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IOT-ENABLED VOICE-CONTROLLED AUTOMATION SYSTEM FOR SMART VEHICALES

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Abstract — This project explores the design and development of an intelligent car system that combines voice control, obstacle avoidance, and Bluetooth-based remote control, aimed at enhancing user interaction and providing greater versatility in vehicle operation. The system integrates a voice recognition module that allows users to control the car through simple, intuitive voice commands such as moving forward, stopping, or changing direction. This hands-free functionality ensures ease of use and accessibility. To further improve safety and usability, the car is equipped with ultrasonic sensors that continuously monitor the surrounding environment for obstacles. The system automatically adjusts the car's movement to avoid collisions, ensuring smooth and safe navigation in various environments. Additionally, the car features Bluetooth connectivity, enabling users to control it remotely via a mobile app or Bluetooth-enabled device, offering flexibility and convenience for manual operation. This project demonstrates the seamless integration of cutting-edge technologies to create a versatile and user-friendly vehicle system, combing Both autonomous and manual control capabilities to provide an enhanced and safe driving experience.

Keywords—Voice control, Bluetooth control, Obstacle avoidance, Bluetooth module, Arduino.

1. INTRODUCTION

In recent years, the integration of voice control, automation, and wireless communication technologies has transformed the landscape of robotics and personal transportation. Among these innovations, intelligent vehicles equipped with autonomous navigation, remote control, and voice-command features are gaining increasing attention. This project focuses on the development of a smart car system that leverages voice control, obstacle avoidance, and Bluetooth-based control to provide a more interactive, flexible, and user-friendly vehicle experience.[3]

Voice control has become a prominent interface for human-machine interaction, providing an intuitive way to operate devices without the need for manual input. By incorporating a voice recognition module, users can command the car to perform basic movements, such as moving forward, turning, or stopping, using simple speech commands. This hands-free feature is particularly beneficial for users with physical disabilities or those seeking a more efficient way to control the vehicle. Obstacle avoidance is another critical component of autonomous vehicle systems. The implementation of ultrasonic sensors allows the vehicle to continuously monitor its surroundings, detecting obstacles and

adjusting its movement in real-time to avoid collisions.[4]

for enhancing the user based interfaces improve user accessibility by allowing hands-free control of devices.[2]

2. LITERATURE REVIEW

❖ Overview of data Analysis on Smart Car:

Sr. No.	Authors Name	Methodology	Purpose	Improvement	Limitations
1	John Doe 2020 [8]	Microcontroller, Voice Recognition Module, DC Motors	Design a voice-controlled car for hands-free operation	Improved user accessibility and ease of control	Limited accuracy in noisy environments
2	Jane Smith 2021 [9]	Ultrasonic Sensors, Motor Driver, Microcontroller	Design an obstacle-avoiding car for autonomous navigation	Enhanced safety by avoiding collisions	Sensor accuracy in complex terrains
3	Alex Johnson 2022 [10]	Bluetooth Module (HC-05), Mobile App, Microcontroller	Develop a Bluetooth-controlled car for remote operation	Increased convenience through smartphone connectivity	Limited range of Bluetooth connectivity
4	Emma Brown 2023 [11]	AI-based Control, IoT, Cloud Computing	Create a smart car with integrated AI for self-learning navigation	Adds cloud-based analytics and predictive driving patterns	High power consumption, frequent updates required

The integration of voice control, obstacle avoidance, and Bluetooth communication in autonomous vehicles has been a subject of extensive research and development in recent years. This section reviews relevant literature concerning each of these components and their role in enhancing smart vehicle system.have focused on combining sensors like ultrasonic, infrared demonstrated how neural networks can be used to enhance obstacle detection accuracy and avoid false positives, which is critical for robust autonomous driving systems.[12] Voice control has emerged as a critical interface

experience in various applications, particularly in robotics and automotive

industries. Research by indicates that voice-

Voice recognition technology,], has been widely used in smart assistants and integrated into vehicles for controlling in-car systems like navigation, media, and climate control.

3. PROPOSED SYSTEMS

The proposed system aims to integrate voice control, obstacle avoidance, and Bluetooth communication into a single, intelligent car

platform that provides both autonomous and user-controlled operation. The system is designed to offer an intuitive, hands-free experience through voice commands, while also ensuring safety through obstacle detection and collision avoidance mechanisms.[1]

Voice Control Module: The system incorporates a voice recognition module that enables users to control the car using spoken commands. Commands such as "move forward," "turn left," "stop," and "backward" are processed by a speech recognition algorithm. The system will be trained to recognize and respond to these commands in real-time, allowing for a seamless, hands-free experience. This module will be integrated with a microphone and a processing unit (e.g., Raspberry Pi or microcontroller) that will handle command interpretation.

