한국외국어대학교
HANKUK UNIVERSITY OF FOREIGN STUDIES

Internet of Things (IoT) Systems

Week 7

Raspberry Pi Programming

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Spring – 2025

Announcement

- Midterm Exam:

  When: Tuesday, April 22, 2025
  Location: Same Classroom 301

  Duration: 01:10 pm- 02: 40 pm

- Exam Style:

  During the exam, you will be assigned tasks to complete.

  The tasks will involve working with a Raspberry Pi, connecting various sensors, and writing C code to accomplish specific objectives.

- **Don't Stress — Just Learn and Enjoy the Process!**
- Please **don't stress** about the **course or the project**. The goal is to learn, explore, and grow — not to feel overwhelmed.
- For your **project**, try to come up with a meaningful and interesting idea.
- Focus on learning and building something you're proud of, rather than worrying about perfection.
- The **project evaluation** will be based on several parts:
  - Project idea
  - Application area
  - Components used
  - Coding and logic
  - Your understanding of the project
  - Whether the project is working
- We'll be using **Raspberry Pi** to cover all types of communication and various components. Don't worry, connecting components is simple. Most of them can be easily installed on a **breadboard**, and it usually takes just **15 minutes** to get the hang of it.
- If you ever feel stuck or confused, **please reach out**. You can **text me, email me, call me, or drop by my office** — I'd love to help you learn and make the most of this experience.
- **Let's make this a fun and stress-free journey!**

