OBSTACLE DETECTION & NAVIGATION ROBOT

BAJAJ INSTITUTE OF TECHNOLOGY

WARDHA-442 001 (INDIA)

2023-24

OBSTACLE DETECTION & NAVIGATION ROBOT

Project report submitted to
Dr. Babasaheb Ambedkar Technological University, Maharashtra
in partial fulfilment of the requirements for the award of
the degree

Bachelor of Technology

In

Mechanical Engineering

By

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under the guidance of

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Wardha-442 001 (India)

2023-24

BAJAJ INSTITUTE OF TECHNOLOGY, WARDHA

DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

This is to certify that the Project report titled

OBSTACLE DETECTION & NAVIGATION ROBOT has been successfully completed

by

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in partial fulfilment of the requirements for the award of

the degree in Bachelor of Technology, Mechanical Engineering

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Date:

Place: Wardha

DECLARATION

We, hereby declare that the project report titled "Obstacle Detection and Navigation Robot" submitted by us to the Bajaj Institute of Technology, Wardha, in partial fulfillment of the requirement for the award of Degree of B. Tech. in Mechanical Engineering discipline is a record of bonafide project work carried out by me under the guidance of **Dr. M.D.Pasarkar .**

We, further declare that this submission by the undersigned represents our original work and We have quoted the references where others words have been included. We understand any violation of the above will levy a disciplinary action on us.

We, further declare that the work reported in this project report has not been submitted either in-part or in-full for the award of any other degree in any other Institute or University.

Date :- / /

Place :- Wardha

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The development of our "Obstacle Detection and Navigation Robot" has been an invaluable educational experience, fostering teamwork, problem-solving, and innovation. It would not have been possible without the collaborative efforts of our dedicated project team and the unwavering support of our academic institution. We extend our sincere thanks to every individual, from peers to faculty, who contributed to the successful execution of this project.This project has not only been a technical accomplishment but also a testament to the strength of mentorship, collaboration, and the learning opportunities our institution offers. We are appreciative of the roles each of you has played in shaping our academic journey.

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ABSTRACT

This paper present the design and implementation of an obstacle detection system for a mobile robot, specifically tailored for scenarios where the robot operates along a straight path. The proposed system utilizes sensor technology to detect obstacle in the robot's path, triggering a responsive rotational mechanism to navigate around the impediment.

The core functionality of the robot involves the integration of sensor capable of identifying obstacle within a predetermined detection range. When an obstacle is detected, the robot employs a dynamic rotation mechanism, adjusting its orientation by a specified degree angle to navigate around the obstacle. The rotation angle is adaptively determined based on the proximity and size of the detected obstacle, ensuring an efficient and timely response.

The system include control algorithm that governs the robot's behavior in response to identified obstacle when the obstacle is detected. The implementation is designed to strike a balance between robust obstacle detection and maintaining a smooth trajectory along the intended path.The effectiveness of the proposed obstacle detection system is demonstrated through experimental results, showcasing the robot's ability to autonomously detect and navigate around obstacle while maintaining its overall path. The adaptive rotation mechanism enhances the robot's agility in diverse environments, making it suitable for applications in confined spaces.

This report contributes to the field of autonomous robotics by providing a practical solution for obstacle detection in scenarios where a straight working path is crucial. The adaptability of the rotation mechanism ensures the robot's responsiveness to various obstacle, making it a versatile and reliable platform for tasks requiring precise navigation in unstructured environments.

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LIST OF SYMBOLS

Symbols & Description

INP	Input Pin
OUTP	Output Pin
IR	Infrared

CHAPTER 1
INTRODUCTION

Obstacle detection and navigation robot is the crucial process of identifying physical obstructions that might impede the movement of object or system, like vehicles, robots and autonomous devices.

This intricate task often utilizes an array of advanced technology such as sensors or other sophisticated systems to perceive and assess obstacle. The primary goal is to avert collisions, thereby ensuring the smooth and safe operation of these systems.

Within this landscape, infrared (IR) sensors emerge as a key tool for obstacle detection and navigation. IR sensor operate by emitting infrared light and meticulously gauging the reflections or the absence of this emitted light to discern the presence or absence of obstacle in their path.

At the core of its functionality lies a sophisticated obstacle detection system, leveraging sensor and intelligent algorithm to identify obstacle directly in its path. When an obstacle is detected, the robot swiftly initiates a precise rotation to a predetermined degree, skillfully maneuvering around the obstruction. This innovative approach ensures not only the safety of the robot but also guarantees uninterrupted progress along its designated route.

The precision of the rotation mechanism is a testament to the precise design and engineering invested in this robot. With a keen understanding of spatial awareness, the robot calculates the optimal degree of rotation required to evade the obstacle without deviating from its intended path. This ensures an efficient and fluid traversal, minimizing disruptions and maximizing productivity in any environment.

What sets 'Obstacle Detection and Navigation Robot' apart is its adaptability to diverse scenarios. Whether navigating through cluttered indoor spaces or dynamic outdoor environments, the robot responds dynamically to its surroundings, making split-second decisions to guarantee an obstacle-free journey.

Its ability to seamlessly integrate obstacle detection into its workflow position it as a reliable and indispensable asset for industries ranging from manufacturing and logistics to healthcare and beyond.

In a world where automation and efficiency are paramount, our ‘Obstacle Detection and Navigation Robot’ stands as a testament to the possibilities of smart robotics. Embrace the future of autonomous navigation with a solution that not only detects obstacle but elegantly sidesteps them, ensuring a smooth and uninterrupted trajectory towards operational excellence.

CHAPTER 2

LITERATURE SURVEY

2.1 : By Faiza Tabassum, Susmita Lopa, Muhammad Masud Tarek & Dr. Bilkis Jamal Ferdosi - East West University Obstacle Avoiding Robot

This project developed an obstacle avoiding robot which can move without any collision by sensing obstacle on its course with the help of three ultrasonic distance sensors.

