Report

Analysis of the Distance using a Ultrasonic Sensor

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Introduction

1.1 **Ultrasonic Ranging Module (HC-SR04):**

The HC-SR04 Ultrasonic Ranging Module is a sensor used for detecting the distance to an object using sonar. The module consists of an ultrasonic transducer that can both emit and receive ultrasonic waves. The transducer typically operates at a frequency of around 40 kHz. It provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. To measure distance, the HC-SR04 sends out a short pulse of ultrasonic sound (an ultrasonic burst). This module operates at 5V DC and has two main pins: Trigger for sending the ultrasonic pulse and Echo for receiving the reflected signal. To measure distance, you typically send a short 10 microsecond pulse to the Trigger pin. The module then sends out an ultrasonic pulse and starts a timer. When the reflected pulse is received, the Echo pin goes high. By measuring the time, the Echo pin stays high, you can calculate the distance.

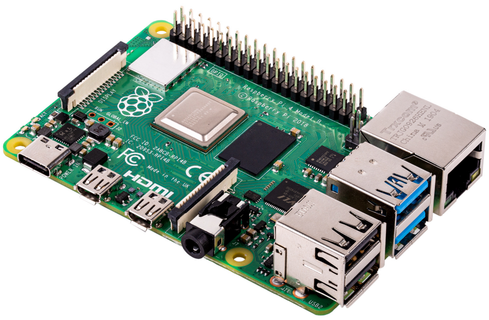
The HC-SR04 Ultrasonic Range Module Features:

- Input Voltage: 5V
- Current Draw: 20mA (Max)
- Digital Output: 5V
- Digital Output: 0V (Low)
- Working Temperature: -15°C to 70°C
- Sensing Angle: 30° Cone
- Angle of Effect: 15° Cone
- Ultrasonic Frequency: 40kHz

- Range: 2 cm - 400 cm
- Dimensions
  - Length: 43mm
  - Width: 20mm
  - Height (with transmitters): 15mm
  - Centre screw hole distance: 40mm x 15mm
  - Screw hole diameter: 1mm (M1)
  - Transmitter diameter: 8mm

