International Journal of Engineering Technology Research & Management
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REAL-TIME PATH CORRECTION FOR OBSTACLE-FREE MOVEMENT AND AERO ALERT

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ABSTRACT
This paper presents a real-time path correction mechanism for obstacle-free movement integrated with an Aero Alert system for gas leakage detection. The proposed system uses machine learning (ML) algorithms to improve its performance. decision trees for path classification, and sensor fusion techniques to improve obstacle detection and environmental adaptability. The integration of an MQ5 gas sensor enhances safety by triggering alerts upon gas leakage detection. The experiments show that the system accurately detects obstacles and navigates efficiently in real-time.

KEYWORDS:
Autonomous robots, obstacle detection, real- time path correction, machine learning, gas leakage detection, sensor fusion, Arduino, decision trees, ultrasonic sensors, AI-driven navigation.

INTRODUCTION
Obstacle detection and avoidance is a critical area in robotics, automation, and autonomous systems, ensuring safe and efficient navigation in real-world environments. The primary objective of An Obstacle Detection Systems is to identify and avoid potential hazards, allowing robots, autonomous vehicles, drones, and industrial machines to function smoothly. This technology plays a vital role in applications such as self-driving cars, automated warehouse robots, and UAVs (Unmanned Aerial Vehicles), where real-time decision-making is essential. Advanced obstacle detection systems integrate multiple sensors, such as ultrasonic sensors, LiDAR, cameras, and radar, combined with Artificial Intelligence (AI) and Machine learning algorithms to enhance accuracy and reliability. The research aims to design an intelligent system that detects obstacles effectively and autonomously determines a safe path by using sensor fusion, path planning algorithms, and control strategies.

BACKGROUND AND MOTIVATION
Obstacle detection has evolved significantly over the years. Earlier systems relied on simple infrared (IR) and ultrasonic sensors, which could only detect obstacles within a limited range. These traditional methods faced challenges such as false detections due to environmental conditions like reflections and ambient light interference. The introduction of LiDAR technology revolutionized the field by enabling highly accurate 3D mapping, making it a preferred choice for modern applications such as autonomous driving and robotic navigation Recent advances in AI and deep learning have made obstacle detection more effective, allowing real-time object classification and trajectory prediction. Studies show that combining multiple sensors, like vision-based systems with LiDAR or radar, improves accuracy, enhances reliability, reduces collision risks, and boosts navigation efficiency.

LITERATURE REVIEW
Several studies focus on obstacle avoidance and autonomous navigation in robotics. Bello and Baballe
[1] designed an ultrasonic sensor-based obstacle avoidance robot using an Arduino microcontroller, but the system was limited by sensor range and environmental interference. Raj et al.

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[2] Proposed a deep reinforcement learning (DRL)-based Approach for Dynamic Obstacle Avoidance, integrating mobility pattern prediction, though performance constraints existed in unpredictable environments. Rangesh et al.
[3] developed an Arduino-based surveillance robot with live video transmission, demonstrating 93.3% accuracy but lacking advanced AI for enhanced image processing Raiz Ahamed
[4] introduced an AVR microcontroller-based system utilizing IR sensors, highlighting cost-effectiveness but facing limitations with dark-colored obstacle detection. Rohith et al.
[5] implemented an IR sensor-based robot for obstacle avoidance, demonstrating reliability but suffering from limited sensor range in complex environments. Pithode et al.
[6] developedan ultrasonic sensor-integrated robotic vehicle for real-time obstacle avoidance, effectively adjusting paths dynamically. Singh
[7] explored a gesture-controlled pick-and- place robotic vehicle, integrating accelerometers and ultrasonic sensors, yet the system faced limitations in sensor accuracy. Sahu et al.
[8] demonstrated a line-following robot utilizing PID control, achieving high precision in navigation but struggling in dynamic environments. Finally, Neelakrishnan et al.
[9] introduced an IoT-based Gas leakage Detection System using MQ5 sensors, addressing LPG hazards but requiring improvements in sensor accuracy and network reliability.

These studies contribute to the field of autonomous robotics, with key advancements in obstacle detection, real-time navigation, and environmental adaptability. However, challenges such as sensor limitations, unpredictability in dynamic environments, and scalability for complex applications remain areas for further research.

SYSTEM DESIGN

The system design integrates both hardware and software components to facilitate real-time obstacle avoidance and gas leakage detection. The hardware includes an Arduino Mega 2560 as the central processing unit, Ultrasonic Sensors for Obstacles Detection, an MQ5 gas sensor for hazardous gas identification, and an L298D motor driver to control motor speed and direction. An OLED display is incorporated for real-time data visualization, while a buzzer provides audio alerts for gas leakage or obstacle detection.

