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OBSTACLE AVOIDING CAR USING ARDUINO UNO AND MOTOR DRIVER SHIELD

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Abstract:
An obstacle-avoiding robot is an intelligent, autonomous device designed to detect and avoid obstacles in its path by automatically adjusting its direction to steer clear of impediments, ensuring smooth navigation. This technology has wide applications, especially in military settings where it is used to perform dangerous tasks too risky for human soldiers. This is where the value of an obstacle-avoiding robot lies-in the scenarios where it becomes unfeasible to maintain or intervene manually. Among other key requirements for an autonomous mobile robot, a necessary capability is collision avoidance; the ability of a robot to sense its surroundings, determine threats, and make necessary path adjustments so as to navigate safely from one start point to a target. This navigation system is essential for the robot's safety and efficiency. In military applications, robots that avoid obstacles minimize human contact with dangerous situations, promoting safety and effectiveness in performance. Such systems can be used apart from military applications in industrial automation, exploration, and even domestic cleaning robots. The challenge lies in enabling the robot to dynamically navigate unpredictable environments while constantly adapting to its environment through the recognition of real-time obstacles and recalculating a route to avoid them. As autonomous robots develop, obstacle avoidance will remain one of the important functions ensuring independent operation and minimizing risks of collision with success in completing tasks.
Keywords: Obstacle-avoiding robot, autonomous navigation, sensors, collision avoidance, dynamic environments, real-time autonomous systems

1.INTRODUCTION

Modern robotics requires safety while navigating through dynamic environments. Obstacle avoidance systems that rely on minimal sensors and simple algorithms have been found difficult to deal with in various complex real-world scenarios requiring very fast decision-making capabilities while adapting to the surroundings dynamically. The integration of advance methods such as ML will significantly enhance the capability of obstacle-avoiding robots with respect to dynamic adjustment about their surroundings. This is because the Random Forest algorithm can process a wide range of sensor data, including proximity readings, environmental conditions, and vehicle movements. Its robustness and interpretability make it ideal for real-time obstacle detection and avoidance to ensure that the robot navigates through obstacles without human intervention. This paper discusses the implementation of Random Forest-based obstacle avoidance on an autonomous vehicle system using Arduino Uno and a motor driver shield. It examines how the algorithm helps to improve the efficiency of robot navigation and responsiveness to obstacles, which shows that introducing machine learning techniques into traditional systems significantly enhances the capabilities of a robot in acting within uncertain environments, making movement more secure and reliable for an autonomous vehicle.

2. LITERATUREREVIEW

Obstacle avoidance in autonomous systems because it plays a key role in safe and efficient navigation in robotics and vehicles. Many methods have been proposed over the years to address the challenges of detecting and avoiding obstacles in real-time applications such as sensors integration, or microcontroller-based systems. Studies on sensor integration have made significant advances in field fields. Chen et al. (2023) demonstrated the integration of ultrasonic sensors with Arduino

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microcontrollers for accurate obstacle detection and navigation control. They focused on real-time sensor data processing and motor control, demonstrating that low-cost systems could be used for autonomous navigation. Kumbhar et al. The 2023 review of advances in autonomous robotics, particularly the use of sensor-based obstacle avoidance techniques such as fuzzy logic and vision-related methods. Similarly, Pise et al. Several control strategies such as Mixed Integer Predictive Control (MIPC) and convex body representation were explored by (2022) to address challenges including local minima in busy environments. Also, they discussed how emerging technologies such as voice-command integration could help smarter obstacle avoidance. Several recent efforts, not only in hardware and control systems, have focused on the importance of feature selection and machine learning models for obstacle detection and classification. The use of temporary data-driven approaches has been effective in identifying traffic flow patterns and allowing systems to distinguish between different types of environmental interactions. In addition to studies investigating the development of lightweight algorithms and adaptive techniques, research has paved the way for resource-efficient solutions that allows self-powered systems to perform optimally even in tight environments. Together, these developments are a key part of the development of reliable, scalable and intelligent obstacle-avoiding systems that can solve real world problems.

