Journal of
Mechatronics and Automation
https://journals.stmjournals.com/joma
ISSN: 2455-1988
Volume 13, Issue 1, 2026
January–April
DOI (Journal): 10.37591/JoMA
Research JoMA

Design and Implementation of Intelligent Obstacle Avoiding Robot

Pratik Pandey[1,*], Rachit Srivastava[2]

Abstract

The Intelligent Obstacle Avoiding Robot is an autonomous robotic system designed to navigate safely through unknown or congested environments by detecting and avoiding obstacles in real time. This robot integrates sensor modules, embedded control systems, and intelligent decision-making algorithms to achieve smooth and collision-free movement. Ultrasonic, infrared, or LiDAR-based sensors are used to continuously measure the distance between the robot and surrounding objects. The sensor data is processed by a microcontroller such as Arduino, Raspberry Pi, or any other embedded platform, which evaluates the proximity of obstacles and selects an appropriate navigation strategy. Based on predefined logic or intelligent algorithms like reactive control, fuzzy logic, or rule-based decision making, the robot determines whether to stop, turn left, turn right, or reverse its path. Motor driver circuits control the movement of DC motors, ensuring accurate directional changes according to the microcontroller's commands. The robot's design emphasizes efficiency, low power consumption, and adaptability to different terrains and lighting conditions. Such systems have significant applications in industrial automation, warehouse navigation, military reconnaissance, home assistance, and educational robotics. The project highlights the growing importance of autonomous mobility in modern technology and provides a practical platform for understanding embedded systems, sensor integration, and robot intelligence. Overall, the Intelligent Obstacle Avoiding Robot demonstrates a reliable, cost-effective, and scalable approach to autonomous navigation, contributing to ongoing research and development in smart robotic systems.

Keywords: Arduino UNO, battery, motor, motor driver, robot, ultrasonic sensor

INTRODUCTION

In recent years, autonomous robotic systems have become an essential part of modern technology, contributing significantly to industrial automation, smart transportation, surveillance, and household applications. One of the fundamental requirements for any mobile robot is the ability to sense its environment and navigate safely without human intervention. Obstacle avoidance is therefore a core feature that enables robots to operate efficiently in dynamic and unpredictable surroundings. An Intelligent Obstacle Avoiding Robot is a practical implementation of this concept, designed to detect obstacles in its path and make real-time decisions to prevent collisions [1–5].

This robot uses various sensing technologies such as ultrasonic sensors, infrared sensors, or LiDAR modules to measure distance and identify nearby objects. The sensor inputs are processed by a microcontroller, which interprets the data and issues appropriate movement commands to the robot's motors. By incorporating intelligent algorithms – such as rule-based logic, reactive control, or fuzzy decision systems – the robot can choose the most suitable navigation path, making its movement smooth, safe, and adaptive to changing environments [6–12].

***Author for Correspondence**
Pratik Pandey
E-mail: pratikpandey1539@gmail.com

[1]B. Tech Student, Department of Electrical Engineering Bansal Institute of Engineering and Technology Lucknow, Uttar Pradesh, India
[2]Assistant Professor, Department of Electrical Engineering Bansal Institute of Engineering and Technology Lucknow, Uttar Pradesh, India

Received Date: December 10, 2025
Accepted Date: January 20, 2026
Published Date: February 06, 2026

Citation: Pratik Pandey, Rachit Srivastava. Design and Implementation of Intelligent Obstacle Avoiding Robot. Journal of Mechatronics and Automation. 2026; 13(1): 1–6p.

The development of such a system enables students and researchers to understand core concepts of robotics, including sensor fusion, embedded programming, motor control, and autonomous navigation. It also offers a foundation for more advanced robotic systems such as service robots, self-driving vehicles, and smart delivery robots. The Intelligent Obstacle Avoiding Robot thus represents an important step toward creating fully autonomous machines capable of interacting intelligently with the real world [12–20].

LITERATURE REVIEW

Obstacle detection and avoidance have been central research areas in the field of mobile robotics, with numerous studies proposing different sensing methods, algorithms, and hardware implementations. Early developments established the theoretical foundations for autonomous navigation. Khatib's classical work on real-time obstacle avoidance introduced the Artificial Potential Field (APF) method, where obstacles exert repulsive forces on the robot's path [15]. Similarly, Borenstein, and Koren proposed the Vector Field Histogram (VFH), a fast and effective local navigation algorithm that addressed limitations of APF, such as local minima [16]. Hart et al. algorithm further contributed to global path planning through heuristic minimum-cost search [17]. These foundational methods continue to influence modern robot navigation systems.

