**OBSTACLE AVOIDANCE ROBOT PROJECT REPORT**

*( for the partial fulfillment of* Bachelor of Technology Degree in Computer Science & Engineering)

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**CERTIFICATE**

This is to certify that the thesis titled **“Obstacle Avoidance Robot” submitted** by **Aadarsh Kumar Singh,Parth Dohan**,**Saksham Bhandari,Vatsalya Singh Baghel** to Graphic Era Hill University for the award of the degree of **Bachelor of Technology**, is a bona fide record of the research work done by him/her under our supervision. The contents of this project in full or in parts have not been submitted to any other Institute or University for the award of any degree or diploma.

**Mr. Sameer Rana** Project Guide

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**ABSTRACT**

This project aims to design and implement an obstacle avoidance robot using ultrasonic sensors. The robot is designed to navigate through an environment and avoid obstacles in its path. The project involves a detailed analysis of the requirements, design, implementation, and testing of the robot.

The requirement analysis phase of the project involves identifying the functional and non-functional requirements of the obstacle avoidance robot. This includes defining the use cases, creating data flow diagrams, and developing class and entity relationship diagrams. The functional requirements of the robot include the ability to move forward, backward, left, and right, detect obstacles using ultrasonic sensors, take appropriate action to avoid collision, and navigate through an environment autonomously. The non-functional requirements include the ability to operate for at least 30 minutes on a single charge, operate in low light conditions, operate in a noisy environment, and operate in a temperature range of 0-50°C.

The design and implementation phase of the project involves developing the system architecture, hardware design, and software design of the obstacle avoidance robot. The system architecture includes the ultrasonic sensor, microcontroller, motor driver, and DC motors required to run the robot. The hardware design includes the physical components of the robot, such as the sensor and motors. The software design includes the program written in C language that runs on the microcontroller and controls the movement of the robot.

The testing phase of the project involves testing the obstacle avoidance robot to ensure that it meets the functional and non-functional requirements. The robot is tested in various environments, such as indoors and outdoors, to evaluate its performance. The performance of the robot is evaluated based on its ability to detect obstacles and avoid collision, as well as its ability to navigate through an environment autonomously.

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# CHAPTER 1

**INTRODUCTION**

The Obstacle Avoidance System using Ultrasonic Sensor is a project aimed at developing a smart system that can detect and avoid obstacles in its path. With the increasing demand for autonomous robots, drones, and other robotic systems, it has become essential to develop reliable obstacle detection and avoidance mechanisms. The system utilizes ultrasonic sensors, which emit high-frequency sound waves and measure the time it takes for the waves to bounce back after hitting an object. By analyzing the sensor readings, the system can determine the distance between the sensor and the obstacle, allowing it to navigate its environment safely.

The primary objective of this project is to design and implement an effective obstacle avoidance system using ultrasonic sensors. The system will be capable of detecting obstacles in real-time and making prompt decisions to avoid collisions. By integrating this system into autonomous robots or drones, it can significantly enhance their navigation capabilities and ensure safer operation in complex and dynamic environments.

# CHAPTER 2

**REQUIREMENT ANALYSIS**

In the requirement analysis phase, the project team conducted a thorough assessment to identify the key objectives and functionalities of the obstacle avoidance robot system. This phase involved defining the scope of the project, determining the hardware and software requirements, and outlining the desired features and performance goals.

2.1 Scope Definition

The project team carefully defined the scope of the obstacle avoidance robot system. This included specifying the intended environment in which the robot would operate, such as indoor or outdoor settings. The team also identified the target applications for the robot, considering scenarios such as warehouse navigation, surveillance tasks, or assistance in hazardous environments. The scope definition process helped to establish the boundaries and limitations of the system, ensuring a focused and achievable project outcome.

2.2 Hardware and Software Requirements

Identifying the necessary hardware and software components was a crucial aspect of the requirement analysis phase. The project team assessed the sensor requirements and selected suitable ultrasonic sensors that could accurately measure distances and detect obstacles.

Other hardware components, such as motors, wheels, and a microcontroller or single-board computer, were also determined based on the robot's mobility and control needs.Hardware such as Arduino Uno,Motor Driver Sheild,Ultrasonic Sensor and DC Motor are used.



Figure 2.1



Figure 2.2



Figure 2.3

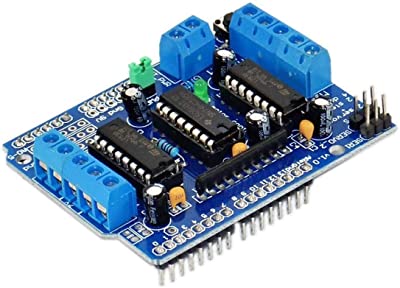


Figure 2.4

On the software side, the team identified the programming language or framework that would be used to develop the robot's control algorithms. Additionally, any supporting software tools or libraries necessary for data processing, motor control, and communication were specified. The hardware and software requirements were determined to ensure compatibility and effective integration of the various components.

