iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 13 **Issue:** III **Month of publication:** March 2025

**DOI:** https://doi.org/10.22214/ijraset.2025.67921

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

# Mean_Based Approach to Omnidirectional Pathfinding Algorithm Using Single Ultrasonic Sensor for Robotic Car

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***Abstract: For design and testing the smart pathfinding system for a robotic car using ultrasonic sensor. In this project we are using Q learning algorithm which means it can be created own path itself. The proposed algorithm works in two phases: normal detection and intensive detection. In the normal detection phase, the sensor scans for obstacles directly in front of the car. In the intensive detection phase, a servo motor moves the sensor to scan a wider area, acting like multiple sensors combined. This method improves obstacle detection and Accuracy. The system is built on an Arduino UNO platform and controls DC motors using an H-W 130 motor shield. The ultrasonic sensor gathers distance data, and the algorithm processes this information to determine the safest path. A mean based approach is used to reduce false detections and improve accuracy. Unlike traditional robotic systems that require multiple sensors, our proposed model achieves 360-degree obstacle detection with single sensor, reducing cost hardware complexity and Energy Consumption. The robotic car was tested in real world conditions, and obstacles were successfully detected and avoided with high accuracy.***
***Keywords: Arduino UNO, Servo Motor, Ultrasonic Sensor, L293D Motor driver, LCD Display, Camera Module.***

## I. INTRODUCTION

In today's world, pathfinding algorithms (A pathfinding algorithm finds the most efficient route from a start to a destination while avoiding obstacles) are essential for robotics and automation. However, commonly used algorithms for ultrasonic sensors typically make simple left or right decisions, which can be inaccurate and inefficient. Our research focuses on improving these algorithms to enhance navigation and obstacle avoidance. Pathfinding plays a crucial role in guiding autonomous vehicles and robots, whether for military applications in hazardous or inaccessible areas or for exploration on extraterrestrial surfaces with an atmosphere. The main inspiration for this project comes from the limitations of traditional ultrasonic sensors. Their monodirectional approach can lead to inaccuracies such as false positives (explained in the algorithm section). While wide angle Sensing alternatives exist, they are often costly and complex. To address this issue, we designed a composite sensor system using an ultrasonic sensor mounted on a servo motor. By combining hardware enhancements with a newly developed omnidirectional pathfinding algorithm, we aim to improve obstacle detection and navigation efficiency. Overall, our project is the robotic car is moving in path if any obstacle is there then detected by using ultrasonic sensor mounted on servo motor then the robotic car is automatically change the direction to move safely.

## II. LITERATURE SURVEY

Tandon, A. et al.– Proposes a mean-based approach for omnidirectional pathfinding using a single ultrasonic sensor in robotic cars. Presented at IEEE SCEECS 2024 [1]. Khojasteh, M. S., & Salimi-Badr, A. – Introduces a deep reinforcement learning-based autonomous quadrotor path-planning approach incorporating monocular depth estimation [2]. Mahmud, T. et al.– Designs and implements an Arduino-based ultrasonic sensor system for obstacle avoidance in robots. Focuses on sustainable technology applications [3]. Borenstein, J., & Koren, Y. – A foundational study on obstacle avoidance using ultrasonic sensors, widely cited in robotics research [4]. Massoud, M. M. et al. – Compares various indoor pathplanning techniques for omni-wheeled mobile robots, evaluating performance and optimization [5].Mu, W. Y. et al. – Proposes an omni-directional scanning localization method for mobile robots based on ultrasonic sensors [6]. Massoud, M. M. et al. – Duplicate of Reference [7]. Hsu, C. C. et al.– Discusses localization techniques for mobile robots using omnidirectional ultrasonic sensing[8].Chen, L. et al. – Describes a wireless car control system using Arduino UNO R3, integrating remote communication [9]. Sissodia, R. et al. – Develops an Arduinobased Bluetooth voice-controlled robot car with obstacle detection [10]. Akilan, T. et al. – Proposes a surveillance robot for hazardous environments using IoT technology [11].