Modern implementations increasingly rely on low-cost sensors and microcontrollers. Bendimrad et al. developed a line-follower robot integrated with obstacle detection, demonstrating how simple ultrasonic sensing can support autonomous behavior [1]. Several researchers have implemented Arduino-based ultrasonic obstacle avoidance systems, emphasizing affordability and ease of assembly [2, 20]. Ultrasonic sensors remain widely adopted due to their accuracy, low power consumption, and reliability, as also highlighted by Azeta et al[5]. and Jones [19]. Other works incorporated additional sensors such as accelerometers for motion control with obstacle detection [3].

More advanced systems have leveraged multiple sensing technologies. RGB-D cameras were used by Skoczeń et al. to detect obstacles in agricultural environments, enabling high-precision 3D perception [6]. Deep learning approaches for obstacle detection and collision avoidance were demonstrated by Li et al., achieving improved accuracy in unstructured outdoor fields [7]. Sensor-fusion-based navigation, as described by Pathak [21], shows that combining ultrasonic, inertial, and visual data enhances robustness in complex environments.

Specialized robotic applications also incorporate obstacle avoidance as a core function. Surveillance robots for security applications [4, 8], assistive robots for visually impaired users [13], vacuum-cleaner robots [12], and autonomous lawn-mower robots [14] all integrate obstacle detection modules to ensure safe operation. Nasucha's development of a basic obstacle-avoiding robot [11] and Azeta et al.'s simulation of a mobile robot platform [10] further demonstrate how ultrasonic sensing and microcontroller programming form the foundation of many educational and research-level robotic systems.

Overall, the literature shows a progression from simple reactive robotics using ultrasonic sensors to more intelligent systems utilizing sensor fusion, computer vision, and deep learning. While low-cost ultrasonic sensors remain dominant in educational and prototype robots, modern applications increasingly demand higher precision and situational awareness, paving the way for advanced algorithms and multi-sensor perception. Collectively, these studies provide a strong foundation for designing reliable obstacle-avoiding robots and highlight opportunities for future enhancements in autonomous mobility.

METHODOLOGY

The methodology for the intelligent obstacle-avoiding robot is based on a continuous Sense-Process-Act loop, implemented using the Arduino Uno as the central controller. The system's primary input is

Journal of Mechatronics and Automation
Volume 13, Issue 1
ISSN: 2455-1988

the HC-SR04 ultrasonic sensor, which continuously measures the distance to objects directly in front of the robot. This distance is calculated by the Arduino by measuring the time-of-flight of the emitted sound pulse. The measured distance is then fed into the processing stage, where it is compared against a pre-defined threshold distance (e.g., 30 cm). If the distance exceeds the threshold, the Arduino executes the Act stage by sending control signals via the L298N motor driver to keep the two DC motors moving the robot forward.

Conversely, if the distance is less than or equal to the threshold, the robot is determined to be too close to an obstacle. In this avoidance scenario, the robot's action sequence is: Stop momentarily, reverse briefly to gain clearance, and then perform a Turn (left or right) based on a simple algorithm (e.g., a fixed 90-degree turn or a path-finding scan) to orient itself toward the path with the greatest available distance before resuming the forward movement, thereby ensuring continuous autonomous navigation. Figure 1 shows the circuit diagram of the Intelligent Obstacle Avoiding Robot system.

COMPONENTS USED

In this section, various components used for the Intelligent Obstacle Avoiding Robot system have been discussed.

Arduino Uno

The Arduino Uno serves as the central processing unit of the system. It reads sensor data, processes intensity values, executes the ultrasonic rays detection algorithm, and controls the motor. Its built-in ADC, ease of programming, and compatibility with external modules make it ideal for prototyping. Figure 2 shows the picture view of the Arduino Uno.

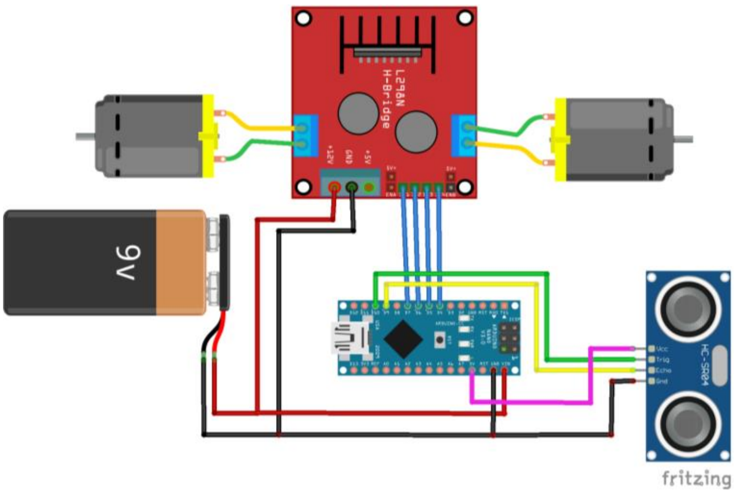

Figure 1. Circuit diagram of intelligent obstacle avoiding robot.

