

Obstacle Avoiding Robot Car

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Abstract: *Robotics and autonomous systems play a crucial role in modern technology, with applications that span from personal assistance to industrial automation. To avoid collisions, any mobile robot must navigate its surroundings safely and identify obstacles in its path. Although traditional remote-controlled (RC) vehicles can be operated manually, their lack of environmental awareness renders them susceptible to accidents.*

This project introduces an obstacle detection robot car that utilizes an Arduino microcontroller. The system is equipped with an HC-SR04 ultrasonic sensor to detect nearby objects and avert collisions. Furthermore, an HC-05 Bluetooth module is incorporated to facilitate wireless manual control.

The robot car operates in two modes: an autonomous mode that automatically detects and avoids obstacles, and a manual mode that allows control via Bluetooth and a smartphone application. The Arduino Uno processes sensor data and user commands to manage the robot's operations.

Keywords: Obstacle Avoidance, Arduino, Ultrasonic Sensor, Robotics

I. INTRODUCTION

The domain of mobile robotics has experienced significant expansion, propelled by innovations in sensors, microcontrollers, and communication technologies. Robots are increasingly utilized in dynamic environments where they must interact with their surroundings and respond to human commands. Autonomous navigation and remote user control are two essential features for these systems.

An obstacle-detecting vehicle can operate autonomously by employing sensors to sense its environment and make decisions to avert collisions. This ability is crucial for applications such as robotic vacuum cleaners, warehouse automation, and autonomous vehicles. On the other hand, Bluetooth control provides a simple yet effective method for direct human interaction, which is advantageous in scenarios that require precise maneuvering, such as material transport or remote surveillance.

While advanced systems utilize technologies like LiDAR, computer vision, or 4G/5G networks, these solutions are often expensive and complicated for beginners or small-scale projects. To address this challenge, this project introduces an affordable, dual-mode Obstacle Detector Robot Car built with easily accessible embedded components. The system is based on an Arduino Uno microcontroller, linked to an HC-SR04 ultrasonic sensor for distance measurement and an HC-05 Bluetooth module for wireless control. An L298N motor driver module manages the operation of DC gear motors that drive the wheels.

The system offers two operational modes. In autonomous mode, the robot car continuously scans for nearby obstacles and skillfully avoids them without any user intervention. In manual mode, the user can fully control the car's movement—forward, backward, left, right, and stop—using a Bluetooth-enabled smartphone application. This dual-mode functionality makes the project an excellent resource for both educational and demonstration purposes.

In conclusion, the Obstacle Detector Robot Car serves as a comprehensive platform for understanding fundamental robotics concepts by integrating various technologies.



II. LITERATURE SURVEY

By leveraging IoT technology, Patel et al. [1] developed a smart surveillance robot that incorporates live video streaming and obstacle avoidance, highlighting its importance in security and remote monitoring applications. Sharma and Lee [2] employed a multi-sensor fusion technique for autonomous navigation by integrating ultrasonic and infrared sensors to improve environmental awareness. Chen [3] created a Bluetooth-controlled robotic arm mounted on a mobile platform, designed for educational purposes and basic pick-and-place operations.

Kumar et al. [4] introduced an intelligent wheelchair system that combined voice and Bluetooth control with semi-autonomous obstacle avoidance, focusing on assistive technology. Garcia and Martinez [5] explored the use of Arduino and Raspberry Pi in swarm robotics, demonstrating inter-robot communication and essential obstacle avoidance methods. Wang et al. [6] proposed an enhanced path-planning algorithm for autonomous vehicles, although it required significant computational resources.

Singh and Agarwal [7] developed a cost-effective agricultural robot for weed detection and removal, utilizing ultrasonic sensors for boundary management. Tanaka et al. [8] designed an interactive toy car for children, featuring clap-activated movement and basic obstacle detection capabilities. Fernandez [9] constructed a line-following robot equipped with obstacle detection, enabling it to stop and resume its path when encountering objects.

