Avoidance" by Sepehr Ashtari
• Smart Voice-Controlled Robot with Obstacle Detection and Remote Monitoring" by Shubham Kumar and Divyansh Srivastava
• Voice-Controlled Robot with Obstacle Avoidance using Deep Learning" by Srikar Shastry and Sangeetha Varadarajan
• Intelligent Robot with Voice Control, Obstacle Detection, and Remote Access" by Vishal Anand and Priyanka Deshmukh

III. METHODOLOGY

A. Flow Chart

1. Start
2. Gather required hardware components:
- Microcontroller
- Motor drivers
- Ultrasonic sensors
- Microphone
- Wireless module
3. Assemble the physical structure of the robot.
4. Connect hardware components to the microcontroller.
5. Set up the development environment for the microcontroller.
6. Program the microcontroller:
- Control motors based on voice commands
- Detect obstacles using ultrasonic sensors
- Process voice commands using a speech recognition library
- Implement obstacle avoidance algorithms
- Establish communication with the wireless module for remote control
7. Develop a remote control interface:
- Choose a suitable interface (mobile app, web, or physical remote)
- Establish wireless communication with the robot
8. Test the robot:
- Voice control functionality
- Obstacle detection and avoidance
- Remote control operation
9. Refine and improve the system as necessary.
10. End

B. Algorithm

1. Initialization:
- Set up the microcontroller, motor drivers, ultrasonic sensors, microphone, and wireless module.
- Initialize variables and define constants.

2. Voice Control:
- Capture voice input from the microphone.
- Convert voice commands to text using a speech recognition library.
- Process the text commands and map them to specific robot actions.
- Execute corresponding actions, such as moving forward, backward, turning, or stopping the robot.

3. Obstacle Avoidance:
- Read data from ultrasonic sensors to detect obstacles.
- Calculate distances between the robot and detected obstacles.
- If an obstacle is within a certain range:
- Determine the direction of the obstacle relative to the robot's position.
- Adjust the robot's movement or direction to avoid the obstacle.
- Continue monitoring for obstacles and adjusting robot movement as necessary.

4. Remote Control:
- Establish communication between the robot and the remote control device using the wireless module.
- Receive remote control commands from the device.
- Process the commands and map them to specific robot actions.
- Execute the corresponding actions, such as moving, turning, or stopping the robot based on the remote control commands received.

5. Loop:
- Continuously repeat steps 2 to 4 to provide real-time voice control, obstacle avoidance, and remote control functionalities.
- Monitor for voice commands, obstacle detection, and remote control commands.
- Update the robot's actions accordingly.

6. Termination:
- End the program or provide an option to stop the robot when desired.

C. Block Diagram

Install any Bluetooth Application for Arduino. Pair HC-05 Bluetooth module with the mobile Default password is "1234" or "0000".Click on the "MIC" icon and speak/instruct the robot .On speaking our speech gets recognized and converted into text. That text is transferred using Bluetooth .The Bluetooth Module receives the string, decodes it and compares it with the Instructions that are described in the program and moves the robot in direction given by the user using mobile application

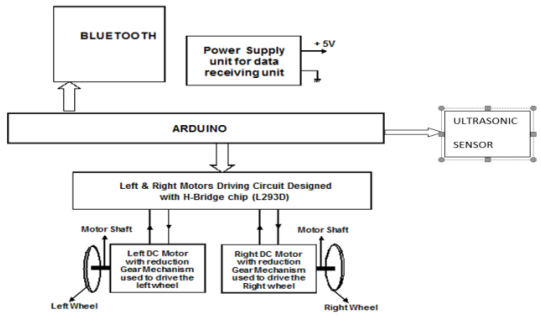

Fig. 1. Block Diagram Voice Controlled And Obstacle Avoidance Robotic Car

IV. THE HARDWARE

ARDUINO UNO

The Arduino Uno is an open-source microcontroller board dependent on the Microchip ATmega328P microcontroller and created by Arduino.cc. It is programmable with the Arduino IDE through a kind B USB cable. It can be controlled by the USB link or by an outside 9-volt battery, however it acknowledges voltages between 7 and 20 volts. Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

