### 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.

#### 1 L298N A Module Wiring

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

#### 2 L298N B Module Wiring

Function	L298N B	Raspberry Pi GPIO	Raspberry Pi
	Pin	(BCM)	Physical Pin
Left Rear Wheel Direction	IN1	GPIO5	Pin 29
Control 1			
Left Rear Wheel Direction	IN2	GPIO6	Pin 31
Control 2			
Right Rear Wheel Direction	IN3	GPIO19 (PWM)	Pin 35
Control 1			

Right Rear Wheel Direction	IN4	GPIO26	Pin 37		
Control 2					
Left Rear Wheel PWM	ENA	GPIO20 (PWM)	Pin 38		
(Speed Control)					
Right Rear Wheel PWM	ENB	GPIO21 (PWM)	Pin 40		
(Speed Control)					
Motor Power Input	VCC	External Battery Positive			
Motor Power Ground	GND	Raspberry Pi GND	Pin 6 / 14 etc		
		(Common Ground)			

## 3 Front Ultrasonic Sensor Wiring

Function	HC-SR04 Pin	Raspberry	Pi	GPIO	Raspberry	Pi	Physical
		(BCM)			Pin		
TRIG	TRIG	GPIO20			Pin 8		
ECHO	ECHO (Voltage	GPIO21			Pin 10		
	Divider)						
Power	VCC	5V			Pin 2 / 4		
Ground	GND	GND			Pin 6 / 14 / 3		

# 1 Left Ultrasonic Sensor Wiring

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

# **Sample 1** Right Ultrasonic Sensor Wiring

Function	HC-SR04 Pi	n	Raspberry	Pi	GPIO	Raspberry	Pi	Physical
			(BCM)			Pin		
TRIG	TRIG		GPIO25			Pin 22		
ECHO	ECHO	(Voltage	GPIO26			Pin 36		
	Divider)							
Power	VCC		5V			Pin 2 / 4		
Ground	GND		GND			Pin 6 / 14 /		

### 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.

