BRAC UNIVERSITY

Inspiring Excellence

Department of Computer Science and Engineering

Course Code: CSE461	Credits: 1.5
Course Name: Introduction to Robotics Lab	Semester: Spring 23

Lab 2

Measuring distance using ultrasonic sensor.

I. Topic Overview:

In this lab report, we will be discussing the process of measuring distance using an ultrasonic sensor with the help of a Raspberry Pi. Ultrasonic sensors are a common type of sensor that are used for measuring distances by sending out sound waves and measuring the time it takes for them to bounce back. Raspberry Pi is a small, affordable computer that can be used for various purposes such as programming, robotics, and education. The aim of this lab is to demonstrate how to use an ultrasonic sensor with Raspberry Pi to measure distance accurately.

III. Learning Outcome:

After this lecture, the students will be able to:

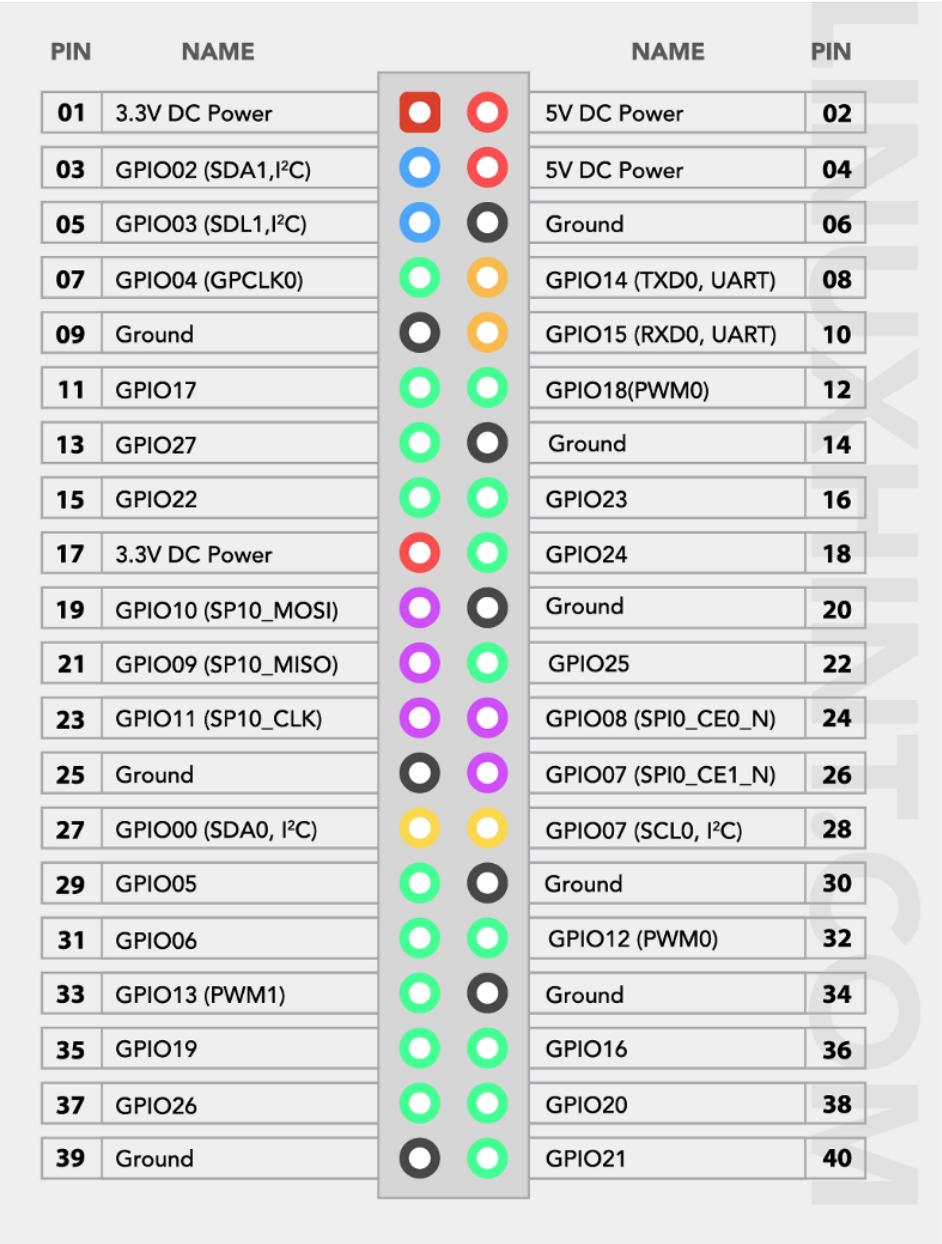
a. Understanding the basic principles of ultrasonic sensors and how they can be used to measure distance.

b. Familiarizing oneself with the Raspberry Pi and its components, including the GPIO pins and how to connect sensors to them.

c. Learning how to install Python libraries on the Raspberry Pi and how to create and run Python programs using the terminal.

