IC231 Spring 2022 – Lab 2 – Distance Measurement I

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In this lab you will learn the fundamentals to use an ultrasound distance measurement module (HC-SR04) to measure the distance of an object using time-of-flight measurement

Learning outcomes

In this lab, you will learn how to operate on the

- How to drive the HC-SR044 module to measure distance
  - How to generate a trigger pulse.
  - How the Transmit mode is triggered
  - How to measure time of flight
- Limitation of the module
  - How to measure minimal resolution

Tasks

1. Complementing the python code by select the correct pins for TRIG and ECHO according to circuit connection instructions. Generate a single trigger pulse of 10 µs pulse width and measure the travel time.
2. Modify the code in a way# that the flight time and the distance of the object (in mm with 1 decimal point accuracy) is printed
3. Uncomment the scope code. Measure the trigger pulse (channe11) and echo pulse (ch 2) with the oscilloscope. Take care of correct trigger setting, vertical and horizontal scaling and the offsets.
4. Change the trigger pulse duration to 100 µs and 1 ms and record the trigger and echo. How does the echo pulse depend on trigger pulse?
5. Measure the distance repeatedly with a cycle of 10 times per second and continuously print the result for every measurement for 20 seconds. Store the data points in a vector and plot the data vector. Is the measurement stable? (For this scope reading is not required!)

Task completion criteria

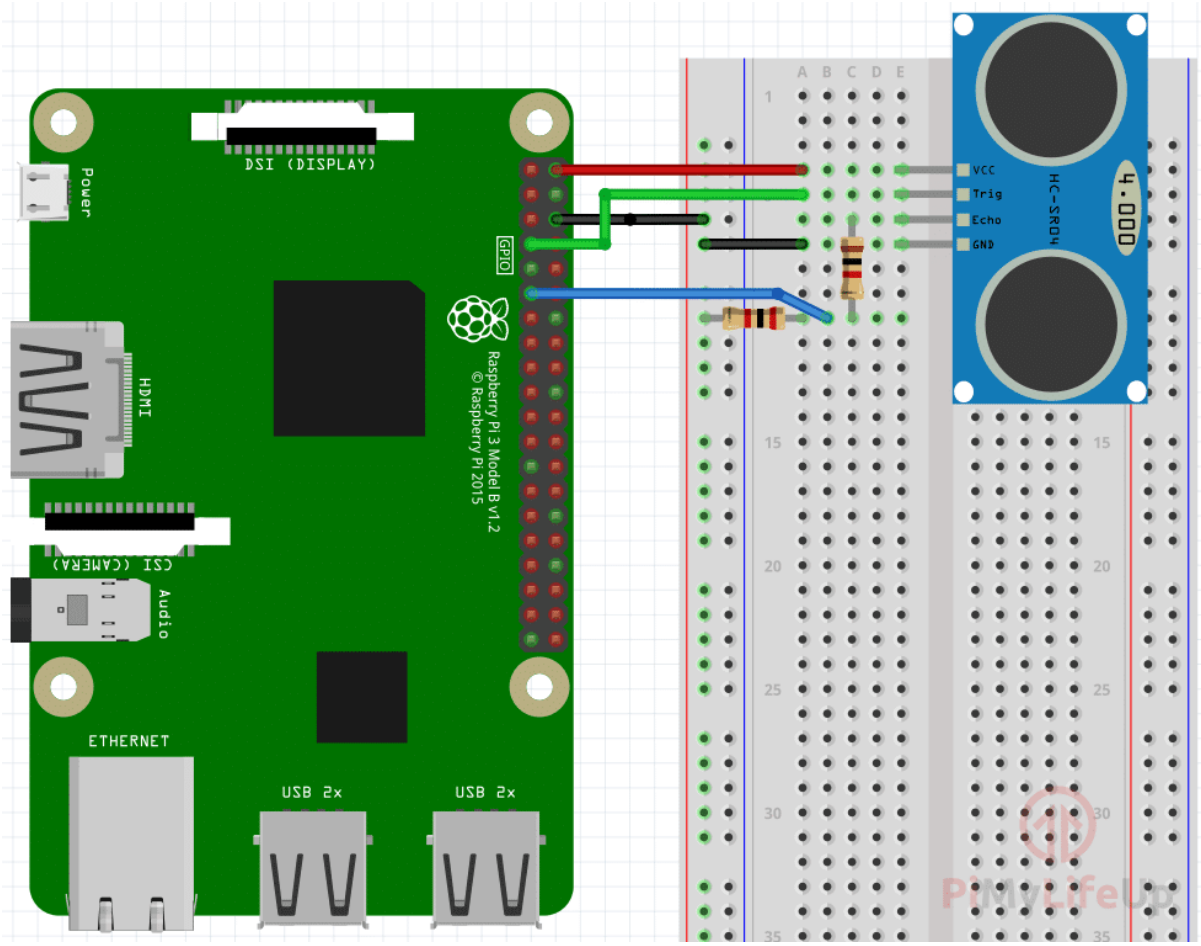
1. Generate a trigger pulse of 10 µs and measure the time of flight
2. Displays the distance of the object measured by the module
3. Record the trigger pulse and the echo pulse using the oscilloscope
4. Present all the recordings with full acquisition of pulses
5. Acquire continuous time-of-flight data.

Pre-reading

- The working principle, applications and limitations of ultrasonic sensors
  - ➔ https://www.microcontrollertips.com/principle-applications-limitations-ultrasonic-sensors-faq/
  - ➔ https://pimylifeup.com/raspberry-pi-distance-sensor/

- User manual of HC-SR04:
  ➔ https://www.mpja.com/download/hc-sr04_ultrasonic_module_user_guidejohn.pdf
- Speed of sound in air:
  ➔ https://pages.mtu.edu/~suits/SpeedofSound.html

Circuit connection instructions:



Adapted from: https://pimylifeup.com/raspberry-pi-distance-sensor/

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1. Connect the VCC pin of the sensor module to a 5V pin of the Pi.
2. Connect the TRIG pin of the sensor module to a GPIO pin.
3. Connect the ECHO pin of the sensor module to a Pi ground pin by using by two resistances in series (1k and 2k), hence make a voltage divider.
4. Connect a GPIO pin to the voltage divider (between the 1k and 2k resistor)
5. Connect the GND pin of the sensor module to a ground pin of the Pi.

Instructions

1. Wait for your TA to signal that the circuit connection is complete.
2. Log on to the Raspberry Pi using VNC Viewer on your computer.
3. Write the program onto the Thonny IDE on the Raspberry Pi.
4. If you run into any issues, ask your TA/Instructor.

5. Recommendations: Generate for each task a new .py-file. In case something goes wrong you can go back to the previous working file.

Challenge exercise

The task is to count the people that are coming in and to count the people that are leaving a shop through a door. Assume a distance sensor is placed inside the room on the room ceiling with one meter distance to the entrance. Hence, it can detect people that go through the entrance and measure the distance in a certain range. Create an acquisition scheme that can count the number of incoming and outgoing people.