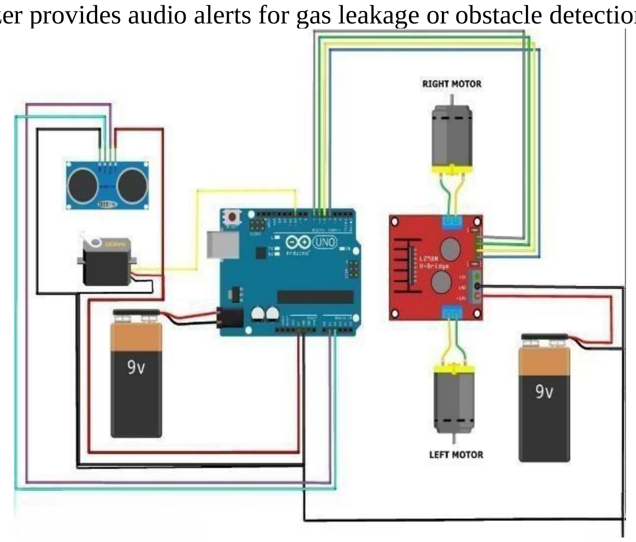

Figure 1.1 Circuit diagram

The software component comprises programming in the Arduino IDE for hardware control, Jupyter Notebook for machine learning model development, and decision tree algorithms to classify actions based on sensor inputs. Sensor fusion techniques enhance detection accuracy, allowing the robot to adjust its path dynamically.

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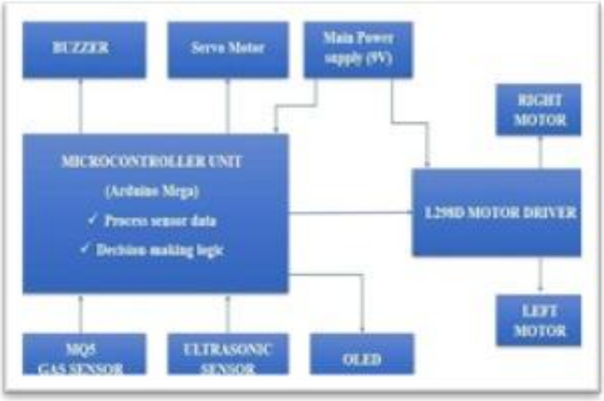

Figure 1.2 Block Diagram

The Aero Alert system continuously monitors air quality and generates alerts when necessary. This integration ensures seamless, autonomous navigation and real-time hazard detection.

