AMRUTVAHINI COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING DEPARTMENT
SUBJECT- ELECTRICAL/ELECTRONICS AND COMPUTER INTERFACING TECHNOLOGY LAB

Title of Experiment:

Interfacing IR or Ultrasonic Sensor for Distance Measurement (Using HC-SR04)

Aim:

To interface an HC-SR04 ultrasonic sensor with Arduino, measure the distance using time of flight principle, and display the result in centimeters on Serial Monitor or LCD.

Apparatus:

- Arduino Uno board
- HC-SR04 ultrasonic sensor
- Breadboard
- Jumper wires
- 16x2 LCD (optional)
- 10kΩ potentiometer (for LCD contrast)
- USB cable
- Arduino IDE installed on PC

Precautions:

1. Ensure correct pin connections: Vcc, GND, Trig, and Echo.
2. Avoid placing the sensor near noisy or reflective surfaces.
3. Power the circuit only after double-checking the connections.
4. Do not touch the sensor while it is powered.
5. Keep the target object directly in front of the sensor for accurate readings.

Theory:

The **HC-SR04 ultrasonic sensor** works on the **time-of-flight principle**. It emits an ultrasonic sound pulse via the **Trig pin** and receives the reflected echo via the **Echo pin**.

- The time taken for the echo to return is proportional to the distance.
- The formula to calculate distance is:

$$\text{Distance (cm)} = \left(\frac{\text{Time (µs)} \times 0.0343}{2}\right)$$

  - The factor 0.0343 cm/µs is the speed of sound in air (343 m/s).

Circuit Diagram:

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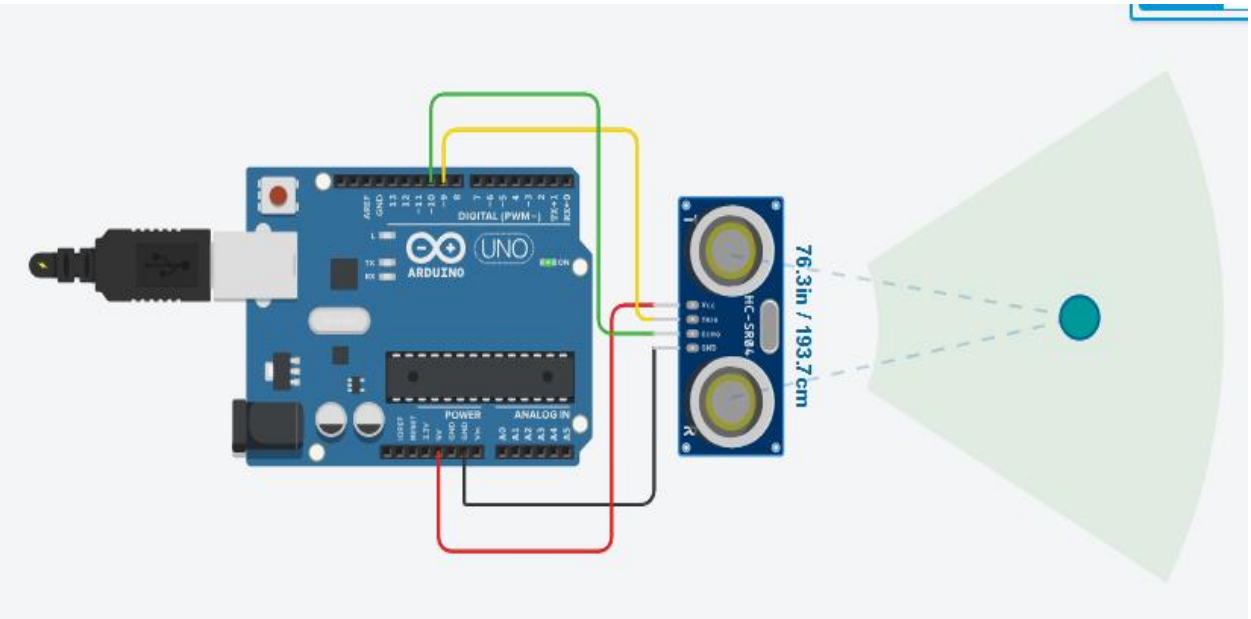
HC-SR04 Pinout:

- Vcc → 5V
- GND → GND
- Trig → Digital Pin 9
- Echo → Digital Pin 10

If using LCD:

- Connect 16x2 LCD as per standard configuration (RS, EN, D4–D7).

Circuit Diagram:



Procedure:

1. Connect the HC-SR04 sensor to the Arduino as per the circuit.
2. (Optional) Connect the 16x2 LCD using standard pin configuration.
3. Open Arduino IDE and write/upload code to read the distance.
4. Open Serial Monitor (or view LCD) to observe the distance output in cm.
5. Place objects at different distances to observe real-time measurements.

Arduino Programming

```
const int trigPin = 9;   // Trig pin connected to digital pin 9

const int echoPin = 10;  // Echo pin connected to digital pin 10


long duration;          // Variable to store pulse duration

float distanceCm;       // Variable to store calculated distance
```

```
void setup() {
  pinMode(trigPin, OUTPUT);  // Set Trig as output
  pinMode(echoPin, INPUT);   // Set Echo as input
  Serial.begin(9600);        // Start Serial communication
}

void loop() {
  // Send a 10µs HIGH pulse to trigger the ultrasonic burst
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Measure the time for echo to return
  duration = pulseIn(echoPin, HIGH);  // Time in microseconds

  // Calculate distance using speed of sound
  distanceCm = (duration * 0.0343) / 2;  // Divide by 2 for round-trip

  // Display the distance
  Serial.print("Distance: ");
```

```
  Serial.print(distanceCm);

  Serial.println(" cm");

  delay(500);  // Wait half a second before next reading

}
```

Conclusion:

In this experiment, the HC-SR04 ultrasonic sensor was successfully interfaced with Arduino. The sensor emitted sound pulses and measured the time taken for the echo to return. This time was used to calculate and display the distance on the Serial Monitor. It demonstrated a practical example of non-contact distance measurement.

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4 Short Questions and Answers:

Q1: What is the function of the Trig and Echo pins in the HC-SR04 sensor?
Answer: The Trig pin sends the ultrasonic pulse, and the Echo pin receives the reflected pulse.

Q2: How is distance calculated from time in this experiment?
Answer: Distance is calculated using the formula:

Distance (cm)=(Time (µs)×0.0343)/2\text{Distance (cm)} = \left(\text{Time (µs)} \times 0.0343 \right) / 2Distance (cm)=(Time (µs)×0.0343)/2

Q3: Why do we divide the product of time and speed by 2?
Answer: The pulse travels to the object and back, so the time is for a round-trip. Dividing by 2 gives the one-way distance.

Q4: What is the range of the HC-SR04 sensor?
Answer: The typical range is from **2 cm to 400 cm** with good accuracy.