2.2 : Vaghela Ankit1, Patel Jigar2, Vaghela Savan3 Obstacle Avoidance Robotic Vehicle Using Ultrasonic Sensor, Android And Bluetooth For Obstacle Detection- International Research Journal of Engineering and Technology (IRJET)

Enormous amount of work has been done on wireless gesture controlling of robots. In this paper, various methodologies have been analyzed and reviewed with their merits and demerits under various operational and functional strategies. Thus, it can be concluded that features like user friendly interface, light weight and portability of android OS based smart phone has overtaken the sophistication of technologies like programmable glove, static cameras etc., making them obsolete. Although recent researches in this field have made wireless gesture controlling a ubiquitous phenomenon, it needs to acquire more focus in relevant areas of applications like home appliances, wheelchairs, artificial nurses, table top screens etc. in a collaborative manner.

2.3 : Arulananth T S, Baskar M, P. Hari babu , R. Divya Sree , R.Sanjana, S.Bhavana: IR Sensor Based Obstacle Detection and Avoiding Robot -- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(9). ISSN 1567-214x

This project uses IR sensor, relay module and transistor. It has a simple structure with two wheels and a base to hold circuitry. It consists of an IR sensor in front of the robot to detect the presence of any obstacle. This is connected to transistor which is then connected to relay module for further communication. Here relay module act as a switching device and transistor acts as an amplifier that amplifies the output of IR sensor.

2.4 Existing Work

The current operation of the obstacle detection and navigation robot involves the use of an ultrasonic sensor, an Arduino, microprocessor, and remote control via Bluetooth and Android. However, this setup is complex and might be considered expensive to implement. Some solutions only use electric circuits without a programmable unit to execute logical algorithmic code. Consequently, these solutions lack accuracy and intelligence.

2.5 Proposed work

This project introduces a self-operating obstacle-detection and navigation robot created with IR sensor and Arduino. Unlike other systems, there's no need for a remote to control the robot. It smartly identifies obstacle in its path using IR sensor, maneuvers around them, and makes decisions based on the per-set internal code.

To ensure its effectiveness, the robot will be tested in various environments to see if it can detect specific objects or not and if detects then determine the detection range for each obstacle.

CHAPTER 3
SYSTEM REQUIREMENTS AND SPECIFICATIONS/ METHODOLOGY

An obstacle detection and navigation robot is a mobile robotic system equipped with IR sensor that detect obstacle in its path. When an obstacle is detected, the robot employs a rotational maneuver, such as turning or rotating to avoid the obstruction while maintaining its intended straight path ensuring safe and uninterrupted navigation.

3.1 SYSTEM REQUIREMENTS AND SPECIFICATIONS*:*

The primary methodology of this project is to design and build an autonomous robot capable of navigating along a straight path while detecting obstacle in its way. When an obstacle is detected, the robot should rotate to avoid the obstacle and then continue along its initial path.

Description of components which are needed for Obstacle Avoidance Robot:

The components are:

3.1.1 IR sensor

3.1.2 Arduino UNO R3

3.1.3 L298 Motor Driver

3.1.4 N20 6v-600rpm Motor

3.1.5 Castor wheel & Wheel having Grip.

3.1.6 Battery (12 volt)

3.1.7 Jumper Wires.

3.1.8 Chassis

3.1.1 IR SENSOR:

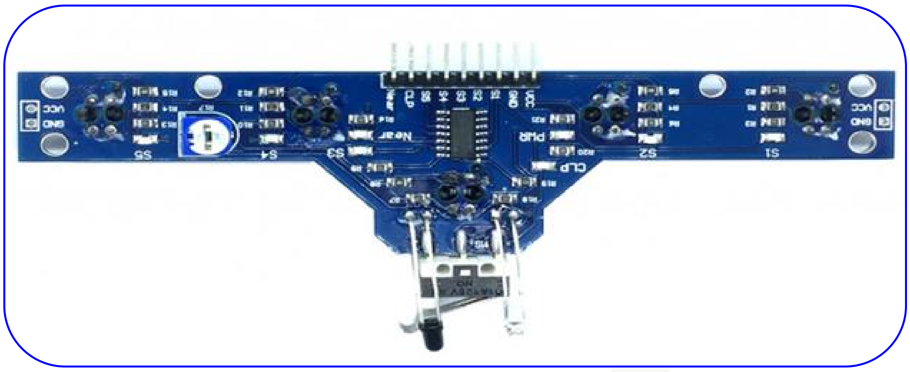

Fig.3.1 IR Sensor

An IR array is used for obstacle detection and navigation detection as shown in Fig 3.1. Here single front sensor pin is to be used from IR array having single input pin and output pin for power supply and for ground. The IR array is mounted on the front part of chassis as the obstacle must be detected first to perform particular motion. The spacing between IR sensors of array is 9.525 mm as four sensors are aligned and one sensor is in front of array for obstacle detection. It detect different variety of obstacle in its straight working path. Selection of this IR array is made as IR sensors are internally connected and it also reduced the need for separately implementation of sensors.

- The specifications of IR array is given below.
- Input voltage : 3.0-5.5v
- Optimal sensing distance: 3mm
- Max. recommended sensing distance: 6mm
- Distance between two IR sensors on array is 9.525mm
- Length x Width x Height: 13mm x 5mm x2mm

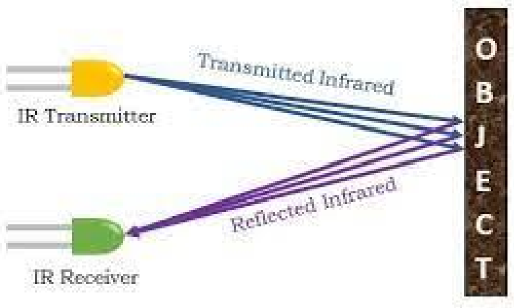

Fig 3.2 WORKING OF IR SENSOR

The IR sensor consists of a transmitter and a receiver which works on principle of transmitting IR rays towards the surface which is then reflected back and detected by receiver making difference in output signal of array which is then send towards Arduino as shown in Fig 3.2. If the surface is black, then the output difference created will be less. The main function of IR array is to detect the surface and send signal to Arduino Uno to command as per given input conditions.

3.1.2 ARDUINO:

Arduino Uno is a micro controller board based on the ATmega328P as shown in Fig.3.3. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It is a programmable board which is programmed in IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms. The IDE is common to all available boards of Arduino. Arduino Uno R3 is selected based on needed requirements. As Arduino Uno R3 have 14 digital I/O pins and 6 analog I/O pins which is sufficient for coordinating with require components. Arduino IDE software is used to write c code for required given problem statement to be run in Arduino Uno R3.The code can be uploaded in Arduino Uno R3 through USB port from IDE software in laptop.

