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Robot Using Ultrasonic Sensing Technology"

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Abstract- Obstacle Avoiding Robot is an intelligent device that can automatically sense the obstacle in front of it and avoid them by turning itself in another direction. This design allows the robot to navigate in an unknown environment by avoiding collisions, which is a primary requirement for any autonomous mobile robot. The application of the Obstacle Avoiding robot is not limited and it is used in most of the military organizations now which helps carry out many risky jobs that cannot be done by any soldiers. Here an Ultrasonic sensor is used to sense the obstacles in the path by calculating the distance between the robot and obstacle. If robot finds any obstacle it changes the direction and continue moving.

Obstacle Avoiding Robot is an intelligent device that can automatically sense the obstacle in front of it and avoid them by turning itself in another direction. This design allows the robot to navigate in an unknown environment by avoiding collisions, which is a primary requirement for any autonomous mobile robot. Obstacle avoiding robots can be used in almost all mobile robot navigation systems. They can be used for household work like automatic vacuum cleaning. They can also be used in dangerous environments, where human penetration could be fatal.

Keywords- Obstacle Avoiding Robot; Autonomous Robotics; Ultrasonic Sensing; Real-Time Navigation.

I. INTRODUCTION

The obstacle avoidance robot is an autonomous mobile system designed to navigate safely by detecting and avoiding obstacles in its path.

The robot employs an ultrasonic sensor to continuously measure the distance between itself and nearby objects. A microcontroller processes the sensor data and controls the robot's movement accordingly. When an obstacle is detected within a predefined range, the robot automatically changes its direction to prevent collision, enabling efficient navigation in unknown environments without human intervention.

The circuit diagram of the proposed robot integrates essential components such as a microcontroller, ultrasonic sensor, servo motor, motor driver, DC motors, and a power supply unit. The ultrasonic sensor mounted on the servo motor scans the surroundings by rotating in different directions, allowing the robot to identify a clear path. Based on the received distance information, the microcontroller generates control signals for the motor driver, which directs the movement of the DC motors. This integrated hardware architecture ensures reliable obstacle detection, intelligent decision-making, and autonomous navigation.

II. LITERATURE SURVEY

Obstacle avoidance robots have become an important area of research in robotics and autonomous navigation due to their applications in industrial automation, household assistance, military operations, and intelligent transportation systems. Researchers have proposed various techniques using sensors and intelligent control algorithms to improve the obstacle

detection and navigation capabilities of autonomous mobile robots.

In 2021, Ahmed A. A. Elhag et al. developed a sensor-based obstacle avoidance system for autonomous mobile robots. Their research demonstrated the effectiveness of ultrasonic sensors in detecting obstacles and enabling robots to navigate safely in dynamic environments. The study highlighted the importance of real-time sensing for collision-free movement and improved robot autonomy.

Also in 2021, Han Tao et al. proposed a multi-sensor intelligent robot capable of obstacle avoidance and road-sign detection. The researchers integrated different sensing technologies to overcome the limitations of using a single sensor. Their findings showed that combining multiple sensors improves environmental perception and navigation accuracy in complex surroundings.

In 2022, S. Kumar et al. designed an autonomous navigation system that utilized ultrasonic sensors for obstacle detection and environmental mapping. The proposed system enabled the robot to move independently while generating a map of the surrounding area. The study demonstrated that ultrasonic sensing could provide reliable information for navigation and obstacle avoidance at a relatively low cost.

Another significant contribution in 2022 was made by Mohammad Samadi Gharajeh and Hossein B. Jond, who introduced an Adaptive Neuro-Fuzzy Inference System (ANFIS) for obstacle avoidance and path planning. Their approach used ultrasonic sensor data to make intelligent navigation decisions. Experimental results indicated improved navigation performance and reduced collision risks compared to conventional obstacle avoidance techniques.

In the same year, Liwei Guan et al. proposed an intelligent obstacle avoidance algorithm for mobile robots operating in uncertain environments.

