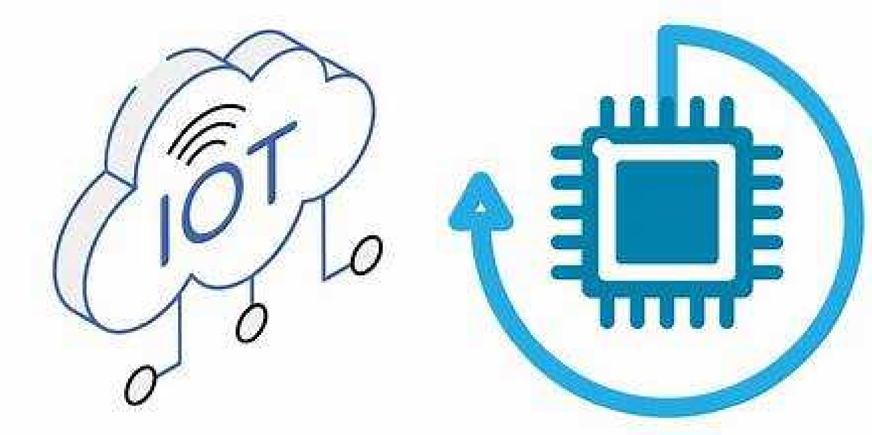
Internet of Things (IoT) Systems



Lecture 5

Raspberry Pi Configuration/ Linux Basic Commands

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Hankuk University of Foreign Studies (HUFS)

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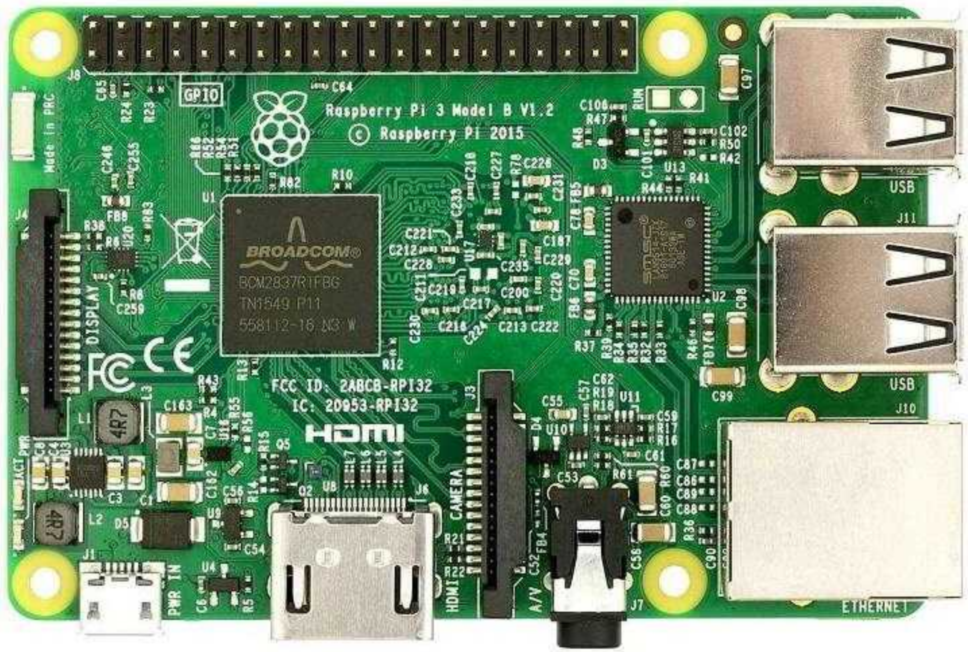
Interfacing with the Raspberry Pi

- Raspberry Pi is a small single board computer
  - A single-board computer is a complete computer built on a single circuit board, with microprocessor, memory, input-output and other features required of a functional computer.

