**Obstacle Detection and Avoidance Robotic Car Using NodeMCU, L298N, and Ultrasonic Sensors**

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**Abstract**:

This paper presents a motion planning system with integrated obstacle detection and shortest-distance path optimization, designed using a Node MCU-based motion planning system. The system uses ultrasonic sensors to detect obstacles in real-time for precise navigation in dynamic environments. The motion planning algorithm calculates the shortest path to the destination while avoiding detected obstacles, using Dijkstra's algorithm for efficiency. The Node MCU is the core processing unit, thus directly allowing for all the communication between sensors and actuators. This low-cost, scalable solution has practical applications in various autonomous robotics, warehouse automation, and smart transportation systems. Its accuracy, responsiveness, and energy efficiency have all been demonstrated by experimental results that appear to make it a promising candidate for deployment in real-world settings.

### **Keywords**

NodeMCU, Motion Planning, Obstacle Detection, Shortest Distance, Autonomous Navigation, Dijkstra's Algorithm.

**1. Introduction**

Motion planning is a fundamental aspect of robotics and automation, enabling systems to navigate from a starting point to a target location efficiently. In this context, implementing a **NodeMCU-based motion planning system** offers a cost-effective and versatile solution. The **NodeMCU**, powered by the ESP8266 microcontroller, is widely recognized for its robust wireless communication capabilities, compact design, and compatibility with various sensors and modules. By integrating these features, a motion planning system can be created with enhanced functionalities such as **shortest path optimization** and **real-time obstacle detection**.

This system addresses key challenges in autonomous navigation, including:

* **Path Optimization**: Utilizing algorithms like Dijkstra's for identifying the shortest and most efficient route to the destination.
* **Obstacle Detection**: Employing sensors like ultrasonic or infrared (IR) to detect and avoid obstacles dynamically during navigation.
* **Wireless Connectivity**: Leveraging the NodeMCU's Wi-Fi capabilities to allow remote monitoring and control.

The proposed system finds applications in diverse fields such as robotics, smart home automation, and industrial automation. Its ability to plan efficient paths while ensuring safety through obstacle avoidance makes it ideal for real-world scenarios requiring high precision and adaptability.

**2. Literature Review**

The development of NodeMCU-based motion planning systems with shortest distance criteria and obstacle detection is informed by extensive research in the fields of robotics, sensor technology, IoT, and computational algorithms. This expanded review explores existing work in depth to contextualise the research problem and establish the relevance of current solutions.

#### **2.1 Path Planning and Obstacle Avoidance**

Path planning is an essential component of autonomous navigation, ensuring efficient and collision-free travel. Various algorithms have been developed, each suited to specific environmental conditions:

**2.1.1 Global Path Planning**:

* **Dijkstra's Algorithm**: Provides optimal solutions in static environments by finding the shortest path between nodes in a graph. However, its computational expense limits real-time applications in large-scale or dynamic environments [1] [2].
* *A Algorithm*\*: Combines Dijkstra's exhaustive search with heuristic functions to improve efficiency, making it suitable for static and semi-dynamic environments [3].

**2.1.2 Local Path Planning**:

* Methods like **Bug Algorithms** and **Vector Field Histogram (VFH)** focus on obstacle avoidance in real-time by leveraging sensor data to guide robots away from obstructions. VFH, for instance, dynamically adjusts the robot's path while maintaining an efficient trajectory [4].

**2.1.3 Dynamic Path Planning**:

* Research highlights the importance of integrating global and local path planning approaches. For instance, the Hybrid A\* algorithm integrates heuristic functions with real-time obstacle detection, balancing optimality and responsiveness in dynamic environments [5].

#### **2.2 Hybrid Navigation Systems**

Hybrid systems that blend global planning for path optimization and local planning for obstacle avoidance have gained prominence.

* **Multi-Agent Systems**: Phan Gia Luan et al. (2020) demonstrated a multi-agent A\*-based hybrid navigation system. By combining curvature-continuous Bézier curves for path smoothing and weighted-sum models for local reactivity, this system excelled in obstacle-dense environments [6].
* **Real-Time Re-Planning**: Studies have implemented systems where robots continuously update their paths based on sensor input, ensuring adaptability to unforeseen changes in the environment [7].

#### **2.3 NodeMCU Integration in IoT and Robotics**

NodeMCU’s low power consumption, compact size, and wireless communication capabilities make it ideal for embedded robotic systems. Its integration enables real-time data collection, processing, and transmission, critical for autonomous navigation.

