

Ultrasonic

Ultrasonic Sensors (HC-SR04): Comprehensive ToF Ranging System

The robot is equipped with a total of four HC-SR04 Ultrasonic Sensors that form the primary short-range ranging system. These sensors provide the vehicle with echolocation capabilities, on par with how bats and dolphins locate objects in complete darkness and beneath the water surface. This array is fundamental for robust, real-time obstacle avoidance and precise navigation .along the course boundaries

Strategic Implementation and System Integration

The four HC-SR04 sensors are strategically positioned to maximize situational awareness: one mounted in the front, one in the rear, and one on each of the right and left sides of the chassis. This arrangement minimizes blind spots and provides the angular data necessary for .advanced Sensor Fusion

Power and Interface: The sensors require a stable +5V regulated supply, drawing less than 15mA each. Each sensor utilizes two dedicated GPIO pin (Trigger and Echo) on the Raspberry Pi for control and data .acquisition

Sensor Fusion Role: The simultaneous input from four points allows the control system to accurately determine both the distance and the angular position of an obstacle. This redundancy is vital for high-reliability autonomy, allowing the algorithm to differentiate between a critical

frontal obstacle and a simple boundary wall alongside the .vehicle

Principle of Operation and Technical Specification

The HC-SR04 module operates on the principle of measuring the Time-of-Flight (ToF) of an ultrasonic .sound wave

1. Triggering: Measurement begins when the Raspberry Pi sends a minimum 10uS high pulse to the Trigger pin, prompting the transmitter to emit an 8-cycle burst of .ultrasonic sound at 40kHz

2. Echo Reception: The sound wave reflects off an object, and the duration it takes to return is measured. The sensor outputs a high pulse on the Echo pin, the width of which is directly proportional to the distance

3. Calculation: The Raspberry Pi measures this pulse width (time), and the distance is calculated using the formula

Distance = Speed \times Time, divided by two since the time .measured is for the signal's round trip

The sensor boasts a practical measuring range of 2cm to 400cm and an accuracy that can reach 3mm. This combination of range and precision makes it perfectly suited for the short-range, dynamic obstacle avoidance challenges presented in the competition course

HC-SR04 Pinout

Crystal Oscillator (4 MHz)

www.TheEngineeringProjects.com

Transmitter for
Ultrasonic Waves

Receiver for
Ultrasonic Waves



Vcc (+5V)

GND (Connected to 0V or Ground)

Trig (Input Pin)

Echo (Output Pin)