2.3 Desired Features and Performance Goals

To meet the project's objectives, the team outlined a set of desired features and performance goals for the obstacle avoidance robot system. These goals typically included accurate obstacle detection, reliable navigation, and efficient obstacle avoidance maneuvers. The system was expected to react promptly to detected obstacles, allowing the robot to change its trajectory or stop to avoid collisions. The team also considered factors such as speed, agility, and power efficiency to optimize the robot's performance.

Furthermore, additional features, such as wireless communication capabilities for remote control or real-time monitoring, could be identified based on specific application requirements. The project team aimed to define clear and measurable performance criteria to assess the effectiveness of the system and ensure that it met the desired objectives.

By conducting a comprehensive requirement analysis, the project team laid the foundation for the successful development of the obstacle avoidance robot system. Defining the scope, determining the hardware and software requirements, and outlining the desired features and performance goals enabled the team to move forward with the subsequent phases of the project, such as software design, implementation, and testing.

# CHAPTER 3

**Software/Project Design**

The software/project design phase of the obstacle avoidance robot project involved creating the necessary algorithms and blueprints for the system. This phase encompassed the development of the logic for obstacle detection and avoidance, designing the user interface (if applicable), and planning the overall system architecture. Diagrams such as use case diagrams, data flow diagrams (DFDs), class diagrams, and entity-relationship (ER) diagrams were utilized to represent the system design.

**3.1 Obstacle Detection Algorithm**

The project team designed an algorithm to detect obstacles using the data from the ultrasonic sensors. The algorithm processed the sensor readings to determine the distance between the robot and any nearby objects. By analyzing this data, the system could identify potential obstacles within its range. The algorithm employed techniques such as thresholding and filtering to differentiate between obstacles and background noise. The detected obstacles were then passed to the obstacle avoidance module for further action.

**3.2 Obstacle Avoidance Algorithm**

To ensure safe navigation, the project team developed an obstacle avoidance algorithm. This algorithm utilized the obstacle detection information to make decisions on the robot's movement. When an obstacle was detected, the algorithm calculated an alternative path or determined appropriate avoidance maneuvers to avoid collisions. This involved evaluating the available space, considering the robot's current velocity, and selecting the most feasible avoidance strategy. The algorithm aimed to provide smooth and efficient navigation around obstacles while maintaining the robot's trajectory towards its intended destination.

**3.3 System Architecture**

The project team planned the overall system architecture, considering the integration of hardware and software components. This involved determining the communication protocols and interfaces between different modules, such as the microcontroller or single-board computer, sensors, motors, and user interface (if applicable). The architecture ensured seamless interaction between these components, enabling effective data exchange and coordination for obstacle detection, avoidance, and overall robot control.

By designing the software and project components in this manner, the project team laid the groundwork for the successful implementation of the obstacle avoidance robot. The algorithms for obstacle detection and avoidance ensured the robot's ability to navigate safely in dynamic environments, while the user interface (if applicable) provided an intuitive means of controlling and monitoring the system. The well-defined system architecture facilitated the integration of hardware and software components, ensuring smooth communication and efficient functioning of the entire system.

# CHAPTER 4

**Result/Testing of Project/Software**

In the result/testing phase of the obstacle avoidance robot project, the developed system was thoroughly tested to ensure its functionality, effectiveness, and adherence to the project requirements. The testing phase aimed to validate the accuracy of obstacle detection, assess the efficiency of obstacle avoidance maneuvers, and evaluate the overall performance of the system.

**1. Test Case Design**

The project team designed a set of test cases that covered various scenarios and potential challenges the obstacle avoidance robot may encounter. The test cases included different types of obstacles, varying distances, and diverse environmental conditions to ensure comprehensive testing. The test cases were designed to assess the system's ability to detect obstacles accurately, respond effectively, and navigate around them successfully.

**2. Test Execution**

The designed test cases were executed to observe the robot's performance in real-world or simulated environments. The robot was placed in different scenarios, and its behavior and responses were closely observed and recorded. The test execution phase aimed to validate the accuracy and reliability of the obstacle detection algorithm, as well as the effectiveness of the obstacle avoidance maneuvers employed by the robot.

**3. Accuracy of Obstacle Detection**

The accuracy of obstacle detection was evaluated by comparing the sensor readings with the actual presence of obstacles. The test cases included scenarios with known obstacles at specific distances, and the robot's ability to detect and report those obstacles was assessed. The performance of the obstacle detection algorithm was measured in terms of its ability to accurately identify obstacles and provide timely feedback.