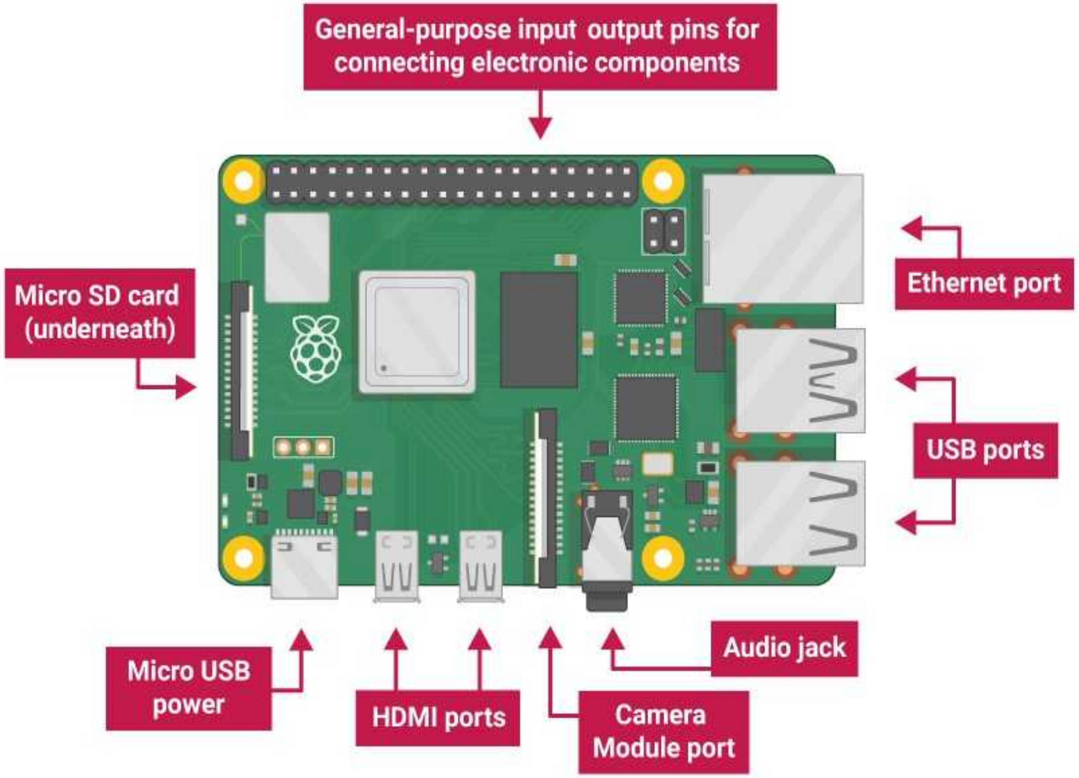


Interfacing with the Raspberry Pi

- USB ports are used to connect a mouse and keyboard. You can also connect other components such as a USB drive

- SD card slot you can slot SD card. This is where the operating system software and your files are stored

- Audio jack you can connect headphones or speakers here.