Figure 2. Picture view of arduino uno.

Ultrasonic Sensor

An ultrasonic sensor is a distance-measuring device that uses high-frequency sound waves (ultrasound) to detect objects and measure their distance. It is widely used in robotics, automation, automotive parking systems, and industrial safety due to its accuracy, low cost, and ease of interfacing with microcontrollers like Arduino. Figure 3 shows the picture view of the ultrasonic sensor.

Motor Driver and Motor

A motor driver such as L293D or L298N acts as an interface between the microcontroller and the motor. It supplies the required voltage and current to the DC motor and enables direction control via logic inputs. Figure 4 shows the picture view of the motor driver circuit. In this work, two 60-rpm battery-operated gear motors are used.

Power Supply

A DC power supply or rechargeable lithium-ion battery powers the microcontroller, sensors, and motor. Typical operating voltage ranges from 3.7–12V depending on the components used. In this work, two batteries of 3.7V (2000 mAh each) have been used. Figure 5 shows the picture view of the battery used.

Figure 3. Ultrasonic sensor.

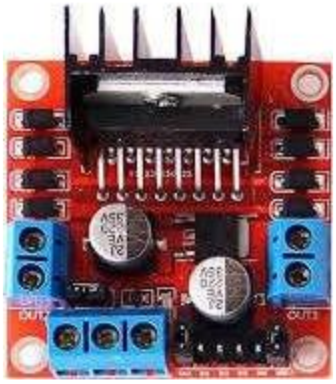

Figure 4. Picture view of motor driver.

Figure 5. Battery used in the work.

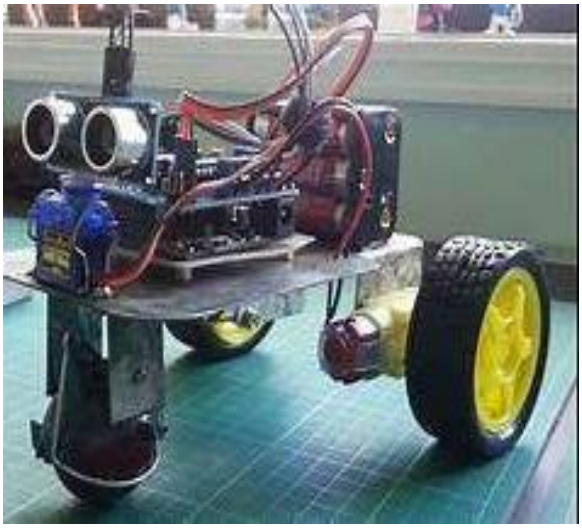

Figure 6. Intelligent obstacle avoiding robot.

RESULT

The Intelligent Obstacle Avoiding Robot was successfully designed and implemented using an ultrasonic sensor, microcontroller, and motor control system. The robot demonstrated the ability to detect obstacles in real time and navigate safely by adjusting its direction automatically. During testing, the ultrasonic sensor accurately measured distances between 2–400 cm, allowing the robot to make timely decisions when objects appeared in its path.

The robot consistently avoided collisions by stopping and turning when an obstacle was detected within the defined threshold range. It was also able to operate effectively in different indoor environments, including narrow paths and cluttered areas. The response time of the obstacle detection system was observed to be fast and reliable, enabling smooth and continuous movement.

Experimental results showed that the robot maintained stable movement, demonstrated efficient path correction, and performed well under varying lighting conditions since the ultrasonic sensor is not affected by light. The system also remained cost-effective and consumed minimal power during operation. Figure 6 shows the implemented system.

CONCLUSION

The Intelligent Obstacle Avoiding Robot successfully demonstrates how autonomous navigation can be achieved using simple, low-cost electronic components such as the Arduino Uno, ultrasonic sensor, motor driver, and DC motors. By continuously monitoring the environment and detecting obstacles in real time, the robot is able to make intelligent decisions to change its path and avoid collisions.