* **Applications**: NodeMCU has been successfully used in robotic navigation systems to control motors, read sensor data, and communicate with cloud platforms for monitoring and control [8][9].
* **Scalability**: Due to its compatibility with various sensor technologies, NodeMCU-based systems are cost-effective and scalable, making them suitable for academic, industrial, and personal robotics projects.

#### **2.4 Sensor Technology for Obstacle Detection**

Effective obstacle detection relies on robust sensors and their integration with computational algorithms:

* **Ultrasonic Sensors**: Suitable for detecting obstacles in close proximity. They are cost-effective and widely used, though susceptible to inaccuracies in noisy or irregular environments [10].
* **LiDAR**: Provides detailed 3D environmental mapping, allowing for precise obstacle detection. Despite its higher cost, LiDAR has become a standard for navigation in complex environments[11].
* **Infrared Sensors**: Work effectively in detecting nearby objects and are frequently used in combination with other sensors for robustness[12].
* **Sensor Fusion**: Combining multiple sensor types improves system reliability. For example, fusing ultrasonic and infrared sensors provides comprehensive data for both long-range and short-range obstacle detection[13].

#### **2.5 Algorithmic Efficiency and Advanced Techniques**

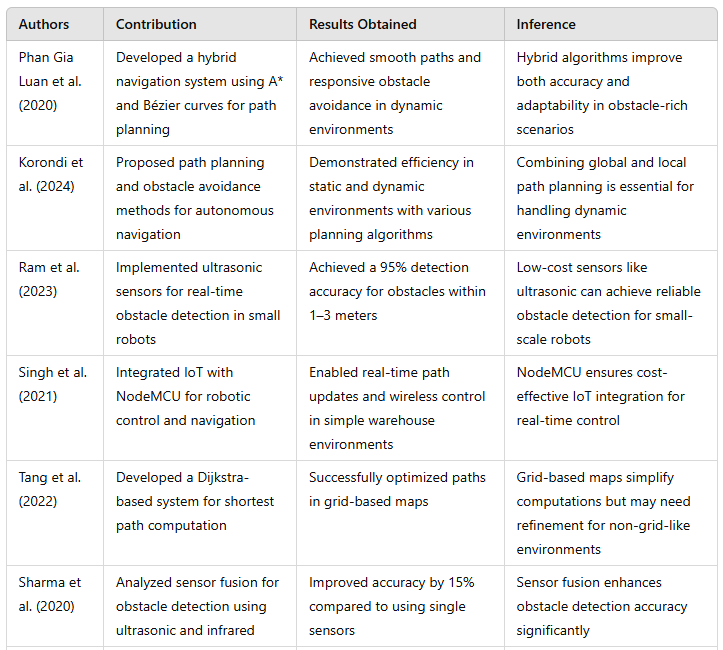
Recent advancements in algorithms emphasise computational efficiency and adaptability:

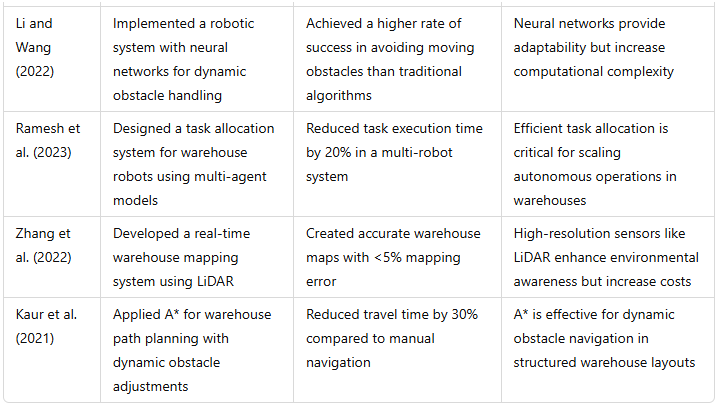
1. **Neural Networks and Genetic Algorithms**: These techniques optimise path planning by learning from environmental data, reducing computation times, and improving decision-making in dynamic settings[14][15].
2. **Reinforcement Learning**: Robots trained using reinforcement learning can adapt to unstructured environments, improving performance over traditional rule-based systems[16].

#### **2.6 Experimental Validation and Applications**

Experimental studies have validated the performance of motion planning systems across diverse applications:

* **Warehouse Robotics**: Systems have demonstrated efficiency in optimising retrieval paths in warehouse environments[17].
* **Service Robots**: Navigation systems in hospitals and airports have utilised similar technologies to ensure seamless operation amidst dynamic obstacles[18][19].

