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Obstacle Avoiding Car

Vaishali Rajeshirke[1], Shreya Bait[2], Neharika Bamhane[3], Yash Bansode[4], Manasi Gondal[5]

[1] Professor, [2,3,4,5] Student, Electronics and Tele-communication Engineering, Vivekanand Education Society's Polytechnic, Chembur, Mumbai, 400071

ABSTRACT :

This paper presents the design and implementation of an Obstacle Avoiding Car, an autonomous robotic vehicle capable of detecting obstacles and stopping its movement to prevent collisions. The system is developed using an Arduino Uno as the primary controller, interfaced with an HC-SR04 ultrasonic sensor for real-time obstacle detection. When an object is detected within a predefined range, the microcontroller processes the sensor data and immediately halts the motor driver circuit, ensuring safe operation without requiring human intervention. Unlike conventional obstacle-avoidance systems that navigate around obstacles, this system prioritizes collision prevention through an immediate stopping mechanism. The simplicity and efficiency of this approach make it well-suited for applications in automated warehouses, industrial robotics, and smart mobility solutions, where sudden stops are necessary for safety

Keywords: Obstacle Avoidance, Autonomous Vehicle, Arduino Uno, Ultrasonic Sensor, Embedded Systems, Robotics, Motor Control, Real-Time Navigation, Collision Detection, Automation.

Introduction :

The rapid advancement in autonomous robotic systems has led to the development of intelligent vehicles capable of navigating complex environments with minimal human intervention. Among the key challenges in autonomous navigation is obstacle detection and avoidance, which ensures safe and efficient movement. The Obstacle Avoiding Car is designed to address this challenge by utilizing an ultrasonic sensor-based system to detect obstacles and halt movement upon detection, preventing collisions.

The system architecture is built around an Arduino Uno microcontroller, which continuously receives data from an HC-SR04 ultrasonic sensor to monitor the surroundings. When an obstacle is detected within a predefined range, the microcontroller commands the motor driver circuit to stop the vehicle. This design prioritizes collision prevention over navigation redirection, making it suitable for applications where immediate stopping is critical. The development of such systems can further contribute to the evolution of autonomous vehicle technology, ensuring safer and more efficient robotic operations in dynamic environments.

Problem Definition :

In autonomous robotic systems, obstacle detection and avoidance is a critical challenge that directly impacts safety, efficiency, and real-time decision-making. Traditional robotic vehicles either require human intervention or rely on complex navigation algorithms to reroute paths. However, in many real-world applications, an immediate stop upon obstacle detection is preferred to prevent collisions and system failures.

The Obstacle Avoiding Car is designed to address this issue by implementing a sensor-driven control mechanism that enables real-time obstacle detection using an HC-SR04 ultrasonic sensor. The system processes distance measurements and halts vehicle movement upon detecting an obstruction within a predefined range. This approach eliminates the need for complex path-mapping algorithms, making it a cost-effective and efficient solution for scenarios where collision prevention is prioritized over rerouting.

The project aims to develop a fully autonomous vehicle that can function effectively in environments where sudden stops are necessary, such as automated warehouses, industrial workspaces, and smart mobility solutions.

Literature Survey :

Obstacle detection and avoidance are essential components in the development of autonomous robotic systems. Various approaches have been proposed to improve real-time obstacle detection, utilizing ultrasonic, infrared, LiDAR, and vision-based sensors. This section reviews key studies that have contributed to the advancement of obstacle-avoidance systems.

Faiza et al. (2017) explored a multi-sensor approach for mobile robotics, integrating ultrasonic and infrared sensors to enhance obstacle detection accuracy. Their research demonstrated that combining multiple sensors improves the horizontal range and detection reliability, reducing false positives in dynamic

environments. Similarly, **Vairavan et al. (2018)** developed an Arduino-based obstacle avoidance system using an ultrasonic sensor, where the robot successfully detected obstacles and stopped its motion based on predefined distance thresholds. **Iswarya et al. (2018)** proposed an intelligent robotic vehicle that detects obstacles and prevents collisions using an ATmega328P microcontroller and ultrasonic sensors. Their findings highlighted the efficiency of ultrasonic sensing in real-time navigation, particularly in structured environments

From the reviewed studies, ultrasonic sensors are widely recognized for their cost- effectiveness, accuracy, and real-time response capabilities in obstacle detection. This project builds upon these findings by implementing an ultrasonic sensor-based stopping mechanism, focusing on immediate collision prevention rather than complex rerouting.