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## III. PROPOSED METHODOLOGY

The proposed IoT-based autonomous navigation system leverages ultrasonic sensors, servo motors, L293D motor drivers, a buzzer, and HC-05 Bluetooth communication to enhance obstacle detection and avoidance. The ultrasonic sensor scans the environment, and the servo motor rotates it to create a wider field of view, improving detection accuracy. The L293D motor driver efficiently controls motor movement, while the buzzer provides alerts when an obstacle is detected. The HC-05 Bluetooth module facilitates remote control and monitoring. The camera module captures images and videos in mobile phone. This model helps a robotic car move smoothly in any direction while avoiding obstacles, using just one ultrasonic sensor and a smart decision-making approach. Instead of relying on multiple sensors, the car analyzes its surroundings by scanning different directions and calculating the average open space available. The ultrasonic sensor either rotates on a servo motor or the car itself makes small movements to gather distance data. Based on these readings, the car identifies the safest path by choosing the direction with the most space. If the car detects an obstacle too close, it quickly checks for alternative routes using its omnidirectional wheels, which allow it to move in any direction without turning. If no clear path is found, the car rotates 180° and scans again. This process repeats constantly, helping the car adapt in real-time and navigate efficiently. By using this approach, the car avoids unnecessary stops, reduces errors, and makes smart movement decisions, all while keeping the hardware simple and costeffective.

PROPOSED MODEL

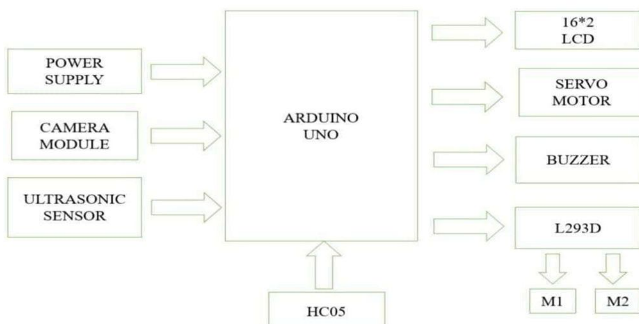


Fig:1 Proposed Block Diagram

The block diagram represents a proposed system based on Arduino Uno for a robotics application. Here's an explanation of each block:

1) Power Supply: Provides the necessary electrical power to all the components in the system. It ensures the Arduino and sensors receive the required voltage.
2) *Camera Module*

Fig:2 Camera Module

Captures images or video to provide visual input for processing.

3) *Ultrasonic Sensor*

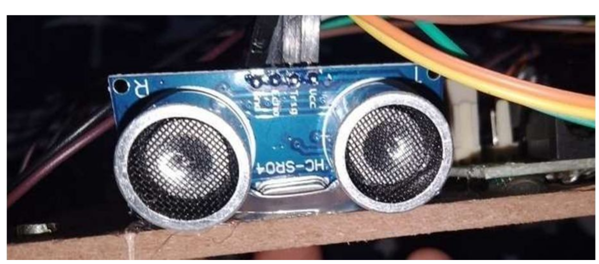


Fig:3 HC-SR04 Ultrasonic Sensor

Scans the environment or surroundings and measures the distance.

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*4) Arduino UNO*


Fig:4 Arduino Uno

Arduino Uno is microcontroller board based on ATmega328P chip, widely used for embedded systems and automation.

*5) 16×2 LCD Display*


Fig:5 LCD Display

A display unit that shows information such as sensor readings, messages, or status updates of the system.

*6) Servo Motor*

Fig:6:SG90 Servo motor

A servo motor moves to a specific angles. It is useful to control the robotic arms.

