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ROBOT FOR OBSTACLE AVOIDANCE

Rahul Dahale[*1], Rani Chaudhari[*2], Mandar Bathe[*3], Adesh Chavan[*4], Prof. Ganesh R. Phulay[*5]

[*1,2,3,4]Student, Department of Electronics and Telecommunication, Government College of Engineering And Research Avasari Khurd, Pune, Maharashtra, India.

[*5]Professor, Department of Electronics and Telecommunication, Government College of Engineering And Research Avasari Khurd, Pune, Maharashtra, India.

ABSTRACT

This paper presents a project on developing an obstacle-avoiding robot. The goal is to design and implement an autonomous robotic vehicle capable of navigating environments and evading obstacles. The robot integrates the ultrasonic sensor, the combined circuit of ATMega328Pu and L298n, and the embedded system. Combinational circuits act as controls that process sensor data to make decisions. The embedded system executes obstacle avoidance algorithms and analyzes sensor data to determine the optimal path. Results demonstrate effective obstacle detection and avoidance. This project contributes to robotics and highlights embedded system potential.

Keywords: Obstacle Avoidance, Ultrasonic Sensor, Combine circuit of ATMega328Pu and L298n, Robotic Vehicle, Embedded System.

I. INTRODUCTION

Technology developments are driving the fast-evolving field of robotics, which has a wide range of applications. Obstacle-avoiding robots are one of the many varieties of mobile robots that have attracted a lot of attention. These self-driving robots are built to move around their environment while evading collisions with unexpected obstacles. Our goal in this project is to create an obstacle-avoiding robot using the Micro Controller - AtMega328PU and ultrasonic range finder sensors to prevent collisions. Component selection, robot assembly, programming development, and testing are some of the project's crucial tasks. The importance of choosing the right parts for the robot's construction cannot be overstated. These parts include a microcontroller, ultrasonic range finder sensors, servo motor, motor driver, motors, wheels, and a power source. Assembly involves configuring the robot using a custom PCB, with the ultrasonic sensors placed on a servo motor at the front of the robot to detect obstacles, motors attached to the wheels, and the power supply connected to the combined circuit of the ATMega328Pu microcontroller and the L298n motor driver IC. The robot's mobility and the operation of the ultrasonic range finder sensors are controlled by the programming that is being developed. The programming should give the ability to recognize and avoid obstacles. The robot is carefully tested after development to make sure it can move forward, backward, turn, identify obstacles, and effectively navigate around them. The obstacle-avoiding robot has passed testing and is now prepared for use in a variety of activities, including cleaning, distribution, and security applications. This project's main goal is to develop an obstacle-avoidance robot using an ultrasonic sensor and the AtMega328PU microcontroller. Another goal of the study is to create and refine an obstacle detection system to lower traffic accidents on highways. The technology uses ultrasonic sensors and reactive obstacle avoidance algorithms to identify impediments in real-time and alert the vehicle's controller to change the trajectory of the vehicle to avoid collisions. The obstacle detection system's development and design, testing in actual surroundings, and evaluation of its performance are the project's specific goals. This system has the potential to drastically lower the frequency of traffic accidents on highways by avoiding collisions with automobiles, pedestrians, and other objects. This project's focus is on the problem of obstacle avoidance, which is essential for moving through settings with lots of obstacles. Our robot can detect obstacles using ultrasonic sensors and determine the best routes to avoid them, resulting in safe and effective navigation. The robot has been extensively tested in various industrial and automobile settings, proving its effectiveness in avoiding obstacles and ensuring safe traversal.

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II. METHODOLOGY

The mobility of the robot for obstacle avoidance is achieved through the integration of various components and circuits. The key components used in the project include a microcontroller, ultrasonic range finder sensors, servo motor, motor driver, motors, wheels, and a power source. These components work together to enable the robot to navigate its environment while avoiding obstacles.