METHODOLOGY

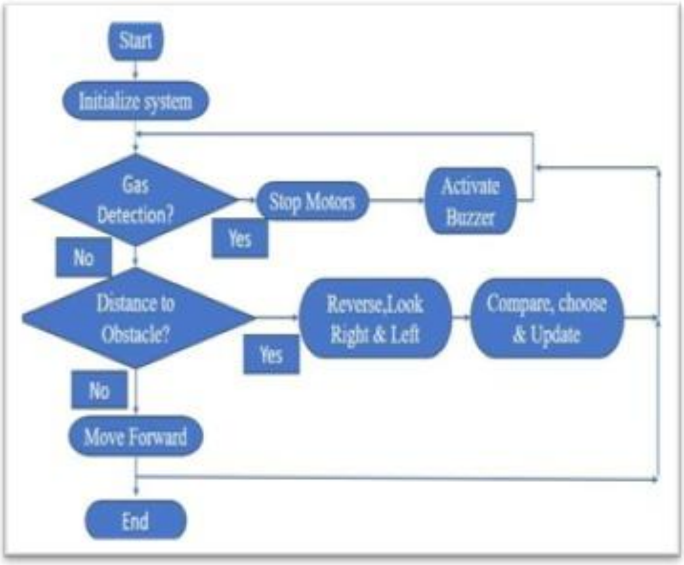

Figure 1.3 Mechanism at user end

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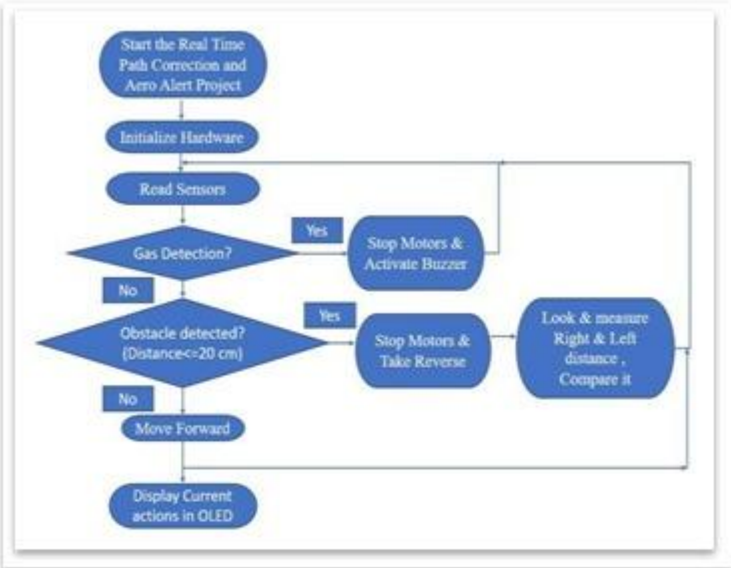

Figure 1.4 Mechanism at ROBOT end

The methodology involves a combination of hardware implementation and software-based machine learning techniques to ensure optimal performance. Initially, data is collected using ultrasonic sensor for obstacles detection, which is then pre-processed and labelled accordingly. A decision tree model is trained to classify obstacle distances and determine appropriate rerouting actions. The trained model is deployed on the Arduino Mega, allowing the robot to make real-time navigation decisions based on incoming sensor data. Hardware components such as motors, sensors, and displays are tested individually before being integrated into the complete robotic system. The performance of the robot is evaluated through unit and integration testing, ensuring smooth operation and real-world applicability. Additionally, real-time gas leakage detection is implemented using an MQ5 gas sensor, with alerts being triggered via a buzzer and OLED display. Experimental results demonstrate the highest accuracy in obstacle detection, path correction, and gas leakage identification, making the system robust and reliable for various real-world applications

EXPERIMENTAL RESULTS

The experimental evaluation of the system was conducted in a controlled environment to assess the accuracy, efficiency, and reliability of obstacle detection, path correction, and gas leakage identification. The decision tree model achieved a training accuracy of approximately 93% and a testing accuracy of around 86%. The obstacles detection system was tested in varying environmental conditions, yielding an accuracy of 98%. The Gas Leakage Detection system using MQ5 sensor demonstrated 100% accuracy in detecting hazardous gas concentrations and triggering alerts

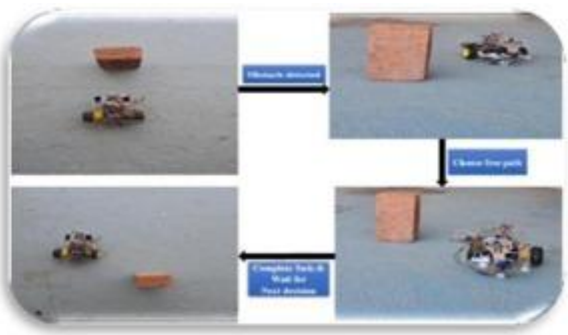

Figure 1.5 Working Model Snapshot

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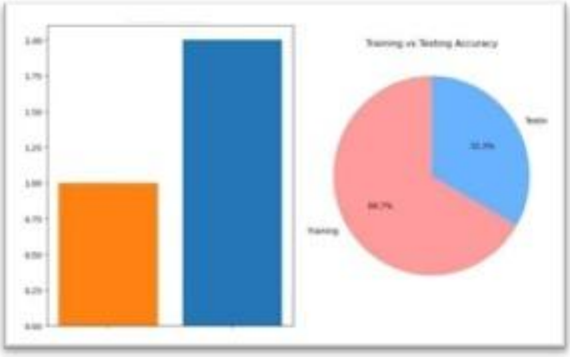

Figure 1.6 Visualized Display

Further real-world tests were conducted in dynamic environments with obstacles placed at different angles and varying distances. The robot successfully detected obstacles and adjusted its path dynamically, ensuring seamless navigation. The Aero Alert system was tested by introducing controlled gas leaks, and the system effectively identified and responded to hazardous conditions within seconds. Additionally, power consumption analysis indicated that the robot could operate continuously for an extended duration without requiring frequent recharging.

The performance of the Obstacles Detection and avoidance system is evaluated based on accuracy, response time, and efficiency in different scenarios. Testing shows that integrating multiple sensors significantly improves detection accuracy compared to single-sensor systems. LiDAR provides precise distance measurements, while AI-based vision enhances object recognition. The use of sensor fusion reduces false detections and improves decision-making reliability. The system successfully avoids obstacles in both static and dynamic environments, demonstrating its effectiveness in real-world applications. Future improvements may involve enhancing AI models with reinforcement learning and incorporating more advanced sensors to improve robustness in extreme conditions.