*7) Buzzer*

Fig:7 Buzzer

An output device that produces sound alerts for notifications, warnings, or obstacle detection alerts

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8) *L293D Motor Driver*

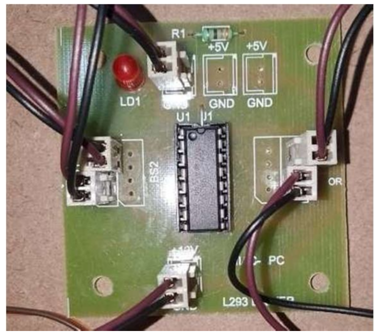

Fig:8 L293D Motor Driver

A driver can controls motor movement and distance speed.

9) *M1 & M2 (Motors):* DC motors responsible for the movement of the robotic system, enabling it to navigate its environment.

10) *HC-05 (Bluetooth Module)*

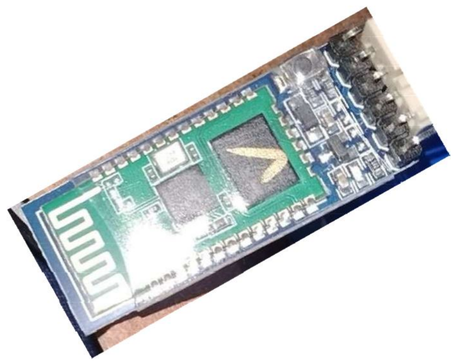

Fig:9 HC-05 Bluetooth Module It can be facilitates remote control and monitoring.

## IV. RESULTS AND ANALYSIS

The mean-based pathfinding algorithm, using a single ultrasonic sensor, has shown good results in helping an Robotic car move smoothly while avoiding obstacles. By operating in two phases. Normal and intensive detection. In the normal phase, the ultrasonic sensor directly scans for obstacles. In the intensive detection phase, where a servo motor rotates the sensor, expanding its field of view and allowing the car to assess its surroundings from multiple angles. When the robotic car moves freely and encounters an obstacle, it stops. Then the ultrasonic sensor mounted on a servo motor scans the surroundings within 180 or 360 degrees. Based on the detected area, the robotic car is automatically changes direction to move safely. And by using HC05 Bluetooth module we can see the direction like for example Forward, right in the LCD display.

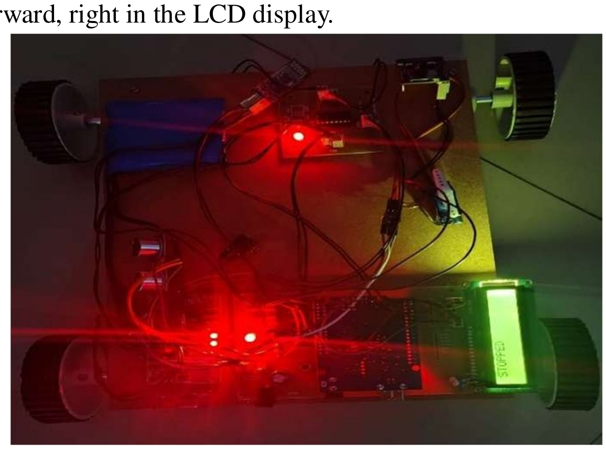

Fig:10


Fig:11 Fig:12

## V. CONCLUSION

After thorough development and testing, we have successfully implemented an enhanced pathfinding and obstacle-avoidance algorithm on a test RC car. Practical trials have shown that this algorithm allows the vehicle to navigate with high accuracy. The dual-phase approach optimizes power consumption while ensuring reliable and precise path selection. This technology holds significant potential for applications in military operations, research projects, and hazardous environments where human presence is risky.

## VI. ADVANTAGES AND FUTURE SCOPE

Robots can navigate hazardous or inaccessible areas, such as fire-affected zones or toxic environments, much like the robotic technology used during the Chernobyl disaster. These machines play a crucial role in disaster response, minimizing human risk while efficiently performing critical tasks in dangerous locations. A robotic car can be effortlessly controlled via a smartphone app, allowing users to operate it with simple commands. This accessibility makes robotic vehicles user-friendly and adaptable for various applications, from personal projects to industrial automation. These robots excel in remote monitoring and exploration, enabling data collection and analysis without human intervention. By deploying them in inaccessible or high-risk environments, we can gather crucial information in real-time, improving decision-making and operational efficiency.