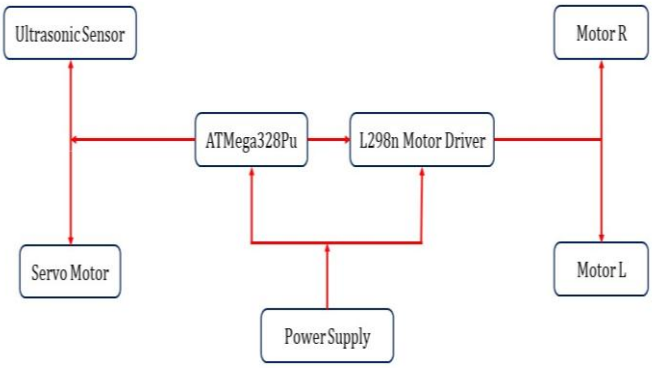

Figure: 1 Block Diagram of Robot for Obstacle Avoidance

The robot works as follows:

- The ultrasonic sensor detects an obstacle.
- The distance to the obstacle is calculated by the microcontroller.
- The microcontroller sends a signal to the servo motor to turn the ultrasonic sensor.
- The ultrasonic sensor detects the obstacle again.
- The microcontroller calculates the distance to the obstacle again.
- The microcontroller compares the two distances.

If the distance has decreased, the microcontroller sends a signal to the DC motors to turn the robot away from the obstacle.

If the distance has increased, the microcontroller sends a signal to the DC motors to turn the robot towards the obstacle.

The robot can detect obstacles from a distance of 20 cm and 30 cm from left and right side. This means that it can avoid collisions with most obstacles that it encounters. The robot can also navigate in a variety of environments, including indoors and outdoors. The robot is a valuable tool for a variety of applications. It can be used to inspect industrial machinery. The robot is also a great educational tool for students who are interested in robotics.

III. MODELING AND ANALYSIS

Combine Circuit of ATMega328PU and L298n

A combination of ATMega328PU and L298N in a single circuit board refers to the electronic design combining ATMega328PU microcontroller and L298N motor driver in a single PCB (Printed Circuit Board). This combination has many advantages such as compactness, ease of assembly and easy connection. The main details of this integrated circuit are as follows:

Microcontroller Section: There will be a section for ATMega328PU microcontroller on the PCB. This chapter covers the microcontroller itself and its supporting components such as capacitors, resistors and a crystal oscillator for clock generation. The appropriate pins of the microcontroller will be assigned to various connectors or headers, allowing external connection and operation.

Motor Driver: The PCB will also contain the L298N motor driver. This section covers the L298N IC, its components, and the connectors or terminals required to connect the motor. It may include a heatsink or other cooling system if required, depending on its power dissipation characteristics.

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Power: The combined circuit will power the microcontroller and the motor driver. These electrical connections will be well designed to control the voltage and current requirements of the products and to control the motors.

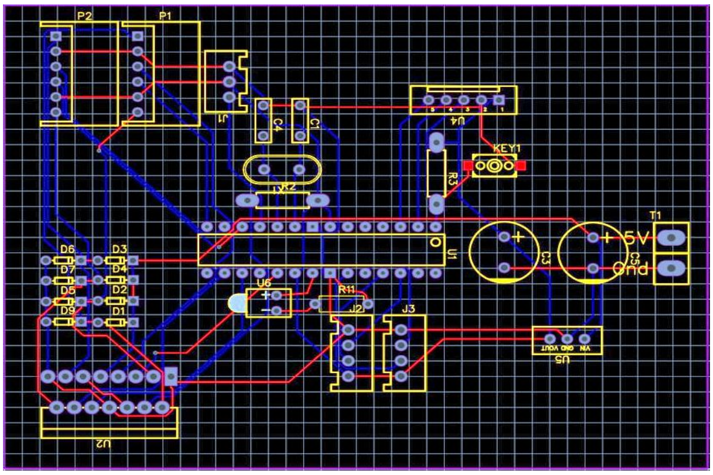

Figure: 2 Layout of ATMega328PU and L298n Combine Circuit

When designing the integrated ATMega328PU and L298N circuit on a single board, it is important to consider proper operation and grounding to reduce noise and ensure safety. Adhering to PCB design best practices such as proper component placement, configuration, and power distribution will help improve performance and reduce potential issues.