In practical scenarios, the system showed minimal false positives in obstacle detection and maintained a low response time for path correction. The integration of multiple sensors significantly enhanced detection reliability, and sensor fusion techniques helped minimize errors. Future enhancements could include advanced AI-driven predictive path planning and real-time cloud-based monitoring to further optimize performance.

LIMITATIONS

Limited Range: The ultrasonic sensor has a maximum range of 200 cm, which may not be sufficient for large environments.

Overshooting in Turns: The robot occasionally overshoots by 2-3 cm during sharp turns, which could be improved with better motor control algorithms.

Gas Sensitivity: The gas sensor may trigger false alarms if the threshold is not calibrated properly for specific environments.

Power Consumption: The use of multiple components (motors, sensors, display) may lead to higher power consumption, reducing battery life.

Complexity: The integration of multiple modules (sensors, motors, display) increases the complexity of the system, requiring careful calibration and testing.

Cost: The use of additional components like the OLED display and servo motor increases the overall cost of the system

RESULT COMPARSSION

Paper	**Methodology**	**Proposed System**
Mukhtar Ibrahim Bello et al. [1]	Arduino Uno, Ultrasonic Sensor, C Programming, LEDs	Obstacle detection with two powered wheels, sensor range up to 200 cm, reliable in dynamic environments.
Ravi Raj et al. [2]	DRL-based neural network	Training and testing achieve the best accuracy.
R. Rangesh et al. [3]	Arduino Uno, Ultrasonic Sensor, FPV Camera, Servo Motor	98% high sensor accuracy, modular for advanced sensors, real-time troubleshooting.

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S.S. Raiz et al. [4]	ATMEGA-8, IR Sensors, Differential Drive, Dynamic Steering	Excellent detection accuracy, modular design for additional sensors.

CONCLUSION

Obstacle detection and avoidance is essential for autonomous systems, ensuring safety and efficient navigation. The integration of multiple sensors, AI- based algorithms, and real-time processing enables accurate obstacle detection and effective avoidance strategies. The results indicate that sensor fusion and AI-driven approaches significantly enhance performance compared to traditional methods. With advancements in AI, computing power, and sensor technology, Future systems will become even more intelligent and capable of handling complex environments

REFERENCES

[1] Mukhtar Ibrahim Bello and Muhammad Ahmad Baballe, "Simulation of Obstacle Avoidance Robots," ESP International Journal of Advancements in Computational Technology, pp. 5-8, 2025.

[2] Ravi Raj, "Dynamic Obstacle Avoidance for Mobile Robots Using Deep Reinforcement Learning with Mobility Pattern Prediction," International Journal of Emerging Trends in Engineering Research, pp. 7-9, 2025.

[3] R. Rangesh et al., "Arduino-Based Obstacle Avoidance Robot for Live Video Transmission and Surveillance," International Research Journal of Engineering and Technology (IRJET), Volume 07, Issue 05, pp. 4-9, May 2020.

[4] S.S. Raiz Ahamed, "Obstacle Avoidance Strategy for Mobile Robot using AVR Microcontroller," International Journal of Soft Computing and Engineering (IJSCE), Volume 3, Issue 4, pp. 9-11, September 2013.

[5] M. Rohith, M. Rakshith Varma, B. Naveen, D. Lickith, and K. Kranthi Kumar, "Obstacle Avoidance Robot Using IR Sensor and Arduino," International Journal of Advanced Research in Science and Technology, 2024.

[6] Akrati Pithode, Harsha Wagadre, Neha Verma, Riya Rathore, Vaishnavi Bhange, and Amey Joshi, "Obstacle Avoiding Robotic Vehicle Using Arduino," International Journal of Engineering Applied Sciences and Technology (IJEAST), Vol. 5, Issue 1, pp. 11-14, May 2020.

[7] Sarthak Singh, "The Motion Controlled Pick and Place Obstacle Avoider Robotic Vehicle," International Journal of Engineering Research & Technology, 2024.

[8] Abhishek Sahu et al., "The Design and Development of a Line-Following Robot Using an Arduino Uno and PID Control," International Journal of Creative Research Thoughts (IJCRT), pp. 6-10, 2024.

[9] G. Neelakrishnan et al., "Smart Gas Level Monitoring, Booking and Gas Leakage Detector over IoT," International Journal of Innovative Research in Science, Engineering and Technology, Volume 9, Issue 3, pp. 5-11, March 2020.