- **GPIO Pin Numbering Schemes**

  - Physical

    - The actual pin numbers on 40-pin connector

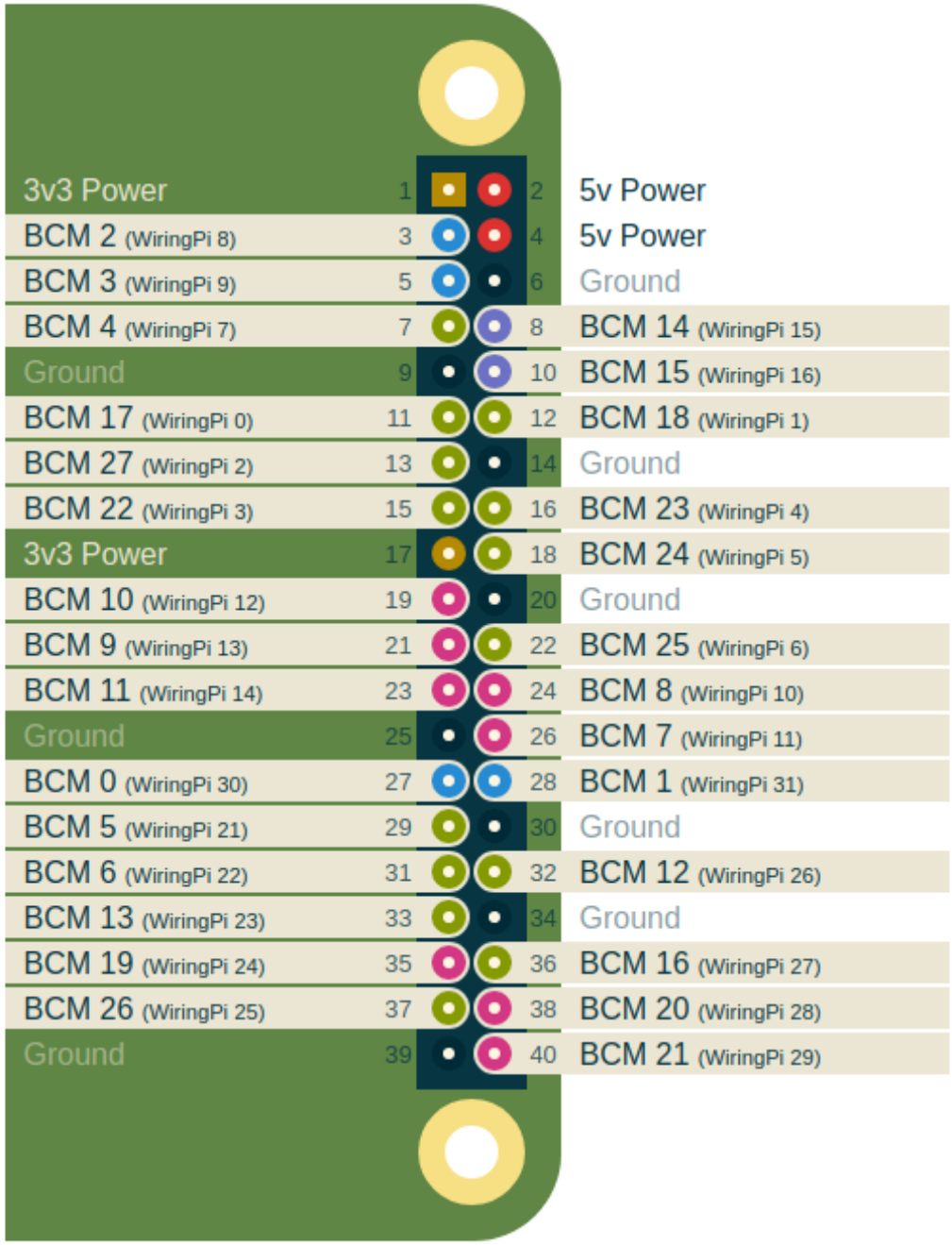
  - BCM

    - Broadcom pin numbers often called GPIO numbers

    - This is the most common method of naming the GPIO pins

  - WiringPi

    - Pin numbers used in WiringPi library

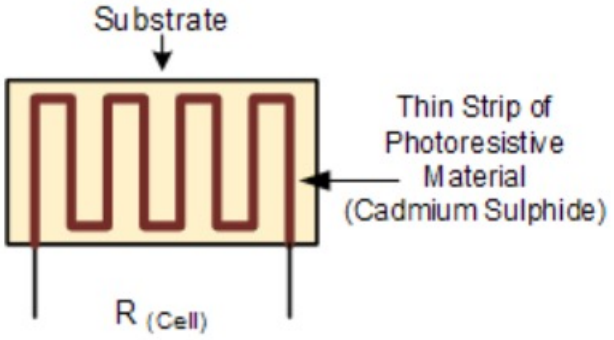


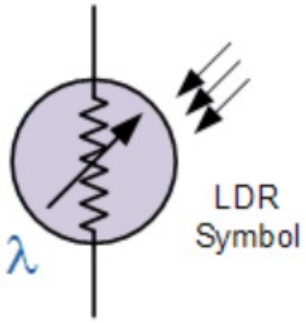
Access and Control of IoT Devices

- Light Sensors are photoelectric devices that convert light energy whether visible or infra-red light into an electrical signal
  - Auto screen brightness adjustments
  - Automatically turn on light systems if getting dark

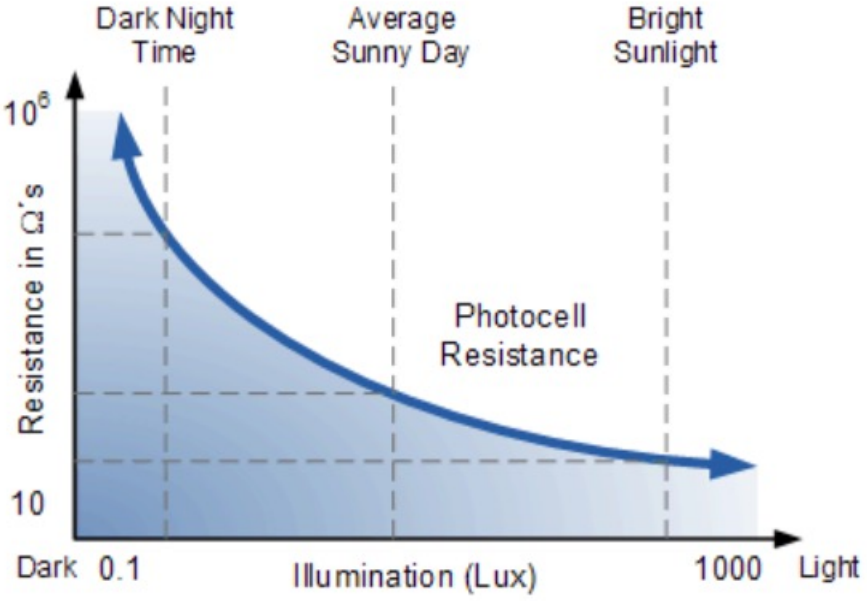
  - A CDS (Cadmium Sulfide) photo resistor, also known as a light-dependent resistor (LDR) or photocell,
  - Changing its electrical resistance in response to the intensity of light.
  - When light shines on the CDS material, it increases the conductivity of the material, making it easier for electricity to flow through.
  - The more intense the light, the lower the resistance and the higher the conductivity.