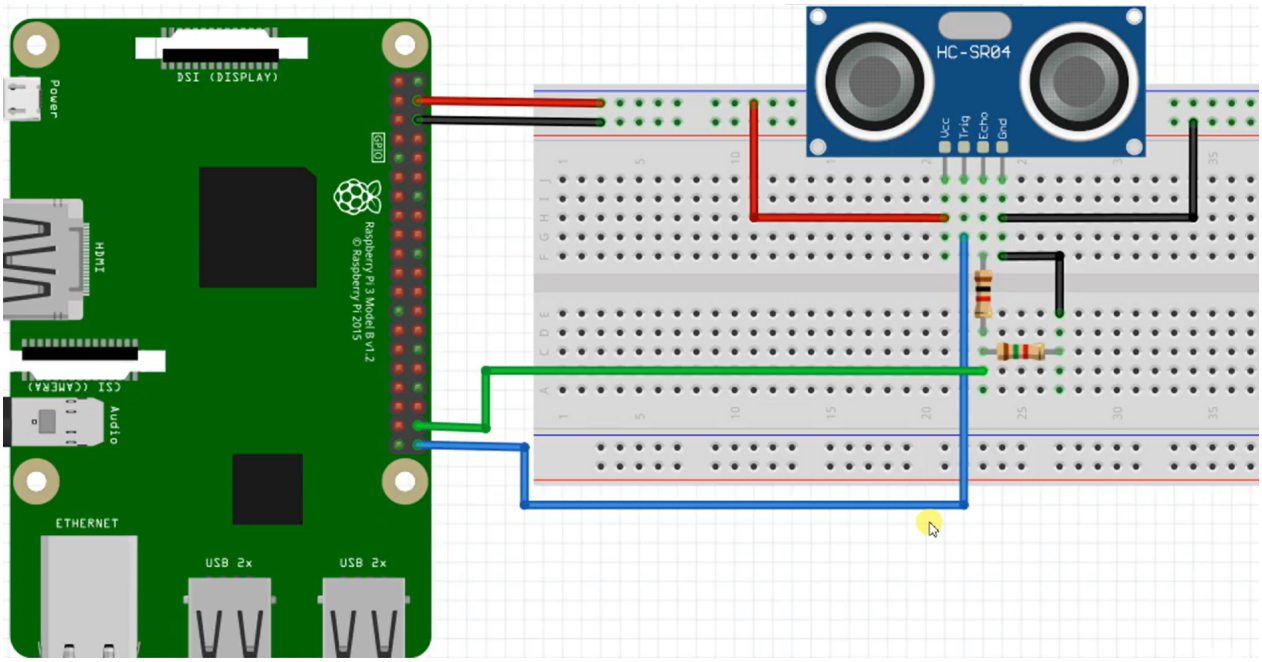
d. Gaining hands-on experience with coding in Python to measure distance using the ultrasonic sensor with the Raspberry Pi.
e. Understanding the importance of accuracy in distance measurement and how to test the accuracy of the sensor in various scenarios.
f. Acquiring problem-solving skills by troubleshooting any issues that may arise during the setup and testing process.

The Raspberry Pi 4 has 40 GPIO pins that can be easily configured to read inputs or write outputs.



PIN	NAME		NAME	PIN
01	3.3V DC Power		5V DC Power	02
03	GPIO02 (SDA1,I²C)		5V DC Power	04
05	GPIO03 (SDL1,I²C)		Ground	06
07	GPIO04 (GPCLK0)		GPIO14 (TXD0, UART)	08
09	Ground		GPIO15 (RXD0, UART)	10
11	GPIO17		GPIO18(PWM0)	12
13	GPIO27		Ground	14
15	GPIO22		GPIO23	16
17	3.3V DC Power		GPIO24	18
19	GPIO10 (SP10_MOSI)		Ground	20
21	GPIO09 (SP10_MISO)		GPIO25	22
23	GPIO11 (SP10_CLK)		GPIO08 (SPI0_CE0_N)	24
25	Ground		GPIO07 (SPI0_CE1_N)	26
27	GPIO00 (SDA0, I²C)		GPIO07 (SCL0, I²C)	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12 (PWM0)	32
33	GPIO13 (PWM1)		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40

Circuit:



Components required for the setup:

For controlling the LED with a push button on the Raspberry Pi 4, we need the following electronic components:

- **Raspberry Pi**
- **Ultrasonic Sensor (HC-SR04)**
- **Breadboard**
- **Jumper Wires**
- **1k and 1.5k resistor**
- **MicroSD Card**
- **USB Cable**
- **Monitor, Keyboard, and Mouse (Optional)**

The code:

```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BCM)

TRIG = 21
ECHO = 20

GPIO.setup(TRIG,GPIO.OUT)
GPIO.setup(ECHO,GPIO.IN)

def distance():
        GPIO.output(TRIG, False)
        time.sleep(0.5)
        GPIO.output(TRIG, True)
        time.sleep(0.00001)
        GPIO.output(TRIG, False)
        pulse_start = time.time()
        while GPIO.input(ECHO)==0:
                pulse_start = time.time()
        while GPIO.input(ECHO)==1:
                pulse_end = time.time()
        pulse_duration = pulse_end - pulse_start
        distance = pulse_duration * 17150
        distance = round(distance, 2)

        return distance

print(distance())

GPIO.cleanup()
```

Lab Task

Explain the following questions:

1) Why are the resistors used?