

Obstacle Avoiding Robot Using Arduino Uno R4 Minima, HC-SR04 Ultrasonic Sensor and L298N Motor Driver

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ABSTRACT- This report describes the design and construction of a small wheeled robot that senses obstacles with an HC-SR04 ultrasonic sensor and stops before hitting them. An Arduino Uno R4 Minima measures distance from the echo time of each ultrasonic pulse and drives two DC motors through an L298N H-bridge driver using PWM. The robot moves forward at a fixed duty cycle and halts when an object lies closer than 20 cm or when no echo returns. The hardware, wiring, working principle, software, build procedure and troubleshooting notes are documented so the project can be reproduced.

Index Terms— Arduino, ultrasonic sensor, HC-SR04, L298N, obstacle avoidance, PWM, mobile robot

I. INTRODUCTION

Obstacle detection is a basic capability of every autonomous mobile robot. Low-cost ultrasonic ranging is a popular way to add it because the sensor is cheap, needs only two digital pins and works regardless of the colour or lighting of the obstacle.

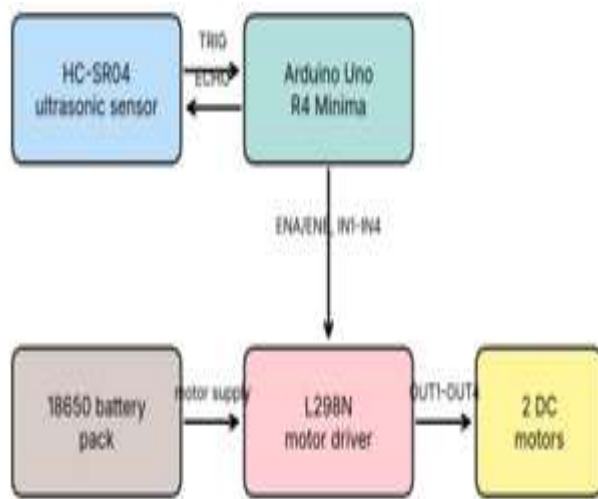


Fig. 1. System block diagram of the obstacle avoiding robot

This project combines such a sensor with a microcontroller and a dual H-bridge driver to build a two-wheel robot that detects an object in its path and brakes in time.

The objectives are: (i) measure distance reliably with the HC-SR04, (ii) control two DC motors with speed control through the L298N, and (iii) stop the robot when the path ahead is blocked.

II. HARDWARE COMPONENTS

Each component of the build is described below, with a drawing of the part.

1. Chassis with two DC motors

A two-wheel acrylic chassis carries all parts. Two yellow gear motors drive the left and right wheels independently and a passive caster ball at the rear keeps the platform level. Independent drive allows the robot to move forward and, in later versions, to turn by differential speed.

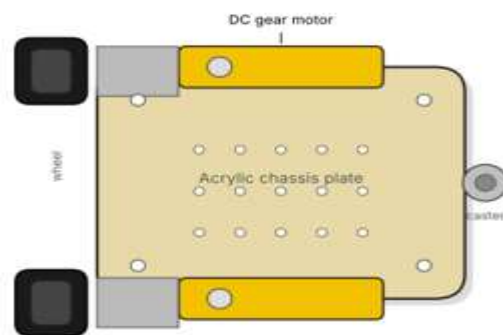


Fig. 2. Chassis with two DC gear motors, wheels and rear caster.

2. Arduino Uno R4 Minima

The Arduino Uno R4 Minima is the controller. Its Renesas RA4M1 microcontroller generates the trigger pulse, measures the echo, decides whether the path is free and outputs the PWM and direction signals. It is programmed through the USB-C port with the Arduino IDE

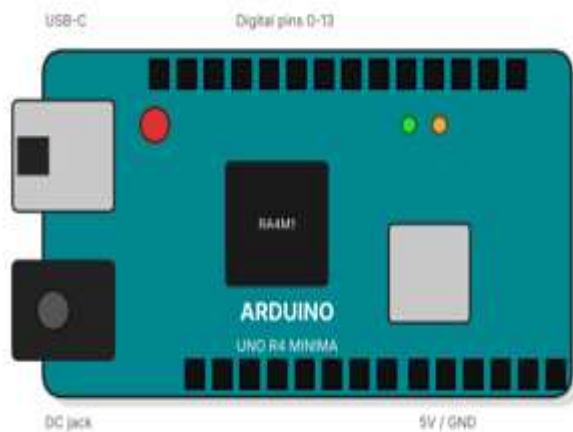


Fig. 3. Arduino Uno R4 Minima board.

