
**INTELLIGENT BLUETOOTH CONTROLLED ROBOTIC VEHICLE
WITH AUTONOMOUS OBSTACLE AVOIDANCE**

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ABSTRACT

The Intelligent Bluetooth Controlled Robotic Vehicle with Autonomous Obstacle Avoidance is a smart robotic mechanism developed to control a vehicle remotely using Bluetooth technology while also detecting & avoiding obstacles automatically. The system uses an Arduino Nano as the important controller that processes instructions obtained from a smartphone via an HC-05 Bluetooth module. The robot can moves forward, backward, left, & right according to user instructions sent through a mobile application. To improve safety & intelligence, the robot is provided with an HC-SR04 ultrasonic sensor which constantly measures the distance between the robot & close obstacles. A SG90 micro servo motor is used to rotate the ultrasonic sensor to scan various directions & define the most secure path for movement. If an obstacle is detected\identified, the robot automatically changes its direction to prevent collision & continues its movement. This project shows the integration of bluetooth- enabled communication, embedded systems, & robotics, making it beneficial for applications like surveillance, industrial automation, & smart robotic vehicles.

INTRODUCTION

Robotics & automation technologies are quickly evolving & are generally used in industries, security systems, & intelligent transportation systems. One of the major applications of robotics is the development of autonomous & remotely controlled vehicles that can navigate

environments safely & efficiently. Bluetooth technology gives a convenient & cost-effective method for bluetooth-enabled communication between devices. By integrating Bluetooth communication with robotic control systems, users can smoothly control robotic vehicles through smartphones or other Bluetooth-enabled devices.

The usage of an Arduino Nano microcontroller allows efficient processing of commands or instructions, sensor data, & motor control operations. This combination of wireless control & intelligent obstacle detection makes the robotic vehicle high reliable & suitable for different real-world applications.

Though, manual control alone could not be enough in environments with obstacles. Therefore, obstacle detection & avoidance systems are useful for secure robotic navigation. The presented system integrates Bluetooth-based remote control with autonomous obstacle avoidance operation using an ultrasonic sensor.

LITERATURE SURVEY

Different studies have researched the advancement of autonomous robotic vehicles with wireless communication abilities. Early robotic vehicles based on wired communication systems, which limited mobility & operational flexibility.

Research studies from Elsevier highlight the significance of obstacle detection techniques using ultrasonic sensors in robotic navigation systems. Ultrasonic sensors give precise distance measurements & help robots prevent collisions in dynamic environments.

Modern robotic systems combine Bluetooth-enabled communication, sensor technologies, & intelligent control algorithms to improve navigation & operational efficiency. The literature demonstrates that integrating Bluetooth control with autonomous obstacle avoidance gives an effective solution for smart robotic vehicles.

Recent research published by IEEE reviews the execution of Bluetooth-controlled robotic systems using microcontrollers for industrial & educational applications. These systems enable wireless control while conserving less cost & ease of operation.

PROPOSED SYSTEM

The proposed system is an intelligent robotic vehicle that can be managed through Bluetooth communication while also operating automatic obstacle detection & avoidance.

A. System Overview

➤ The robotic vehicle is controlled and guided using a smartphone application interconnected via the HC-05 Bluetooth module. The Arduino Nano obtains control

commands or instructions & processes them to control the motors through the L298N motor driver.

- The HC-SR04 ultrasonic sensor constantly measures the distance between the robot & close objects. The sensor is mounted on an SG90 servo motor which rotates to scan various directions. When an obstacle is detected within a predetermined distance, the system automatically manages the movement direction to prevent collision.
- This dual-mode operation enables the robot to control both under manual Bluetooth control & automatic obstacle avoidance.

B. Key Components

- Arduino Nano
- HC-05 Bluetooth Module
- L298N Motor Driver Module
- HC-SR04 Ultrasonic Sensor
- SG90 Micro Servo Motor
- DC Motors
- Robotic Car Chassis
- Wheels
- Battery Pack
- Jumper Wires

C. Working Principle

1. The system is operated using a battery pack interconnected to the Arduino Nano & motor driver.
2. The HC-05 Bluetooth module sets up wireless communication between the robot & a smartphone application.
3. The user transfers movement instructions like forward, backward, left, & right from the mobile application.
4. The Arduino Nano obtains these instructions through the Bluetooth module & processes them.
5. According to the commands/instructions, the Arduino sends control signals to the L298N motor driver.
6. The motor driver controls the rotation & direction of the DC motors, allowing the robot to move accordingly.