BLUETOOTH MODULE

This project work consists of two main modules: the android mobile phone and the Arduino BT board (Bluetooth module). The android mobile phone consists of several Bluetooth apps which enables the user to access the control commands for the robot. In this project we are targeting Android platform since it has huge market and open source. Android is a software stack for mobile devices that includes an operating system, middleware and key applications. The Android OS is based on Linux. Android Applications are made in a Javalike language running on a virtual machine called 'Dalvik' created by Google. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language. Accessory mode is a feature of Android OS since version 2.3.4 Gingerbread and 3.1 Honeycomb and above. A project can also be named as smart phone Android operated robot. Here is a simple control technique for your robot/robo car using Bluetooth module and microcontroller with your android Smartphone device. The controlling devices of the whole system are a Bluetooth module, DC motors that are interfaced to the microcontroller. The data received by the Bluetooth module from android smart phone is fed as input to the controller. The controller acts accordingly on the DC motor of the robot. The robot in the project can be made to move in all the four directions using the android phone. In achieving the task the controller is loaded with program written using Embedded 'C' or assembly Language. The Bluetooth module picks up the packets sent from the cell phone. Subsequently, these packets containing the appliance status commands are pipelined through the microcontroller and the designed analogue circuitry according to the definition of each output. The DC motors are connected to the digital output ports of the controller via H - Bridge to provide sufficiently high currents and voltage compatibility. For demo purpose two DC motors are used fo the robot movement in all the directions.

DC GEAR MOTOR

In this project work two DC motors are used to operate the robot. By giving the command signals from the mobile through the bluetooth app i.e., forward, backward, right and left directions, the robot will be moved. DC motors are widely used, inexpensive, small and poweful for their size. They are most easy to control. One DC motor requires only

two singals for its operation. They are non-polarized, means you can reverse the voltage without any damage to motor. DC motors have +ve and –ve leads. Connecting them to a DC voltage source moves motor in one direction (clockwise) and by reversing the polarity, the DC motor will move in opposite direction (counter clockwise). The maximum speed of DC motor is specified in rpm (rotation per minute). It has two rpms: no load and loaded. The rpm is reduces when moving a load or decreases when load increases. Other specifications of DC motors are voltage and current ratings. Below table shows the specifications of the motor used in the project.

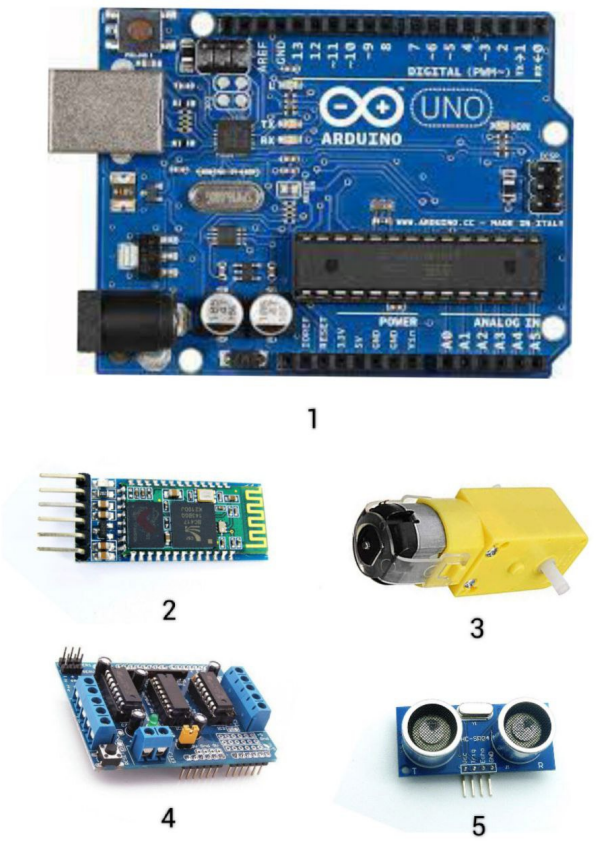

Fig. 2. 1.ARDUINO UNO, 2.BLUETOOTH MODULE, 3.DC GEAR MOTOR, 4.L293D MOTOR DRIVER, 5.ULTRASONIC SENSOR

L293D MOTOR DRIVER

L293d IC is known as a motor driver. It is a low voltage operating device like other ICs. The Other ICs could have the same functions like L293d but they cannot provide the high voltage to the motor. L293d provides the continuous bidirectional Direct Current to the Motor. The Polarity of current can change at any time without affecting the whole IC or any other device in the circuit. L293d has an internal H-bridge installed for two motors. H-Bridge is an electrical circuit that enables the load in a bidirectional way. L293d bridge is controlled by external low voltage signals. It may be small in size, but its power output capacity is higher than our expectation. It could control any DC motor speed and direction with a voltage range of 4.5 – 36 Volts. Its diodes also save the controlling device and IC from back EMF. To control the max 600mA amount of current an internal "Darlington transistor sink" installed in it, which could be used to control a large amount of current by providing a small amount of current. It has also internal "pseudo-Darlington source" which amplifies the input signal to control the high voltage DC motor without any interception.

