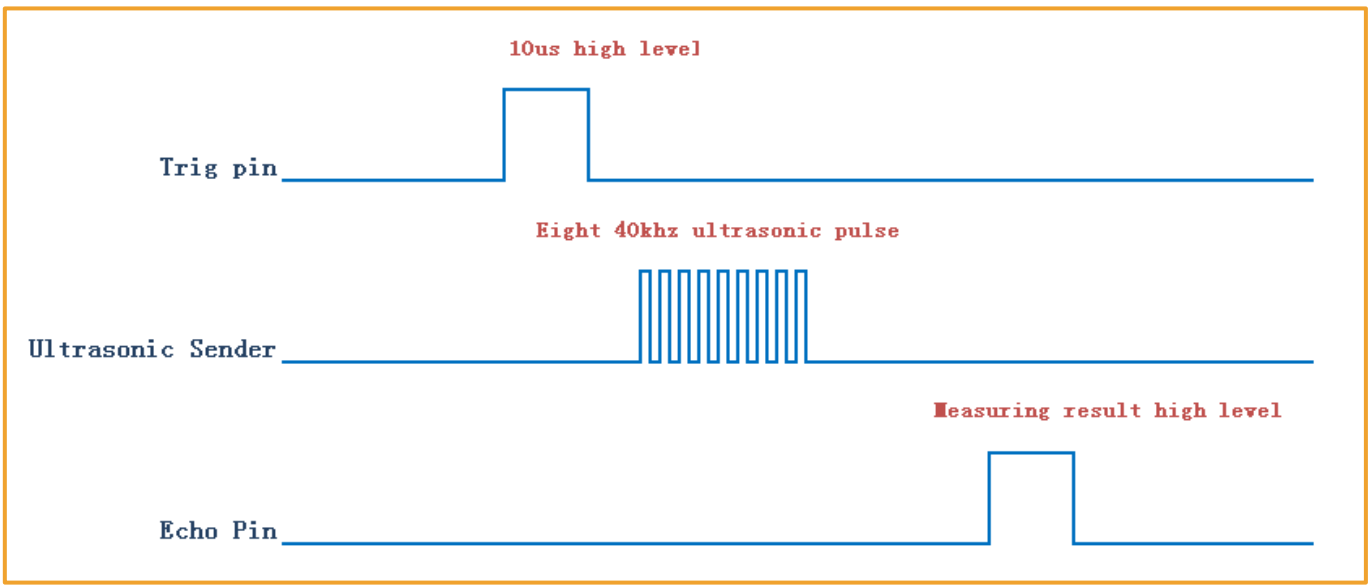
Ultrasonic Ranging Experiment

Introduction

The principle of ultrasonic ranging: the ultrasonic transmitter emits ultrasonic wave in a certain direction and we start timing at the same time. While the ultrasonic wave in the air encounters an obstacle, it will immediately return, the ultrasonic receiver receives the reflected wave and then we stop timing. The speed of sound waves in the air is 340 meters per second. According to the recorded time t, we can use the mathematical formula s = 340m / s * t / 2 to calculate the distance s between the starting point and the obstacle.

The ultrasonic ranging module has four pins, they are VCC, Trig, Echo, GND. Trig is the trigger pin for distance measurement. As long as it maintains a high level voltage of 10 μs, the ultrasonic module will automatically send 40KHZ *8 ultrasonic pulses and detect whether there is a return signal. This step will be automatically completed by the internal module. If it receives any return signal internally and the Echo pin will output a high-level voltage. The duration of the high level voltage is the time from the ultrasonic wave to the return. We can use the pulseIn() function to obtain the result of the distance measurement and calculate the actual distance.