The table below highlights at least 10 research works related to motion planning, obstacle detection, and IoT-enabled robotics systems. Each study includes the authors, their contribution, results obtained, and the inference derived from their work.



### **Problems in Existing Systems**

1. **Lack of Scalability:** Many systems fail to efficiently scale from small, controlled environments to large, complex spaces like warehouses.
2. **Sensor Limitation:** Low-cost sensors often struggle with accuracy in dynamic or cluttered environments.
3. **Real-Time Adjustments:** Existing path-planning systems may lack the responsiveness needed for dynamic obstacle handling.
4. **Integration Complexity:** Combining multiple systems (e.g., path planning, obstacle detection, IoT) can increase implementation difficulty.
5. **Energy Efficiency:** Many autonomous robots have limited battery life, which impacts their operational time.
6. **High Costs of Advanced Sensors:** High-performance sensors like LiDAR significantly increase the cost of implementation, making them less feasible for small-scale projects.
7. **Task Allocation:** Inefficient task scheduling leads to delays in warehouses requiring multi-task execution.

### **Objectives of This Research**

1. **Develop a Cost-Effective System:** Use affordable components like NodeMCU and ultrasonic sensors to create an efficient motion planning and obstacle detection system.
2. **Enhance Obstacle Avoidance:** Implement robust real-time obstacle detection and avoidance mechanisms using sensor integration and dynamic local planning algorithms.
3. **Optimise Path Planning:** Utilise shortest path algorithms (e.g., A\*) for efficient navigation in structured warehouse environments.
4. **Enable IoT Integration:** Integrate IoT features to facilitate real-time monitoring and wireless control of the robot.
5. **Increase Scalability:** Design a system capable of adapting to both small and large-scale warehouse environments.
6. **Improve Task Execution:** Develop a system that efficiently completes tasks such as pick-and-place operations in minimal time.
7. **Focus on Energy Efficiency:** Ensure the robot operates efficiently by optimising power usage and navigation algorithms.

This research aims to address limitations in existing systems and establish a scalable, reliable, and cost-effective solution for autonomous warehouse navigation.

### **3. Proposed Methodology**

The proposed methodology for implementing a NodeMCU-based motion planning system with shortest distance criteria and obstacle detection capability involves a stepwise approach focusing on hardware selection, navigation system development, and iterative testing. These steps ensure that the robotic system is robust, efficient, and capable of operating autonomously in a dynamic warehouse environment.

#### **1. Defining System Requirements**

The objective is to design a mobile robot capable of autonomous navigation within a warehouse, ensuring that it follows the shortest path to complete assigned tasks while avoiding obstacles. Key requirements include efficient navigation, real-time obstacle detection, and task execution. The robot should operate reliably, reducing human intervention and optimising workflow efficiency.

#### **2. Hardware Selection and Assembly**

The robot's physical design starts with selecting a suitable platform that supports smooth mobility and sufficient load-carrying capacity. NodeMCU, a microcontroller known for its IoT compatibility and wireless communication capabilities, is used as the primary control unit. The robot is equipped with ultrasonic sensors for precise obstacle detection and a basic camera module to assist with navigation and mapping. These components are powered by a reliable battery system to ensure uninterrupted operation. The integration of these hardware components ensures the robot's adaptability to the warehouse environment while maintaining cost-effectiveness.

#### **3. Navigation System Development**

A critical aspect of the methodology is the development of an effective navigation system. The warehouse layout is digitally mapped, marking key areas such as storage zones, aisles, and delivery points. The map is represented using a grid-based or coordinate system for computational ease. To compute the shortest path from the robot’s current position to the target, algorithms such as Dijkstra’s or A\* are implemented, ensuring optimal path planning. The system is designed to adapt dynamically to changes in the environment by incorporating real-time data from the sensors. Obstacle detection is managed through ultrasonic sensors, and a local planning algorithm, such as Bug or Vector Field Histogram (VFH), is employed for safe navigation around obstacles. This dual-layer approach of global and local planning ensures both accuracy and flexibility in motion planning.

#### **4. Task Execution System**

The robot’s task execution framework initially involves manual assignment of simple tasks, such as moving items between designated locations. A task queueing mechanism prioritises and schedules tasks efficiently. The robot uses its navigation system to reach the required locations and execute tasks using programmed logic. Future iterations may include automated task assignment via a central control system, enabling real-time task allocation based on warehouse needs.