The main function of Arduino Uno is to take input signal from IR array sensor which is connected to the analog pins of Arduino Uno from A0-A4.The data from ir array are generally in the form of voltage difference as 0 or 1. 1 for white surface and 0 for black surface.

The micro controller processed the input data from array to send command towards Motor Driver Module which is connected to digital pin of Arduino Uno from 2-4 and 9-10 for controlling the speed of motor. As the input data from IR sensor match the given coded condition, the signal is then send to motor driver module for execution of given motion to motor. For maintain proper function of all the components, all ground connection of components are made common.

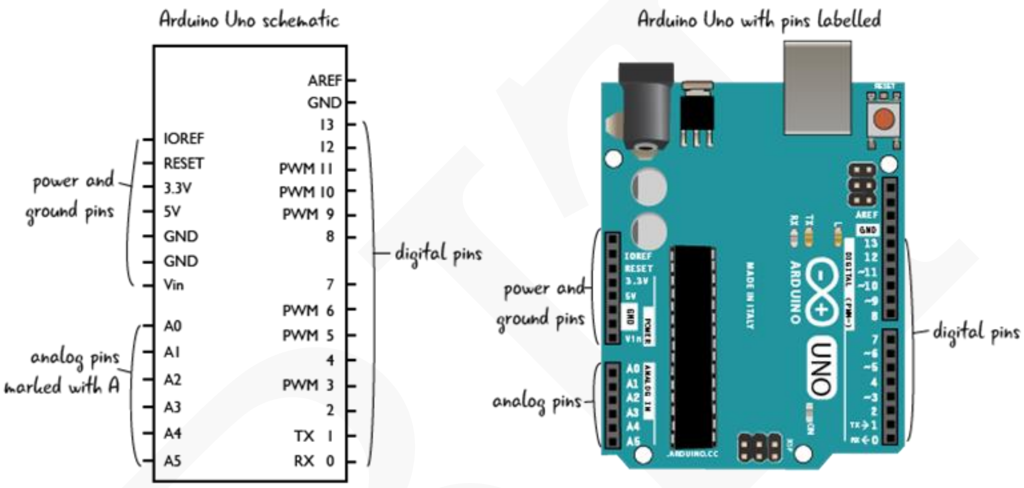

Fig.3.3 ARDUINO UNO

3.1.3 MOTOR DRIVER MODULE L298:

L298N module is a high voltage, high current dual full-bridge motor driver module for controlling DC motor and stepper motor as shown in Fig.3.4. L298 module is selected for obstacle detection and navigation robot as it can control both the speed and rotation directions of two DC motors. The logical voltage of driver module is 5v. This module consists of L298 dual-channel H-Bridge motor driver IC and uses two techniques for the control of speed and rotation direction of the DC motors. The digital pins of Arduino Uno is connected to IN1, IN2, IN3, IN4 of L298 module which work on H-Bridge for controlling rotational directions and PWM pins of Arduino is connected to ENB1 and ENB2 pins of L298 module for controlling speed of tires. L298n motor driver module uses the H-Bridge technique to control the direction of rotation of a DC motor. In this technique, H-Bridge controlled DC motor rotating direction by changing the polarity of its input voltage. An H-Bridge circuit contains four switching elements, like transistors (BJT or MOSFET), with the motor at the centre forming an H-like configuration. Input **IN1, IN2, IN3, and IN4** pins control the switches of the H-Bridge circuit inside L298N IC. These modules can control two DC motor at the same time.

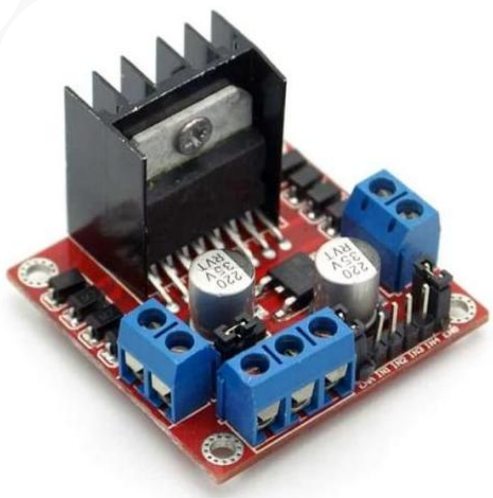

FIG 3.4 L298 MOTOR DRIVER MODULE

The 12 V power supply is provided to Vin pin of motor driver module for operating it. The output 5v power supply of L298 module is also given towards the Arduino Uno for functioning. The out pins OUT1, OUT2, OUT3 and OUT4 of L298 module is connected to two motors for controlling its speed and direction of motors.

3.1.4 MOTOR:

Motor should have high torque for quick start and turning for obstacle detection and navigation robot. To meet this requirement, the N20 Micro Gear 6V 600 RPM DC Motor (High Torque) is used which is lightweight, high torque, and low RPM motor as shown in Fig.3.5. Two motors are used for obstacle avoidance robot which will be mounted on back corner ends of chassis. N20 Micro Gear is equipped with gearbox assembly to increase the torque of the motor. N20 Micro Gear has a cross-section of 10 × 12 mm, and the D-shaped gearbox output shaft is 9 mm long and 3 mm in diameter. N20 Micro Gear has a very small size which can be fitted in complex spaces of small-scale application. One can connect this N20 Micro Gear Motor to wheels to drive them from one place to other while carrying small loads. The output pin OUT1,OUT2,OUT3,OUT4 of L298 module are connected to this motors to execute given motions.

Fig.3.5 N20 GEAR MOTOR

3.1.5 WHEEL:

To support the weight of obstacle detection and navigation robot two types of wheels - ball caster wheel and plastic wheel are used. The wheel as shown in Fig 3.7 is a plastic material wheel having rubber grip surrounded to it. The outer diameter of plastic wheel is 43mm and thickness is 20mm which can bear weight upto 5 kg. The number of plastic wheels used is two which is mounted on motor in the corner side of chassis. Due to weight bearing capacity and grip of rubber material , plastic wheel is relevant to weight carrying capacity of obstacle detection and navigation robot.