Experimental Purpose

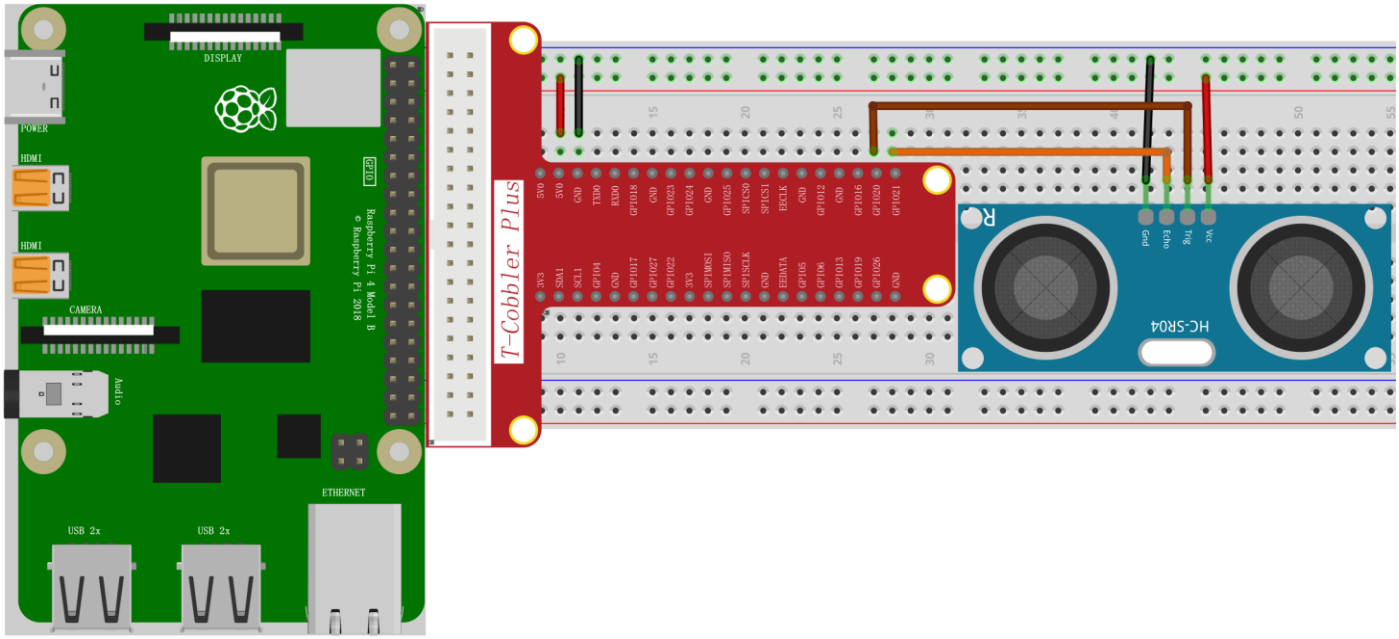
Measure the distance from the object to the destination through the ultrasonic ranging module.。

