한국외국어대학교
HANKUK UNIVERSITY OF FOREIGN STUDIES

Internet of Things (IoT) Systems

Week 11

Raspberry Pi Programming

Ikram Syed, Ph.D.
Associate Professor
Department of Information and Communication Engineering
Hankuk University of Foreign Studies (HUFS)

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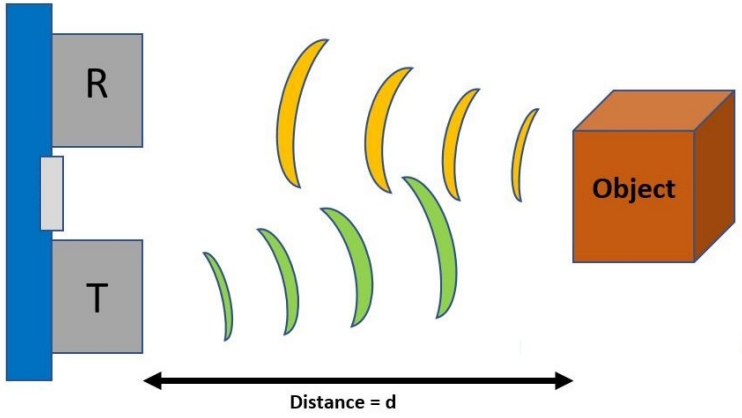
Access and Control of IoT Devices

- Ultrasonic Sensor
  - An ultrasonic sensor is an electronic device that measures the distance to a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal.