Ibrahim et al. [10] focused on Bluetooth-controlled home automation carts intended for transporting small items within indoor environments. Nguyen [11] evaluated IR and ultrasonic sensors for obstacle detection in miniature robots, concluding that ultrasonic sensors provided better range and reliability. Okafor and Eze [12] implemented a mobile phone-controlled robot using DTMF technology, offering an alternative to Bluetooth-based systems. Zhang [13] introduced a dual-mode robot capable of both autonomous and manual control via Wi-Fi, providing versatile functionality.

Table 1: Comparative Review of Robotic Car Projects

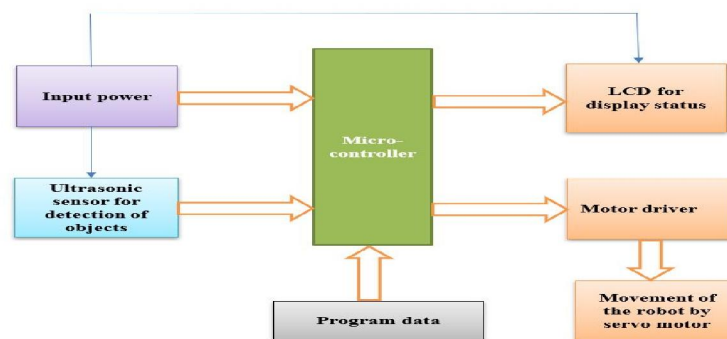
Paper / Project	System Architecture	Cost	Ease of Implementation	Performance	User Experience	Limitations
Singh et al.[5]	Line Following Robot	Low	Easy(IR Sensor)	Accurate Line tracing	Smooth on predefined tracks	Useless without lines
Wang et al.[9]	RFID delivery robot	Moderate	Moderate	Reliable in RFID zoom	Helpful for warehouses	Fixed roots,not obstcle aware
Noor et al.[11]	Solar powered patrol bot	Moderate	Moderate	Energy efficient paterls	Sustainable operation	Low efficiency in low light
Das & Mehta [6]	AI vision robot	High	Complex	Smart detection and decision	Interactive,adaptive	High computational needs
Roy et al.[12]	Maze-solving robot	Moderate	Moderate	Smart pathfinding	Fun for learning AL logic	Not scalable to large areas



Paper / Project	System Architecture	Cost	Ease of Implementation	Performance	User Experience	Limitations
Liu et al. [15]	Voice controlled car	Moderate	Moderate	Responsive to voice	Hands free control	Struggles in noisy environment
Bhatia et al. [16]	Gesture controlled car	Low	Easy	Real time gesture reactive	Intuitive and fun	Requires hand movement always

III. PROPOSED METHODOLOGY

The design and execution of the Obstacle Avoidance and Bluetooth Control Car adhere to a systematic approach that combines a microcontroller, sensors, a communication module, and motor control components to establish a flexible and smart robotic system.



The proposed robotic vehicle is a versatile system designed for both autonomous operation and user-directed steering. It functions with a lithium-ion battery pack, providing a reliable and portable DC power supply for all components, including the microcontroller, sensors, and motors. The proposed robotic vehicle represents a multifunctional system engineered for both autonomous functionality and user-controlled steering. It operates using a lithium-ion battery pack, which serves as a dependable and portable DC power source for all its components, including the microcontroller, sensors, and motors.

The core processing unit of the system is the Arduino Uno microcontroller, which serves as its main intelligence hub. It consistently gathers data from two primary sources: the HC-SR04 ultrasonic sensor and the HC-05 Bluetooth module. The HC-SR04 sensor is affixed to a servo motor, enabling it to scan the surroundings by rotating up to 180 degrees. It emits ultrasonic waves and measures the duration taken for the echo to return, thereby calculating distances to obstacles that range from 2cm to 400cm. In autonomous mode, this information is utilized to inform navigation decisions.

The HC-05 Bluetooth module enables wireless communication between the vehicle and a smartphone. A custom mobile application, developed using platforms such as MIT App Inventor or a comparable Android IDE, offers a user-friendly interface with buttons for controlling movement (Forward, Backward, Left, Right, Stop). Commands dispatched from the app are received by the HC-05 and transmitted to the Arduino, which executes them in manual mode.