Access and Control of IoT Devices

- Light Sen 

y whether visible or
  - Auto s 

  - Autom



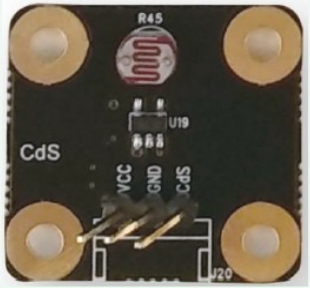
  - A CD dependent resisto
  - Chang ght.
  - When ity of the material, making it easier for electricity to flow through.
  - The more intense the light, the lower the resistance and the higher the conductivity.

Access and Control of IoT Devices

A CDS photocell or Light Dependant Resistor is a resistor where the resistance changes based on the amount of light. As the amount of light increases the resistance of the sensor decreases and vice versa.

CDS = **Cadmium Sulfide**

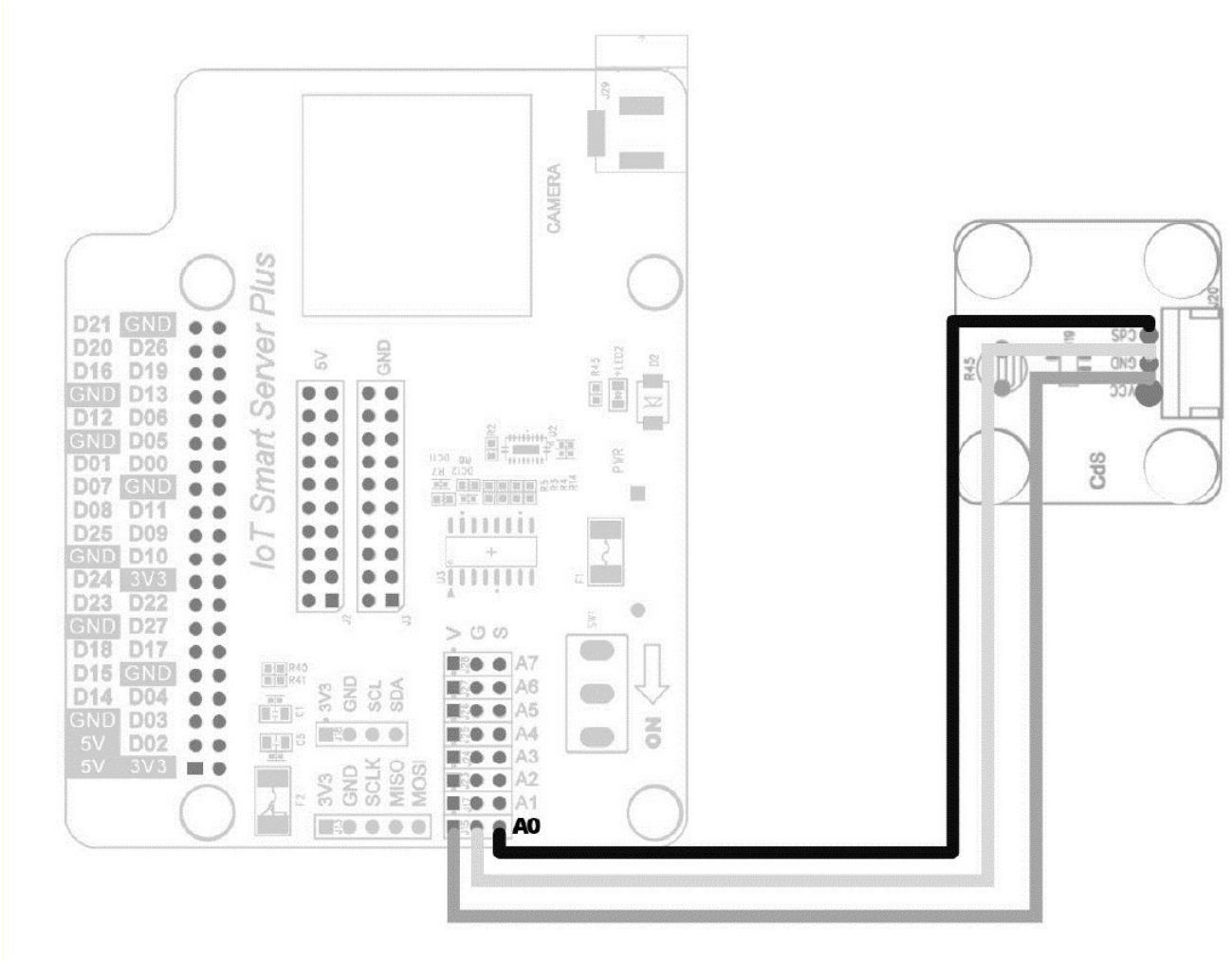
〈Table 3-17〉 Specifications of Light Sensor Module