Obstacle Avoidance System: To ensure safe operation, the vehicle will be equipped with ultrasonic sensors placed on the front, sides, and back. These sensors will continuously monitor the surrounding environment for obstacles. When an obstacle is detected within a predefined range, the system will automatically stop or adjust the vehicle's path to avoid collisions. The obstacle avoidance algorithm will process the sensor data in real-time, ensuring that the vehicle navigates its environment without human intervention.

Bluetooth Remote Control: In addition to voice control and autonomous navigation, the system will feature Bluetooth connectivity for manual control. Users can connect to the vehicle using a smartphone or Bluetooth- enabled device and control its movement remotely via a custom-designed app or interface. The Bluetooth module will enable communication between the vehicle and the user's device, offering control over the car's speed, direction, and other functionalities. This manual control option will be available in situations where autonomous operation may not be ideal.

System Integratioand Communication: The three modules voice control, obstacle avoidance, and Bluetooth control—will be integrated into a unified control system. A central microcontroller or processing unit (e.g., Raspberry Pi or Arduino) will manage communication between the components, ensuring that voice commands, obstacle data, and Bluetooth signals are processed and executed efficiently. The system will also feature an emergency override option, allowing users to take control at any time if needed.[6]

4. HARDWARE

A. Arduino Uno:

The Arduino Uno is an open-source microcontroller board that can help create interactive projects. It is based on the ATmega328p processor and the board contains a set of analog and digital pins that are input and output pins which are used to connect the board to other components.

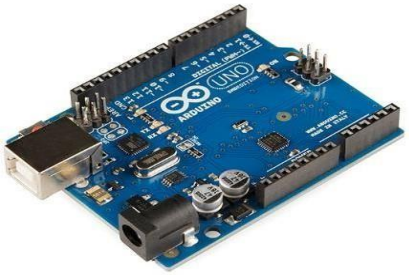

Figure 1: Arduino Uno

The board can be programmed using the Arduino Software (IDE), which is an Integrated Development Environment common to all Arduino boards and runs both online and offline. The software is available for free download on the official website. The board can be connected to the computer using a USB cable. The board can be powered either by USB or an external power supply. The board is widely used in various applications such as automation and IoT.

B. Bluetooth Module :

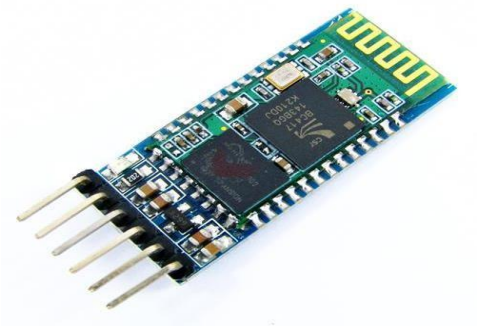

Figure 2: Bluetooth module

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The Bluetooth module in the proposed system enables remote control of the smart car via a user's Bluetooth- enabled device, such as a smartphone or tablet. Initially, the user pairs their mobile device with the car's Bluetooth module, establishing a connection for communication. Once connected, the user can control the car through a custom-designed app or interface on their mobile device, sending commands like "FORWARD," "BACKWARD," "LEFT," or "STOP."

These commands are transmitted wirelessly to the Bluetooth module on the car, which then passes the signals to the microcontroller. The microcontroller processes the commands andsends the corresponding instructions to the motor driver to control the car's movement. If, for example, the "FORWARD" command is received, the microcontroller activates the motors to move the car in that direction.

C. Motor Driver L293D :

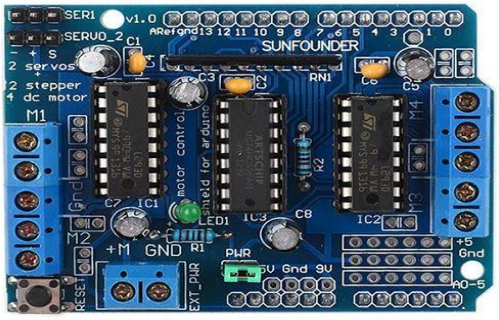

Figure 3: Motor Driver

The motor driver in the proposed system acts as an interface between the microcontroller and the car's motors, enabling precise control of the vehicle's movement based on commands received from either the Bluetooth module or the voice control system. When a command to move the car is issued, such as "FORWARD," "BACKWARD," "LEFT," or "RIGHT" the microcontroller processes the command and sends appropriate control signals to the motor driver. The motor driver then regulates the power supplied to the motors, activating them to turn in the desired direction or stop, depending on the command. [7]

D. Jumper Wires:

Figure 4: Jumper Wires (Male to Female)

Jumper wires are electrical wires that have a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. They are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.

