Hardware Control course--Ultrasonic +IR avoid

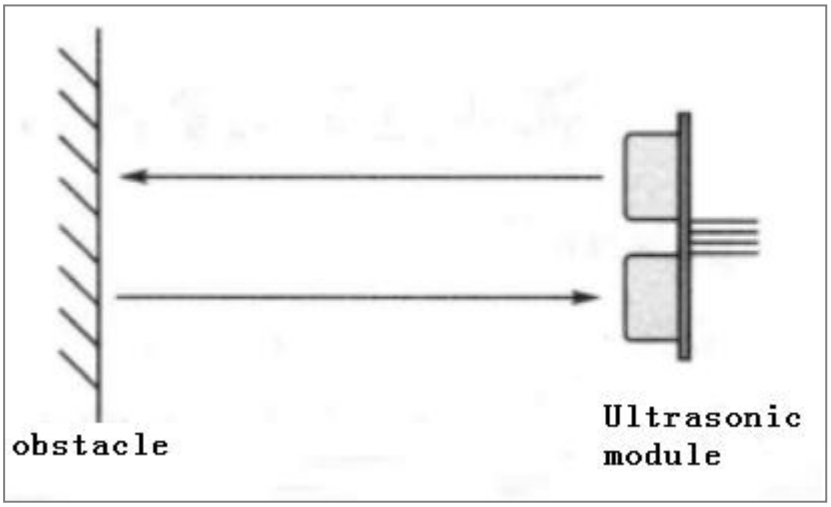
1. Learning target

In this course, we will learn how to use ultrasonic module and infrared obstacle avoidance sensor completes obstacle avoidance experiment.

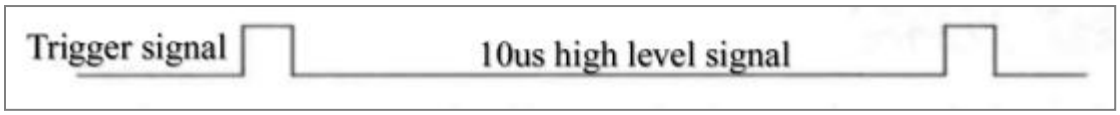
2. Principle of experimental

About ultrasonic module:

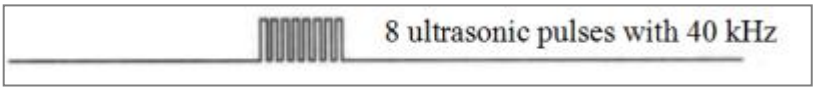
The ultrasonic module is a sensor that uses ultrasonic characteristics to detect the distance. It has two ultrasonic probes for transmitting and receiving ultrasonic waves. The range of measurement is 3-450 cm.



(1) You need to input a high level signal of at least 10us to the Trig pin to trigger the ranging function of the ultrasonic module.



(2) After the ranging function is triggered, the module will automatically send out 8 ultrasonic pulses with 40 kHz and automatically detect whether there is a signal return. This step is done internally by the module.



(3) When the module detects an echo signal, the ECHO pin will output a high level. The high level duration is the time from when the ultrasonic wave is sent to when it returns. You can calculate the distance by using the time function to calculate the high level duration.

Formula: Distance = High level duration * Speed of sound(340M/S)/2.

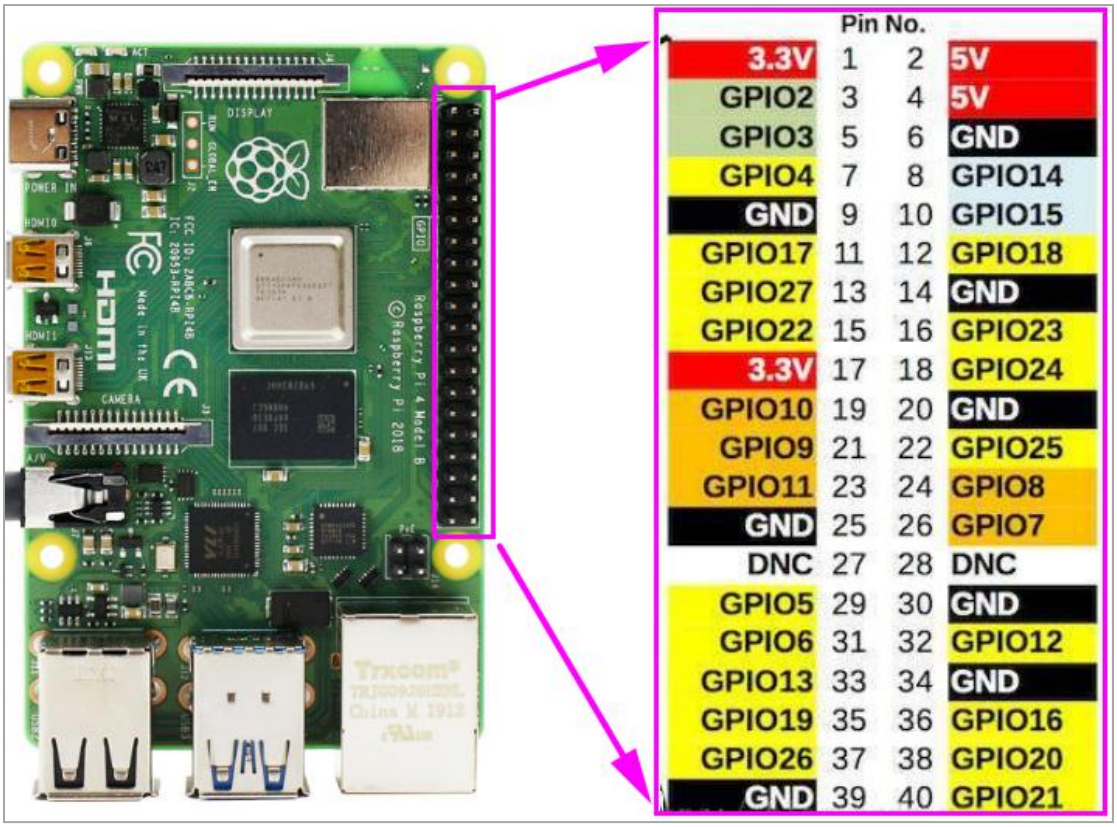
About Infrared obstacle avoidance sensor:

There are two sets of infrared obstacle avoidance sensors on both sides of the trolley.
Their transmitting tube emits infrared light from the luminous tube, and the receiving tube receives the infrared light reflected by objects in front of them to determine whether there are obstacles in front.
When there is an obstacle in front, the infrared sensor pin is low and the indicator light is on;
When there are five obstacles in the front, the infrared sensor pin is high and the indicator light is off;
Because the infrared pair tube is turned on for a long time, it will heat up and shorten its service life, so we specially designed a switch for it, which needs to be turned on before using infrared obstacle avoidance.

For the Raspbot car, we use 4 TT DC gear motors. They are driven by the TB6612 chip. The driver chip is not directly connected to the Raspberry Pi pins.
Raspberry Pi communicates with STM8 MUC through IIC, and then STM8 MCU drives TB6612 chip to drive the motor.

3. Coding method
In this course, we use BOARD coding method.
According to the hardware interface manual, we see that the ultrasonic Echo and Trig pins are connected to the 18 and 16 pin of the Raspberry Pi board.
The left and right infrared obstacle avoidance sensors and switches are respectively connected to pins 21, 19, and 22 of the Raspberry Pi board.
STM8 is connected to SDA.1, SCL.1 on the Raspberry Pi board.
We have provided a library text dedicated to driving motors and servos --YB_Pcb_Car.py.
It is located in the same directory as the motor driver.

The pin comparison table of Raspberry Pi as shown below.


Pin No.
3.3V 1 2 5V
GPIO2 3 4 5V
GPIO3 5 6 GND
GPIO4 7 8 GPIO14
GND 9 10 GPIO15
GPIO17 11 12 GPIO18
GPIO27 13 14 GND
GPIO22 15 16 GPIO23
3.3V 17 18 GPIO24
GPIO10 19 20 GND
GPIO9 21 22 GPIO25
GPIO11 23 24 GPIO8
GND 25 26 GPIO7
DNC 27 28 DNC
GPIO5 29 30 GND
GPIO6 31 32 GPIO12
GPIO13 33 34 GND
GPIO19 35 36 GPIO16
GPIO26 37 38 GPIO20
GND 39 40 GPIO21

wiringPi	BCM	Function	BOARD		Function	BCM	wiringPi
		3.3V	1	2	5V		
8	2	SDA.1	3	4	5V		
9	3	SCL.1	5	6	GND		
7	4	GPIO.7	7	8	TXD	14	15
		GND	9	10	RXD	15	16
0	17	GPIO.0	11	12	GPIO.1	18	1
2	27	GPIO.2	13	14	GND		
3	22	GPIO.3	15	16	GPIO.4	23	4
		3.3V	17	18	GPIO.5	24	5
12	10	MOSI	19	20	GND		
13	9	MISO	21	22	GPIO.6	25	6
14	11	SCLK	23	24	CE0	8	10
		GND	25	26	CE1	7	11
30	0	SDA.0	27	28	SCL.0	1	31
21	5	GPIO.21	29	30	GND		
22	6	GPIO.22	31	32	GPIO.26	12	26
23	13	GPIO.23	33	34	GND		
24	19	GPIO.24	35	36	GPIO.27	16	27
25	26	GPIO.25	37	38	GPIO.28	20	28
		GND	39	40	GPIO.29	21	29

4. About code

Path: /home/pi/Yahboom_project/Raspbot/2.Hardware Control course/6.Ultrasonic+IR avoid/Ultrasonic+IR avoid.ipynb

1) Import time, GPIO and YB_Pcb_Car library

```
#-*- coding:UTF-8 -*-
import RPi.GPIO as GPIO
import time
import YB_Pcb_Car
```

2)Set the GPIO code and the mode of the ultrasonic pin, and define the car class is used to drive motors or servos.