  - It has two main components
    - Transmitter which emits the sound using piezoelectric crystals
    - Receiver which encounters the sound after it has travelled to and from the target

$$\text{Sound } speed = 340\ m/s = 0.034\ cm/\mu s$$

$$distance = \frac{speed * time}{2}$$



〈Table 3-19〉 The Specifications of Ultrasonic Sensor Module

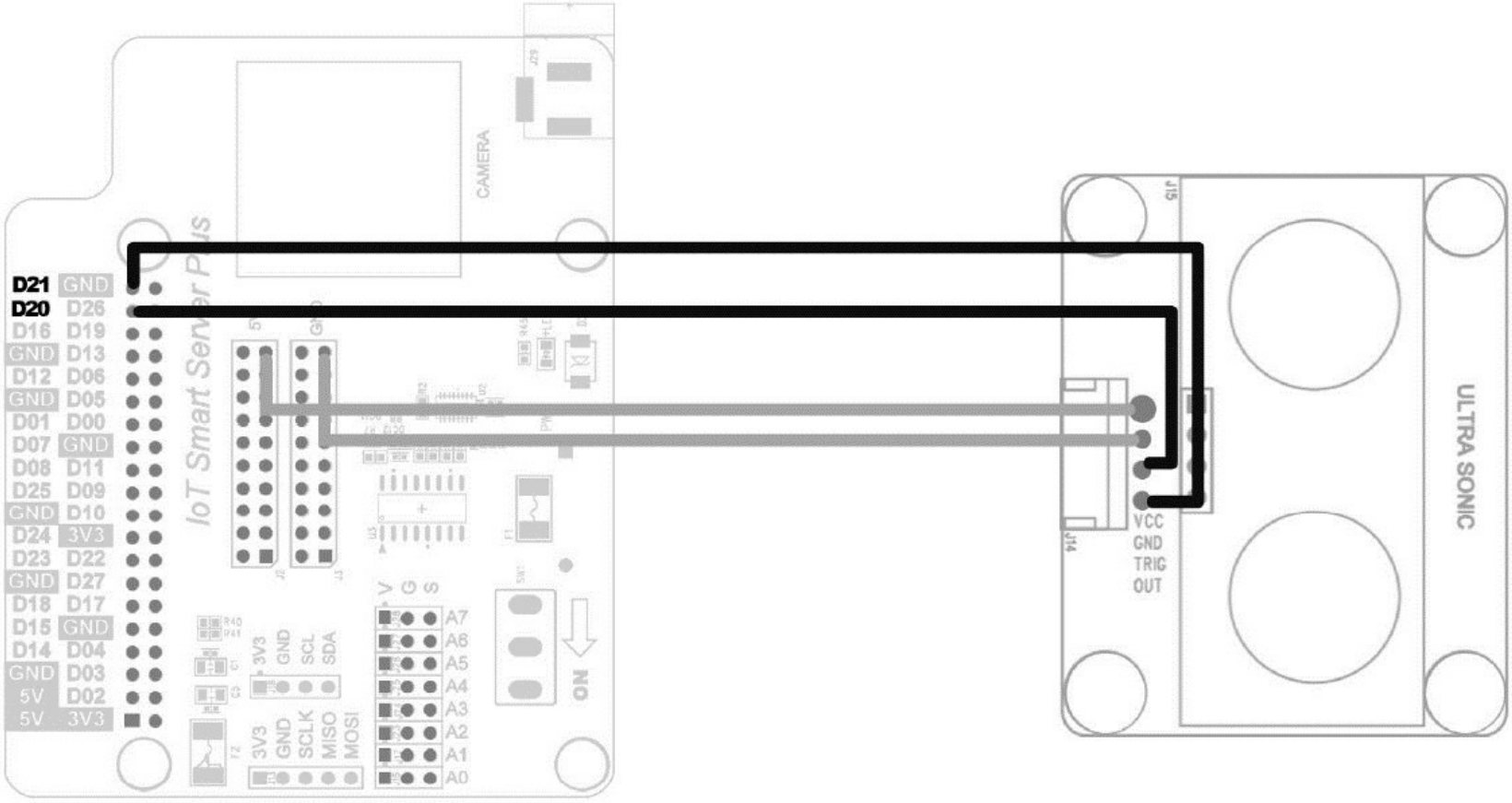
Shape	Category	Description
	Detecting Range	2 ~ 500cm
	Interface	1pin Digital Input , 1pin Digital OUTPUT
	Operating Voltage	5V