The ball caster wheel is also used for obstacle detection and navigation robot as shown in Fig 3.6 which is mounted in front part of chassis to support front weight alongside plastic grip wheel. The caster wheel material is steel which is driven by back wheels of robot. It can bear weight upto 5kg having 3 mounting holes with wheel height 18mm and base material of 27.5mm.

Fig.3.6 CASTOR WHEEL

Fig 3.7 RUBBER WHEEL

3.1.6 BATTERY:

3.7 volt recharge able lithium-ion cell is used to power supply the components of obstacle detection and navigation robot. The number of cells used is 3 as shown in Fig 3.8 which are connected in series for increasing the voltage upto 11.1 V. lithium-ion cells are rechargeable cell and can last upto 3 hours which meet the requirement of obstacle detection and navigation robot.

Nominal voltage:12 V

Capacity:2200mAh

Material: ABS case

Fig 3.8 LITIUM ION CELLS

3.1.7 JUMPER WIRE:

Jumper wire is used for connecting all the components of obstacle detection and navigation robot with each other.The types of jumper wire used is male-to-male, male-to-female and female-to-female as shown in Fig 3.9. As it can carry current from 4-20 mA and voltage upto 12V which match the basic requirements of connections for obstacle detection and navigation robot. The cable length is 20cm-8 inch with rated pressure of 25KPA.

Fig 3.9 JUMPER WIRES

3.1.8 CHASSIS :

Chassis is the main base for obstacle detection and navigation robot where all the components are to be mounted on. By considering all the components dimension, optimized design of chassis is made which is strong enough to bear the load of each components. The dimensions of chassis in terms of length , breath and width are 24×14×0.5 cm.The material used for the chassis is acrylic sheet which is a transparent sheet and can bear the weight of mounted components on it.The design of chassis is made in coral software as shown in Fig 3.10 with optimized considered dimensions.The design is then cut from acrylic sheet through CNC laser cutting as shown in Fig 3.11.Then the assembly is made on designed acrylic sheet chassis and all the components are fixed on chassis and connected to the controller with the help of jumper wire.

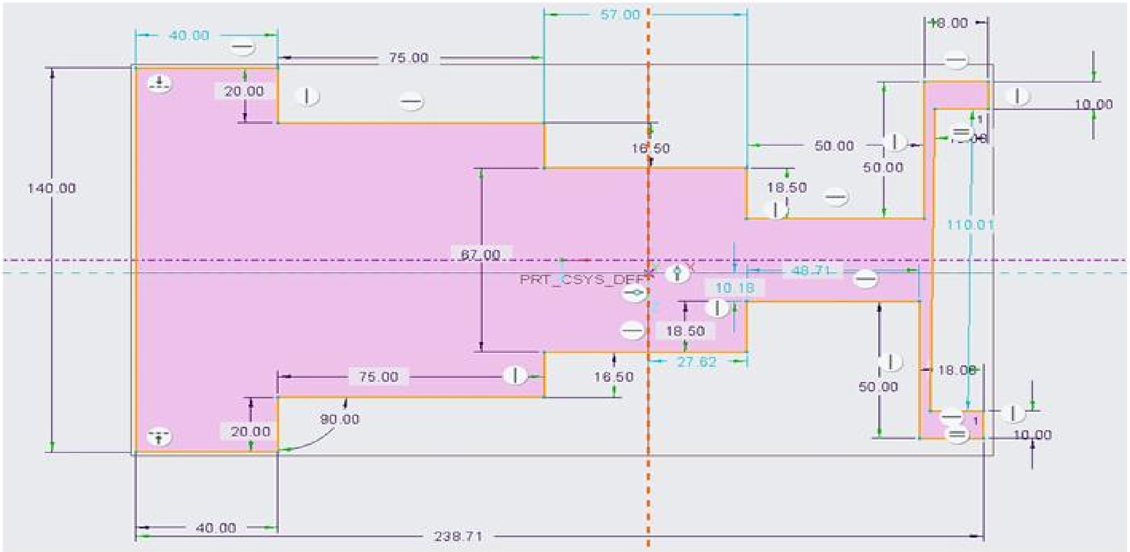

Fig.3.10 CORAL SOFTWARE DESIGN

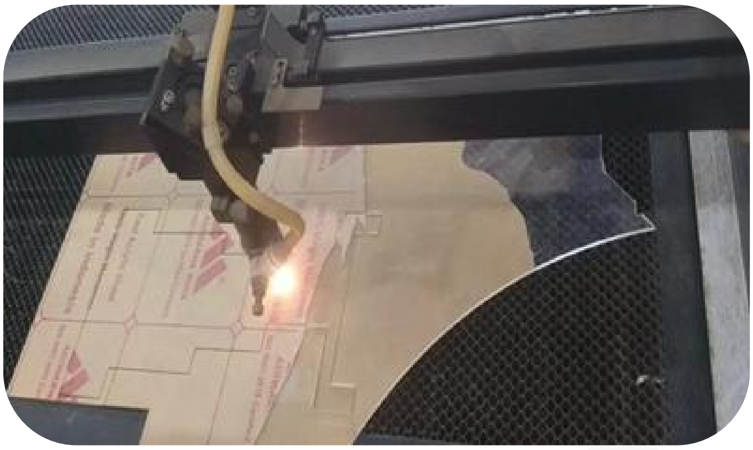

Fig.3.11 CNC LASER CUTTING

3.2 METHODOLOGY:

3.2.1 By considering all the components dimension which is to be fixed on chassis, optimized design of chassis is made which is strong enough to bear the load of each components.

3.2.2 All the components are fixed on chassis and connected with each other with the help of jumper wire as shown in Table 3.1.