Shape	Category	Description
	Sensor	Light(CDS)
	Interface	1pin Analog OUTPUT
	Operating Voltage	5V

〈Table 3-18〉 Pin Connection Information of SPI ADC and Light Sensor Module

ADC Port	Light Sensor Pin No.
ADC0	CdS

Connect module without applying power to RPi



Access and Control of IoT Devices

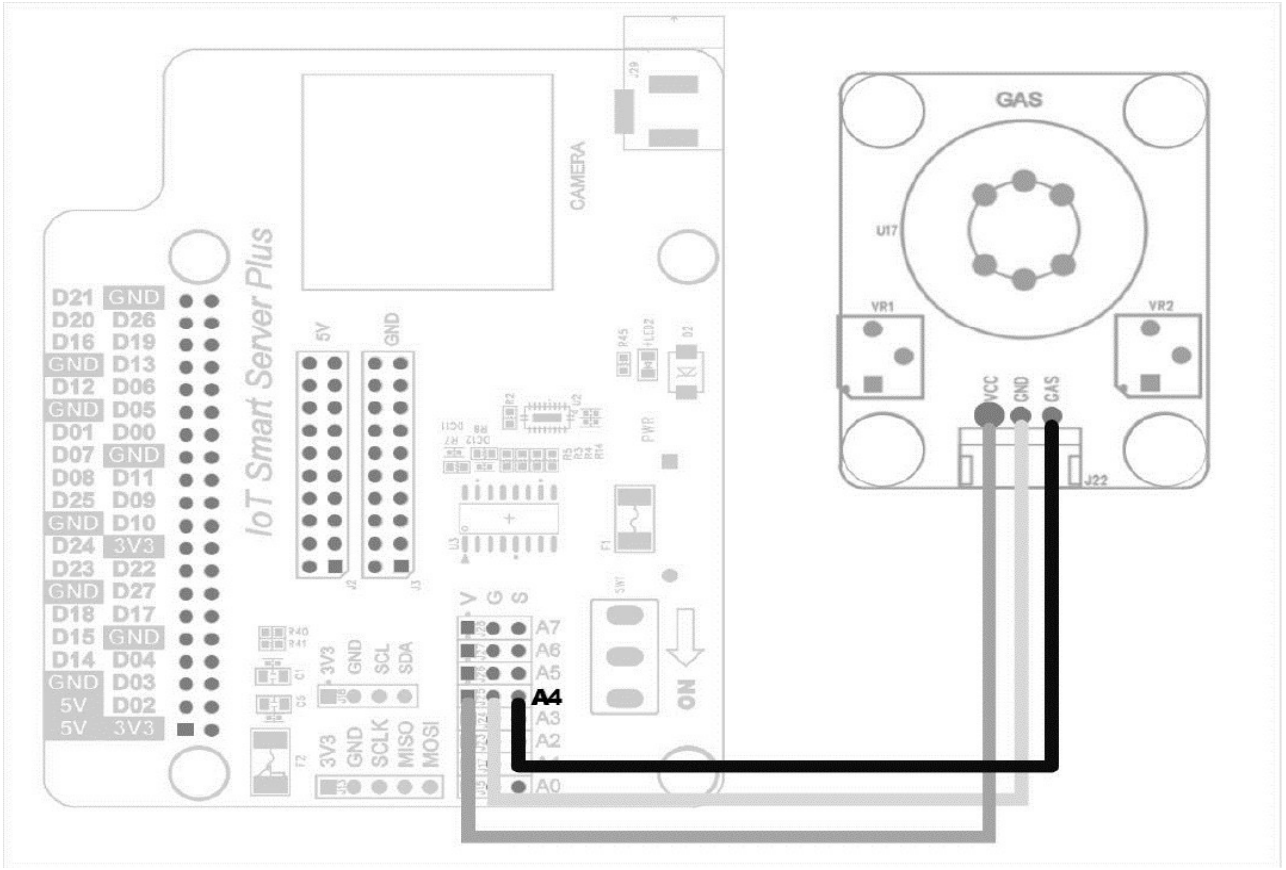
- Gas Sensor detect and identify different types of gasses
  - Gas sensors are employed in factories and manufacturing facilities to identify gas leaks, and to detect smoke and carbon monoxide in homes
  - MQ-6 gas sensor can detect kinds of flammable gases, especially has high sensitivity to LPG
  - The MQ6 sensor, detects gases by utilizing a heated sensing material, typically tin oxide (SnO2) , it is a semiconductor, which changes its electrical resistance when exposed to certain gases.
  - This change in resistance, due to the chemical reactions between the sensing material and the target gas, is then used to determine the gas concentration