〈Table 3-20〉 Pin Connection Information for Raspberry Pi and Ultrasonic Sensor

GPIO	Wiring Pi Pin No.	Pin Info.	ULTRA Pin No.
20	28	GPIO	TRIG
21	29	GPIO	OUT

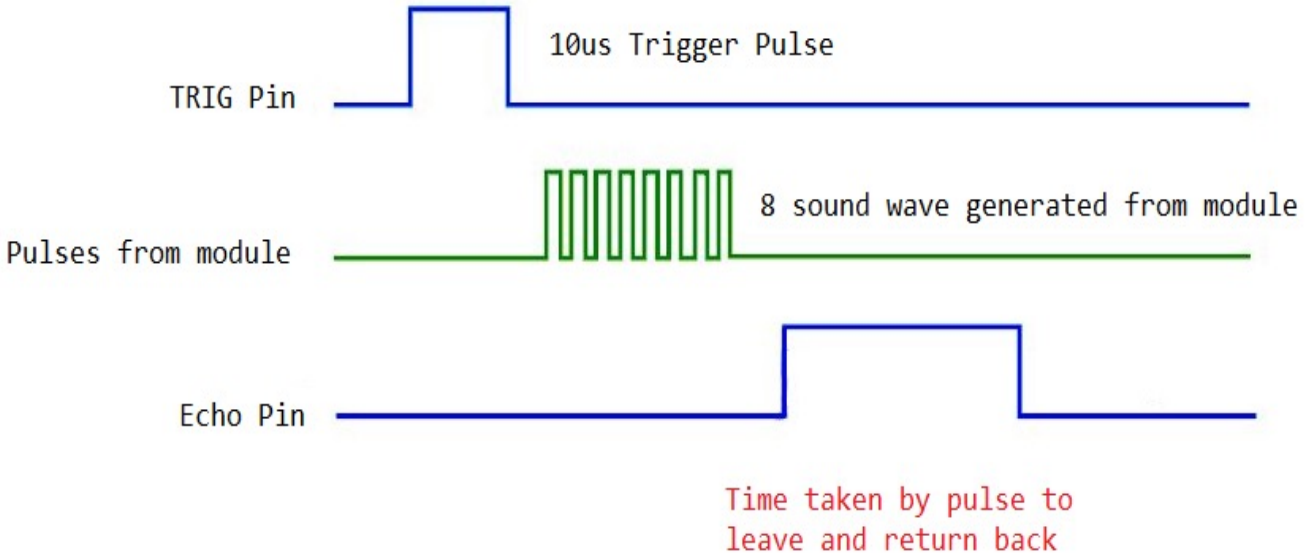
TRIG = Trigger input of sensor

Connect module without applying power to RPi

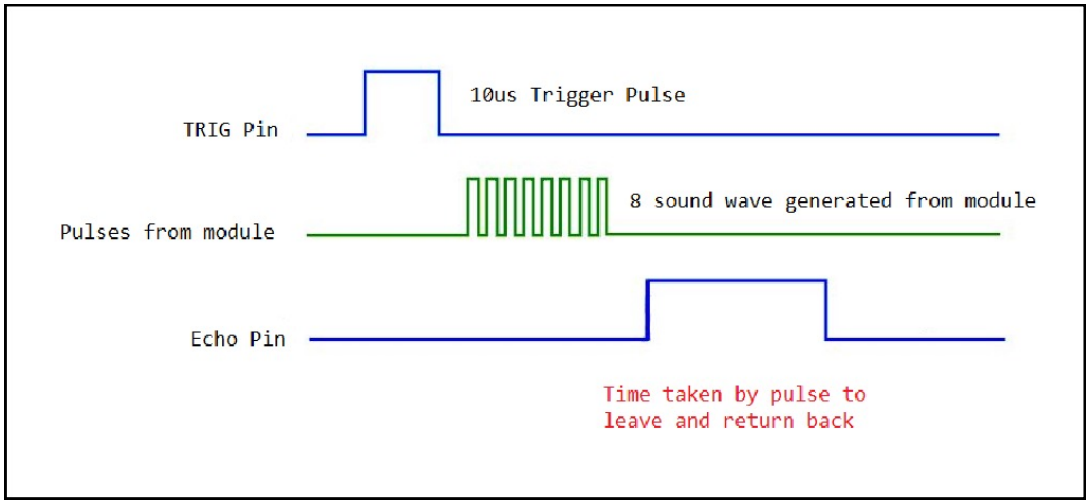


Access and Control of IoT Devices

- Working Principle
  - To start measurement, TRIG pin has to be made high for 10uS and then turned off
  - The sensor module automatically sends sound wave
  - Wait for rising edge output at Echo pin
  - When rising edge capture occurs at Echo pin, start Timer and wait for falling e dge on Echo pin
  - As soon as the falling edge is captured at the Echo pin, read the count of the T imer



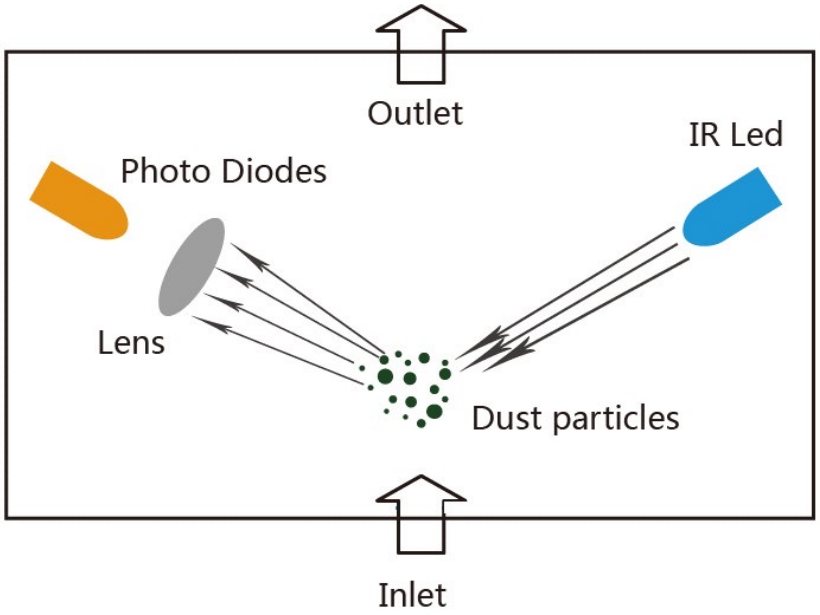
```c
#include <stdio.h>
#include <wiringPi.h>
#define TRIG 28
#define OUT 29
int main(void)  {
        int dis=0, i;
        long start,travel;
        if(wiringPiSetup() == -1) return 1;
        pinMode(TRIG,OUTPUT);
        pinMode(OUT,INPUT);

        for(i=0; i<20; i++) {
                // TRIG pin must start LOW
                digitalWrite(TRIG,0);
                //Wait for sensor to settle"
                usleep(2);

                //Send trig pulse
                digitalWrite(TRIG,1);
                usleep(20);
                digitalWrite(TRIG,0);

                //Wait for echo start
                while(digitalRead(OUT) == 0);

                start = micros();
                //Wait for echo end
                while(digitalRead(OUT) == 1);

                travel = micros() - start;

                /* Speed of Sound: 340m/s = 29 microseconds/cm
                Sound wave reflects from the obstacle, so to calculate the distance
                we consider half of the distance traveled.
                DistanceInCms = microseconds/29/2 */
                dis = travel / 58;
                printf("%d\n", dis);
                delay(100);
        }
}
```