#### **5. Testing and Refinement**

The system is first tested in a controlled environment to validate its navigation, obstacle detection, and task execution capabilities. Performance metrics, such as path efficiency, response time to obstacles, and task completion rates, are recorded and analysed. Based on these results, adjustments are made to sensor calibration, algorithm parameters, and hardware configuration to optimise the system. This iterative testing and refinement ensure the robot operates reliably under real-world conditions.

#### **6. Deployment and Monitoring**

The deployment process begins with a pilot phase in a small, less critical section of the warehouse. This phase allows for the assessment of the robot's performance in live scenarios and provides insights for further refinement. As the robot proves its reliability, its operational area is gradually expanded, and it is assigned more complex tasks. Continuous performance monitoring is implemented to identify potential issues and maintain operational efficiency. Regular maintenance schedules are established to ensure long-term system reliability.

#### **7. Expected Outcomes**

The proposed methodology aims to produce a robotic system capable of autonomously navigating a warehouse environment, efficiently completing assigned tasks while safely avoiding obstacles. This system is expected to reduce human intervention, enhance operational efficiency, and provide a scalable solution for warehouse automation. The integration of NodeMCU ensures cost-effectiveness and IoT compatibility, enabling future expansions and real-time monitoring capabilities.

This detailed methodology provides a comprehensive framework for implementing and deploying a motion planning system, addressing both technical and operational challenges in warehouse automation.

### **Advantages of the Proposed Methodology**

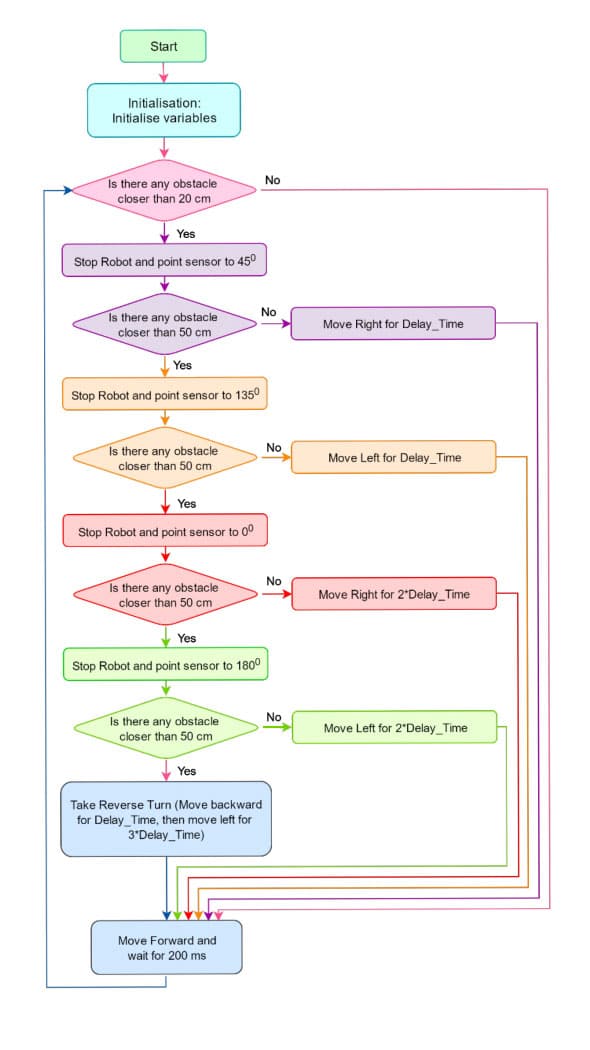
1. **Cost-Effectiveness:** Utilises affordable components like NodeMCU and ultrasonic sensors, making it accessible for small and medium-scale warehouses.
2. **Real-Time Obstacle Detection:** Sensor integration ensures safe navigation in dynamic environments by enabling immediate response to obstacles.
3. **Path Optimization:** Algorithms like A\* and Dijkstra's ensure efficient navigation, reducing travel time and energy consumption.
4. **Scalability:** The system can adapt to both small and large-scale warehouse environments, making it flexible for future expansions.
5. **IoT Integration:** Enables remote monitoring and control, providing a robust framework for real-time system analysis.
6. **Energy Efficiency:** Optimised navigation and task execution minimise energy usage, prolonging operational time.
7. **Improved Workflow:** Automating tasks like item retrieval and delivery increases operational efficiency and reduces human intervention.