3. L298N motor driver

The L298N contains two H-bridges, so it can drive two DC motors in both directions. ENA and ENB accept PWM for speed control, while IN1-IN4 select the direction of each motor. The Arduino pins cannot supply motor current directly, so the driver is needed as an interface to the battery.

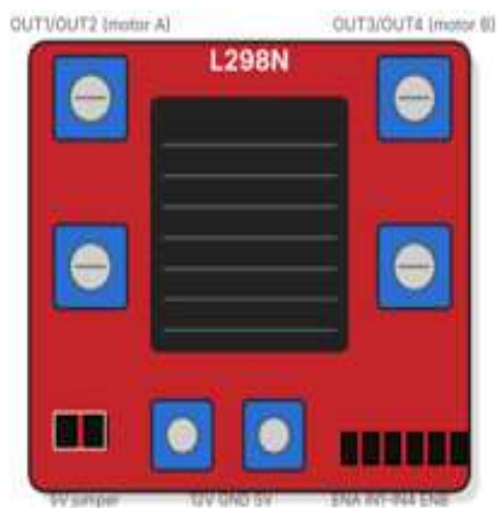


Fig. 4. L298N dual H-bridge motor driver module.

4. HC-SR04 ultrasonic sensor

The HC-SR04 has a transmitter (TX) and a receiver (RX) capsule. It sends a 40 kHz burst when TRIG is pulsed and raises ECHO for a time equal to the round trip of the sound. Its useful range is about 2 cm to 400 cm.

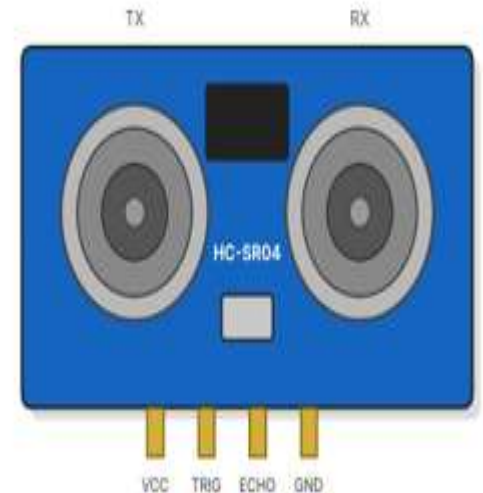


Fig. 5. HC-SR04 ultrasonic distance sensor with VCC, TRIG, ECHO and GND pins.

5. 18650 battery holder and cells

Rechargeable 18650 Li-ion cells in a holder power the motors through the L298N. Using a separate battery pack keeps the motor current away from the USB supply of the Arduino.

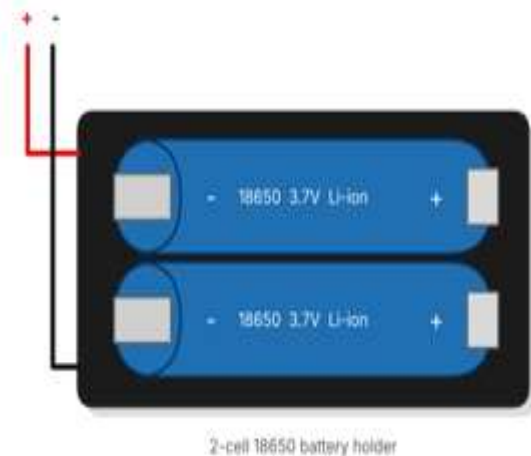
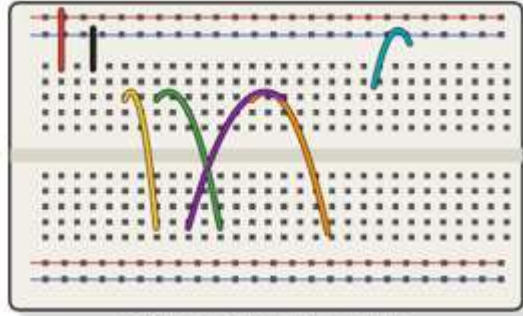


Fig. 6. Two-cell 18650 battery holder with cells.

6. Breadboard and jumper wires

A solderless breadboard and male-to-male jumper wires connect the sensor and the Arduino and provide shared power and ground rails without soldering, so the circuit can be changed easily.



Solderless breadboard with jumper wires

A USB cable connects the Arduino to the computer for programming and serial monitoring.

III. CIRCUIT CONNECTIONS

Table I lists the connections used in the code, and Table II gives the L298N direction logic

Table I
Pin Connections.