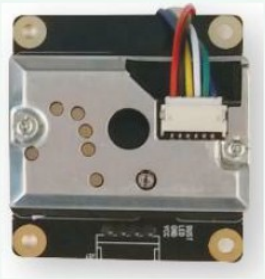
Access and Control of IoT Devices

- Dust Sensor detects the dust particle concentration in air
  - The air enters through the air inlet where a light source illuminates the particles and the scattered light is transformed into a signal by a phototransistor.
  - The intensity of the scattered light depends on the dust particles. More the dust particles in the air, the greater will be the intensity of light.

A photodiode converts light into an electrical current



〈Table 3-43〉 The Specification of Dust Sensor Module

Shape	Category	Description
	Sensor	Dust Sensor
	Operating Voltage	5V
	I/O Interface	1 digital INPUT / 1 analog OUTPUT

〈Table 3-44〉 Pin Connection Information of SPI ADC and Dust Sensor Module

ADC Port	Dust Sensor Module Pin No.
ADC3	DUST

SPI use

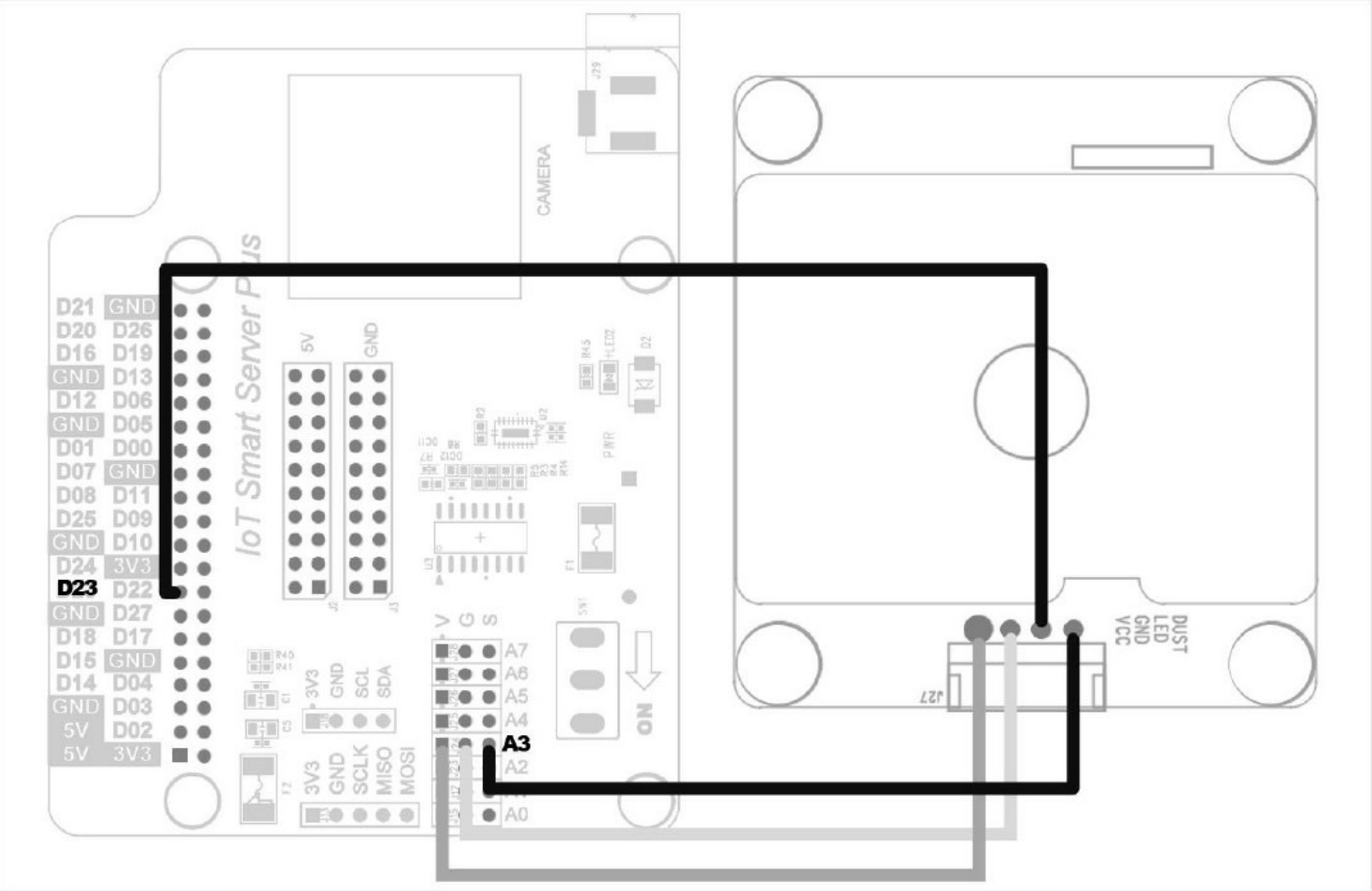
Dust sensor outputs analog value

In addition, since the IR emitter (light emitting element) must be controlled, a digital pin must be connected. Connect Raspberry Pi pin #23 to the LED pin on the Dust Sensor Module. When programming with the Wiring Pi library, it should be specified as a number that can be used in Wiring Pi unlike the Pin No. of Raspberry.