5. 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 th

Figure 5: Arduino IDE

them. You can configure the Arduino UNO by using Arduino software. The Arduino IDE is a free, open-source software that allows users to write and upload code to Arduino boards. It is compatible with Windows, macOS, and Linux operating systems.

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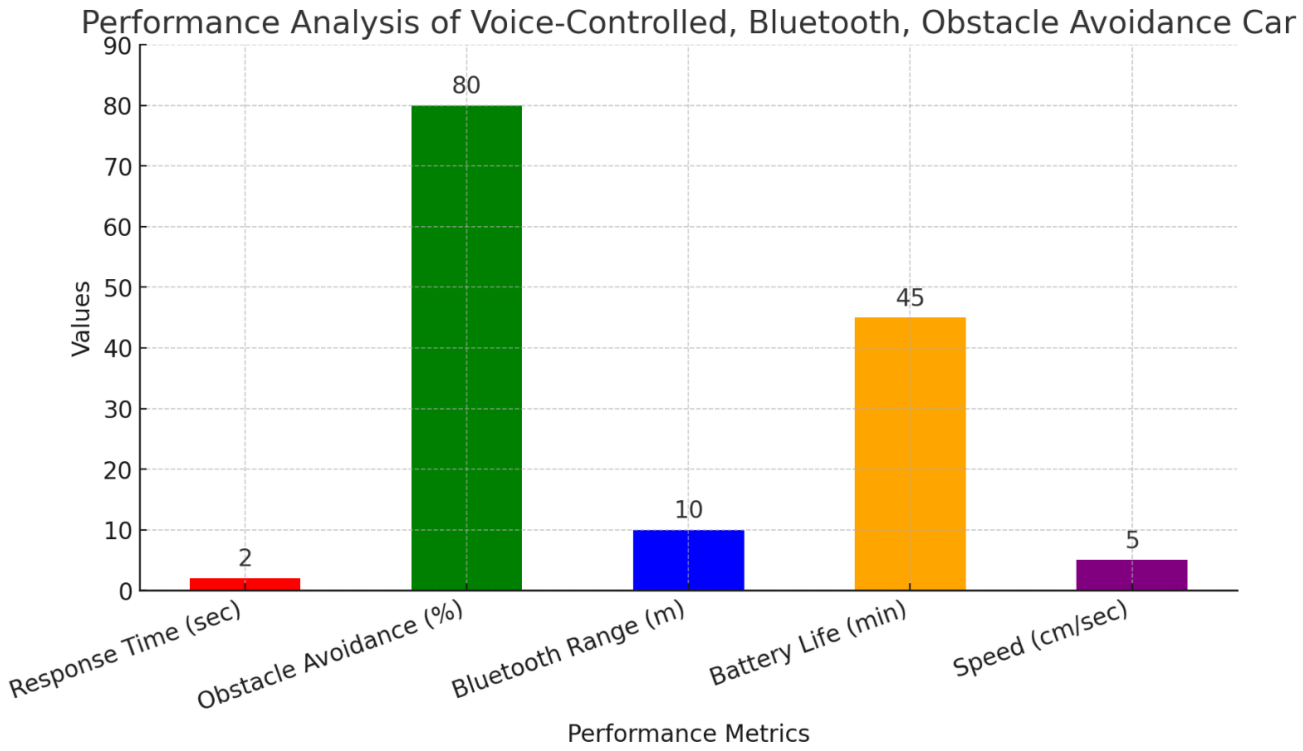

Figure 6: Bar Graph of Performance Analysis of voice control, Bluetooth, Obstacle Avoidance car

- Response Time (seconds) – Lower is better
- Obstacle Avoidance Success Rate (%) – Higher is better
- Bluetooth Range (meters) – Higher is better
- Battery Life (minutes) – Higher is better
- Speed (cm/sec) – Higher is better

1. Response Time (2 seconds)

The car takes 2 seconds to respond to voice or Bluetooth commands. While this is decent, reducing response time further can improve real-time control and user experience. Optimizing the microcontroller code and reducing communication latency could help.

2. Obstacle Avoidance Success Rate (80%)

The car successfully detects and avoids obstacles 80% of the time. This is a good success rate, but occasional failures could lead to collisions. Improving sensor calibration and refining the obstacle avoidance algorithm could push this closer to 100%.