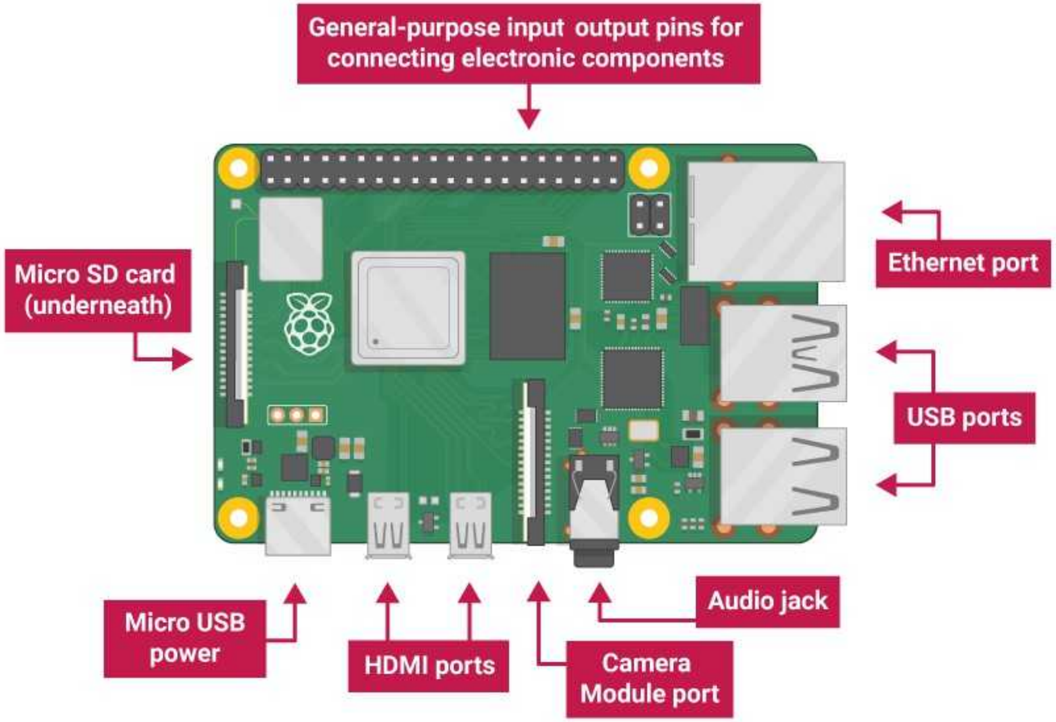

General-purpose input output pins for connecting electronic components
Micro SD card (underneath)
Ethernet port
USB ports
Micro USB power
HDMI ports
Audio jack
Camera Module port

source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Interfacing with the Raspberry Pi

- Ethernet port is used to connect Raspberry Pi to a network with a cable. Raspberry Pi can also connect to a network via wireless LAN.

- HDMI port you can connect monitor or projector to display the output from the Raspberry Pi.
- If your monitor has speakers, you can also use them to hear sound.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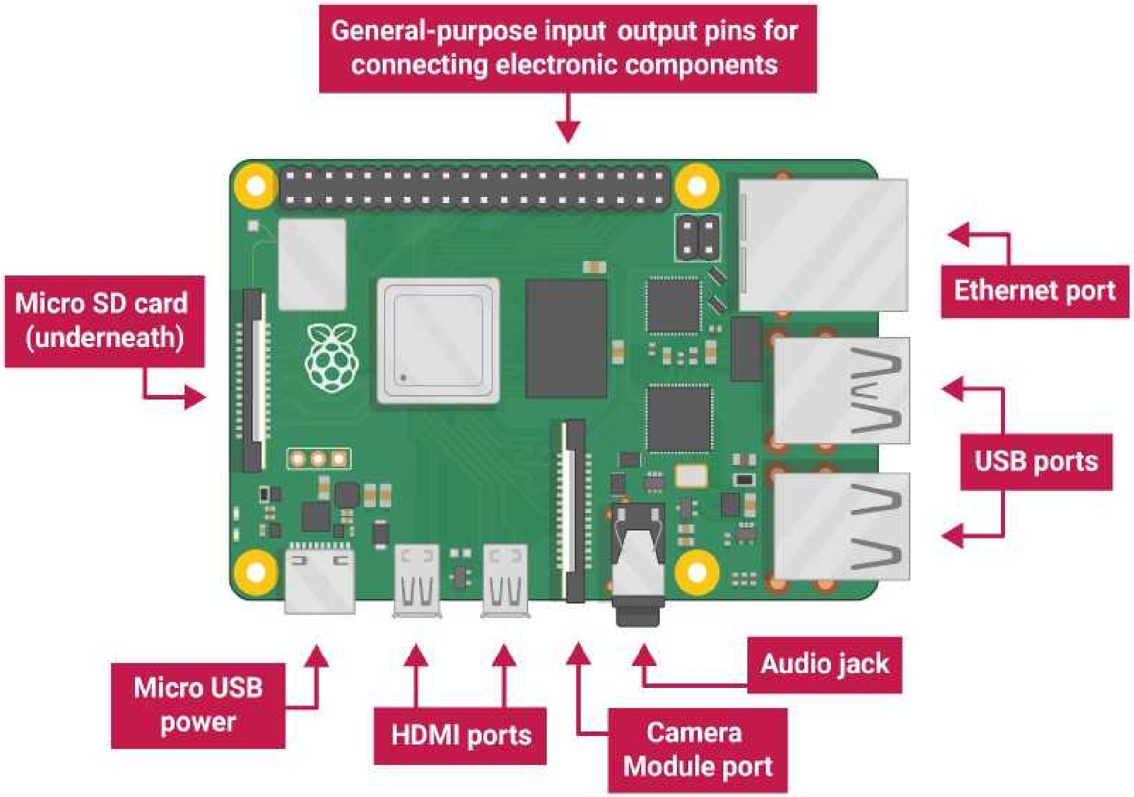
Interfacing with the Raspberry Pi