Schematic diagram and connections

This schematic diagram illustrates the connections between an ATMega328PU microcontroller and various components, including an ultrasonic sensor, a servo motor, and an L298N motor driver IC. These connections allow the microcontroller to interact with and control these components for specific functionalities.

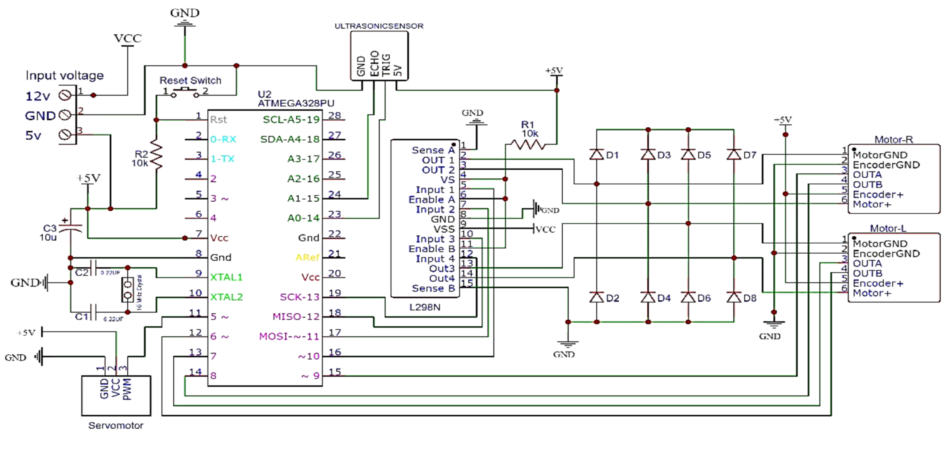

Figure 3: Schematic diagram and connections.

Ultrasonic Sensor: The ultrasonic sensor is connected to the microcontroller via two pins: the trigger pin and the echo pin. The trigger pin, connected to Pin 23 (A0-14) of the microcontroller, is responsible for sending a signal to the ultrasonic sensor to initiate a distance measurement. The echo pin, connected to Pin 24 (A1-15) of the microcontroller, receives the echo signal from the ultrasonic sensor, which is used to calculate the distance of objects in front of the sensor.

Servo Motor: The servo motor is connected to the microcontroller using a PWM (pulse-width modulation) pin. In this case, the PWM (attach) pin of the servo motor is connected to Pin 11 (~5) of the microcontroller. This pin allows the microcontroller to generate PWM signals, which are used to control the position of the servo motor accurately.

L298N motor driver IC: The L298N motor driver IC is utilized to control the movement of motors. It receives control signals from the microcontroller and provides power to the motors accordingly. The connections between the microcontroller and the L298N motor driver IC involve four input pins and four output pins.

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The four input pins of the L298N motor driver IC are connected to specific pins on the microcontroller. Input 1 (Pin 5) of the L298N is connected to Pin 16 (~10) of the microcontroller, Input 2 (Pin 7) is connected to Pin 17 (MOSI-~-11), Input 3 (Pin 10) is connected to Pin 18 (MISO-12), and Input 4 (Pin 12) is connected to Pin 19 (SCK-13). These connections allow the microcontroller to send control signals to the L298N motor driver IC, which in turn determines the direction of rotation for the connected motors. And also, the L298N motor driver IC has four output pins to which the motors are connected.

The positive terminal of the right-side motor (R) is connected to Out 1 (Pin 2) of the L298N, and the negative terminal of the right-side motor is connected to Out 2 (Pin 3). Similarly, the positive terminal of the left-side motor (L) is connected to Out 3 (Pin 13), and the negative terminal of the left-side motor is connected to Out 4 (Pin 14). These connections allow the L298N motor driver IC to provide power to the motors, enabling them to move forward or backward as per the control signals received from the microcontroller.