https://components101.com/sensors/mq-6-gas-sensor-pinout-equivalent-datasheet

Connect module without applying power to RPi

<Table 3-46> Specifications of Gas Sensor Module

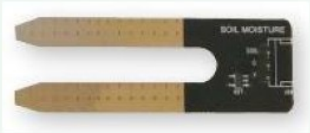
Shape	Category	Description
	Sensor	Gas Sensor
	I/O Interface	1pin Analog OUTPUT
	Operating Voltage	5V



Access and Control of IoT Devices

- Soil Moisture Sensor is used for measuring the moisture in soil and similar materials
  - Smart farming systems
  - Works by measuring the electrical properties of the soil, which are affected by the water content.
  - Use two probes to measure the soil's resistance, with more moisture leading to lower resistance.

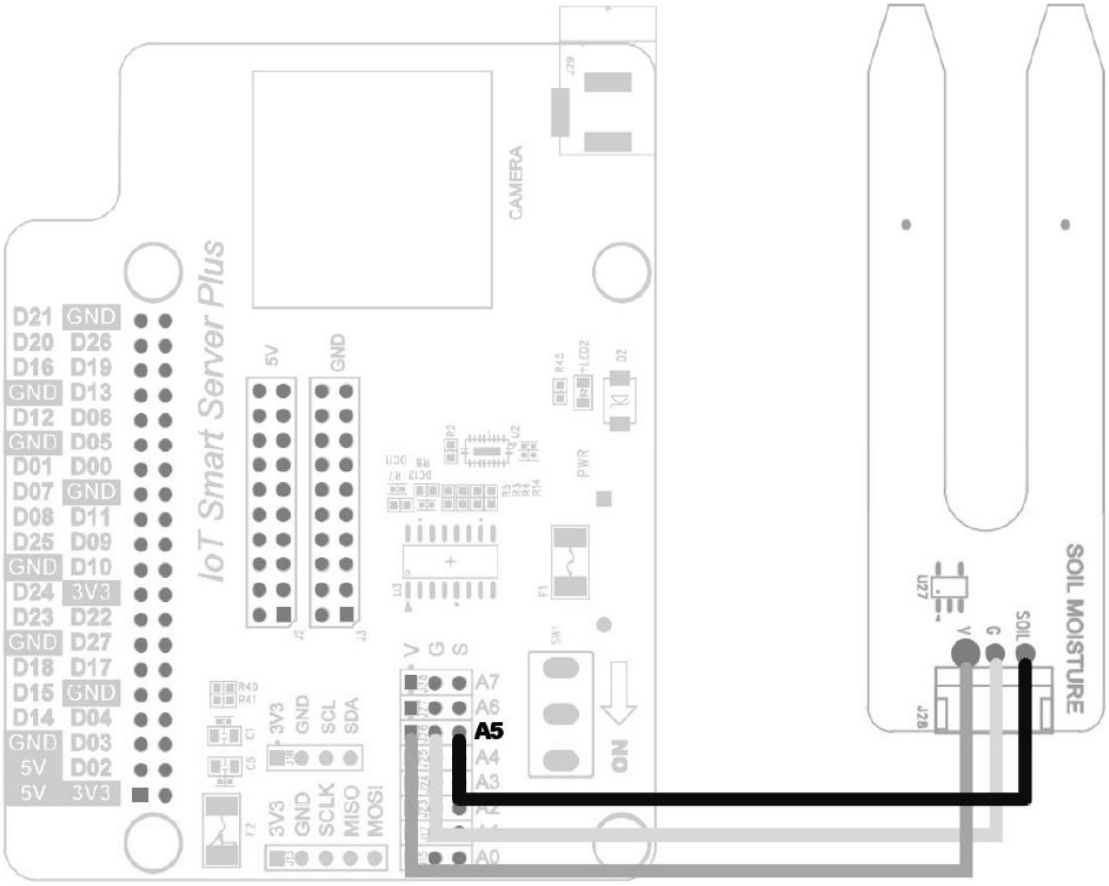
<Table 3-52> Specfications of Soil Moisture Sensor Module

Shape	Category	Description
	Sensor	Soil Moisture Sensor
	I/O Interface	1pin Analog OUTPUT
	Operating Voltage	3.3V~5V

