**System architecture**

This section provides a detailed description of the hardware wiring configuration between the Raspberry Pi 5, the motor driver modules (L298N), and the ultrasonic sensors (HC-SR04). The system utilizes two L298N motor drivers to independently control the four-wheel drive motors, while three ultrasonic sensors are used for real-time obstacle detection. Each module is connected to the Raspberry Pi's GPIO pins through designated physical pin mappings to ensure stable control and data acquisition. The wiring tables below outline the specific GPIO assignments for all modules.

**1️⃣ L298N A Module Wiring**

|  |  |  |  |
| --- | --- | --- | --- |
| Function | L298N A Pin | Raspberry Pi GPIO (BCM) | Raspberry Pi Physical Pin |
| Left Front Wheel Direction Control 1 | IN1 | GPIO17 | Pin 11 |
| Left Front Wheel Direction Control 2 | IN2 | GPIO18 | Pin 12 |
| Right Front Wheel Direction Control 1 | IN3 | GPIO27 | Pin 13 |
| Right Front Wheel Direction Control 2 | IN4 | GPIO22 | Pin 15 |
| Left Front Wheel PWM (Speed Control) | ENA | GPIO12 (PWM) | Pin 32 |
| Right Front Wheel PWM (Speed Control) | ENB | GPIO13 (PWM) | Pin 33 |
| Motor Power Input | VCC | External Battery Positive | — |
| Motor Power Ground | GND | Raspberry Pi GND (Common Ground) | Pin 6 / 14 etc |

**2️⃣ L298N B Module Wiring**

|  |  |  |  |
| --- | --- | --- | --- |
| Function | L298N B Pin | Raspberry Pi GPIO (BCM) | Raspberry Pi Physical Pin |
| Left Rear Wheel Direction Control 1 | IN1 | GPIO5 | Pin 29 |
| Left Rear Wheel Direction Control 2 | IN2 | GPIO6 | Pin 31 |
| Right Rear Wheel Direction Control 1 | IN3 | GPIO19 (PWM) | Pin 35 |
| Right Rear Wheel Direction Control 2 | IN4 | GPIO26 | Pin 37 |
| Left Rear Wheel PWM (Speed Control) | ENA | GPIO20 (PWM) | Pin 38 |
| Right Rear Wheel PWM (Speed Control) | ENB | GPIO21 (PWM) | Pin 40 |
| Motor Power Input | VCC | External Battery Positive | — |
| Motor Power Ground | GND | Raspberry Pi GND (Common Ground) | Pin 6 / 14 etc |

**3️⃣ Front Ultrasonic Sensor Wiring**

|  |  |  |  |
| --- | --- | --- | --- |
| Function | HC-SR04 Pin | Raspberry Pi GPIO (BCM) | Raspberry Pi Physical Pin |
| TRIG | TRIG | GPIO20 | Pin 38 |
| ECHO | ECHO (Voltage Divider) | GPIO21 | Pin 40 |
| Power | VCC | 5V | Pin 2 / 4 |
| Ground | GND | GND | Pin 6 / 14 / 39 |

**4️⃣ Left Ultrasonic Sensor Wiring**

|  |  |  |  |
| --- | --- | --- | --- |
| Function | HC-SR04 Pin | Raspberry Pi GPIO (BCM) | Raspberry Pi Physical Pin |
| TRIG | TRIG | GPIO23 | Pin 16 |
| ECHO | ECHO (Voltage Divider) | GPIO24 | Pin 18 |
| Power | VCC | 5V | Pin 2 / 4 |
| Ground | GND | GND | Pin 6 / 14 / 39 |

**5️⃣ Right Ultrasonic Sensor Wiring**

|  |  |  |  |
| --- | --- | --- | --- |
| Function | HC-SR04 Pin | Raspberry Pi GPIO (BCM) | Raspberry Pi Physical Pin |
| TRIG | TRIG | GPIO25 | Pin 22 |
| ECHO | ECHO (Voltage Divider) | GPIO26 | Pin 37 |
| Power | VCC | 5V | Pin 2 / 4 |
| Ground | GND | GND | Pin 6 / 14 / 39 |

**6️⃣ Raspberry Pi 5 GPIO Pinout Diagram**

The following diagram illustrates the Raspberry Pi 5 GPIO header layout, showing both the physical pin numbers (1–40) and the corresponding BCM GPIO numbers. This diagram serves as a reference for understanding the pin assignments used in the wiring tables below.