The work highlights the importance of embedded systems, sensor integration, and automation in modern robotics. It provides a practical understanding of how sensors and microcontrollers work together to create intelligent machines capable of operating without human intervention.

The developed robot is efficient, reliable, and suitable for applications such as automated vehicles, warehouse automation, surveillance systems, and service robots. With further improvements – such as adding infrared sensors, machine learning algorithms, GPS modules, or advanced motor control – the system can be made more accurate and capable of navigating complex environments.

Overall, this project is a strong foundation for learning autonomous robotics and demonstrates a feasible approach for designing intelligent robots that contribute to safety, efficiency, and automation in various real-world applications.

REFERENCES

1. Bendimrad A, El Amrani A, El Amrani B. Design and implementation of line follower and obstacle detection robot. *Int J Power Electron Drive Syst.* 2020;11(1):160.
2. Mahmud T, et al. Design and implementation of an ultrasonic sensor-based obstacle avoidance system for Arduino robots. In: *Proc. 2023 Int Conf Information and Communication Technology for Sustainable Development (ICICT4SD)*; 2023. p. 264–268.
3. Swetha N. Design and implementation of accelerometer based robot motion and speed control with obstacle detection. *Int J Sci Eng Technol.* 2013;2:749–755.
4. Meghana S, et al. Design and implementation of surveillance robot for outdoor security. In: *Proc. 2017 2nd IEEE Int Conf Recent Trends in Electronics, Information & Communication Technology (RTEICT)*; 2017. p. 1679–1682.
5. Azeta J, Bolu C, Hinvi D, Abioye AA. Obstacle detection using ultrasonic sensor for a mobile robot. *IOP Conf Ser Mater Sci Eng.* 2019;707(1):012012.
6. Skoczeń M, et al. Obstacle detection system for agricultural mobile robot application using RGB-D cameras. *Sensors.* 2021;21(16):5292.
7. Li Y, Iida M, Suyama T, Suguri T, Masuda R. Implementation of deep-learning algorithm for obstacle detection and collision avoidance for robotic harvester. *Comput Electron Agric.* 2020;174:105499.
8. Al AASMO, et al. Embedded design and implementation of mobile robot for surveillance applications. *Indones J Sci Technol.* 2021;6(2):427–440.
9. Mustapha B, Zayegh A, Begg RK, Razak AHA. Design and implementation of wireless obstacle detection system for safe locomotion. In: *Proc. 2012 Third Int Conf Intelligent Systems Modelling and Simulation*; 2012. p. 718–722.
10. Azeta J, Bolu CA, Oyawale FA. Design and simulation of a mobile robot platform for navigation and obstacle detection. *Eng Rev.* 2022;42(1):56–65.
11. Nasucha M, Nasucha M. Development of an obstacle avoiding robot. *Jurnal Sistem Komputer.* 2015;5(2):55–63.
12. Eren A, Doğan H. Design and implementation of a cost-effective vacuum cleaner robot. *Turkish J Eng.* 2022;6(2):166–177.
13. Noman AT, et al. Design and implementation of microcontroller based assistive robot for persons with blind autism and visual impairment. In: *Proc. 2017 20th Int Conf Computer and Information Technology (ICCIT)*; 2017. p. 1–5.
14. Wasif M. Design and implementation of autonomous lawn-mower robot controller. In: *Proc. 2011 7th Int Conf Emerging Technologies*; 2011. p. 1–5.
15. Khatib O. Real-time obstacle avoidance for manipulators and mobile robots. *Int J Robotics Res.* 1986.
16. Borenstein J, Koren Y. The vector field histogram—fast obstacle avoidance for mobile robots. *IEEE J Robotics Autom.* 1991.
17. Hart PE, Nilsson NJ, Raphael B. A formal basis for the heuristic determination of minimum cost paths. *IEEE Trans Syst Sci Cybern.* 1968.
18. Predko M. *Programming and customizing the Arduino microcontroller.* New York (USA): McGraw-Hill; 2011. p. 1–500.
19. Jones TB. Ultrasonic sensors and applications in robotics. *Int J Adv Robotics Syst.* 2018;12(3):45–52.
20. Mohanty SR, Swain A. Design and implementation of obstacle avoidance robot using Arduino. *Int J Eng Res Technol.* 2017;6(2):1–5.
21. Pathak K. Autonomous mobile robot navigation using sensor fusion. *IEEE Trans Robot.* 2016;32(4):889–899.
22. Siegwart R, Nourbakhsh IR. *Introduction to autonomous mobile robots.* 2nd ed. Cambridge (USA): MIT Press; 2011. p. 1–400.