Component 1	Terminal	Terminal	Component 2
L298 Driver	INP 12V	OUTP 12V	LI-ON Battery
L298 Driver	OUTP 5V	INP 5V	Arduino UNO
L298 Driver	GND	GND	LI-ON Battery
L298 Driver	GND	GND	Arduino UNO
L298 Driver	INP ENB A	OUTP PIN 9	Arduino UNO
L298 Driver	INP M1	OUTP PIN 4	Arduino UNO
L298 Driver	INP M2	OUTP PIN 5	Arduino UNO
L298 Driver	INP ENB B	OUTP PIN 10	Arduino UNO
L298 Driver	INP M3	OUTP PIN 2	Arduino UNO
L298 Driver	INP M4	OUTP PIN 3	Arduino UNO

Table 3.1 COMPONENTS CONNECTION

3.2.3 Connections between LI-ON battery with L298 motor driver and L298 motor driver with Arduino Uno R3:

Common grounding among LI-ON battery, L298 Motor Driver and Arduino UNO R3 helps stabilize the power supply and minimizes the impact of motor-generated noise on sensitive components like microcontrollers and sensors, which is crucial to avoid potential differences in voltage levels that could cause erratic behaviour or damage to the components.

A 12V power supply from LI-ON is given to the L298 motor driver and 5V power supply is then given towards Arduino Uno R3 from L298 motor driver.All the connections are made as shown in Table.3.1.

3.2.4 Connection between IR sensor and Arduino Uno R3:

Component 1	**Terminal**	**Terminal**	**Component 2**
IR sensor	OUTP PIN	INP PIN A5	Arduino UNO
IR sensor	GND	GND	Arduino UNO
IR sensor	INP 5V	OUTP 5V	Arduino UNO

Table 3.2 IR SENSOR & ARDUINO CONNECTION

Common grounding of IR sensor and Arduino UNO R3 are made to avoid potential differences in voltage levels that could cause erratic behaviour or damage to the components. A 5V power supply is provided from Arduino UNO R3 towards IR sensor as shown in Table 3.2.

3.2.5 Implementation of logical programming code:

Code is program in IDE as per required condition for obstacle detection and navigation and changing direction to some angle after detecting obstacle and then continue to move forward in its straight working path. The code is then uploaded to Arduino Uno R3 from IDE for processing and controlling of obstacle detection and navigation robot with help of USB connector. Arduino Uno R3 is the main controlling unit of obstacle detection and navigation robot. The code is made on basis of object avoiding algorithm using the calibrated sensor values. The code is written to read the sensor values whenever the obstacle is detected, calculate the error which is difference between desired position and actual position of the object, and adjust the motor speeds and change direction of obstacle avoidance robot to keep the robot on its straight path.

Calibrate the IR sensors to determine the threshold values for detecting of the obstacle surfaces. During calibration, keep the working range of IR sensor to full range. Adjust the threshold values accordingly, so the robot can reliably detect obstacle which is also based on obstacle material and working range of IR sensor.

3.2.6 Test and Debug:

After uploading the code to the Arduino Uno R3, threshold values of sensor are need to be adjusted for an obstacle to check the maximum working range of the IR sensor. Make sure the sensor detect obstacle with its maximum working range to change its direction to some angle whenever obstacle is detected.

Different obstacle materials are tested for obstacle detection to check the response time and detection range for different materials when obstructed in bright and dark environment. Different material are tested like wood, white body, black body, glass and metal in bright and dark environment to identify which material is detected first in respective bright and dark environment.

3.2.7 Handling Motions and Turns:

To handle intersections or turns, modify your algorithm to detect such scenarios using the sensor inputs. Implement a decision-making logic to guide the robot through the intersection with obstacle to take turn when obstacle is detected and then continue navigating its straight path.

CHAPTER 4
IMPLEMENTATION OF PROJECT

The implementation of the obstacle detection and navigation robot encompasses the following key points:

4.1 Assemble the robot hardware, including mounting sensors, motors, and micro controller on the chassis:

The assembly of the robot involves the meticulous placement of all components onto the chassis as shown in Fig 4.1. The design and development of the chassis were executed by accurately measuring the dimensions of essential components, including the Arduino, Motor Driver, N20 Motors, and Battery.

To secure the components onto the chassis, 3.2 mm diameter holes were drilled as per the designated locations for each components. The front part of the robot features an infrared (IR) sensor strategically placed for detecting obstacle. In the central region, the Arduino Uno serves as the control unit, facilitating easy connectivity with all other components. Adjacent to the Arduino, the L298 motor driver is positioned and linked to the Arduino to receive commands. Two N20 motors are located beneath the robot chassis to bear its entire weight effectively. Rubber wheels are affixed to the shafts of these motors to facilitate movement. Positioned above the motors, the power supply (battery) is installed, considering its substantial weight relative to other robot components. This strategic weight distribution ensures balanced momentum and enhances the robot's flexibility.

Lastly, a caster wheel is affixed at the front of the robot to provide front support. This wheel imparts all degrees of freedom necessary for the robot to move in any directions. This comprehensive assembly configuration ensures the structural integrity and optimal functionality of the obstacle detection and navigation robot.