This proposed methodology outlines a step-by-step approach to developing an efficient, scalable, and cost-effective robotic system for warehouse automation.

**3.1 FLOW CHART and CIRCUIT DIAGRAM**

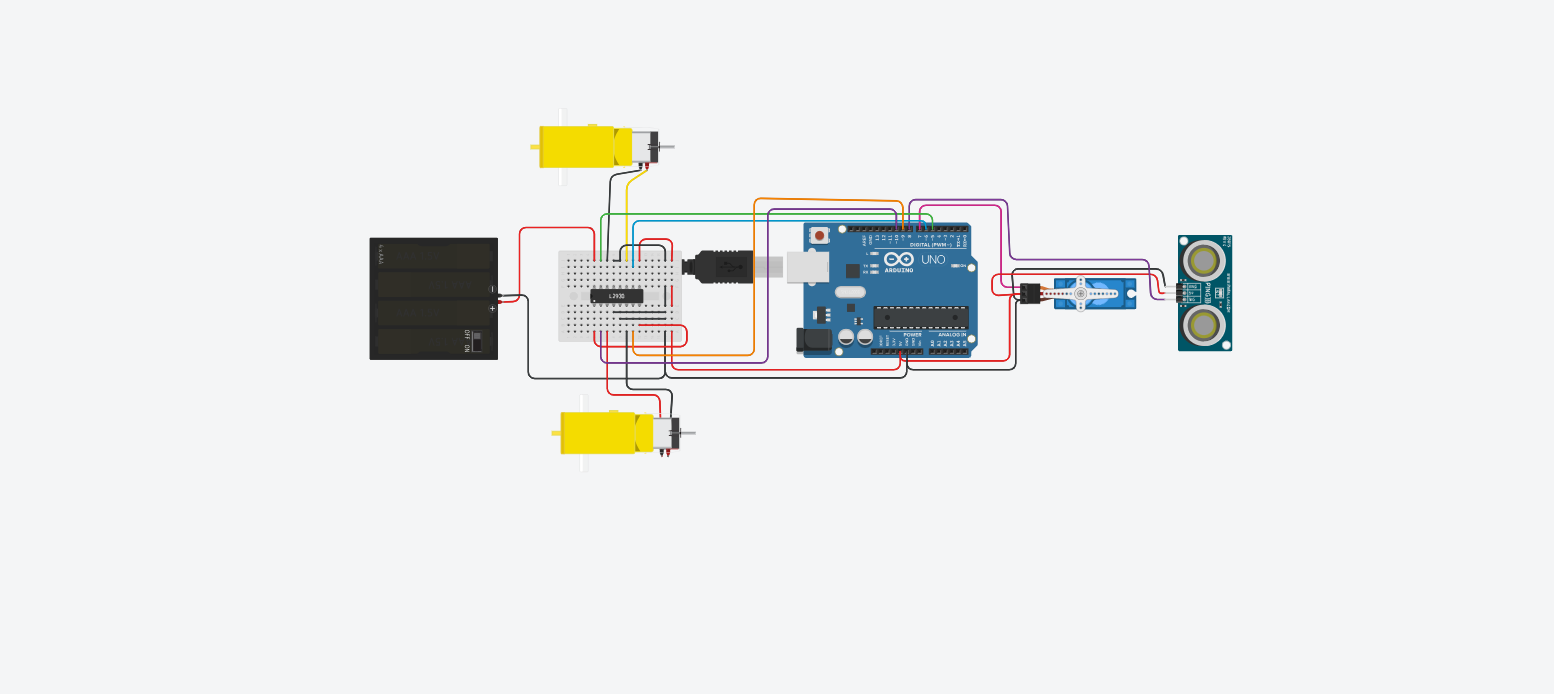
A flowchart is ideal for explaining the logical flow of the system, particularly the algorithm. Example:

* Start the system.
* Rotate the servo motor to scan for obstacles.
* Measure distance using the ultrasonic sensor.
* If an obstacle is within the threshold, decide a new direction.
* Move in the selected direction.
* Repeat the process.
* Use diamonds for decision points, rectangles for actions, and ovals for start/stop.



A circuit diagram is best for providing electrical connections between components.

* NodeMCU GPIO pins to L298N Motor Driver IN1, IN2, IN3, IN4 for motor control.
* Servo motor control pin to a NodeMCU digital pin.
* Ultrasonic sensor TRIG and ECHO pins to NodeMCU GPIO pins.
* Battery connected to the L298N for power.
* Software like Fritzing can be used to create a clear circuit diagram.