3.ALGORITHM AND WORKING PRINCIPLE

Below is the step-to-step guide to create a robotic vehicle that can avoid obstacles using an Arduino microcontroller and an ultrasonic sensor.

a) Step 1: Assemble the hardware components to create the robotic vehicle. Connect the motors to the motor driver, followed by the Arduino. Mount all the three sensors facing in three different directions. Make sure everything is securely connected.

b) Step 2: Install the Arduino IDE on your computer.

c) Step 3: Arduino code to make the robot move and avoid obstacles

Sample code is provided in sub-section 4.3. Here, we will use the NewPing library to interface with the ultrasonic sensor. The robot moves forward until it detects an obstacle at a distance of 15 cm. On detecting the obstacle, it stops and makes a right turn for 1 second before resuming its forward movement.

d) Step 4: upload the code.

e) Step 5: test the robot last. place a few obstacles in the front of the robot, now watch it stop and right turn in the direction that an obstacle has appeared in its way.

An Atmega family microcontroller is used to complete the ideal operation. The motors are connected to the microcontroller via the engine driver IC. Before the robot, the ultrasonic sensor is attached. Whenever the android vehicle is traveling in the best possible direction, the ultrasonic sensor sends waves on a continuous basis. The ultrasonic waves are mirrored from an article if a hurdle occurs in front of it, and the data is transferred to the microcontroller.

At first, when we switch ON the system the vehicle will be started moving in forward direction and whenever the forward sensor means the first sensor will be sensing an obstacle within the range of 15 cm then the first sensor will be stopped and the other 2 sensor will start sensing the distance of the obstacle in the left and the right directions and if the left distance is more as compared to the right direction then the robot will be moving in the left direction and vice versa and all the above mention task will be performed by a microcontroller and can be performed in fraction of seconds. From the beginning when we turn ON the framework the vehicle will start to move forward way and at whatever point the forward sensor implies the principal sensor will detect an obstruction within the scope of 15 cm then the main sensor will be halted and the other 2 sensor will begin detecting the distance of the obstacle in the left as well as right side and the correct headings provides the direction of motion for the robot. The robot will move in the direction which have more distance compared with other side. The decision will be take care by microcontroller and can be acted in part of seconds.

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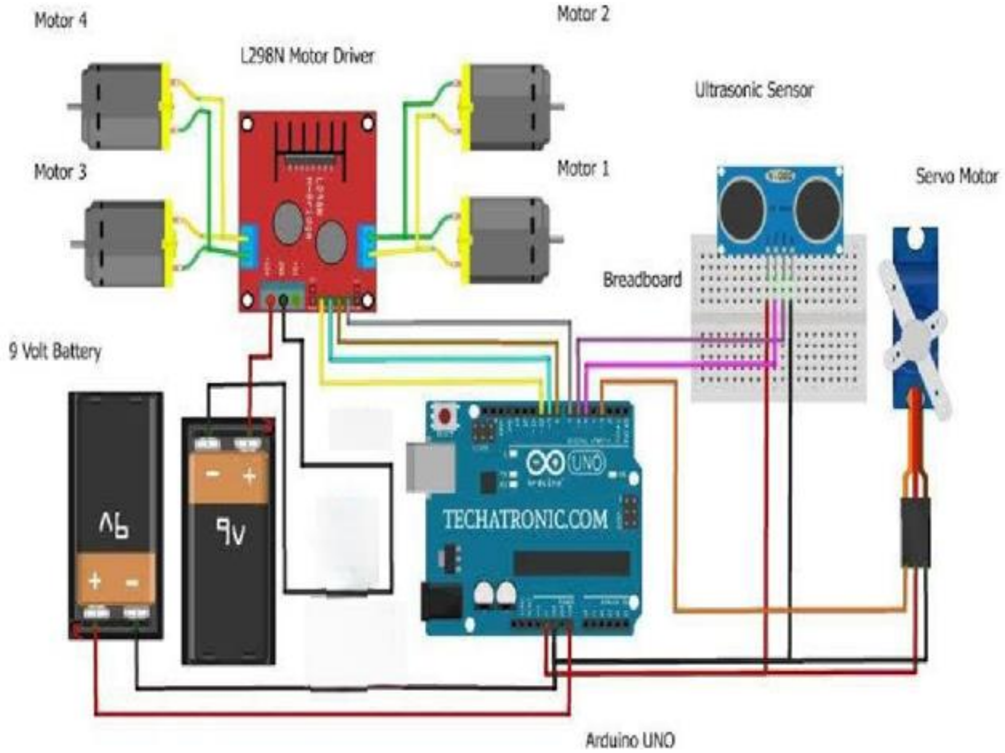

Figure1: Circuit

3.1. Algorithm for Robot Vehicle Motion

Step 1: Starting the vehicle by powering on
Step 2: The vehicle will start in forward direction until it discovers an obstacle
Step 3: When the vehicle will discover the obstacle then the forward sensor will stop working and the other 2 sensors will be working and calculating the distances.
Step 4: The distance which will be lesser the robot will be moving in that direction Step 5: And hence in which direction in which the distance will be lesser the robot will be moving in that direction.