- Micro USB power connector this is where you connect a power supply. You should always do this last, after you have connected all your other components.

- GPIO ports
  these allow you to connect electronic components such as LED and buttons to Raspberry Pi.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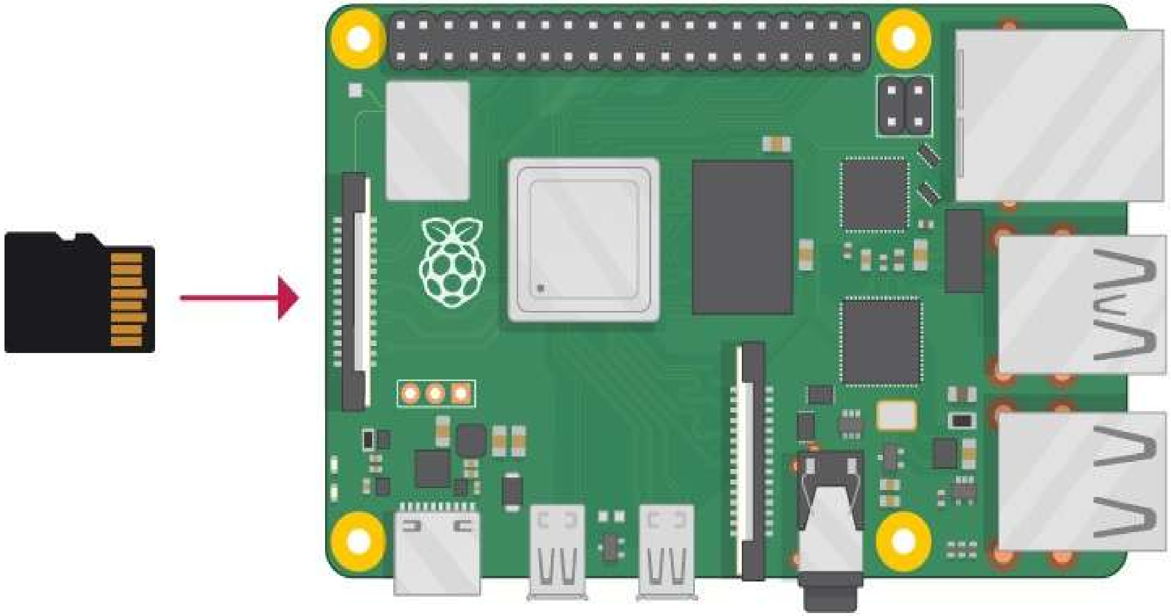
HDMI ports
Camera Module port

source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Interfacing with the Raspberry Pi