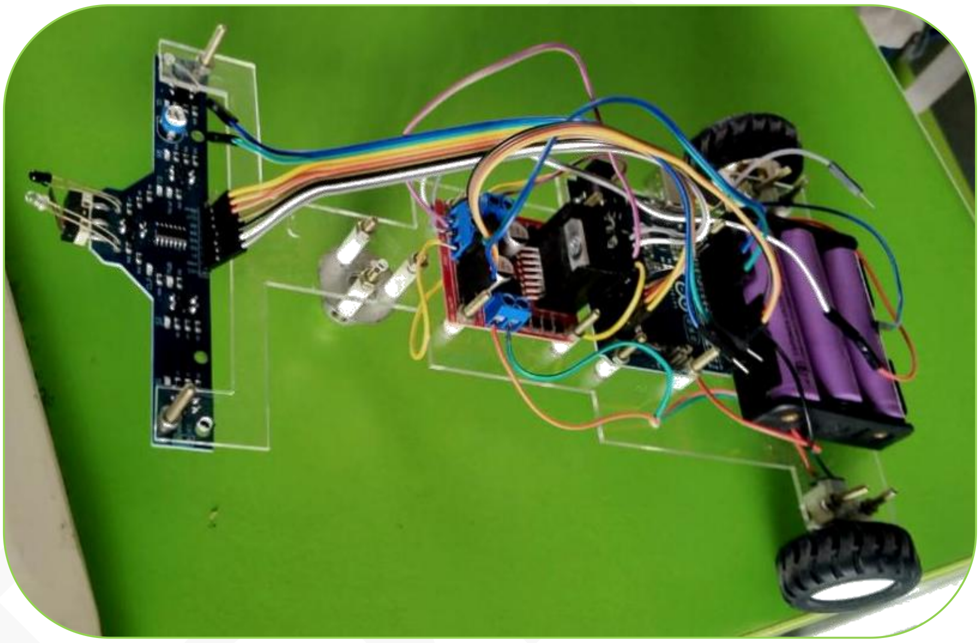

Fig 4.1 Robot Assembly

4.2 Connections of robot components to power source and controller unit and sensor:

The interconnection of all components is achieved through the utilization of male-female jumper wires. A 12V power supply is routed to the motor driver to provide the necessary power for both motors and enable dynamic speed control. Additionally, the motor driver possesses the capability to convert the 12V input to a 5V output, a crucial requirement for the Arduino's operation. This underscores the necessity of establishing a connection between the Arduino and the motor driver.

The connection between the Arduino and the motor driver serves dual purposes. Firstly, it allows the Arduino to receive the requisite 5V supply for its functionality. Secondly, it facilitates the transmission of control signals from the Arduino to the motor driver. These signals are pivotal for modulating the speed of both motors and manipulating the direction of motors rotation, whether in a clockwise or anti-clockwise manner.The power and signal flow diagram is shown in Fig 4.2.

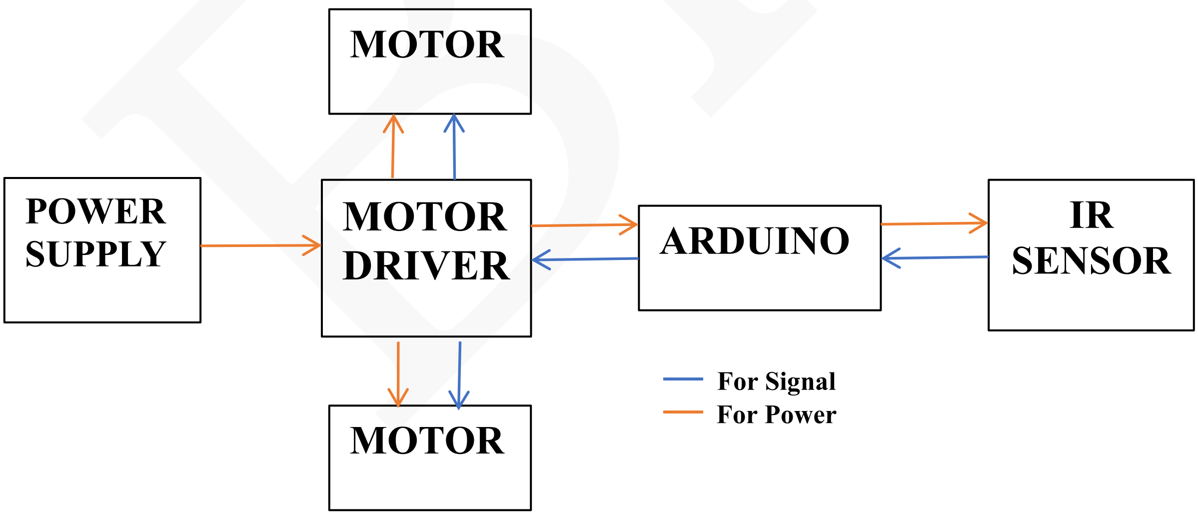

Fig 4.2 Power and Signal flow diagram

Furthermore, a direct linkage is established between the Arduino and the IR sensor to capture signals for indicating the presence of the objects. This connection ensures that the Arduino receives real-time information from the IR sensor, enabling prompt and adaptive responses to the surrounding. In essence, the meticulous arrangement of these connections forms a cohesive network, empowering the obstacle detection and avoidance robot with the necessary functionalities for effective navigation and responsiveness.

4.3 Write and upload the sensor data processing code to the microcontroller, allowing it to read data from the sensors.

A flowchart to enhance comprehension of the logical programming algorithm for the robot, ensuring to easily understand working of robot algorithm as shown in Fig 4.3.