Set the infrared sensor switch pin is high level to enable infrared obstacle avoidance function.

```
car = YB_Pcb_Car.YB_Pcb_Car()
```

```
GPIO.setmode(GPIO.BOARD)

GPIO.setwarnings(False)

AvoidSensorLeft = 21
AvoidSensorRight = 19
Avoid_ON = 22

EchoPin = 18
TrigPin = 16

GPIO.setup(AvoidSensorLeft,GPIO.IN)
GPIO.setup(AvoidSensorRight,GPIO.IN)
GPIO.setup(Avoid_ON,GPIO.OUT)
GPIO.setup(EchoPin,GPIO.IN)
GPIO.setup(TrigPin,GPIO.OUT)
GPIO.output(Avoid_ON,GPIO.HIGH)
```

3) Define the ultrasonic ranging function

We need to set a high level signal of at least 10us to the TRIG pin of the ultrasonic module to trigger the module's ranging function.

```
def Distance():
    GPIO.output(TrigPin,GPIO.LOW)
    time.sleep(0.000002)
    GPIO.output(TrigPin,GPIO.HIGH)
    time.sleep(0.000015)
    GPIO.output(TrigPin,GPIO.LOW)

    t3 = time.time()

    while not GPIO.input(EchoPin):
        t4 = time.time()
        if (t4 - t3) > 0.03 :
            return -1
    t1 = time.time()
    while GPIO.input(EchoPin):
        t5 = time.time()
        if(t5 - t1) > 0.03 :
            return -1

    t2 = time.time()
    time.sleep(0.01)
    #print ("distance_1 is %d " % (((t2 - t1)* 340 / 2) * 100))
    return ((t2 - t1)* 340 / 2) * 100
```

4) Define the ultrasonic ranging optimization program to optimize the test results.

```
def Distance_test():
    num = 0
    ultrasonic = []
    while num < 5:
            distance = Distance()
            #print("distance is %f"%(distance) )
            while int(distance) == -1 :
                distance = Distance()
                #print("Tdistance is %f"%(distance) )
            while (int(distance) >= 500 or int(distance) == 0) :
                distance = Distance()
                #print("Edistance is %f"%(distance) )
            ultrasonic.append(distance)
            num = num + 1
            #time.sleep(0.01)
    #print ('ultrasonic')
    distance = (ultrasonic[1] + ultrasonic[2] + ultrasonic[3])/3
    #print("distance is %f"%(distance) )
    return distance
```

5)Define the avoid function to complete the ultrasonic +IR obstacle avoidance function of the car.

```
def avoid():
    distance = Distance_test()
    LeftSensorValue  = GPIO.input(AvoidSensorLeft);
    RightSensorValue = GPIO.input(AvoidSensorRight);
    [illegible]
    if distance < 15 and LeftSensorValue == False and RightSensorValue == False :
        car.Car_Stop()
        time.sleep(0.1)
        car.Car_Spin_Right(100,100)
        time.sleep(1)
    elif distance < 15 and LeftSensorValue == True and RightSensorValue == False :
        car.Car_Stop()
        time.sleep(0.1)
        car.Car_Spin_Left(80,80)
        time.sleep(1)
        if LeftSensorValue == False and RightSensorValue == True :
            car.Car_Stop()
            time.sleep(0.1)
            car.Car_Spin_Right(90,90)
            time.sleep(2)
    elif distance < 15 and LeftSensorValue == False and RightSensorValue == True :
        car.Car_Stop()
        time.sleep(0.1)
        car.Car_Spin_Right(80,80)
        time.sleep(1)
        if LeftSensorValue == True and RightSensorValue == False  :
            car.Car_Stop()
            time.sleep(0.1)
            car.Car_Spin_Left(90,90)
            time.sleep(2)
    elif distance < 15 and LeftSensorValue == True and RightSensorValue == True :
        car.Car_Stop()
        time.sleep(0.1)
        car.Car_Spin_Right(80,80)
        time.sleep(0.5)
    elif distance >= 15 and LeftSensorValue == False and RightSensorValue == False :
        car.Car_Stop()
        time.sleep(0.1)
        car.Car_Spin_Right(90,90)
        time.sleep(1)
```

```
elif distance >= 15 and LeftSensorValue == False and RightSensorValue == True :
    car.Car_Stop()
    time.sleep(0.1)
    car.Car_Spin_Right(80,80)
    time.sleep(0.5)
elif distance >= 15 and LeftSensorValue == True and RightSensorValue == False :
    car.Car_Stop()
    time.sleep(0.1)
    car.Car_Spin_Left(80,80)
    time.sleep(0.5)
else:
    car.Car_Run(100,100)
```

6) Call the obstacle avoidance function in loop to complete the obstacle avoidance experiment.
When we click the stop button, we exit the loop, stop the car, and clear the car class and GPIO.

```
try:
    while True:
        avoid()
except KeyboardInterrupt:
    pass
car.Car_Stop()
del car
print("Ending")
GPIO.cleanup()
```

5. Running code

Click the button shown in the figure below to run the program on the Jupyter Lab interface

6. Experimental phenomenon

After the program runs, we can see that the car will move forward, and it will avoid obstacles when it encounters obstacles in front of it.