<Table 3-45> Pin Connection Information for Raspberry Pi and Reed Sensor Module

GPIO	Wiring Pi Pin No.	Pin Info.	Dust Sensor Pin No.
23	4	GPIO	LED

Connect module without applying power to RPi

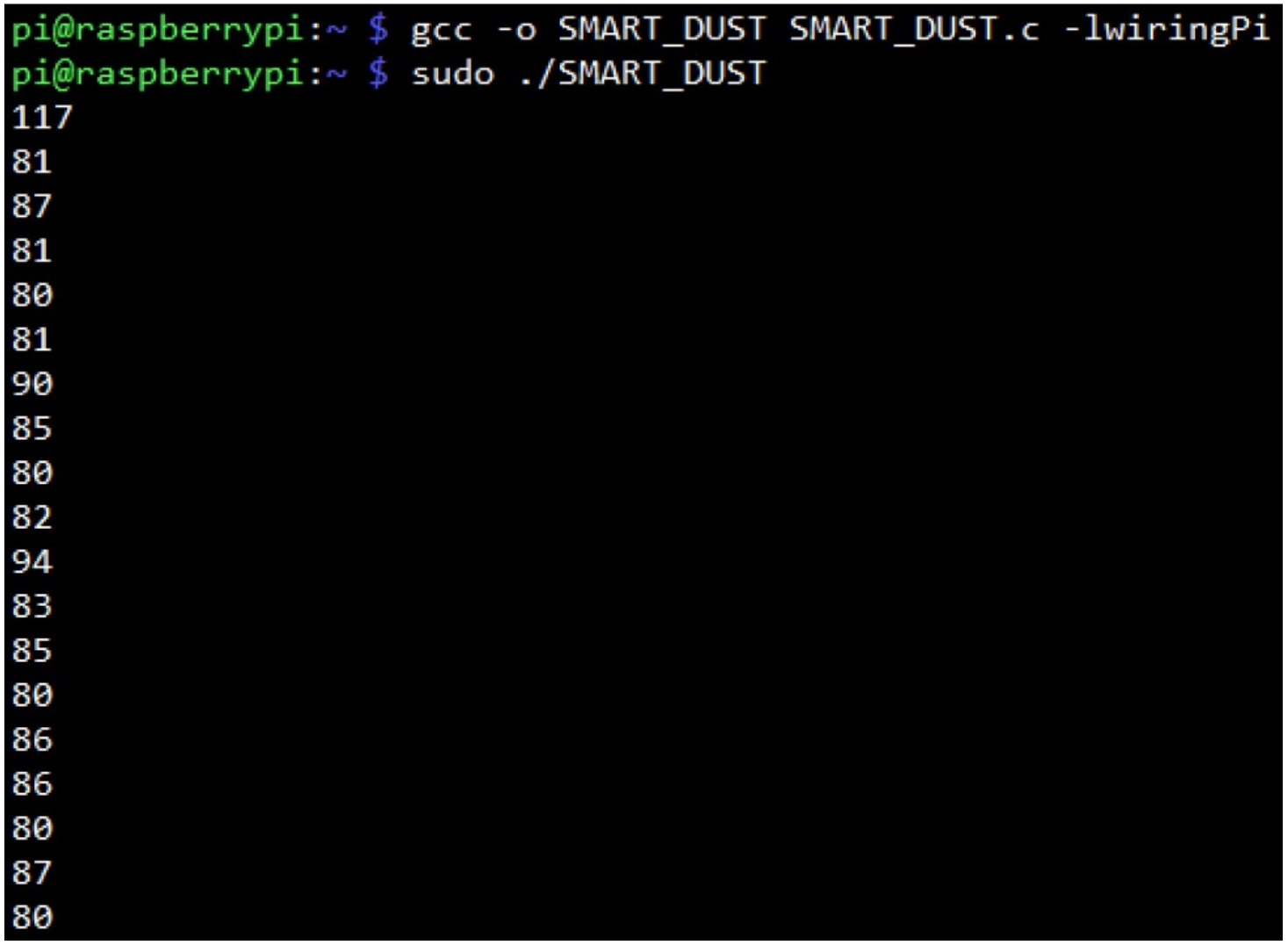


[Figure 3-121] Pin Connections for Dust Sensor Module

```c
#include <stdio.h>
#include <wiringPi.h>

 #define OUT 4
 #define SPI_CH 0
 #define ADC_CH 3
 #define ADC_CS 29
 #define SPI_SPEED 500000

int main(void){
        int value=0, i;
        unsigned char buf[3];

        if(wiringPiSetup() == -1) return 1;

        if(wiringPiSPISetup() == -1) return -1;

        pinMode(ADC_CS,OUTPUT);
        pinMode(OUT,OUTPUT);

```

```
21      for(i=0; i<20; i++){
22          digitalWrite(OUT,LOW);
23              delayMicroseconds(280);
24
25           buf[0] = 0x06 | ((ADC_CH & 0x04)>>2);
26             buf[1] = ((ADC_CH & 0x03)<<6);
27              buf[2] = 0x00;
28
29              digitalWrite(ADC_CS,0);
30
31              wiringPiSPIDataRW(SPI_CH,buf,3);
32
33              buf[1]=0x0F & buf[1];
34
35              value = (buf[1]<<8) | buf[2];
36
37              digitalWrite(ADC_CS,1);
38
39              delayMicroseconds(40);
40              digitalWrite(OUT,HIGH);
41              delayMicroseconds(9680);
42
43          printf("%d\n",value);
44          delay(100);
45      }
46  }
```

// activate IR emitter and after 280 us output LOW signal to CS pin



Clean air if value less than 100

Any Questions!