Connect module without applying power to RPi

〈Table 3-53〉 Pin Connection Information for SPI ADC and Soil Moisture Sensor

ADC Port	Soil Moisture Sensor Pin No.
ADC5	SOIL

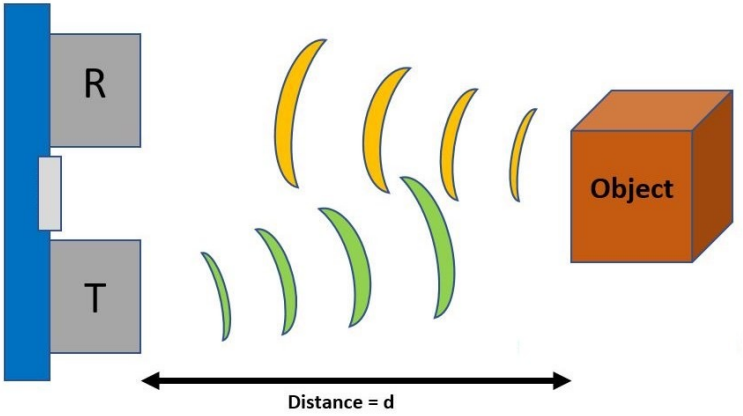


Access and Control of IoT Devices

- **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

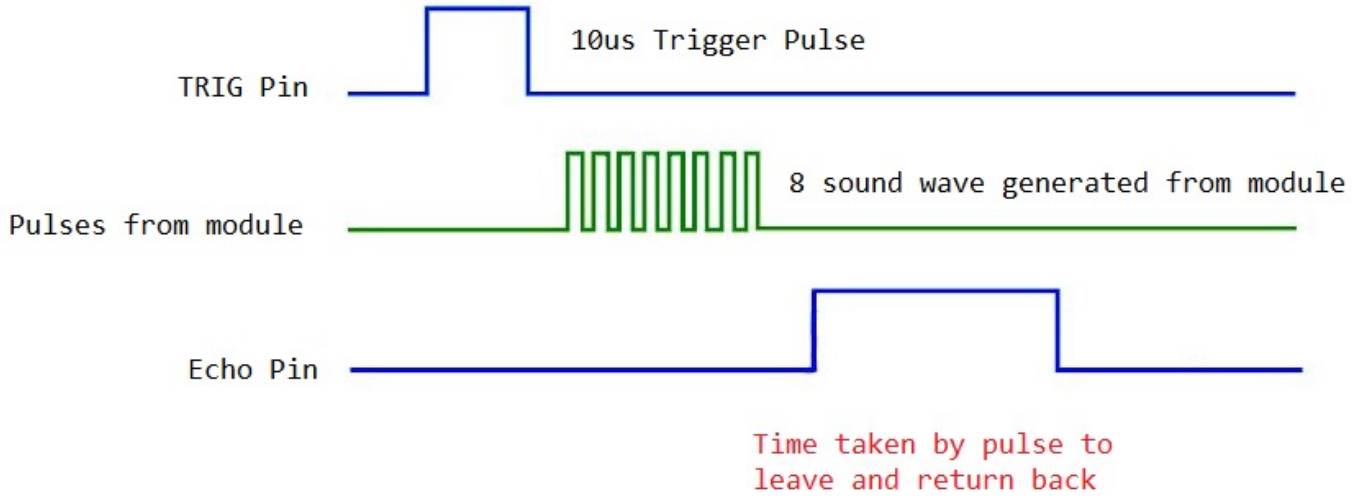
$$\text{Sound } speed = 340\ m/s = 0.034\ cm/\mu s$$