- **Connect your Raspberry Pi**
  - Insert an SD card with Raspbian installed



source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

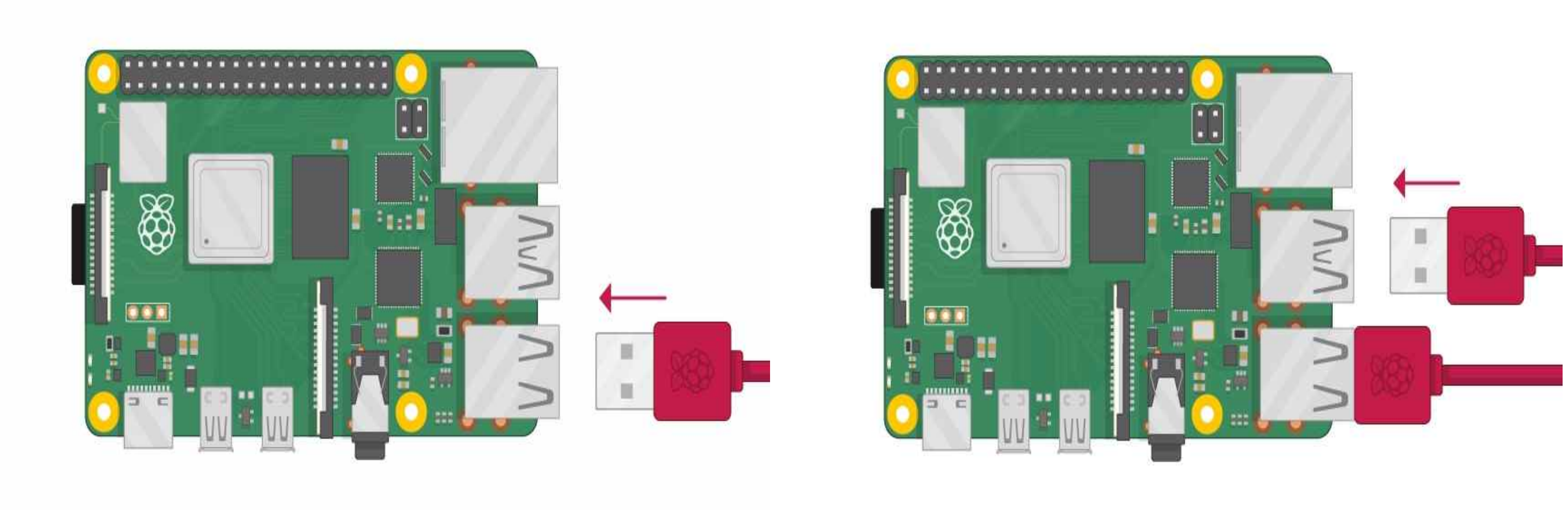
Interfacing with the Raspberry Pi

- **Connect your Raspberry Pi**
  - Many vendors sell SD cards with a simple Raspberry Pi OS installer called NOOBS preinstalled but you can really easily install Raspberry Pi OS yourself using a computer that has an SD card port or using an SD card reader.
  - How to install a Raspberry Pi operating system image on an SD card

source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Interfacing with the Raspberry Pi

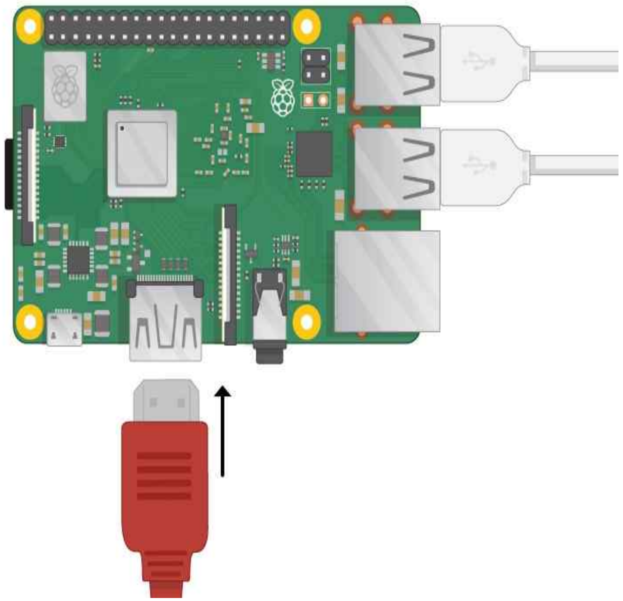
- **Connect your Raspberry Pi**
  - Connect the mouse to a USB port on your Raspberry Pi
  - Connect the keyboard