Block Diagram :

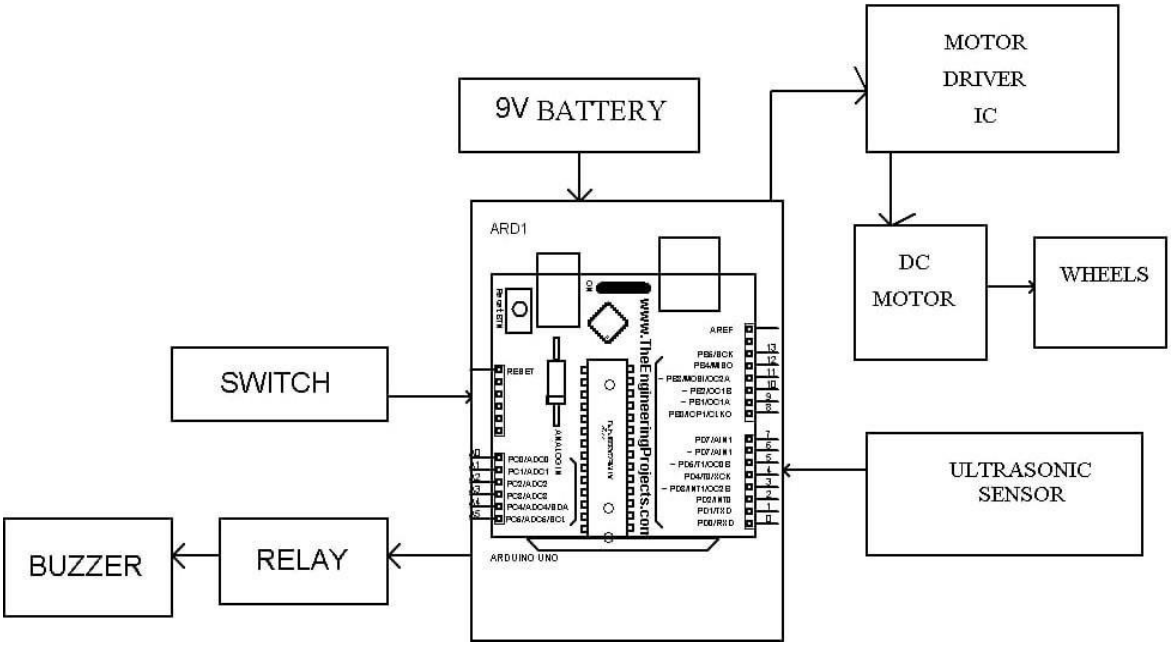


Figure 3.1 Block Diagram

The Obstacle Avoiding Car system is designed to autonomously detect obstacles and stop to prevent collisions. At the core of the system is the Arduino Uno, which acts as the central processing unit. It
receives power from a 9V battery and processes data from an HC-SR04 ultrasonic sensor. This sensor continuously sends out ultrasonic waves and detects reflected signals to determine the presence of an obstacle. If an object is detected within a predefined range, the Arduino immediately processes this data and takes action.

To control movement, the Arduino is connected to a motor driver IC, which regulates the DC motor responsible for driving the wheels. Under normal conditions, the motor driver allows the car to move forward. However, when an obstacle is detected, the Arduino halts the motor, stopping the vehicle to avoid collision. Unlike traditional obstacle-avoidance robots that change direction, this system prioritizes safety by simply stopping movement upon detection.

Additionally, a relay module is used to activate a buzzer, providing an audible alert when an obstacle is detected. A manual switch is also integrated into the system, allowing users to turn it on or off as needed. This setup ensures a simple yet effective obstacle detection mechanism, making it suitable for applications such as automated vehicles, industrial automation, and smart robotic systems.

Hardware Description :

Arduino Uno

This is the microcontroller unit responsible for processing data from the ultrasonic sensor and controlling the motor driver IC. It acts as the brain of the system, ensuring real-time decision- making based on obstacle detection. It is used in the project due to its ease of programming, reliability, and compatibility with multiple sensors and modules, making it ideal for embedded applications.