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



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 edge on Echo pin
  - As soon as the falling edge is captured at the Echo pin, read the count of the Timer



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

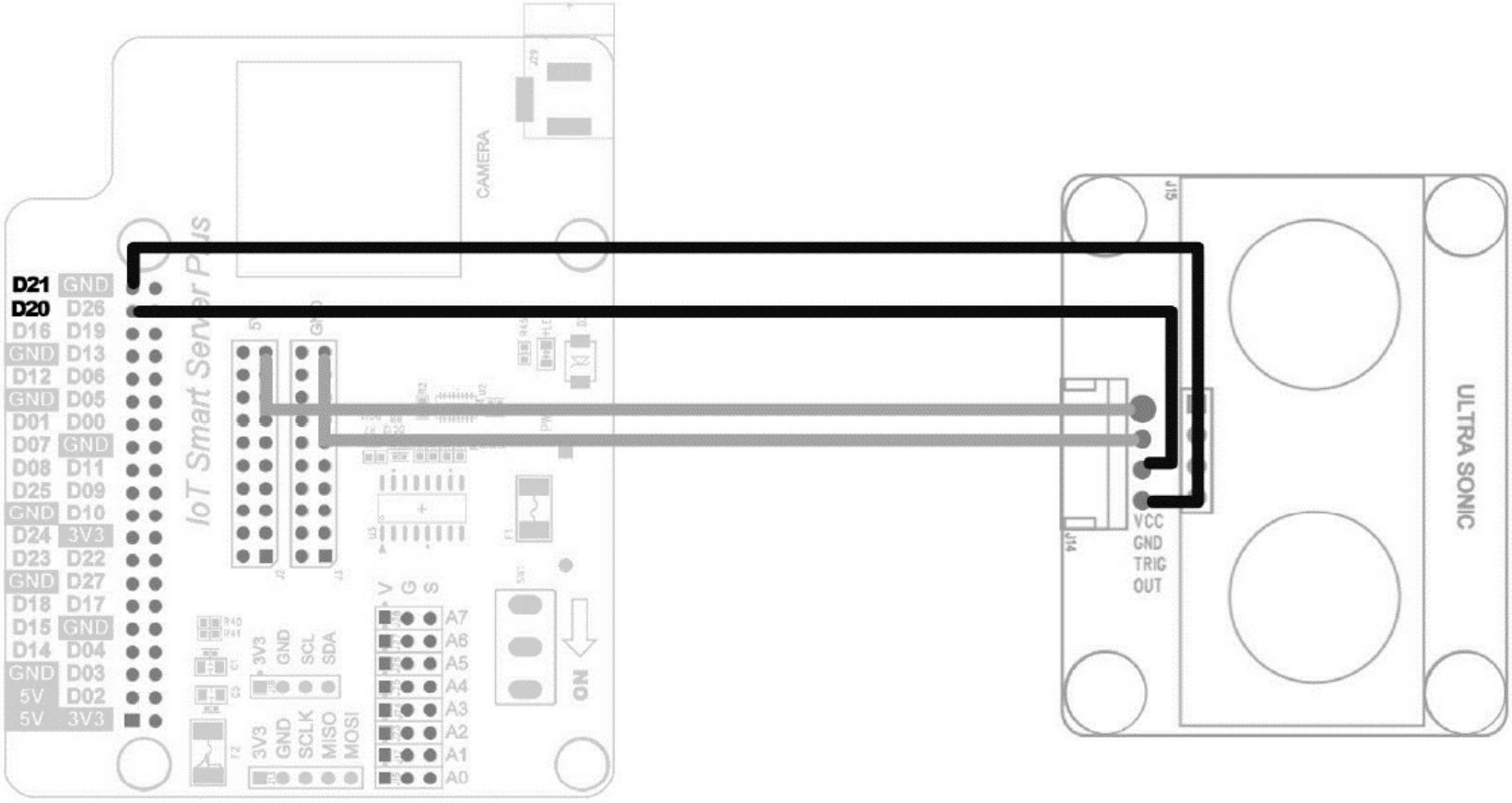
Shape	Category	Description
	Detecting Range	2 ~ 500cm
	Interface	1pin Digital Input , 1pin Digital OUTPUT
	Operating Voltage	5V