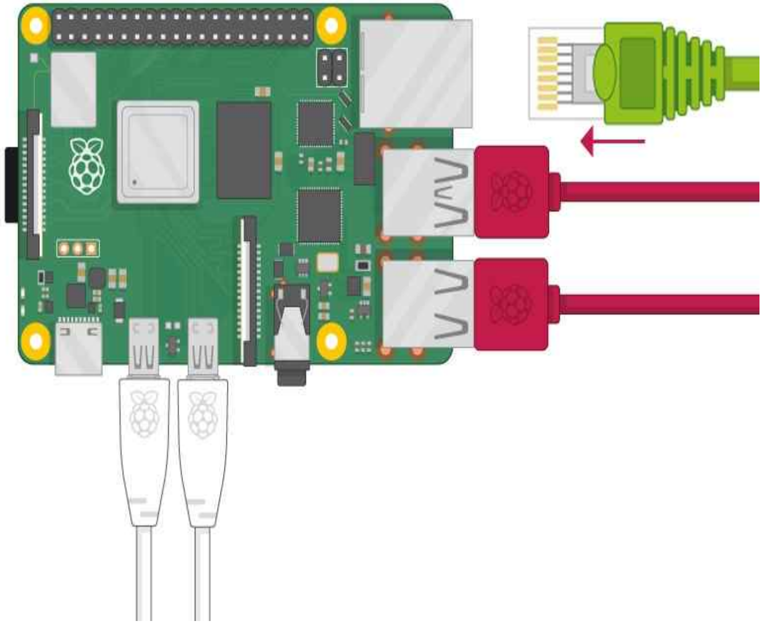


source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Interfacing with the Raspberry Pi

- **Connect your Raspberry Pi**
  - Connect your screen to HDMI port

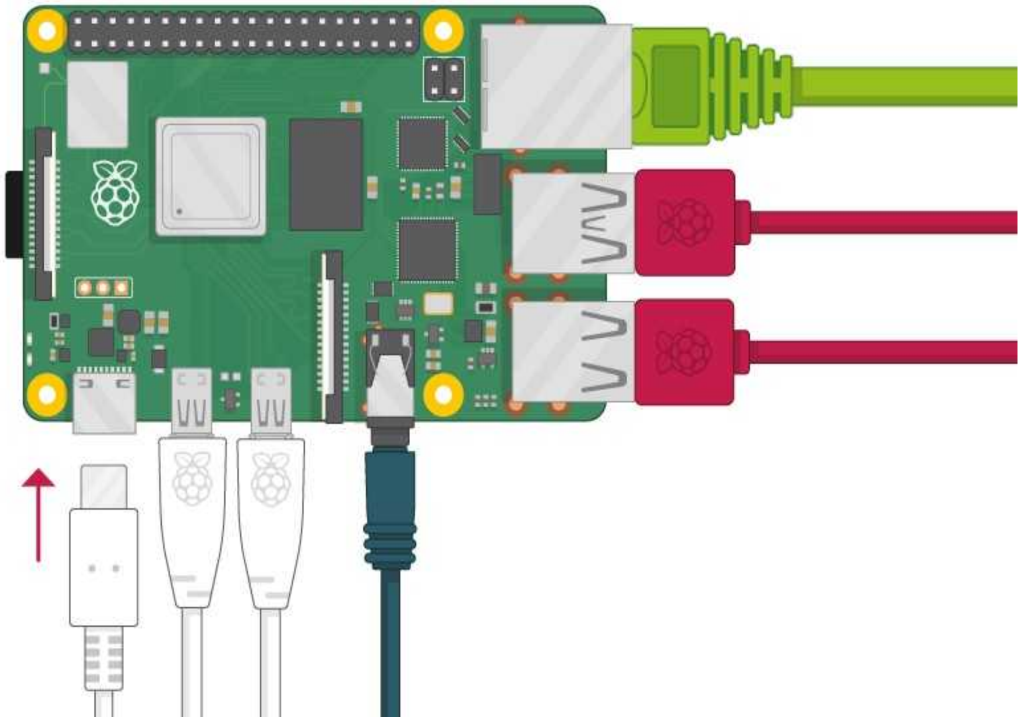




source: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Interfacing with the Raspberry Pi