**3.2 WORKING**

**3.2.1** **Hardware Connections**

* The NodeMCU receives power from the connected battery pack and serves as the central processing unit.
* The L298N motor driver is connected to the NodeMCU GPIO pins for directional and speed control of the gear motors.
* The HC-SR04 ultrasonic sensor is mounted on the servo motor and connected to NodeMCU to provide real-time obstacle detection data.
* The servo motor is also connected to the NodeMCU to rotate the ultrasonic sensor for scanning.

**3.2.2 Control Algorithm**

* The obstacle detection robotic car operates based on the following algorithm:

1. Initialization: The NodeMCU initializes all components and performs a system check.
2. Scanning: The servo motor rotates the ultrasonic sensor to scan for obstacles within a specified range (e.g., 0–180°).
3. Distance Measurement: The HC-SR04 sensor calculates distances using the formula: Distance = Time of Flight × Speed of Sound 2 Distance= 2 Time of Flight×Speed of Sound ​
4. Decision Making: If an obstacle is detected within a threshold distance (e.g., <20 cm), the car halts and adjusts its direction. The NodeMCU determines the direction with the maximum free path (left, right, or forward) and sends commands to the L298N motor driver. Motion: The car moves in the chosen direction, avoiding collisions.

**3.2.3 Software Implementation** The firmware was developed using the Arduino IDE and programmed into the NodeMCU. Key libraries include the Servo library for motor control and the NewPing library for ultrasonic distance sensing.

**4. RESULTS**

This NodeMCU motion-planning system based on Dijkstra's algorithm aimed at navigating a route from a start to a target destination while balancing the shortest path with real-time capabilities for obstacle detection and avoidance. The results yielded during testing present strengths and weaknesses of the system, especially with regard to Dijkstra's algorithm and processing capabilities of the NodeMCU.

Upon being implemented with Dijkstra's algorithm, the system was able to compute the shortest path in several scenarios. Dijkstra's method takes into consideration each possible route on the grid by picking the path with the least cumulative distance from the start. Coming off very effective, particularly for structured environments, it ensured that the system followed the optimal path with as minimal a distance as possible. When it encountered obstacles, the system was re-evaluating an alternative shortest path while still navigating in an efficient manner toward the target. Since Dijkstra's algorithm was naturally scanning every node in the grid, the NodeMCU required more time and resources to process dense or complex grids. This introduced noticeable delays within bigger, more obstacle-occluded environments where the system's memory and processing powers have become its limiting factors. In these cases, it was mandatory to use reduced layouts or grids with reduced nodes in order to make the system work appropriately.

The ultrasonic sensors were used for detecting the obstacles. It can accurately sense an obstacle at a distance of 20 to 30 cm. The system would halt on sensing an obstacle and would activate Dijkstra's algorithm to recalculate a path that avoids the obstacle. In controlled experiments, sensors correctly sensed the static obstacles sufficiently beforehand for the system to respond appropriately. Yet, in dynamic environments or at reflective surfaces, sensor data would sometimes yield false readings that would reflect on the recalculated path sometimes. Further, in narrower paths or environments where obstacles scatter relatively complexly, recalculated routes would take a little more time due to the limited processing capabilities of the NodeMCU. In fact, amidst all these constraints, the system was still able to avoid colliding and maintain a safe distance from the obstacles.

The proof-of-concept boasts excellent NodeMCU power efficiency. The microcontroller ran at peak powers for all test procedures and miraculously consumed a very low level of power, ideal for mobile and battery operation applications. Power consumption remained low when static navigation and simpler obstacle situations are encountered. However, when the path recalculations were often needed, the power consumption became higher. This efficiency proved the NodeMCU to be a suitable option for light, low-power applications. However, capability limitations in processing complex pathfinding scenarios suggested that larger or more dynamic environments would gain with higher processing power.

From the results of the above sections, it can be said that the motion planning system based on the NodeMCU met its main goals, shortest path navigation and obstacle avoidance, but in simpler environments. While making sure the optimal pathfinding, the computational load of this algorithm, together with the capabilities limitations of NodeMCU, severely damaged the performance of the algorithm, especially on more complex cases. For obstacle detection, satisfactory performance was observed; sometimes, however, inaccuracies were observed in some environments. The project shows that this approach using NodeMCU is suitable for low-cost applications of navigation, but it is clearly under some scope for improvements, like increased processing capacity or different path-finding algorithms, for a more demanding environment.