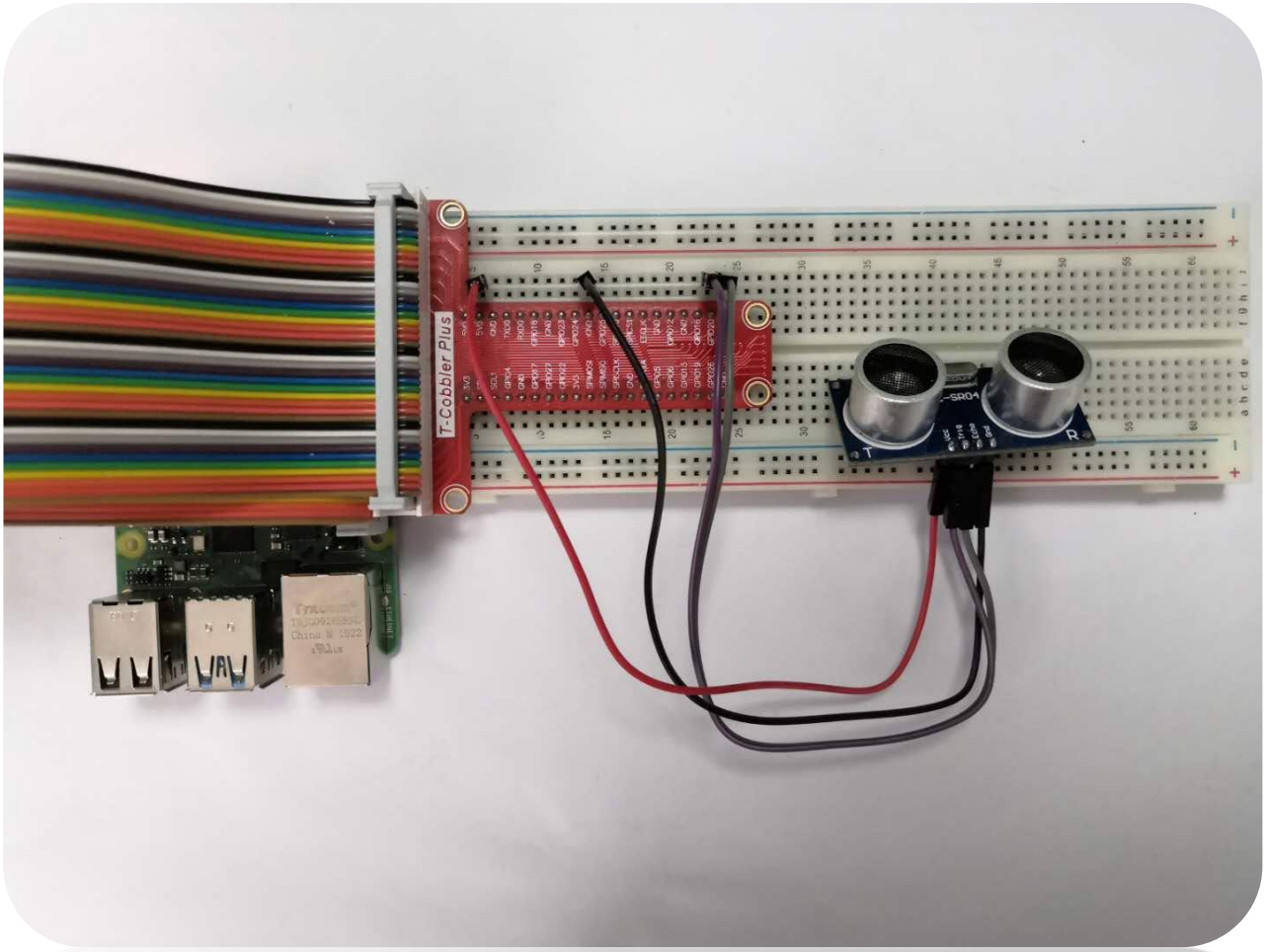
Component List

- Raspberry Pi main board
- Raspberry Pi T-Cobbler Plus expansion board
- Breadboard
- Cable
- Ultrasonic Module * 1
- Several jumper wire

Wiring

Raspberry Pi	Ultrasonic
VCC	1Vcc)
28(wiringPi)/20(BCM)	2 (Trig)
29(wiringPi)/21(BCM)	3(Echo)
GND	4 (Gnd)





C++ program

```
#include <wiringPi.h>
#include <stdio.h>
#include <sys/time.h>

#define Trig    28
#define Echo    29

void ultraInit(void)
```

```
{
    pinMode(Echo, INPUT);
    pinMode(Trig, OUTPUT);
}

float disMeasure(void)
{
    struct timeval tv1;
    struct timeval tv2;
    long start, stop;
    float dis;

    digitalWrite(Trig, LOW);
    delayMicroseconds(2);

    digitalWrite(Trig, HIGH);
    delayMicroseconds(10);      // Send out ultrasonic pulses
    digitalWrite(Trig, LOW);

    while(!(digitalRead(Echo) == 1));
    gettimeofday(&tv1, NULL);          // Get current time

    while(!(digitalRead(Echo) == 0));
    gettimeofday(&tv2, NULL);          // Get current time

    start = tv1.tv_sec * 1000000 + tv1.tv_usec;   // Microsecond time
    stop  = tv2.tv_sec * 1000000 + tv2.tv_usec;

    dis = (float)(stop - start) / 1000000 * 34000 / 2;  // Calculate the distance

    return dis;
}

int main(void)
{
    float dis;

    if(wiringPiSetup() == -1){ //when initialize wiring failed,print messageto screen
        printf("setup wiringPi failed !");
        return 1;
    }
```

```
    ultraInit();

    while(1){
        dis = disMeasure();
        printf("distance = %0.2f cm\n",dis);
        delay(1000);
    }

    return 0;
}
```

Python program

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
trig=20 #send-pin
echo=21 #receive-pin
GPIO.setup(trig, GPIO.OUT,initial=GPIO.LOW)
GPIO.setup(echo, GPIO.IN)

def Measure():

    #send
    GPIO.output(trig, True)
    time.sleep(0.00001) #1us
    GPIO.output(trig, False)

    #start recording
    while GPIO.input(echo)==0:
        pass
    start=time.time()

    #end recording
    while GPIO.input(echo)==1:
        pass
    end=time.time()