**4. Efficiency of Obstacle Avoidance Maneuvers**

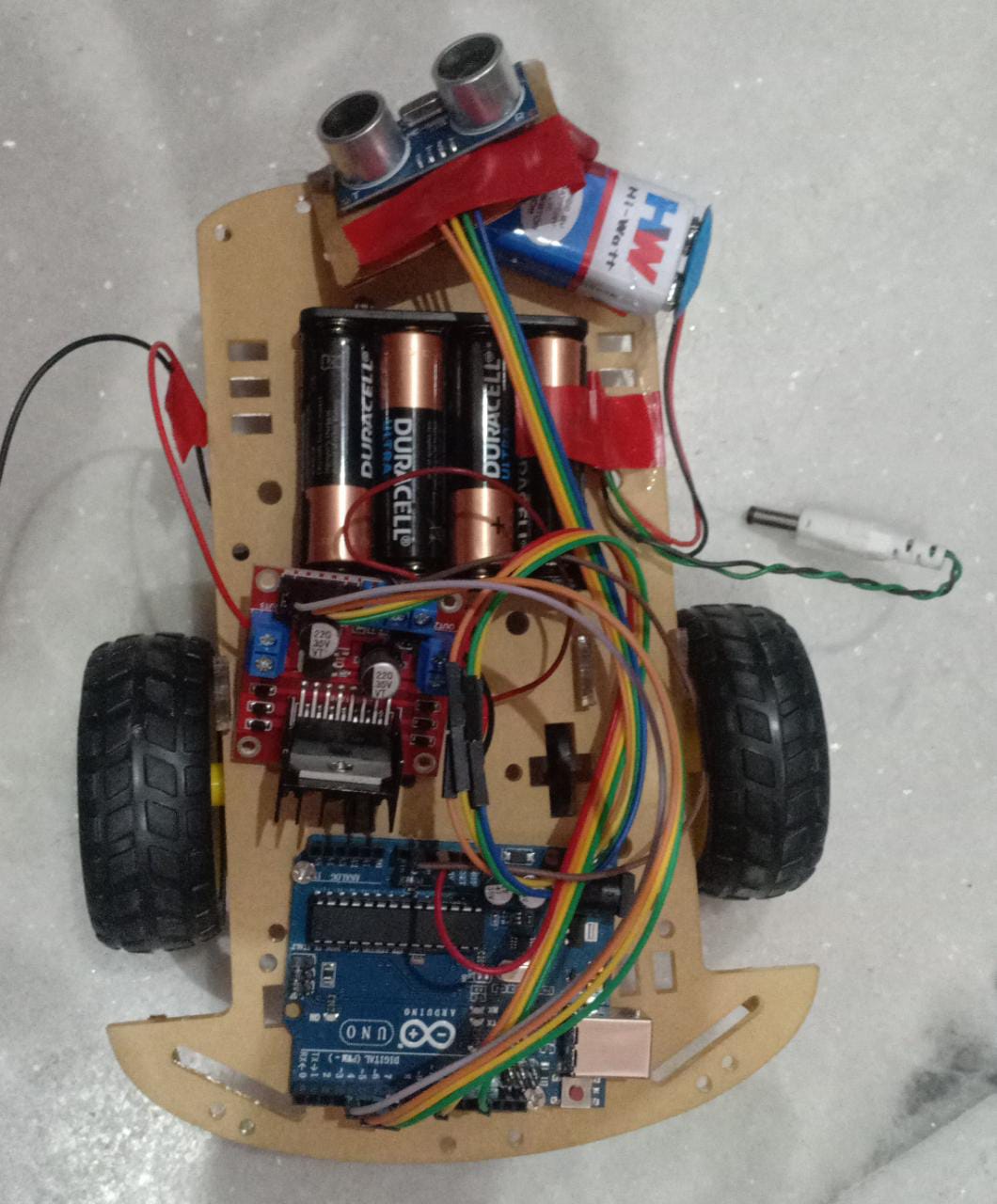
The efficiency of obstacle avoidance maneuvers was assessed by evaluating the robot's ability to navigate around obstacles smoothly and efficiently. The test cases included scenarios where the robot encountered obstacles and needed to select appropriate avoidance strategies, such as path planning or adjusting its trajectory. The efficiency of the avoidance maneuvers was measured based on factors such as time taken to avoid the obstacle, the smoothness of the robot's motion, and the effectiveness of its chosen avoidance path.

**5. Overall Performance Evaluation**

The overall performance of the obstacle avoidance robot was evaluated based on its ability to successfully navigate through complex environments while avoiding obstacles. The robot's behavior, responsiveness, and accuracy in detecting and avoiding obstacles were assessed. Factors such as real-time performance, robustness in varying environmental conditions, and the system's reliability were considered during the evaluation.