# **5. Discussion and Comparison with Existing Methodology**

NodeMCU motion planning vs. sophisticated motion planning systems:

* Traditional motion planning systems rely on the stronger microcontrollers or embedded processors, because they possess much stronger computational power, for instance the Raspberry Pi, Arduino Mega, or custom PCBs using ARM Cortex processor. In general, the systems can execute algorithms more complex than the simple variant used in this example, being instead the complete A\* or Dijkstra's algorithm, which would much better optimize paths. The advantage of the lightweight NodeMCU microcontroller is that it accommodates reduced computational overload pathfinding algorithms.
* As compared to the more advanced systems using SLAM or deep reinforcement learning that is adapted into real-time navigation, the system here is for basic pathfinding and obstacle detection using the NodeMCU. It is effective enough in simpler environments it is designed for; however, it is not as adaptive in its ability to learn or map its environment like the more advanced systems. Obstacle Detection Capabilities.
* Our NodeMCU-based setting detects obstacles using ultrasonic or infrared sensors, which give the basic range information. For a more advanced system, LiDAR or stereo cameras or even depth sensors will be used that can give richer spatial data to detect obstacles at a higher accuracy and with more contextual details.
* Unlike LiDAR-based environmental mapping systems, which are quite precise, NodeMCU-implementation of obstacle detection is ideal for relatively simpler structured environments due to the limitations in the capability of the sensors used.

Cost-effective, this NodeMCU-based approach finds it challenging with obstacle passages in environments that have fast-changing or densely populated obstacles.

Efficiency in recalculation and path optimization:

* Although the NodeMCU system was able to dynamically recalculate paths when it recognized obstacles at this level, the above would be implemented at a higher level with advanced motion planning systems that are better equipped to have advanced algorithms for the actual time optimization of paths and planning routes while adapting to obstacles with greater efficiency.
* The system employing A\* or D\* algorithms is more optimal in providing paths, both known and unknown real-time obstacles in its path. Whereas the NodeMCU solution uses A\* approximated in a grid-based algorithm that is less effective for minimizing travel distance or optimizing paths in highly dynamic settings.

Power Consumption and Cost Comparison:

* The NodeMCU-based motion planning platform saves significantly in terms of power and money and so is ideal for low budget solutions. High-end platforms are certainly more capable but usually costlier and consume more power primarily due to added sensors and processing.
* The NodeMCU is a good solution where applications require basic navigation without the need for real time complexity in decision making.

**6. Conclusion**

A prototype for motion planning, using shortest distance criteria along with the detection of obstacle positions, can be adopted by setting up a system using NodeMCU as its microcontroller. The aim, in terms of purpose, is shown to be achievable within a simple structured environment, thereby proving that this can constitute a possible low-cost and power-efficient solution for navigation tasks with NodeMCU.

Compared with other advanced motion planning methods, the NodeMCU constraints in terms of processing and sensor integration make it less likely that the deployment of said board will enter highly dynamic or complex environments. The project, however places a stamp on its appropriateness for certain scenarios where simplicity, cost-efficiency, and basic navigation assume priority.

Some further improvements would involve installing more advanced sensors, optimised algorithms, or even cooperative processing with other microcontrollers. This project thus sets a good foundation in striving to make further reductions in the price of autonomous navigation systems, hence proving to be a proof-of-concept in using NodeMCU as a viable option for entry-level robotics and educational applications.

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**Appendix**

#### **A. Hardware Components**

1. **NodeMCU ESP8266**: Microcontroller for processing and Wi-Fi communication.
2. **Ultrasonic Sensors**: Used for obstacle detection by measuring distances.
3. **Motor Driver Module (L298N or L293D)**: Controls the DC motors for movement.
4. **DC Motors**: Provide motion to the robotic platform.
5. **Power Supply**: Battery or USB power source for the NodeMCU and motors.
6. **Chassis**: Base structure to mount all components.
7. **Wires and Connectors**: For electrical connections between components.

#### **B. Software and Tools**

1. **Arduino IDE**: Programming the NodeMCU with motion planning algorithms.
2. **Libraries Used**:
   * ESP8266WiFi.h: Enables Wi-Fi functionality.
   * NewPing.h: Facilitates ultrasonic sensor readings.
   * Servo.h: Optional, for additional servo-based movement if required.
3. **Path Planning Algorithm**: Implementing Dijkstra’s or A\* algorithm for the shortest distance.
4. **Simulation Tools**: Optional tools like TinkerCAD or Proteus for virtual testing.