The provided schematic diagram demonstrates the connections between an ATMega328PU microcontroller and various components necessary for a specific application. The ultrasonic sensor, servo motor, and L298N motor driver IC are connected to the microcontroller to enable functionalities such as obstacle detection, precise servo motor control, and motor movement in different directions. Each component has specific pins or connections that facilitate communication and control between the microcontroller and the respective component.

IV. RESULTS AND DISCUSSION

The Robot for Obstacle Avoidance project successfully demonstrated the effectiveness of the ultrasonic sensor in enabling a robot to autonomously navigate and avoid obstacles. The project's results provide valuable insights and pave the way for further advancements in the field. By addressing the identified limitations and pursuing the suggested future directions, the obstacle avoidance capabilities of autonomous robots can be further enhanced, opening up new possibilities for their application in various industries. The robot was equipped with the ultrasonic sensor, which was strategically placed to ensure optimal coverage and detection of obstacles. The sensor was connected to the AtMega328PU microcontroller, which acted as the brain of the robot. Additionally, two DC motors were used to control the movement of the robot, and the L298n Motor Driver was employed to interface between the microcontroller and the motors. The Servo Motor was utilized to enable the ultrasonic sensor to scan the environment effectively.

Table 1. Test Analysis of Robot for Obstacle Avoidance

SN.	Obstacles Present/Absent	Robot Action	Next Action
1	Obstacle Absent	Move on Straight Path	-
2	Obstacle Present	Stop and checking both sides	Turn left and move forward
3	Obstacle Present	Stop and checking both sides	Turn right and move forward
4	Obstacle Present	Stop and checking both sides	Move backward

This chart provides a comprehensive overview of how the robot should behave in different situations. The chart lists four scenarios:

1. **Obstacle Absent:** If there is no obstacle in front of the robot, the robot will continue to move forward in a straight line.
2. **Obstacle Present:** If there is an obstacle in front of the robot, the robot will stop and check both sides. If there is more space on one side than the other, the robot will turn in that direction and move forward.
3. **Obstacle Present:** If there is an obstacle in front of the robot and there is equal space on both sides, the robot will turn in the direction of the open space.
4. **Obstacle Present:** If there is an obstacle in front of the robot and there is no open space on either side, the robot will move backward.

   By following this procedure, the robot can safely and effectively avoid obstacles in its path.

- The robot should be able to detect obstacles in front of it, to the left, and to the right.
- The robot should be able to stop and turn in the direction of the open space when it detects an obstacle.
- The robot should be able to move forward when there is no obstacle in its path.

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- The robot should be able to move backward when there is no space to turn.

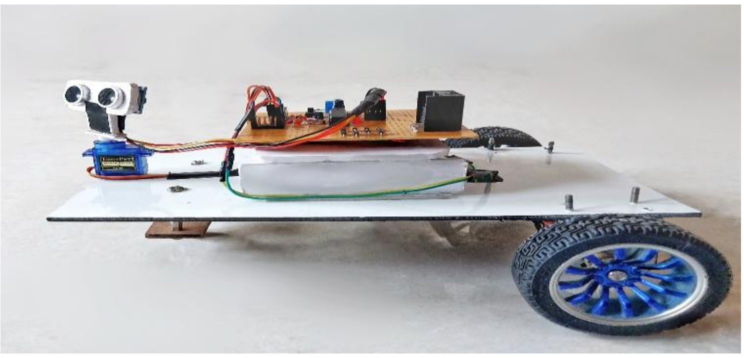

Figure 1: Side View of Robot for Obstacle Avoidance.

V. CONCLUSION

The development of a robot for obstacle avoidance has been successfully achieved through the integration of various components and circuits. By utilizing a microcontroller, ultrasonic range finder sensors, servo motor, motor driver, motors, wheels, and a power source, the robot can autonomously navigate its environment while avoiding collisions with obstacles. The combined circuit of the Atmega328Pu microcontroller and L298n motor driver IC effectively controls the robot's movements. The ultrasonic range finder sensors detect obstacles, enabling the robot to make real-time decisions to avoid them. This project contributes to the field of robotics by demonstrating the practical implementation of an obstacle-avoiding robot, showcasing its potential for various applications such as safety, surveillance, and automation.

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