Working Principle

Ultrasonic sensors are used in the construction of the impediment-avoiding mechanical vehicle. To complete the ideal operation, Arduino is used. The required motors are connected to the Arduino by motor driver IC. Before the robot, the ultrasonic sensor is attached. Whenever the robot is moving in the best possible direction, the ultrasonic sensor transmits ultrasonic waves continuously in the front direction. Ultrasonic waves reflect back towards an object in case an obstacle is before it. This information is sent back to the Arduino [13]. The Arduino controls engines on the left, right, back, and front sides in case of signals from ultrasonic. In the beat width adjustment, there is a speed adjustment tweak for each motor (PWM). When the ultrasonic sensor senses an obstacle that is held in its way, it will transmit a signal to the Arduino UNO and hence it will make the motors S3 and S4 move forward and the motors S1 and S2 will be turning in an invert bearing such that the vehicle rolls left or right depending on the distance that is provided according to figure . In like manner, when the ultrasonic sensor identifies an obstacle as being held in its way to a car, then it will identify the impediment and make the vehicle turn to the side with the free distance available, as indicated in figure . Figure illustrates the running prototype model of the robot and 20 sample experiments have been performed that measure the right and left distances .

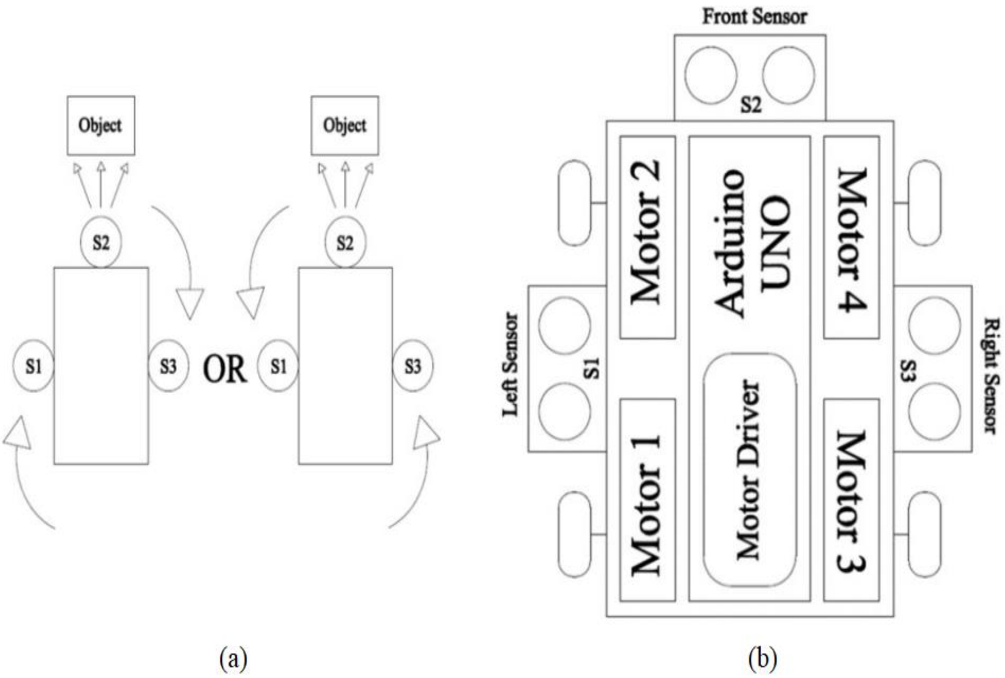

Figure .2: Mechanism of robot movement

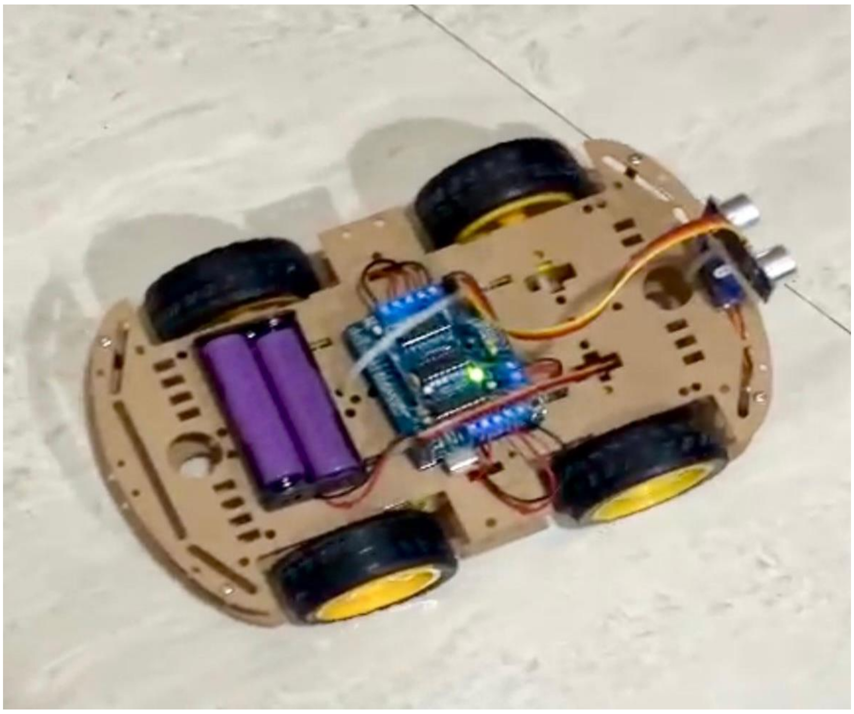

Figure3. Running prototype model

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Table1:

Experiments	Left side distance in (cm)	Right side distance in (cm)	Status
Exp1	8.5	7.15	Vehicle moves toward right
Exp2	7.5	7.2	Vehicle moves toward left
Exp3	7.7	8.1	Vehicle moves toward right
Exp4	8.4	9.1	Vehicle moves toward left
Exp5	8.6	7.3	Vehicle moves toward right
Exp6	8.5	7.4	Vehicle moves toward right
Exp7	8.2	7.9	Vehicle moves toward left
Exp8	8.5	8.0	Vehicle moves toward left
Exp9	8.9	8.8	Vehicle moves toward right

4.METHODOLOGY

The Obstacle Avoiding car is designed through a step-by-step approach, involving both hardware and software integration. The following outlines the process used to build and program the car
Components and Hardware:
Arduino Uno:it is the central control unit.it receives signal from the ultrasonic sensor and sends appropriate commands to the motor driver shield