7. The HC-SR04 ultrasonic sensor constantly measures the distance to close obstacles.
8. The SG90 servo motor rotates the ultrasonic sensor to scan various directions nearby the robot.
9. If an obstacle is detected/identified within a certain distance, the Arduino automatically pauses the robot & defines an alternative path.
10. The robot then changes its direction to prevent the obstacle & endures moving safely.

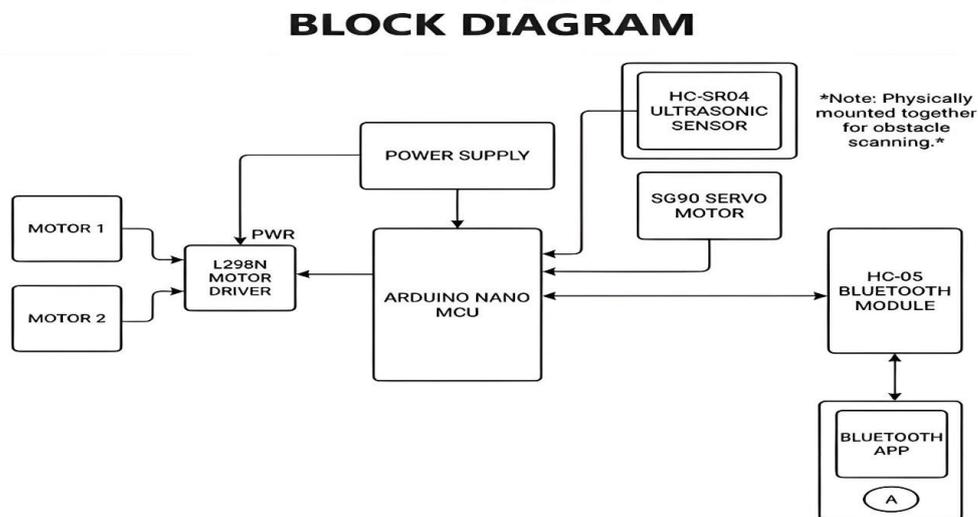
D. Advantages

- Enhances safety & navigation efficiency
- Wireless control using Bluetooth technology
- Automatic obstacle detection & avoidance
- Compatible for both manual & autonomous operation
- Simple & user-friendly operation through smartphone
- Low cost & energy efficient

E. Application

- Smart robotic vehicles for research & development
- Harmful environment exploration
- Robotic surveillance systems
- Military & security monitoring robots
- Industrial automation & material transport
- Educational robotics projects

Block Diagram:



RESULTS AND DISCUSSION

The Intelligent Bluetooth Controlled Robotic Vehicle was examined under various operating conditions to evaluate its performance & operation. The Bluetooth communication between the smartphone & the HC-05 module supplied steady wireless control within the estimated range. The robot successfully implemented movement instructions like forward, backward, left, & right with minimum delay. The ultrasonic sensor precisely measured the distance between the robot & close obstacles, allowing the system to detect potential collisions effectively. The servo motor enabled the sensor to scan multiple directions, which enhanced the robot's capability to identify secure navigation paths. When obstacles were detected, the Arduino controller successfully interrupted the movement instructions & initiated automatic obstacle avoidance procedures. The robot then managed its direction & continued its motion safely. The results illustrate that the system effectively integrates wireless communication & autonomous navigation, making it appropriate for different robotics applications.

CONCLUSION

The Smart Bluetooth Controlled Robotic Vehicle with Autonomous Obstacle Avoidance illustrates an efficient integration of wireless communication, embedded control systems, & robotic navigation technologies. The usage of an Arduino Nano microcontroller allows simple coordination between the Bluetooth module, ultrasonic sensor, servo motor, & motor driver. The system enables users to control the robot remotely using a smartphone while also providing safety through automatic obstacle detection. The integration of manual control & autonomous functionality improves the versatility & reliability of the robotic vehicle. This project gives an affordable & practical solution for designing smart robotic platforms that can control safely in dynamic environments.

FUTURE WORK

- Advancement of AI-based autonomous navigation algorithms.
- Integration with mobile applications for advanced & developed control characteristics.
- Usage of advanced sensors like LiDAR for enhanced obstacle detection.
- Addition of GPS modules for out-of-door navigation.
- Integration of a camera for real-time video inspecting.
- Execution of Wi-Fi or IoT-based remote control systems.

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