From	To	Function
HC-SR04 VCC / GND	Arduino 5V / GND	Sensor supply
HC-SR04 TRIG	Arduino D3	Trigger pulse
HC-SR04 ECHO	Arduino D4	Echo timing
L298N ENA	Arduino D5 (PWM)	Motor A speed
L298N ENB	Arduino D6 (PWM)	Motor B speed
L298N IN1-IN4	Arduino D8-D11	Motor direction
L298N OUT1/OUT2	Left motor	Motor A
L298N OUT3/OUT4	Right motor	Motor B
Battery + / -	L298N 12V / GND	Motor supply
Arduino GND	L298N GND	Common ground

Table II
L298n Direction Logic (One Motor)

INx	INy	Motor
HIGH	LOW	Forward
LOW	HIGH	Reverse
LOW	LOW	Stop
HIGH	HIGH	Brake

All grounds must be common, otherwise the logic levels are not referenced to each other and the motors behave erratically.

IV. WORKING PRINCIPLE

The Arduino holds TRIG low for a few microseconds, then high for 10 μ s. The sensor emits a burst and sets ECHO high until the reflection returns. If t is the ECHO pulse width, the distance is

$$d = (t \times 0.0343) / 2 \text{ (cm, } t \text{ in } \mu\text{s)}$$

where 0.0343 cm/ μ s is the speed of sound in air at about 20 $^{\circ}$ C, and the division by two accounts for the round trip. The control logic is:

- Measure the distance d using pulseIn with a timeout.
- If $d < 20$ cm, or no echo returns (timeout), stop both motors.
- Otherwise drive both motors forward at PWM 220 (about 86 % duty cycle).
- Repeat continuously.

V. SOFTWARE DESCRIPTION

The sketch (Appendix A) has four parts. Setup configures the sensor and motor pins as outputs or inputs and opens the serial port. getDistance() generates the trigger pulse, reads the echo width with a timeout and returns the distance in centimetres. moveForward() and stopMotors() set the direction pins and the PWM level on ENA and ENB. The loop calls getDistance() and chooses between the two actions. A distance of zero (timeout) is treated as unsafe, so the robot stops when the sensor is blocked, disconnected or pointing at an absorbing surface.

Note that the present code only stops at an obstacle. It does not steer around it. A LabVIEW interface for monitoring the data is described in Appendix B.

VI. BUILD AND REPLICATION STEPS

- Mount the two motors and the caster on the chassis and attach the wheels.
- Fix the Arduino, L298N, breadboard and battery holder on the plate.
- Wire the motors to OUT1-OUT4 of the L298N.
- Connect IN1-IN4 to D8-D11 and ENA, ENB to D5 and D6.
- Connect the HC-SR04: VCC to 5V, GND to GND, TRIG to D3, ECHO to D4, facing forward.

- Connect the battery to the L298N supply terminal and join all grounds.
- Upload the sketch from Appendix A over USB and check the distance in the Serial Monitor (115200 baud) or in the LabVIEW VI.
- Disconnect USB, switch on the battery supply and place the robot on the floor.
- Place a hand or box ahead and confirm that the robot stops within 20 cm.

VII. RESULTS AND DISCUSSION

In testing, the robot moved straight ahead and stopped when an object was brought in front of the sensor (qualitative observation; no distance measurements were recorded). The robot also stops when the echo is lost. The sensor works best with flat, hard surfaces facing it. Soft or angled surfaces can reflect sound away and give a missing or wrong reading.

Table III Troubleshooting

Problem	Likely cause / fix
Robot never moves	Distance reads 0: check TRIG/ECHO wires and sensor 5V.
Motors do not spin	Battery low, ENA/ENB not on PWM pins, or grounds not common.
One wheel reversed	Swap that motor's two wires on the L298N output.
Arduino resets	Motor current dips the supply; use a fresh battery and a separate supply.
Erratic distance	Soft or angled obstacle; keep sensor level and add a short delay.

The robot only stops; it does not turn. Extending the program to reverse and turn left or right, adding a servo-mounted sensor to scan both sides, filtering the readings with a median of several samples and using a PID speed loop are natural improvements.

VIII. LIMITATIONS AND FUTURE WORK

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VII. CONCLUSION

A low-cost obstacle detecting robot was built from an Arduino Uno R4 Minima, an HC-SR04 and an L298N driver. It measures distance from the echo time and stops reliably when the path is blocked, which gives a solid base for full autonomous navigation

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