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

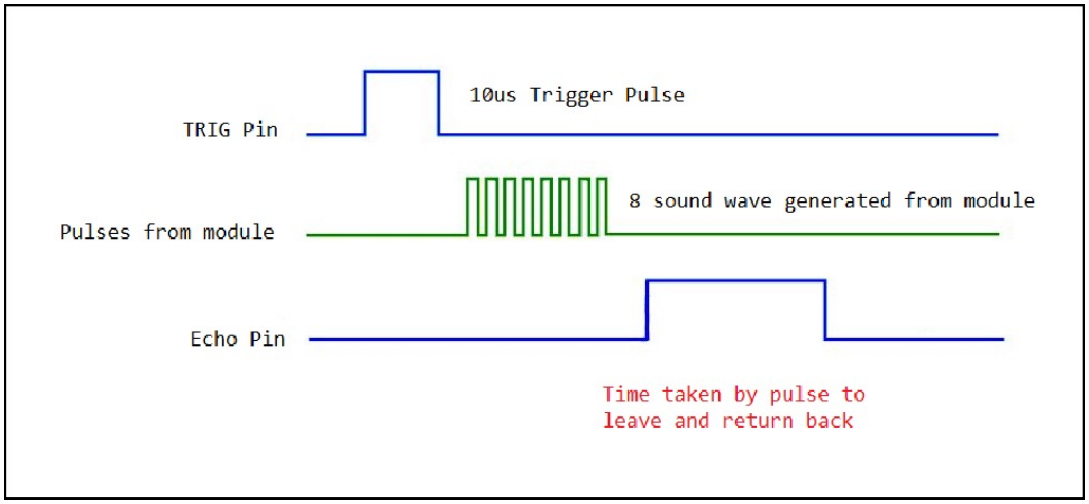
GPIO	Wiring Pi Pin No.	Pin Info.	ULTRA Pin No.
20	28	GPIO	TRIG
21	29	GPIO	OUT

TRIG = Trigger input of sensor

Connect module without applying power to RPi



```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);
```



Any Questions!