The decision-making logic embedded within the Arduino ascertains the operational mode and regulates the actuators. It analyzes sensor data and user inputs, juxtaposing distance readings against a predetermined safety threshold (e.g., 15 cm). When an obstacle is identified within this range during autonomous mode, the Arduino initiates an avoidance



maneuver, such as turning left or right. For motor control, the Arduino transmits signals to the L298N motor driver module, supplying the requisite current and voltage to operate the two DC gear motors connected to the wheels, thereby ensuring precise movement control. The system's software utilizes a state machine architecture, facilitating smooth transitions between "Autonomous" and "Manual" modes based on user commands.

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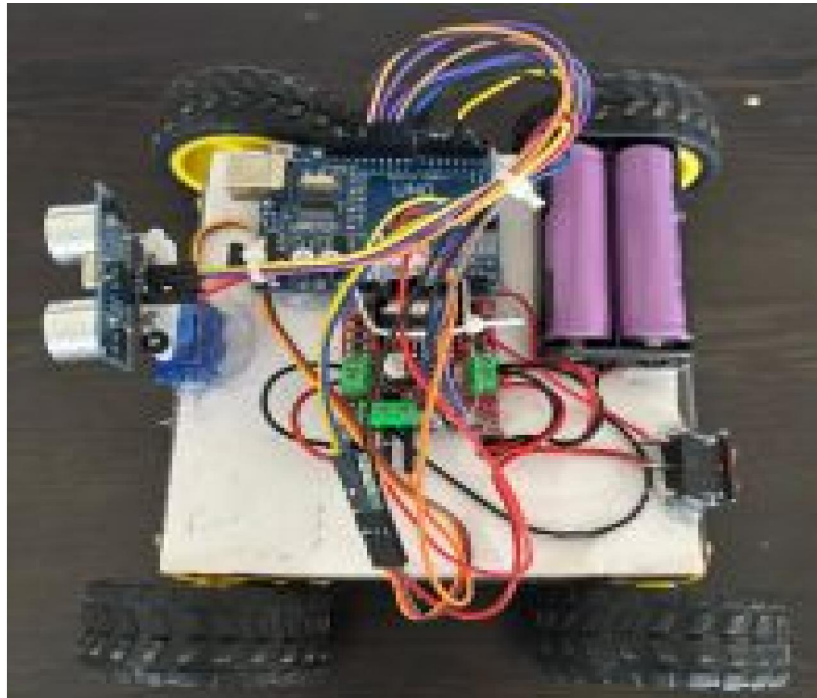
The HC-05 Bluetooth module facilitates wireless communication between the vehicle and a smartphone. A custom mobile application, created using platforms like MIT App Inventor or a similar Android IDE, provides a user-friendly interface with buttons for controlling movement (Forward, Backward, Left, Right, Stop). Commands sent from the app are received by the HC-05 and relayed to the Arduino, which executes them in manual mode.

IV. RESULT

The project involving an obstacle-avoiding robot car built with Arduino was successfully finalized, showcasing the robot's capability to independently navigate its surroundings by identifying and circumventing obstacles. The system employed an Arduino Uno microcontroller, ultrasonic sensors for measuring distance, and DC motors managed through a motor driver module (L298N).

During the testing phase, the robot reliably detected obstacles in its trajectory and made instantaneous decisions to halt, turn, and proceed in a secure direction. The logic programmed into the Arduino facilitated smooth and responsive movement, even in confined or dynamic settings.

In summary, the project fulfilled its goal of creating a cost-effective, efficient, and dependable obstacle-avoiding robotic system, highlighting the practical application of Arduino in autonomous navigation.



V. CONCLUSION

The Obstacle Avoiding robot car project effectively illustrates the integration of essential embedded systems principles within a practical and adaptable robotic platform. The vehicle acts as a valuable educational resource for grasping robotics by providing both autonomous and manual control options.

It skillfully navigates around obstacles in its surroundings, minimizing the risk of damage and facilitating independent operation. The Bluetooth control feature enables smooth and quick user interaction, rendering the project engaging and relevant to real-world remote control applications.

In conclusion, this project offers an affordable and thorough introduction to robotics, making it suitable for both learners and enthusiasts. Its modular design also accommodates future upgrades, such as the addition of extra sensors, sophisticated navigation algorithms, or IoT connectivity.

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