Through rigorous testing, both white box and black box testing methods were employed to thoroughly assess the capabilities of the obstacle avoidance robot. White box testing focused on examining the internal components and algorithms of the system to ensure their correctness and efficiency. Black box testing, on the other hand, evaluated the system's behavior and responses without knowledge of its internal workings, simulating real-world usage scenarios.

The result/testing phase provided valuable insights into the functionality, accuracy, and performance of the obstacle avoidance robot. It helped identify any issues, limitations, or areas for improvement, allowing the project team to refine the system further and enhance its capabilities. The testing phase was crucial in ensuring the reliability and effectiveness of the obstacle avoidance robot in real-world environments, providing confidence in its ability to navigate safely and avoid obstacles successfully.



# CHAPTER 5

**Conclusion and Future Scope**

In conclusion, the obstacle avoidance robot project has successfully developed a system that demonstrates effective obstacle detection and avoidance capabilities. Through rigorous testing, the system has shown accuracy in detecting obstacles and efficient maneuvering to avoid them, thus ensuring safe navigation in complex environments.

The project has achieved its primary objectives of designing and implementing a reliable obstacle avoidance system for the robot. The system utilizes ultrasonic sensors to measure distances and employs intelligent algorithms to analyze the sensor readings and make real-time decisions for obstacle avoidance.

However, there may be certain limitations or areas for improvement that have been identified during the project. These could include challenges such as detecting certain types of obstacles accurately or optimizing the robot's maneuvering speed and trajectory planning. It is important to address these limitations to enhance the system's overall performance and reliability.

For future development, there are several potential areas to explore and enhance the obstacle avoidance robot:

**1. Integration of Machine Learning:** By incorporating machine learning algorithms, the obstacle avoidance system can be trained to recognize and differentiate various types of obstacles more effectively. This can improve the system's ability to adapt to different environments and handle complex situations.

**2. Sensor Fusion:** Additional sensors, such as cameras or lidar, can be integrated into the system to provide more comprehensive environmental perception. Sensor fusion techniques can combine data from multiple sensors to enhance obstacle detection accuracy and improve the overall reliability of the system.

**3. Path Planning and Optimization:** Advanced path planning algorithms can be implemented to optimize the robot's navigation path. By considering factors such as obstacle density, robot speed, and environmental constraints, the system can generate efficient and collision-free paths, enabling smoother and more efficient navigation.

**4. Real-Time Decision Making:** Enhancing the system's decision-making capabilities in real-time can lead to faster and more accurate responses to dynamic obstacles. By incorporating advanced algorithms and predictive models, the robot can anticipate potential obstacles and plan its actions accordingly, ensuring proactive obstacle avoidance.

**5. Robustness and Environmental Adaptability:** Further refinement of the system can focus on improving its robustness in different environmental conditions. This includes adapting to challenging lighting conditions, diverse surfaces, and complex terrain, ensuring the obstacle avoidance robot can operate effectively in various real-world scenarios.

By addressing these future scope areas, the obstacle avoidance robot can become more advanced, reliable, and adaptable in navigating dynamic environments. These enhancements would contribute to the overall safety and efficiency of the robot, making it suitable for a wide range of applications such as autonomous vehicles, drones, or robotic assistants.

In conclusion, the obstacle avoidance robot project has successfully developed a functional system capable of detecting and avoiding obstacles. The project's findings and evaluations provide a solid foundation for further improvements and advancements in the field of obstacle avoidance technology, offering great potential for enhancing the safety and efficiency of robotic systems in real-world environments.

**APPENDIX**

**(Code)**

int trigPin = 9;

int echoPin = 10;

int revright = 4;      //REVerse motion of Right motor

int fwdleft = 7;

int revleft= 6;

int fwdright= 5;       //ForWarD motion of Right motor

int c = 0;

void setup() {

  //Serial.begin(9600);

   pinMode(5, OUTPUT);

   pinMode(6, OUTPUT);

   pinMode(4, OUTPUT);

   pinMode(7, OUTPUT);

   pinMode(trigPin, OUTPUT);

  pinMode(echoPin, INPUT);

  // put your setup code here, to run once:

}

void loop() {

  long duration, distance;

  digitalWrite(trigPin,HIGH);

  delayMicroseconds(1000);

  digitalWrite(trigPin, LOW);

  duration=pulseIn(echoPin, HIGH);

  distance =(duration/2)/29.1;

  //Serial.print(distance);

  //Serial.println("CM");

  delay(10);

  if((distance>20))

 {

  digitalWrite(5,HIGH);                               //       If you dont get proper movements of your robot,

   digitalWrite(4,LOW);                               //        then alter the pin numbers

   digitalWrite(6,LOW);                               //

   digitalWrite(7,HIGH);                              //

 }

  else if(distance<20)

 {

   digitalWrite(5,HIGH);

   digitalWrite(4,LOW);

   digitalWrite(6,HIGH);                                  //HIGH

   digitalWrite(7,LOW);

 }

}

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