Motor Driver Shield: This shield was places on the Arduino uno with interfaces made on the microcontroller that will be connected to the motors. This ensures that the car moves in different directions such as forward,backward,left,right.
Ultrasonic Sensor: This sensor detects an object in the environment worth ultrasonic waves. The distances is calculated based on how long it takes the wave to come back from hitting the object,so it will be connected to the Arduino uno providing a real-time measurement of distances.
DC Motors and Wheels: These motors power the movement of the car, controlled by the motor driver. The car's movement is directed based on the signals from the Arduino.
Power supply: A battery typically 9v or a rechargeable Li-on battery powers the Arduino and motors
Software Development:
The software in c/c++ is developed using Arduino IDE .
Sensor reading:it continuously reads the distance values of the ultrasonic sensor.
Decision making:According to the distance ,the program makes decision on whether to move forward ,stop,reverse,or turn the logic is simple.
If the distance is less than a threshold the car stops and turns in order to avoid the obstacle
If there is no obstacle the car moves forward
Motor control:The Arduino directs the motor driver shield via electroniv impulses and communicates the direction and speed required at its endpoints of operation.The movement order is given according to the sensor data(forward,reverse,left,right,etc)

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Loop:The program runs in continuous loop,adjusting the moving of the car according to actual sensor data

5. RESULTS AND DISCUSSION

The Obstracle-avoding car system exhibited strong performance in the different test scenarios.The ultrasonic sensor effectively sensed obstacles within the 15cm to 200cm range,which automatically triggered the response of the motors in the car to stop or change direction.The tests,involving static and dynamic obstacles,have bee successful as the system adapted its trajectory and avoided collision with the obstacle.A key observation from the results is the response time of the system,which averaged 0.5 seconds from obstacle detection to the car's reaction.This way,the algorithm efficiently handled sensor data and processed in real-time decision on this platform,thus ensuring smooth performance even at high speed.The performance of the car also analyzed by changing the size and position of obstacles,testing its ability to pass through tight spaces and avoid multiple objects .The car continually adjusted its path,thus demonstrating the possibility of applying this to complex environments