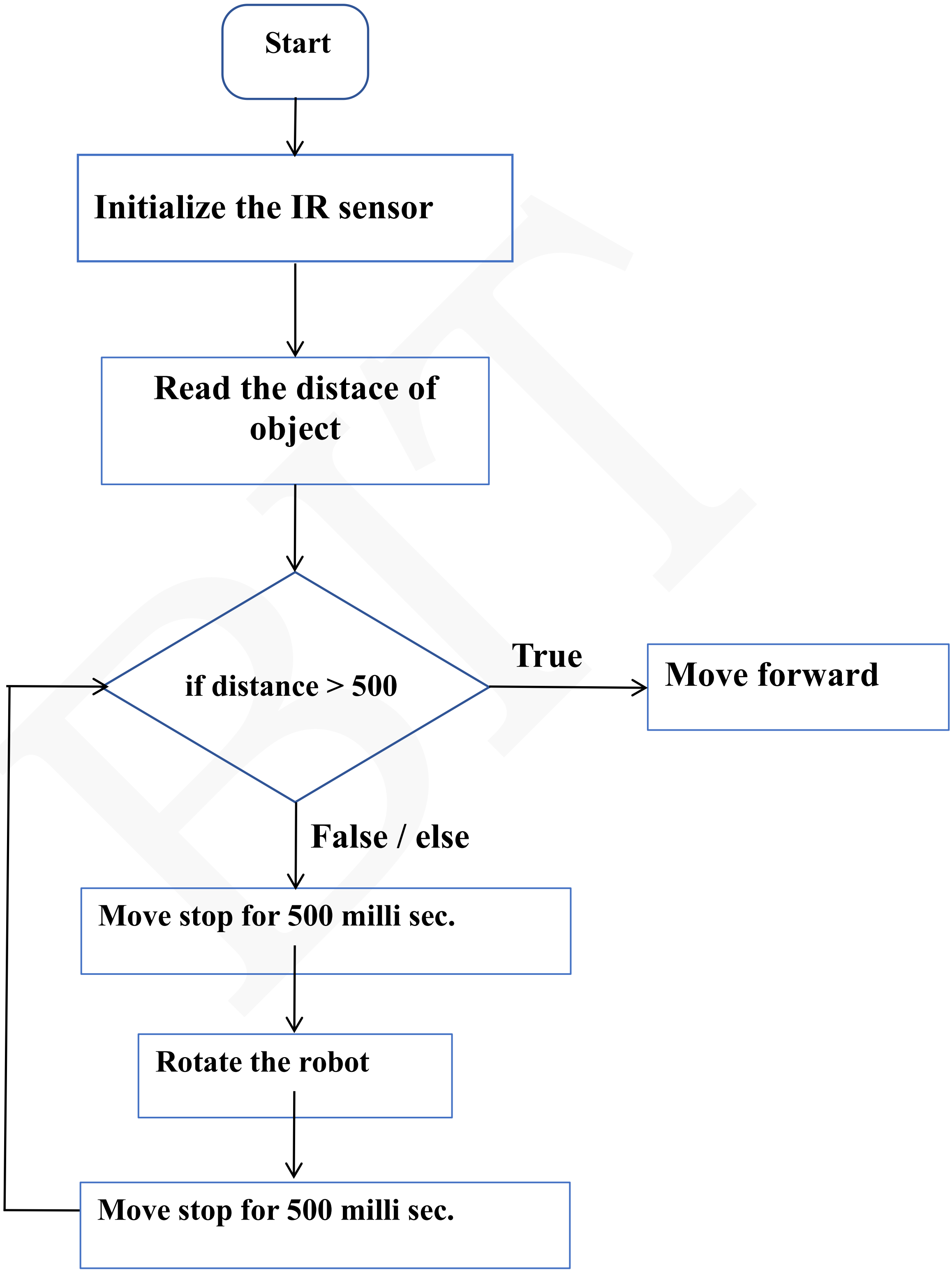

Fig 4.3 FLOWCHART

LOGICAL PROGRAMMING CODE FOR ARDUINO:

```
#define m1 4  //Right Motor MA1
#define m2 5  //Right Motor MA2
#define m3 2  //Left Motor MB1
#define m4 3  //Left Motor MB2
#define e1 9  //Right Motor Enable Pin EA
#define e2 10 //Left Motor Enable Pin EB
#define near A5

//*****************//
void setup()
{
pinMode(m1, OUTPUT);
pinMode(m2, OUTPUT);
pinMode(m3, OUTPUT);
pinMode(m4, OUTPUT);
pinMode(e1, OUTPUT);
pinMode(e2, OUTPUT);

pinMode(near, INPUT);
}
void loop()
{
int s6 = analogRead(near);//distance sensor value

if(s6 > 500 )
{//robot move forward direction
analogWrite(e1, 255);
analogWrite(e2, 255);
```

```
digitalWrite(m1, HIGH);
digitalWrite(m2, LOW);
digitalWrite(m3, HIGH);
digitalWrite(m4, LOW);
}
//obstacle detected and navigation by robot
else
{
//robot change the path by taking turn
analogWrite(e1, 255);
analogWrite(e2, 255);
digitalWrite(m1, HIGH);
digitalWrite(m2, LOW);
digitalWrite(m3, LOW);
digitalWrite(m4, HIGH);
delay(500);

//robot move again on changed path
analogWrite(e1, 255);
analogWrite(e2, 255);
digitalWrite(m1, HIGH);
digitalWrite(m2, LOW);
digitalWrite(m3, HIGH);
digitalWrite(m4, LOW);
delay(500);
}
}
```

4.4 Test the robot with different Objects & in a controlled environment then make adjustments to the algorithms:

The obstacle detection and navigation robot is tested with different objects such as White-body, Metal, Wood, Rubber, Glass, Black-Body for analyzing the detecting range of robot for different objects.

4.4.1 Testing of robot with white body : During the robot testing phase on a white body, it was noted that the robot promptly detected objects as soon as they entered the proximity of the sensor. This rapid detection capability significantly contributes to the robot's effective collision avoidance with white objects. The effectiveness of the infrared (IR) sensor on a white surface can be attributed to the reflective nature of white materials within the infrared spectrum. This inherent property makes white surfaces particularly advantageous for obstacle detection using IR sensors, ensuring a dependable and easily detectable signal. This observation underscores the reliability and efficiency of the IR sensor, especially when navigating in environments featuring white surfaces.

4.4.2 Testing of robot with Metal, Wood & Rubber : In the realm of Infrared (IR) sensors, challenges arise when attempting to detect materials such as rubber wood and metal, each presenting unique hurdles attributable to their inherent properties. Rubber wood, characterized by its dark and matte composition, tends to absorb a notable portion of incident infrared light, diminishing the available light for reflection back to the sensor and thereby impeding effective detection.

Conversely, metals, highly reflective to infrared radiation, exhibit a tendency to redirect the majority of the IR signal away from the sensor, resulting in sub-optimal detection capabilities. Further complicating matters, both rubber wood and metal possess absorption and transmission traits that impact IR interactions; rubber wood may allow some infrared light to pass through, especially in thinner or varied-density sections, leading to reduced reflectivity and detection challenges. In the case of metals, their reflective and highly conductive nature contributes to the absorption of infrared energy, further compromising the signal received by the sensor.

Additionally, surface characteristics play a role in detection reliability, with irregularities, textures, or color variations on rubber wood influencing how the material interacts with the IR sensor, potentially causing scattering or absorption of infrared light in unpredictable ways. Similarly, the smooth and reflective surfaces of metals can cause IR signals to bounce off at angles that may not align with optimal detection by the sensor. The wavelength sensitivity of the emitted infrared light adds another layer of complexity, as the specific wavelengths may not be optimal for effectively interacting with the distinctive properties of rubber wood or metal. In essence, these material-specific challenges underscore the importance of understanding and adapting to the diverse properties of substances encountered in real-world applications involving IR sensors.

4.4.3 Testing of robot with Glass & Black-body : Black surfaces absorb a lot of light, including infrared light that IR sensors use. Since the surface absorbs most of the infrared light, there is very little reflection back to the sensor. This makes it hard for the sensor to detect the black body. Black surfaces also don't reflect much infrared light, which weakens the signals when sensor receives it. IR sensors depends on the difference between the surface and its surroundings for detection, but black surfaces lack this contrast. Additionally, black surfaces don't scatter or diffuse light; instead, they absorb and trap it, reducing the chances of the sensor receiving reflected signals. The specific wavelength of the infrared light emitted by the sensor may not be ideal for interacting with black surfaces, as different materials have different responses to various wave lengths.