    #compute distance
    distance=round((end-start)*343/2*100,2)
    print("distance:{0}cm".format(distance))
```

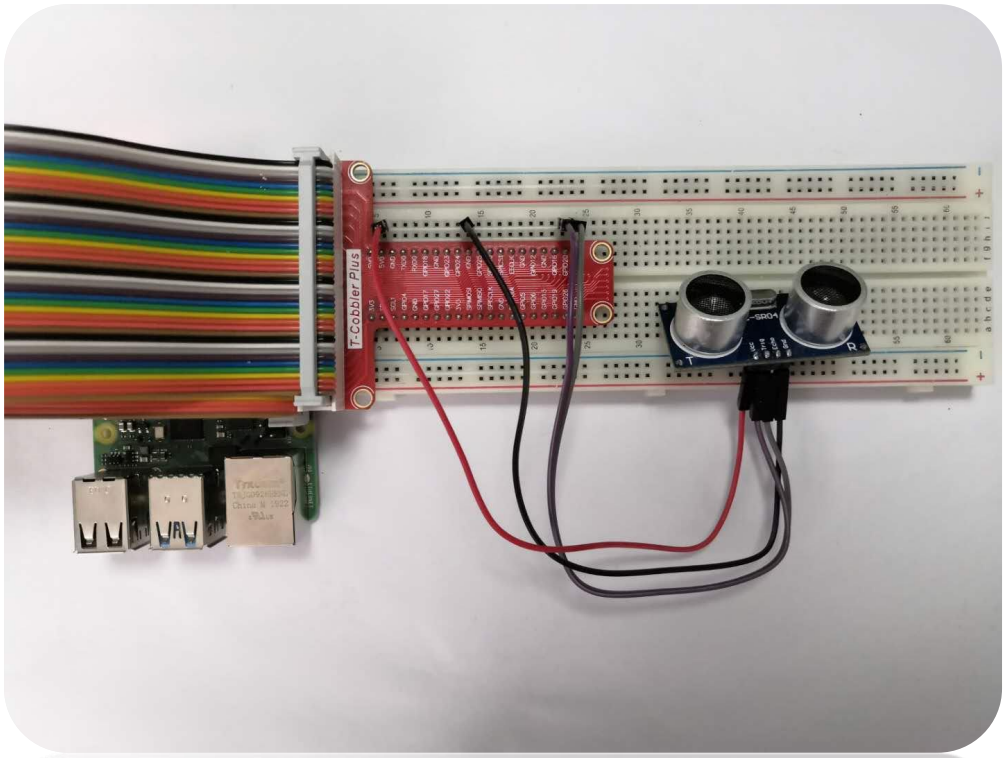
```
while True:
    Measure()
    time.sleep(1)

GPIO.cleanup();
```

Java program

```
import com.pi4j.wiringpi.Gpio;
import com.pi4j.io.gpio.PinEdge;
import com.pi4j.wiringpi.GpioInterrupt;
import com.pi4j.wiringpi.GpioInterruptListener;
import com.pi4j.wiringpi.GpioInterruptEvent;
import com.pi4j.wiringpi.GpioUtil;

public class test {
    static double distance = 0.0, time_1 = 0, time_2 = 0;

    public static Long getmicTime() {
        Long cutime = System.currentTimeMillis() * 1000; // 微秒
        Long nanoTime = System.nanoTime(); // 纳秒
        return cutime + (nanoTime - nanoTime / 1000000 * 1000000) / 1000;
    }

    public static void clean_date() {
        Ultr.time_1 = 0;
        Ultr.time_2 = 0;
    }

    public static void main(String args[]) throws InterruptedException {


        // setup wiring pi
        if (Gpio.wiringPiSetup() == -1) {
            System.out.println(" ==>> GPIO SETUP FAILED");
            return;
        }

        // configure GPIO 29 as an INPUT pin; GPIO_028 is set to output enable it for callbacks
        Gpio.pinMode(28, Gpio.OUTPUT);
        Gpio.pinMode(29, Gpio.INPUT);
```

```
        //Gpio.pullUpDnControl(29, Gpio.PUD_UP);
       GpioInterrupt.enablePinStateChangeCallback(29);