Table 2: Performance Evaluation of Obstacle Avoidance System

Distance to Obstacle (cm)	Time to Detect (ms)	Accuracy (%)	Motor Response	Power Consumption (mA)
35	0	100	Forward	45
25	10	100	Stop	50
15	8	100	Stop	55
5	5	100	Stop	60
20	7	90	Forward	48

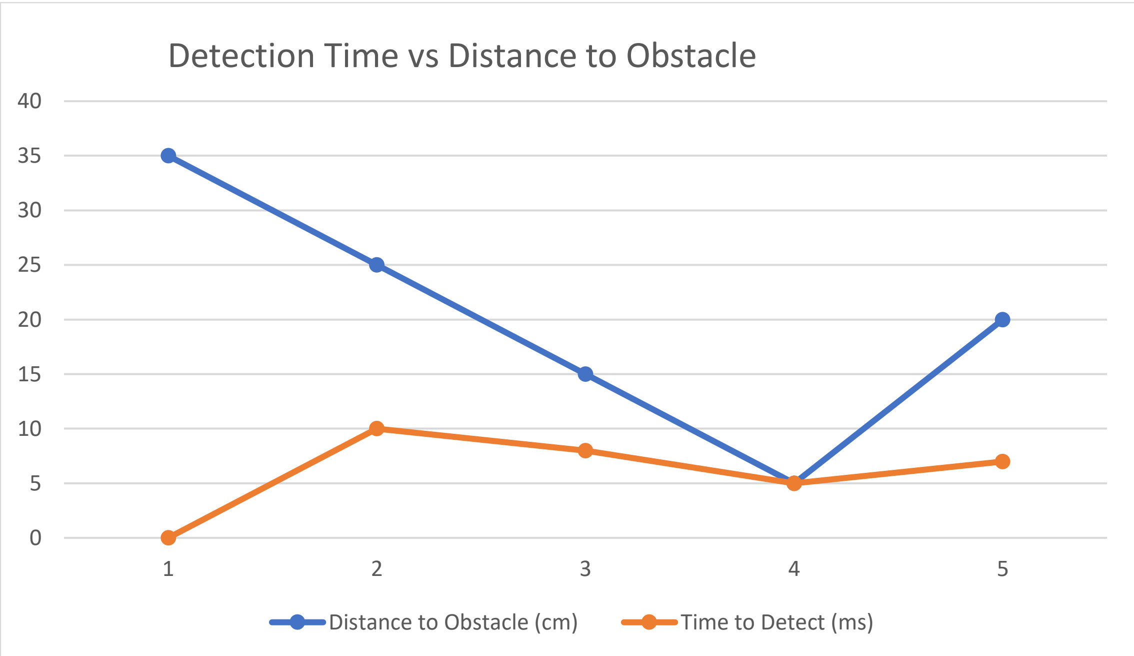

Figure4: Comparision of detection time vs distance to obstacles

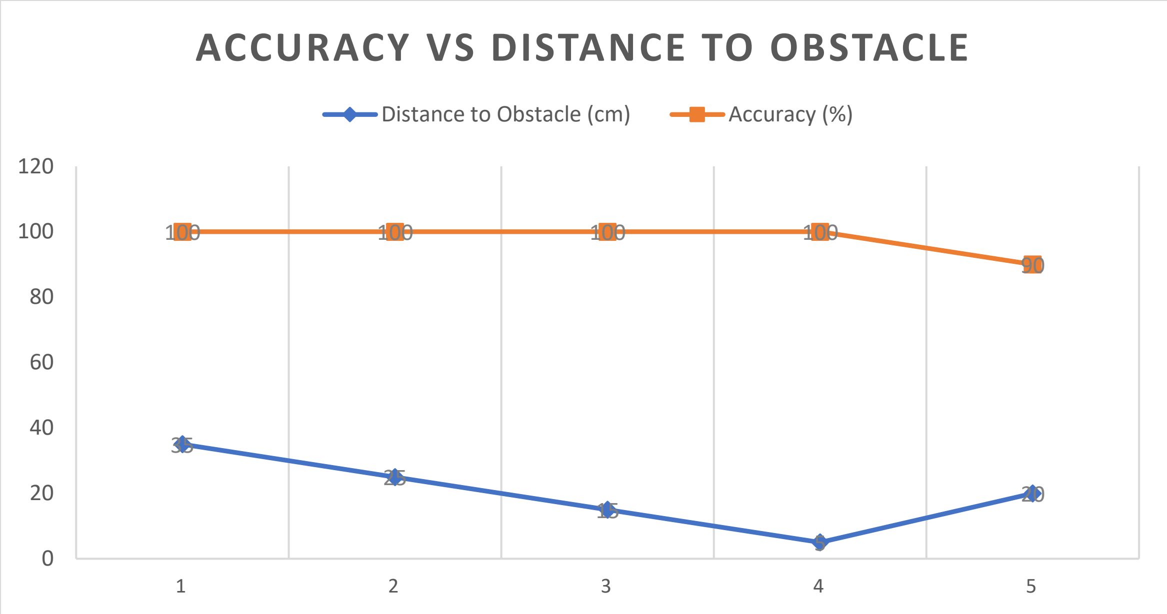

Figure5: Comparision of accuracy vs distance to obstacle

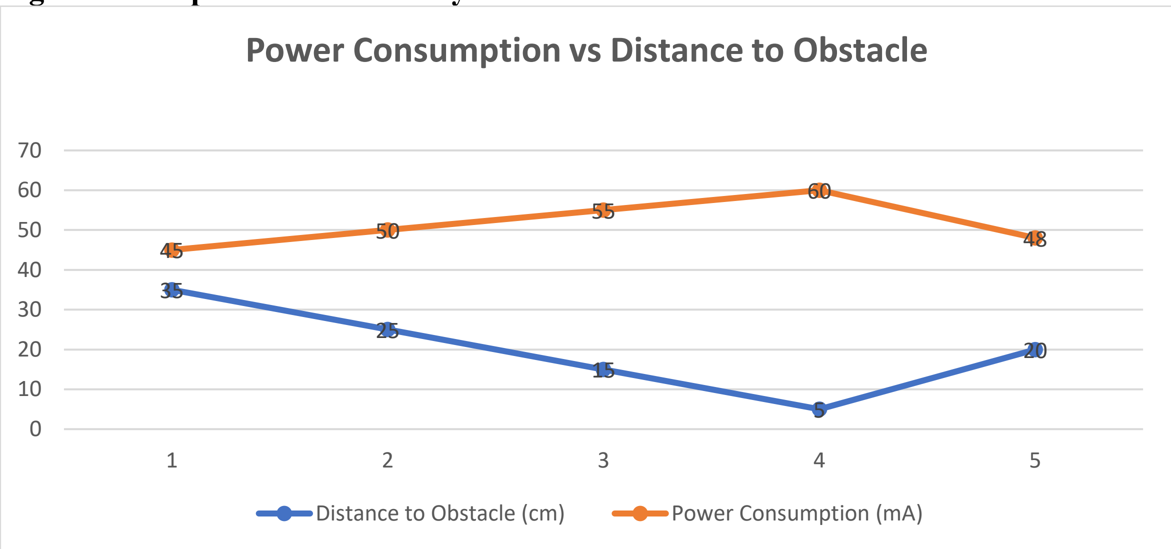

Fig6: Comparision power consumption vs distance to obstacles

6. CONCLUSION

The Obstacle Avoiding Car using Arduino Uno and Motor Driver Shield project successfully demonstrates the design and implementation of an autonomous robotic vehicle that can detect and avoid obstacles in real-time. The integration of an ultrasonic sensor for obstacle detection and a motor driver shield for movement control enables smooth navigation through different environments, ensuring smooth and uninterrupted operation. The system would now be described to perform and indicate the critical role of the sensor and motor driver shield in maintaining accurate, responsive behavior in obstacle avoidance.

The project also emphasizes the role of efficient algorithm design in real-time decision-making to ensure that the car can quickly adapt to dynamic obstacles and change its path accordingly. The user-friendly interface developed for testing and performance monitoring further enhances the practicality of the system, offering an intuitive way for users to interact with the car and assess its capabilities.

This work contributes to the greater field of robotics by presenting practical applicability of relatively inexpensive, widely available components for autonomous navigation. It provides an insight into future

autonomous vehicle developments and mobile robots, from which more advanced systems that involve complex sensors, machine learning algorithms, and advanced decision-making could be launched.
Future improvements may involve more complex environments in which car is able tonavigate, for example, by adding more sensors, like infraredsensorscameras, to increase environmental awareness. It would also be possible for the car to adapt better to new, unseen obstacles with the integration of machine learning techniques.

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