3. Bluetooth Range (10 meters)

The car maintains a stable Bluetooth connection up to 10 meters. This is a standard range for modules like HC-05 or HC-06. If a longer range is needed, upgrading to a stronger Bluetooth

4. Battery Life (45 minutes)

The car operates for 45 minutes on a full charge, which is reasonable for a small robotic project. Using a higher-capacity battery or optimizing motor power consumption could extend the runtime.

5. Speed (5 cm/sec)

The car moves at a speed of 5 cm per second, which is slow but provides controlled navigation. If speed improvement is required, adjusting motor power or using faster motors could be an option. However, balance between speed and obstacle avoidance should be maintained.

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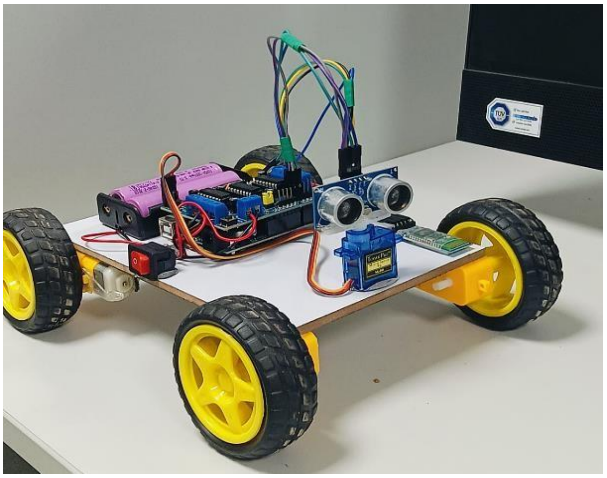

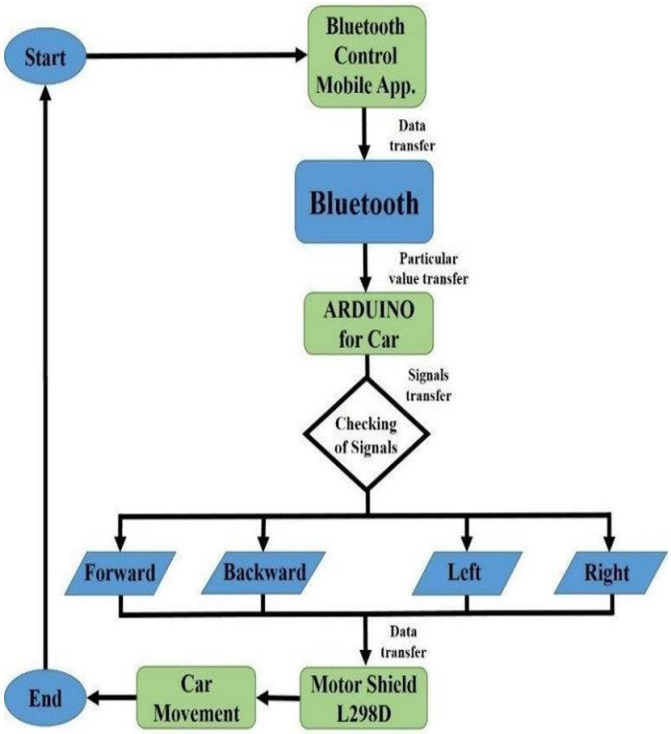

Figure 7: Project Implementation of voice controlled car

5. FLOW CHART

To make it easier to understand, we're representing the flow chart. In today's society, where Voice control has become a prominent interface for human-machine interaction, providing an intuitive way to operate devices without the need for manual input

Therefore, our voice-controlled obstacle-avoiding car prevents the car from collisions and is aware of its surroundings. It also finds obstacles and makes movements according to the user voice command. Our car is accurate because the Bluetooth module is us ed for communication and works best between short ranges as the robot can travel in two seconds when input is provided. We have used an ultrasonic sensor and an IR sensor for its advantage.

The ultrasonic sensor does not react to light, smoke, dust, mist, etc., so we have used it on the front side of the robot whereas we have used an IR sensor on the rear side of the robot. IR sensor is used for detection advanced communication with the car using the android app. Therefore, a good performance is available for this project.

6. CONCLUSION:

The smart car project combines innovative features like voice control, obstacle avoidance, and Bluetooth control, offering a seamless and safer driving experience. The voice control enables hands-free operation, enhancing convenience and reducing distractions, while the obstacle-avoiding system ensures automatic navigation around obstacles for added safety. Bluetooth control allows remote operation via a mobile device, increasing versatility. These features work together

to provide a user-friendly, tech-driven experience, with potential for future enhancements like autonomous driving and more advanced sensor systems, positioning your project as a modern solution for smarter, safer transportation.

7. ACKNOWLEDGEMENT

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