#### **C. Algorithms**

1. **Shortest Path Algorithm**:
   * **Input**: Start point, target point, and a map of the environment.
   * **Output**: A sequence of waypoints representing the shortest path.
   * **Steps**:
     1. Map the environment into a grid or graph.
     2. Apply Dijkstra’s algorithm to find the optimal path.
     3. Translate the path into motor commands.
2. **Obstacle Detection**:
   * **Input**: Distance readings from ultrasonic sensors.
   * **Output**: Adjusted path or stop signal.
   * **Steps**:
     1. Continuously monitor sensor readings.
     2. Detect obstacles within a predefined threshold distance.
     3. Recalculate the path or execute avoidance maneuvers.

#### **D. Applications**

1. Autonomous robotic systems.
2. Industrial automation for material transport.
3. Smart home security patrol systems.
4. Educational robotics projects.

**Code (Arduino IDE)**

#include <NewPing.h>

#include <Wire.h>

#include <Adafruit\_Sensor.h>

#include <Adafruit\_HMC5883\_U.h>

#define TRIG\_PIN 5 // GPIO 5 corresponds to D1 on NodeMCU

#define ECHO\_PIN 4 // GPIO 4 corresponds to D2 on NodeMCU

#define LEFT\_MOTOR\_PIN1 14 // GPIO 14 corresponds to D5 on NodeMCU

#define LEFT\_MOTOR\_PIN2 12 // GPIO 12 corresponds to D6 on NodeMCU

#define RIGHT\_MOTOR\_PIN1 13 // GPIO 13 corresponds to D7 on NodeMCU

#define RIGHT\_MOTOR\_PIN2 15 // GPIO 15 corresponds to D8 on NodeMCU

#define MAX\_DISTANCE 200 // Max distance for ultrasonic sensor (in cm)

NewPing sonar(TRIG\_PIN, ECHO\_PIN, MAX\_DISTANCE);

Adafruit\_HMC5883\_Unified compass = Adafruit\_HMC5883\_Unified();

void setup() {

Serial.begin(115200);

pinMode(LEFT\_MOTOR\_PIN1, OUTPUT);

pinMode(LEFT\_MOTOR\_PIN2, OUTPUT);

pinMode(RIGHT\_MOTOR\_PIN1, OUTPUT);

pinMode(RIGHT\_MOTOR\_PIN2, OUTPUT);

if (!compass.begin()) {

Serial.println("Could not find a valid HMC5883L sensor, check wiring!");

while (1);

}

// The Adafruit HMC5883L library does not require setting the mode manually.

}

void loop() {

sensors\_event\_t event;

compass.getEvent(&event);

float heading = atan2(event.magnetic.y, event.magnetic.x);

if (heading < 0) heading += 2 \* PI;

float headingDegrees = heading \* 180 / PI;

Serial.print("Heading: ");

Serial.println(headingDegrees);

if (sonar.ping\_cm() < 20) {

stopMovement();

} else {

moveForward();

}

delay(100);

}

void moveForward() {

digitalWrite(LEFT\_MOTOR\_PIN1, HIGH);

digitalWrite(LEFT\_MOTOR\_PIN2, LOW);

digitalWrite(RIGHT\_MOTOR\_PIN1, HIGH);

digitalWrite(RIGHT\_MOTOR\_PIN2, LOW);

}

void stopMovement() {

digitalWrite(LEFT\_MOTOR\_PIN1, LOW);

digitalWrite(LEFT\_MOTOR\_PIN2, LOW);

digitalWrite(RIGHT\_MOTOR\_PIN1, LOW);

digitalWrite(RIGHT\_MOTOR\_PIN2, LOW);

}

void turnRight() {

digitalWrite(LEFT\_MOTOR\_PIN1, HIGH);

digitalWrite(LEFT\_MOTOR\_PIN2, LOW);

digitalWrite(RIGHT\_MOTOR\_PIN1, LOW);

digitalWrite(RIGHT\_MOTOR\_PIN2, HIGH);

}

void turnLeft() {

digitalWrite(LEFT\_MOTOR\_PIN1, LOW);

digitalWrite(LEFT\_MOTOR\_PIN2, HIGH);

digitalWrite(RIGHT\_MOTOR\_PIN1, HIGH);

digitalWrite(RIGHT\_MOTOR\_PIN2, LOW);

}