The researchers focused on enhancing robot adaptability through real-time decision-making processes. Their work demonstrated that intelligent algorithms can significantly improve navigation efficiency and obstacle avoidance performance.

In 2023, Muhammad Ahmad Baballe et al. developed an Arduino Uno-based obstacle avoidance robot using ultrasonic sensors. The robot was capable of detecting obstacles and automatically changing its direction to avoid collisions. The study emphasized the simplicity, low cost, and practical implementation of ultrasonic sensor-based robotic systems for educational and industrial applications.

Similarly, in 2023, Tanjim Mahmud et al. designed and implemented an ultrasonic sensor-based obstacle avoidance system for Arduino robots. Their system achieved reliable obstacle detection and autonomous navigation while maintaining low implementation costs. The research highlighted the effectiveness of ultrasonic sensing technology in small-scale robotic platforms.

Also in 2023, Achinta Brata Roy Tonmoy et al. conducted a comparative study between LiDAR and ultrasonic sensors for obstacle avoidance robots. The results showed that while LiDAR offers greater accuracy and environmental awareness, ultrasonic sensors remain a cost-effective and practical solution for many autonomous robotic applications.

Furthermore, Donabel Abuan et al. presented an Arduino-based obstacle avoiding robot equipped with ultrasonic sensors and motor control functions. The proposed system improved navigation efficiency and demonstrated effective obstacle avoidance capabilities through coordinated motor

control and real-time sensing.

In 2024, Yaseen M. et al. reviewed recent advancements in obstacle avoidance and path-planning techniques for autonomous mobile robots.

Their survey compared traditional methods with modern artificial intelligence-based approaches, including neural networks and machine learning algorithms. The study concluded that intelligent navigation techniques represent the future direction of autonomous robotic systems and can significantly enhance obstacle avoidance performance.

From the reviewed literature, it is evident that ultrasonic sensor-based obstacle avoidance robots remain popular because of their low cost, simplicity, and reliability. However, there is still a need for more intelligent and adaptive navigation systems capable of operating efficiently in dynamic and complex environments. Therefore, the proposed obstacle avoidance robot aims to provide an effective, low-cost, and autonomous solution for real-time navigation and collision avoidance applications.

III. WORKING MODEL

The development of an obstacle avoidance robot involves a systematic process that includes component selection, circuit design, mechanical construction, software development, and testing to achieve autonomous navigation. An Arduino Uno microcontroller is commonly used as the control unit due to its simplicity and compatibility with various sensors and modules. Ultrasonic sensors, such as the HC-SR04, are employed to detect obstacles by measuring distances and providing real-time environmental information. The robot typically utilizes a two-wheeled differential drive system powered by DC motors and controlled through a motor driver module like the L298N. A rechargeable battery supplies power to the entire system. The control algorithm continuously processes sensor data and enables the robot to make navigation decisions, such as stopping, reversing, or changing direction when obstacles are detected within a predefined range. Through the integration of sensing, control, and locomotion systems, the robot can move autonomously while effectively avoiding collisions and navigating safely in its environment.