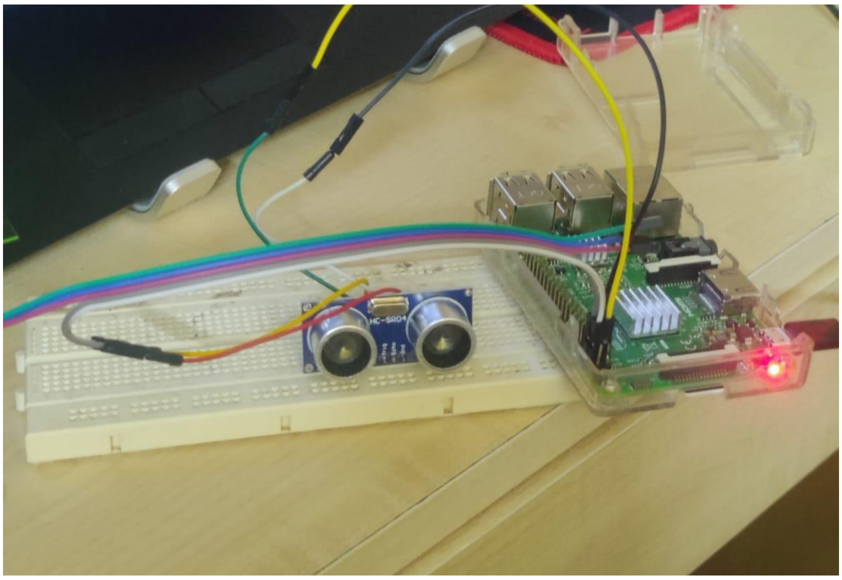
1.2 The Raspberry Pi

Raspberry Pi, that it is commonly known as, is a low-cost ARM GNU/Linux box. Hardly the size of a credit card, this single board computer developed in the UK can be plugged into a computer screen or TV and can function on a standard keyboard and mouse.Launched with the basic idea to educate basic computer science in schools and developing countries, several generations of Raspberry Pi have been released till now. These boards are available in various price ranges from $6 to up to $100 and even more based on various features. The design of Raspberry Pi is based on a Broadcom BCM2835 system on a chip (SoC) including ARM compatible CPU with a speed ranging from 700 MHz to 1.2 GHz for the Pi 3 along with an on chip GPU. The on board memory might range from 256MB to 1 GB RAM. The Raspberry Pi is a versatile and low-cost platform that is widely used in Internet of Things (IoT) applications. Its small size, GPIO pins for sensor interfacing, and powerful processing capabilities make it an excellent choice for collecting sensor data, controlling devices, and sending data to the cloud. The Raspberry Pi serves as a powerful IoT gateway, allowing the creation of interconnected systems that collect, analyse, and act on data from the physical world, making it a popular choice for IoT enthusiasts and professionals alike.



2 . Methodology

Experiment Setup:



Experiment Ideology:

- We used an HC-SR04 Sensor to detect the distance and the change in distance of objects present in front of it.

3. Requirements for the code:

Make sure you have the Adafruit GPIO library installed. You can install it using pip if it's not already installed:

- pip install adafruit-blinka

The code initialises the ultrasonic sensor, continuously measures the distance, and prints it to the console. It will keep running until you stop it with a keyboard interrupt (Ctrl+C).

4.Working of the Code:

The Python code interfaces with an ultrasonic sensor (HC-SR04) and uses the Adafruit Blinka and Adafruit CircuitPython HC-SR04 libraries to measure and display the distance detected by the sensor in centimetres.

Detailed Description of the code:

- Imports Libraries:
  - ➔ Import the necessary Python libraries, including ‘time’ for time management, ‘csv’ for CSV file handling, and the required Adafruit libraries for GPIO and sensor interfacing.
- GPIO and Sensor Initialization:
  - ➔ Initialize GPIO pins for the ultrasonic sensor's trigger and echo pins.
  - ➔ Create an instance of the ‘HCSR04’ class to interface with the ultrasonic sensor.
- CSV File Setup:
  - ➔ Specify the filename for the CSV file as ‘distance_data.csv’.
  - ➔ Use a ‘with’ statement to open the CSV file for writing (‘mode='w'’).
  - ➔ Create a CSV writer object to write data to the file.
  - ➔ Write a header row with column names: "Timestamp" and "Distance (cm)".
- Data Collection Loop:
  - ➔ Enter a continuous loop using ‘while True:’ to repeatedly collect and save distance data.
- Timestamp and Distance Measurement:
  - ➔ Get the current timestamp in the format "YYYY-MM-DD HH:MM:SS" using ‘time.strftime’.
  - ➔ Measure the distance in centimetres using the ultrasonic sensor and store it in the ‘distance’ variable.
  - ➔ Print the timestamp and distance to the console for real-time monitoring.
- Write Data to CSV:
  - ➔ Write the timestamp and distance to the CSV file using the ‘csv_writer.writerow’ method. This appends a new row to the CSV file with each iteration.
- Delay Between Measurements:
  - ➔ Introduce a 1-second delay using ‘time.sleep(1)’ to control the measurement frequency. You can adjust this delay to change the frequency.
- Exception Handling:
  - ➔ Handle a keyboard interrupt (‘KeyboardInterrupt’) to allow the user to stop the program gracefully with Ctrl+C.
- Cleanup:
  - ➔ Deinitialize the sensor and clean up GPIO pins (‘sensor.deinit()’) before exiting the program.

The code continuously collects distance measurements from the ultrasonic sensor, records the timestamp, and saves this data to a CSV file. This format allows you to log and analyse the data over time.

5.Results:

Here is a subset of results that we got.

Timestamp, Distance (cm):

2023-09-27 18:34:19, 45.2

2023-09-27 18:34:20, 44.9

2023-09-27 18:34:21, 40.7

2023-09-27 18:34:22, 39.5

2023-09-27 18:34:23, 37.3