        // continuously loop to prevent program from exiting
        for (;;) {
            // GPIO_29 is set to high level
            Gpio.pinMode(28, Gpio.OUTPUT);
            Gpio.digitalWrite(28, 0);
            Gpio.delayMicroseconds(2);
            Gpio.digitalWrite(28, 1);
            Gpio.delayMicroseconds(10);
            Gpio.digitalWrite(28, 0);
            while (!(Gpio.digitalRead(29) == 1));
            Ultr.time_1 = Ultr.getmicTime();
            while (!(Gpio.digitalRead(29) == 0));
            Ultr.time_2 = Ultr.getmicTime();
            Ultr.distance = (Ultr.time_2 - Ultr.time_1) / 1000000 / 2 * 340 * 100;
            System.out.println(Ultr.distance);
            Ultr.clean_date();
            Thread.sleep(500);
        }
    }
}
```

Experimental Effect



out

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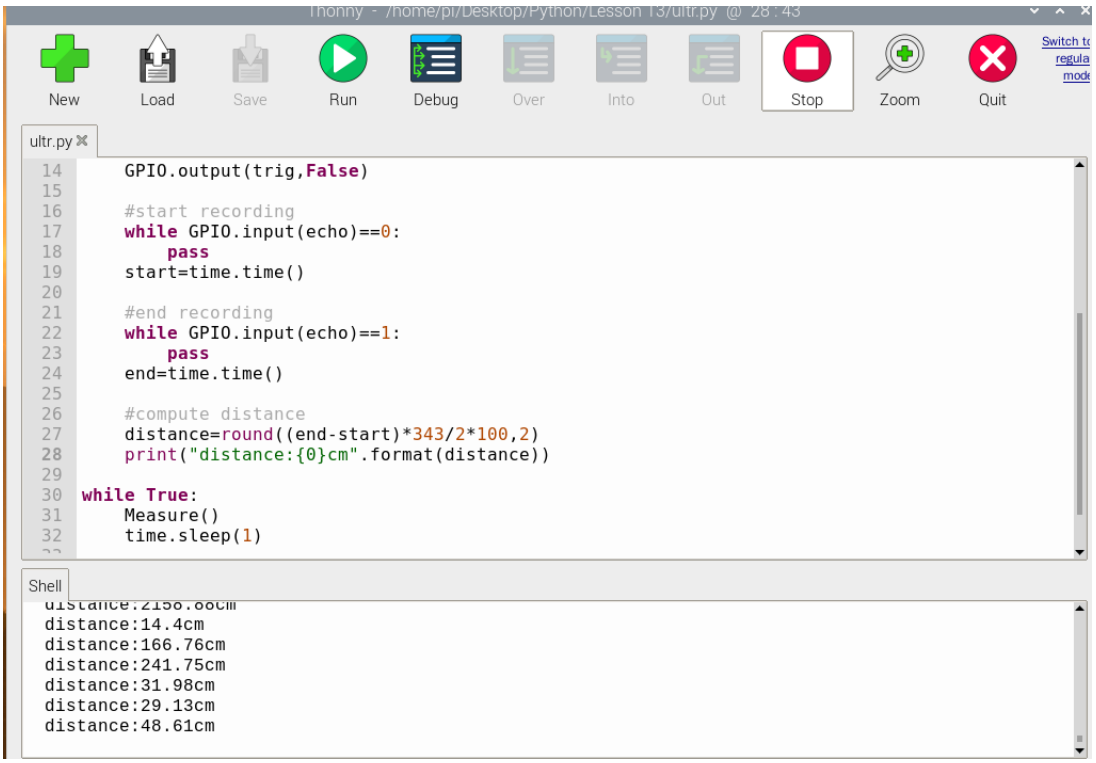
```
distance = 13.69 cm
distance = 9.54 cm
distance = 17.58 cm
distance = 7.85 cm
distance = 260.24 cm
distance = 253.10 cm
distance = 213.67 cm
distance = 214.93 cm
distance = 250.51 cm
distance = 252.21 cm
distance = 251.82 cm
distance = 306.14 cm
distance = 20.14 cm
distance = 9.33 cm
distance = 21.13 cm
distance = 17.70 cm
distance = 14.99 cm
distance = 219.96 cm
distance = 12.34 cm
distance = 306.49 cm
distance = 6.58 cm
distance = 311.95 cm
distance = 273.87 cm
```



We use Raspberry Pi to control ultrasonic to realize this aim of the object distance measurement. The experiment requires us to understand the principle of ultrasonic distance measurement and learn how to use the Raspberry Pi IO port.