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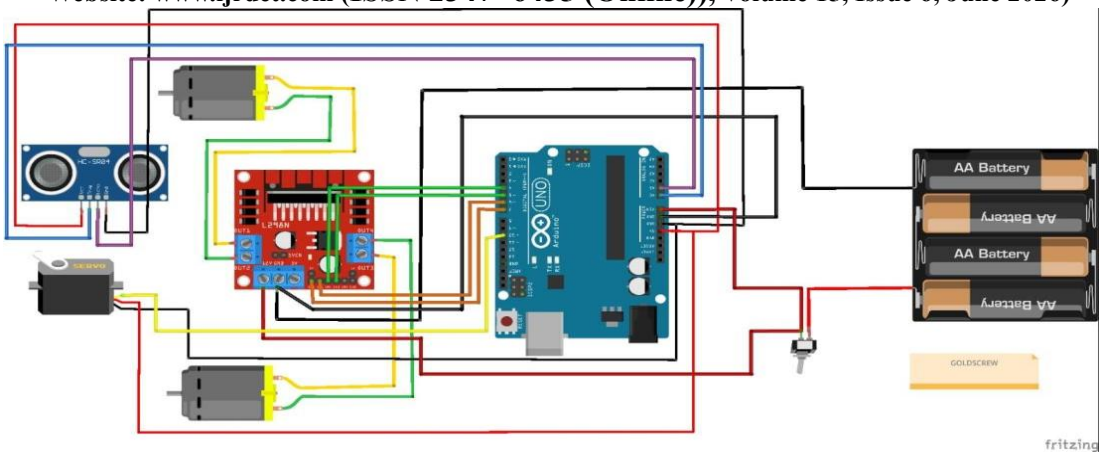

IV. TOOL & TECHNIQUE

The Arduino Uno is the primary microcontroller used in the obstacle avoidance robot and serves as the central processing unit of the entire system. Based on the ATmega328P microcontroller, it is responsible for receiving input data from the HC-SR04 ultrasonic sensor, processing the measured distances, and generating appropriate control signals for the L298N motor driver module. These signals enable the DC motors to move the robot forward, stop, reverse, or change direction whenever an obstacle is detected. The Arduino Uno is widely preferred due to its low cost, ease of programming, open-source development environment, and compatibility with a wide range of sensors and modules. Using the Arduino IDE, programs written in C/C++ can be easily uploaded to the board, allowing the robot to perform autonomous navigation and obstacle avoidance tasks. Furthermore, the Arduino Uno supports integration with additional communication and monitoring modules, such as Bluetooth, RF transceivers, and real-time clock modules, enhancing the system's functionality and flexibility. Its reliable performance, multiple input/output pins, and user-friendly architecture make it an ideal platform for developing intelligent robotic and embedded systems applications.

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V. WORKING

The Arduino Uno functions as the main controller of the obstacle avoidance robot by continuously receiving distance measurements from the HC-SR04 ultrasonic sensor and processing the data according to the programmed algorithm. When the sensor detects an obstacle

within a predefined threshold distance, the Arduino analyzes the received information and sends appropriate control signals to the L298N motor driver module.

Based on these signals, the motor driver controls the DC motors to stop, reverse, or change the robot's direction to avoid a collision. If no obstacle is detected, the Arduino instructs the motors to keep the robot moving forward. This process is repeated continuously in real time, enabling the robot to autonomously navigate its environment while avoiding obstacles. Through its efficient processing capability and interaction with sensors and actuators, the Arduino Uno ensures smooth, reliable, and intelligent operation of the obstacle avoidance system.

VII. CONCLUSION

This paper presented the design and development of an autonomous obstacle avoidance robot using an Arduino Uno microcontroller, HC-SR04 ultrasonic sensor, and L298N motor driver module. The proposed system successfully detects obstacles in its path and autonomously changes its direction to avoid collisions, enabling safe and efficient navigation in unknown environments. The robot demonstrates a simple, reliable, and cost-effective solution for autonomous mobility, making it suitable for educational, industrial, and household applications. The integration of ultrasonic sensing and real-time decision-making provides satisfactory performance in obstacle detection and avoidance while maintaining low system complexity.

In the future, the system can be enhanced by incorporating advanced sensors such as LiDAR, cameras, and infrared sensors to improve environmental perception and navigation accuracy. Artificial intelligence and machine learning algorithms can be integrated to enable intelligent path planning and adaptive decision-making in dynamic environments. Furthermore, wireless communication modules, IoT connectivity, GPS navigation, and autonomous mapping techniques can be implemented to extend the

robot's capabilities for applications in smart surveillance, disaster management, autonomous vehicles, and industrial automation.

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