Glass lets infrared light pass through without absorbing or reflecting it much, making it tough for IR sensors to detect obstacle. IR sensors usually depend on objects reflecting or absorbing infrared light for detection, but glass doesn't do this very well.

The smooth and even composition of glass reduces the scattering of IR signals, making it harder for sensors to pick up reflected signals and detect obstacle. Sometimes, the specific wavelength of the infrared light used by the sensor might not work well with glass properties, complicating the detection process. Additionally, the angle at which the IR signal hits the glass can affect detection; if the angle is straight on, the signal might just pass through without reflecting much.

CHAPTER 5
RESULTS AND DISCUSSIONS

Implemented an obstacle detection and navigation robot employing IR sensors for efficient detection of diverse materials, including metal, black and white surfaces, wood, and rubber. The robot demonstrated robust adaptability, seamlessly navigating through environments with varied materials by intelligently avoiding obstacle. This project underscores the effectiveness of IR sensor technology in creating a versatile and reliable obstacle avoidance system. An obstacle-avoiding robot was constructed using readily accessible components such as N60 gear motors, L298 motor driver, IR sensor, Arduino Uno R3, Chassis, tyres, LI-ON battery and Jumper wires. This robot is designed in such a way that it can prevent crashes when navigating an unfamiliar world and a fulgent backdrop. The designed robot detects obstacle in its way, avoids them, and resuscitate its run. While there is no obstacle in the way, the robot goes forward; when there is an obstacle in the way, it may take left turn or the other way round. Finally, the aim is to develop and construct an obstacle-avoiding robot using IR sensors and an L298 motor driver. When the robot is does not detect any obstacle then it is desired to move in the forward direction, then both the left and the right motor are made to rotate in clockwise direction moving the robot in forward direction.

When the robot detects an obstacle in the left side, it moves towards its right then the right motor moves in the reverse direction and the left motor moves in the forwards direction. When the robot detects an obstacle in the right side then it should take a left turn right motor moves in the forward direction and the left motor moves in the reverse direction.

The following Table.5.1 shows the movement of the robot with respect to the movement of left and right motors.

Robot Movement	**Right Motor**	**Left Motor Movement**
Forward	Clock-wise	Clock-wise
Right turn	Clock-wise	Anticlock-wise
Left turn	Anticlock-wise	Clock-wise

Table.5.1

The created robot platform was not intended to perform a particular role, but rather to serve as a general wheeled autonomous platform. As a result, it may be used for educational, scientific, or industrial purposes. Research on obstacle avoidance robots will help students improve coordination, technological skills, and teamwork. The architecture of such a robot is extremely adaptable, and multiple approaches may be modified for different implementations.

CHAPTER 6
APPLICATIONS

6.1 Industrial Automations: Robots in industrial settings are pivotal for tasks such as material handling, inventory management, and assembly. They can efficiently move materials, track inventory levels, and assist in intricate assembly processes, improving productivity and reducing human error.

6.2 Security Applications: In areas where human access is limited or dangerous, robots equipped with real-time video capabilities and obstacle detection technology serve as efficient security patrollers. They provide continuous surveillance, detecting and reporting any anomalies or potential threats.

6.3 Medical Applications: Within healthcare, robots with obstacle detection abilities are valuable assistants. They aid in delivering medication and supplies to different hospital units, minimizing human contact and ensuring timely delivery. Additionally, they can support patient care by transporting equipment or assisting medical staff.

6.4 Search and Rescue: Obstacle-detecting robots play a crucial role in search and rescue missions, particularly in hazardous environments like collapsed buildings or disaster zones. Their ability to navigate through debris and detect obstacle helps locate and assist survivors, reducing risks for human rescuers.

6.5 Home Automations: In smart homes, robots equipped with obstacle detection technology navigate through spaces, performing tasks like cleaning or surveillance. They enhance convenience by autonomously completing chores, ensuring safety by avoiding obstacle, and providing security through monitoring capabilities.

CHAPTER 7
FUTURE SCOPE

7.1 Advanced Sensing Technology: Implementing cutting-edge sensors such as LIDAR, Radar, or advanced computer vision systems to enhance the robot's ability to detect and recognize obstacle accurately in various environments and lighting conditions.

7.2 Machine Learning Integration: Incorporating machine learning algorithms to improve the robot's decision-making process. This involves training the robot to identify and classify different types of obstacle, enabling it to make more informed navigation choices.

7.3 Autonomous Navigation Development: Enhancing the robot's navigation capabilities to allow for seamless autonomous movement in complex and dynamic environments. This could involve real-time path planning and decision- making algorithms.

7.4 Multi-Robot Collaboration: Exploring the potential for multiple obstacle avoidance robots to collaborate and work together efficiently in shared spaces, allowing for more extensive coverage and coordinated obstacle avoidance.

7.5 Human-Robot Interaction: Developing intuitive interfaces for users to interact with the robot effectively, facilitating better control or supervision, and potentially enabling the robot to assist or collaborate with humans in various tasks.

7.6 Adaptability and Robustness: Improving the robot's adaptability to various terrains, dynamic scenarios, and unforeseen obstacle, making it more robust and reliable in real-world applications.

7.7 Energy Efficiency and Sustainability: Exploring ways to optimize energy consumption and possibly integrating renewable energy sources to ensure prolonged operational durations and reduce environmental impact.

7.8 Integration with IoT and Connectivity: Leveraging the Internet of Things (IoT) for seamless connectivity, enabling remote monitoring, data logging, and potentially integrating with other smart devices or systems for enhanced functionality.

7.9 Commercial and Industrial Applications: Exploring potential commercial and industrial applications, such as warehouse logistics, surveillance, search and rescue operations, agriculture, and more.

7.10 Ethical and Legal Implications: Considering the ethical and legal aspects related to deploying such robots in public spaces, addressing issues like privacy, safety, and regulations to ensure responsible and ethical usage.

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