ULTRASONIC SENSOR

Ultrasonic Sensors also known as transceivers when they both send and receive work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of the fluid. Further applications include: humidifiers, sonar, medical ultrasonography, burglar alarms and non-destructive testing. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed. The technology is limited by the shapes of surfaces and the density or consistency of the material. For example foam on the surface of a fluid in a tank could distort a reading.

V. SOFTWARE

ARDUINO IDE SOFTWARE The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor. Installation The steps to get started with Arduino UNO are listed below: o Install the drivers of the board. As soon we connect the board to the computer, Windows from XP to 10 will automatically install the board

drivers. But, if you have expanded or downloaded the zip package, follow the below steps:
1. Click on Start - Control Panel - System and Security.
2. Click on System - Device Manager - Ports (COM LPT) - Arduino UNO (COMxx). If the COM LPT is absent, look Other Devices - Unknown Device.
3. Right-click to Arduino UNO (COmxx) - Update Driver Software - Browse my computer for driver software.
4. Select the file "inf" to navigate else, select "ArduinoUNO.inf" Installation Finished.

VI. Experimental Setup and Result

Experimental Setup for Voice Control Robot with Obstacle Avoidance and Remote Control:

1. Hardware Components:
- Microcontroller: Arduino Uno
- Motor Drivers: motor shield
- Ultrasonic Sensors: HC-SR04 ultrasonic sensors
- Microphone: Electret microphone
- Wireless Module: Bluetooth module (HC-05)

2. Robot Assembly:
- Assemble the robot using a chassis, two DC motors, and wheels.
- Connect the motor drivers to the Arduino Uno and wire the motors accordingly.
- Connect the Bluetooth module to the Arduino Uno for remote control.

3. Programming:
- Set up the Arduino IDE for programming the Arduino Uno.
- Write firmware code in Arduino programming language (C/C++) to control the motors, detect obstacles using ultrasonic sensors, process voice commands, and establish Bluetooth communication.
- Establish communication protocols for receiving remote control commands via Bluetooth.

4. Voice Control:
- Capture audio input from the electret microphone.
- Process the audio to extract voice commands.
- Convert voice commands to text using a speech recognition library or a custom algorithm.

5. Obstacle Avoidance:
- Program the Arduino Uno to read data from the ultrasonic sensors.
- Implement obstacle detection algorithms based on the sensor readings.
- Adjust the robot's speed or direction using the motor drivers to avoid obstacles.

6. Remote Control:
- Establish Bluetooth communication between the robot and the mobile app.
- Define a protocol for transmitting remote control commands and incorporate them into the robot's firmware.

Results:
The voice-controlled robot with obstacle avoidance and remote control capabilities is able to:
- Receive voice commands and perform corresponding actions such as moving forward, backward, turning left/right, and stopping.
- Detect obstacles using the ultrasonic sensors and autonomously navigate around them.
- Respond to remote control commands sent from a mobile app or other Bluetooth interface.