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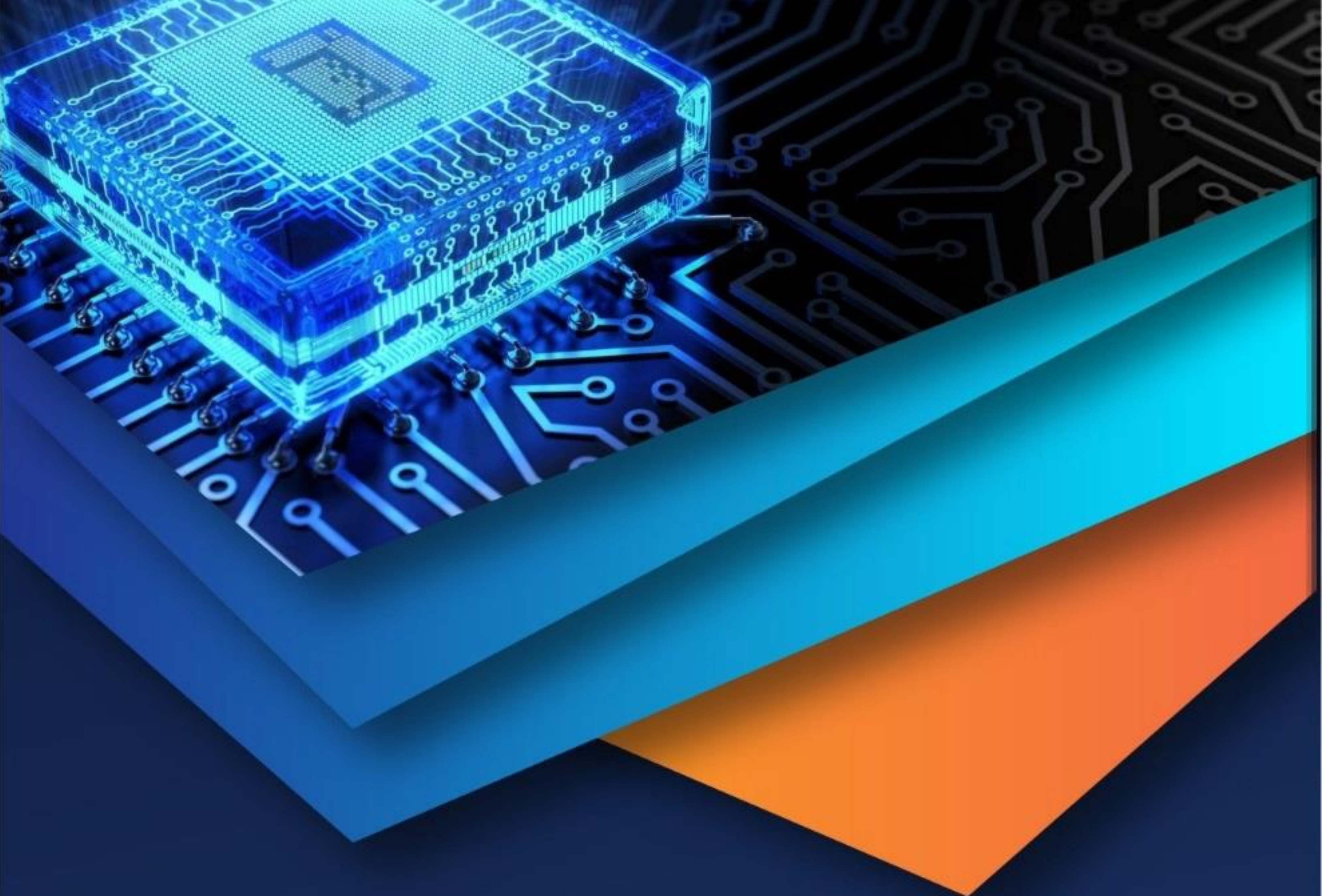


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