Figure 4.1 Arduino Uno Microcontroller Board

HC-SR04 Ultrasonic Sensor

This sensor is used to detect obstacles by emitting ultrasonic waves and measuring their reflection time. It provides accurate distance measurement, allowing the Arduino to determine when an obstacle is within the stopping range. It is used because of its low cost, high accuracy, and fast response time, making it suitable for real-time object detection in robotic applications.

Figure 4.2 Ultrasonic Sensor

DC Motor & Wheels

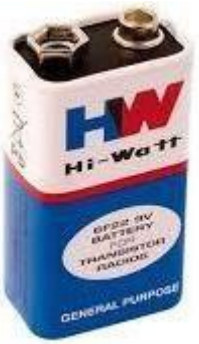
The DC motor is responsible for propelling the vehicle forward. It receives power through the motor driver IC and is controlled based on the signals from the Arduino. In this project, the motor stops moving upon detecting an obstacle, ensuring a collision-free path. DC motors are used because they are compact, energy-efficient, and provide smooth control over movement, making them ideal for small robotic vehicles.

Figure 4.3 DC Motor & Wheels

Power Supply

The system is powered using a 9V battery, which provides sufficient voltage to drive the Arduino Uno, sensor, and motor driver IC. It is used because it is portable, lightweight, and capable of supplying adequate power for small-scale embedded projects.

Figure 4.4 9v Battery



Relay Module

The relay module is used as a switch to control high-power components. In this project, it helps activate or deactivate certain features, ensuring safe operation. It is used because it allows the low-power Arduino to control higher-powered devices safely and efficiently.

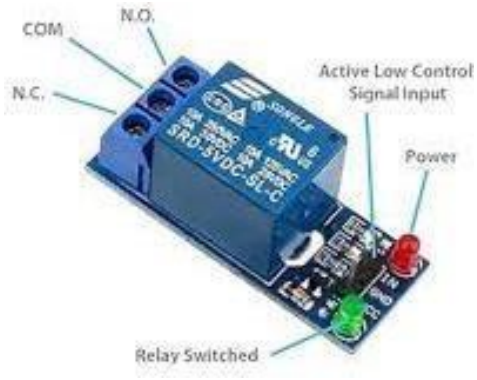


Figure 4.5 Relay Module

Buzzer

The buzzer serves as an alert system, producing a sound when an obstacle is detected. This feature ensures that users are notified of the stop condition. It is used to provide an audible warning, making the system more interactive and user-friendly.

Figure 4.6 Piezoelectric Buzzer

Switch

A manual switch is included to turn the system on or off as needed. This provides better control over the car's operation. It is used to give the user manual control over the system, making it more convenient to operate.

Figure 4.7 Switch

Future Directions :

- **Integration of AI and Machine Learning:** The implementation of AI-based obstacle detection and deep learning algorithms can improve decision-making capabilities. Instead of stopping when an obstacle is detected, the system can analyze the surroundings and adjust its path accordingly.
- **Path Planning and Advanced Navigation**: Incorporating LIDAR sensors or camera- based vision systems will enable better path planning. The car will be able to map its environment and determine the optimal route instead of halting upon obstacle detection.
- **Sensor Fusion for Improved Accuracy:** A combination of ultrasonic, infrared (IR), and gyroscopic sensors can improve obstacle detection accuracy, making the system more reliable across different environmental conditions.
- **Voice and Gesture-Based Control:** The integration of voice recognition or gesture-based control modules will enable hands-free operation, increasing user convenience.
- **IoT Connectivity for Remote Monitoring:** The addition of Wi-Fi or Bluetooth modules can enable wireless control via mobile applications or web interfaces. IoT integration will facilitate real-time data analysis and remote monitoring

These advancements will significantly enhance the capabilities of the Obstacle Avoiding Car, making it a more efficient, intelligent, and versatile system. With continuous improvements, it can pave the way for fully autonomous navigation solutions, contributing to the development of smart mobility and automation technologies.

Output:

Conclusion :

The Obstacle Avoiding Car is a fundamental step toward autonomous navigation, designed to detect obstacles and halt movement to prevent collisions. By utilizing an ultrasonic sensor, Arduino microcontroller, motor driver, relay, and buzzer, the system ensures efficient and responsive operation. While the current model focuses on basic obstacle detection and stopping, future enhancements such as AI integration, sensor fusion, and IoT connectivity can further improve its functionality. With advancements in technology, this project holds potential for applications in robotics, industrial automation, and smart transportation, making it a significant contribution to the field of autonomous systems.

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