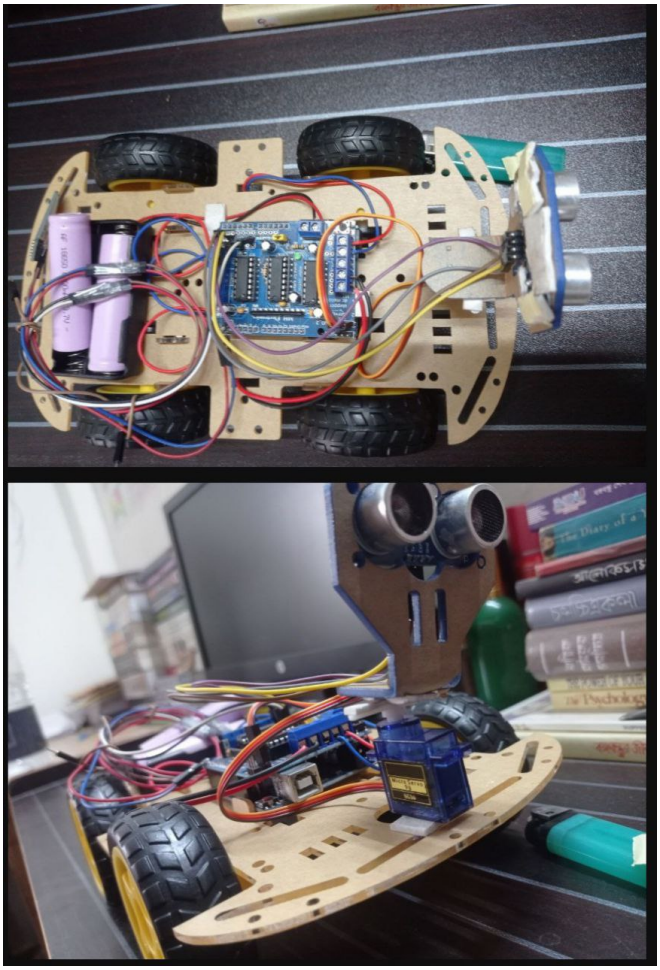

Fig. 3. Project

VII. APPPLICATION

The application is connected to the Arduino uno through the Bluetooth module and the voice commands are taken by the app and send them to Arduino uno through the Bluetooth module.

Fig. 4. APPLICATION

VIII. Discussion

Creating a voice-controlled robot with obstacle avoidance and remote control capabilities combines speech recognition, obstacle detection, and wireless communication.

The robot is equipped with ultrasonic sensors to detect obstacles in its surroundings. It uses a microcontroller to process the sensor data and adjust its movement to avoid collisions.

The voice control feature allows the user to give commands to the robot using their voice. The robot uses a speech recognition system to convert spoken commands into text and then executes the corresponding actions.

Additionally, the robot can be remotely controlled using a wireless module. The user can use a mobile app, web interface, or physical remote control to send commands to the robot wirelessly. This provides flexibility and convenience in controlling the robot from a distance.

Overall, the combination of voice control, obstacle avoidance, and remote control makes the robot versatile and user-friendly, allowing for intuitive interaction and autonomous navigation in various environments.

IX. Conclusion

The project work “Bluetooth controlled Robot” is designed and developed successfully, for the demonstration purpose prototype module is constructed and results are found to be satisfactory. Since it is a prototype module, a simple robot is constructed, which can be used for many applications. While designing and developing this proto type module, we have consulted few experts those who are having knowledge in robotics, embedded systems, etc and these professionals working at different organizations belongs to Hyderabad helped us while fabricating this project work. Since it is a prototype module, much amount is not invested. The whole machine is constructed with locally available components. Some of the modifications must be carried out in design to make it as real working system. In this concept the robot is controlled through the bluetooth technology whose range is nearly 100m approximately. If a camera is placed over the robot, direction can be controlled and will broadcast the video signals to the monitoring station, where the person is monitoring and control operation can be performed much better. The full functionality of the robot control system was tested and the wireless communication between the cell phone and Bluetooth module was found to be limited to ¡50m in a concreted building and maximum of 100m range was reported to be applicable in an open range. This project developed an obstacle avoiding robot to detect and avoid obstacles in its path. The robot is built on the Arduino platform for data processing and its software counterpart helped to communicate with the robot to send parameters for guiding movement.

X. Acknowledgements

We would like to thank our guide Mrs. Nurjahan Nipa and Mrs. Farzana Akter for their continous support and guidance.Because of their guidance,we completed our project successfully.

XI. References

[1] Zhizeng L, Jingbing Z (2004). Speech recognition and its application in voice-based robot control
system. In 2004 International Conference on Intelligent Mechatronics and Automation, 2004. Proceeding.

[2] Tabassum F, Lopa S, Tarek MM,Ferdosi BJ (2017). Obstacle avoiding robot. Global J. Res. Eng., 17(1). Version 1.0.

[3] Ryther CA, Madsen OB (2009). Obstacle Detection and Avoidance for Mobile Robots. Technical
University of Denmark.

[4] Ahasan MA, Hossain SA, Siddiquee AU, Rahman MM (2012). Obstacles Invariant Navigation of an Autonomous Robot Based on GPS. Khulna University.

[5] Dhanya KR, JeyanthiR (2012). Automatic braking system with fusion concept. Int. J. Emerg. Trends Eng.
Dev. April.

Text Books:

[6] Linear Integrated Circuits – By: D. Roy Choudhury, Shail Jain

[7] Digital Electronics. By JOSEPH J.CARR

[8] Fundamental of Radio Communication: By A.SHEINGOLD

[9] Basic Radio and Television: By S.P.SHARMA

[10] Digital and Analog Communication System By: K. sam Shanmugam

[11] Relays and their applications - By: M.C.SHARMA

[12] The concepts and Features of Micro-controllers - By: Raj Kamal

[13] The 8051 Micro-controller Architecture, programming Applications - By: Kenneth J. Ayala

[14] Programming and Customizing the 8051 Micro-controller - By: Myke Predko

[15] Electronic Circuit guide book – Sensors – By JOSEPH J.CARR