- **Connect your Raspberry Pi**
  - Plug the power supply into a socket and then connect it to your Raspberry Pi's USB power port.



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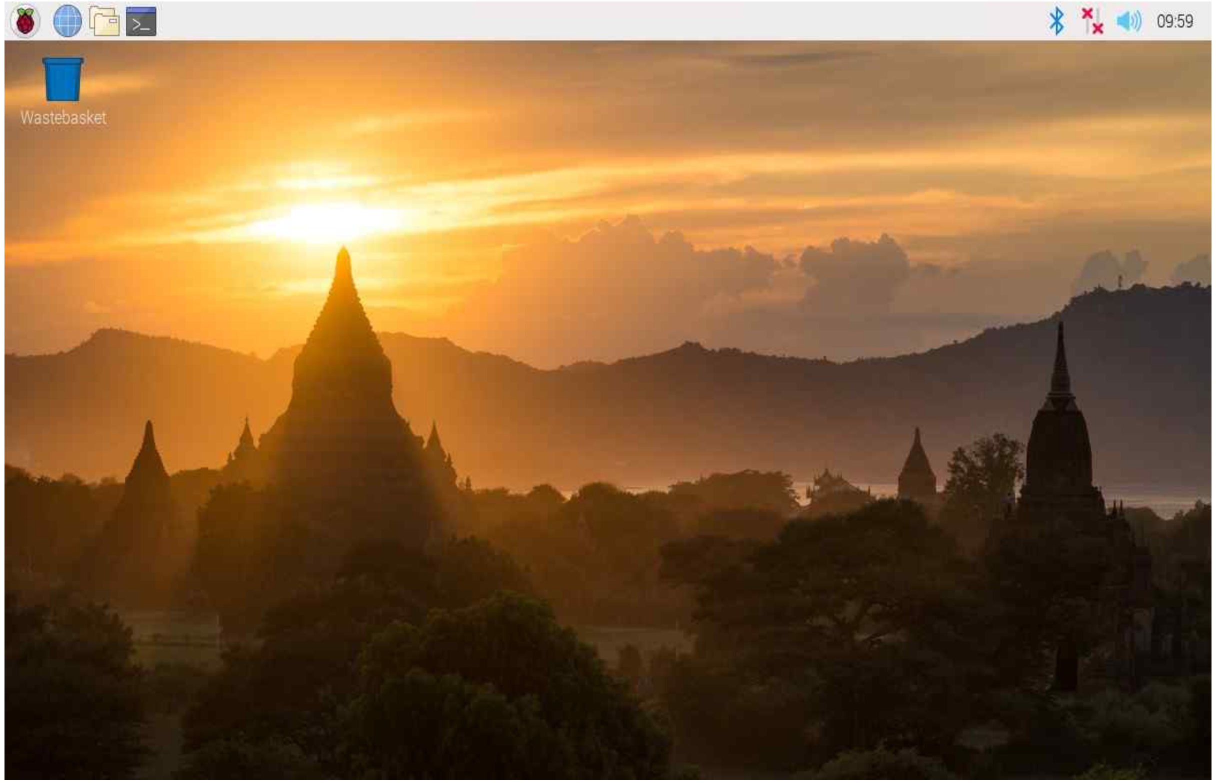
Interfacing with the Raspberry Pi

- **Connect your Raspberry Pi**
  - You should see a red light on your Raspberry Pi and raspberries on the monitor
  - Your Raspberry Pi then boots up into a graphical desktop



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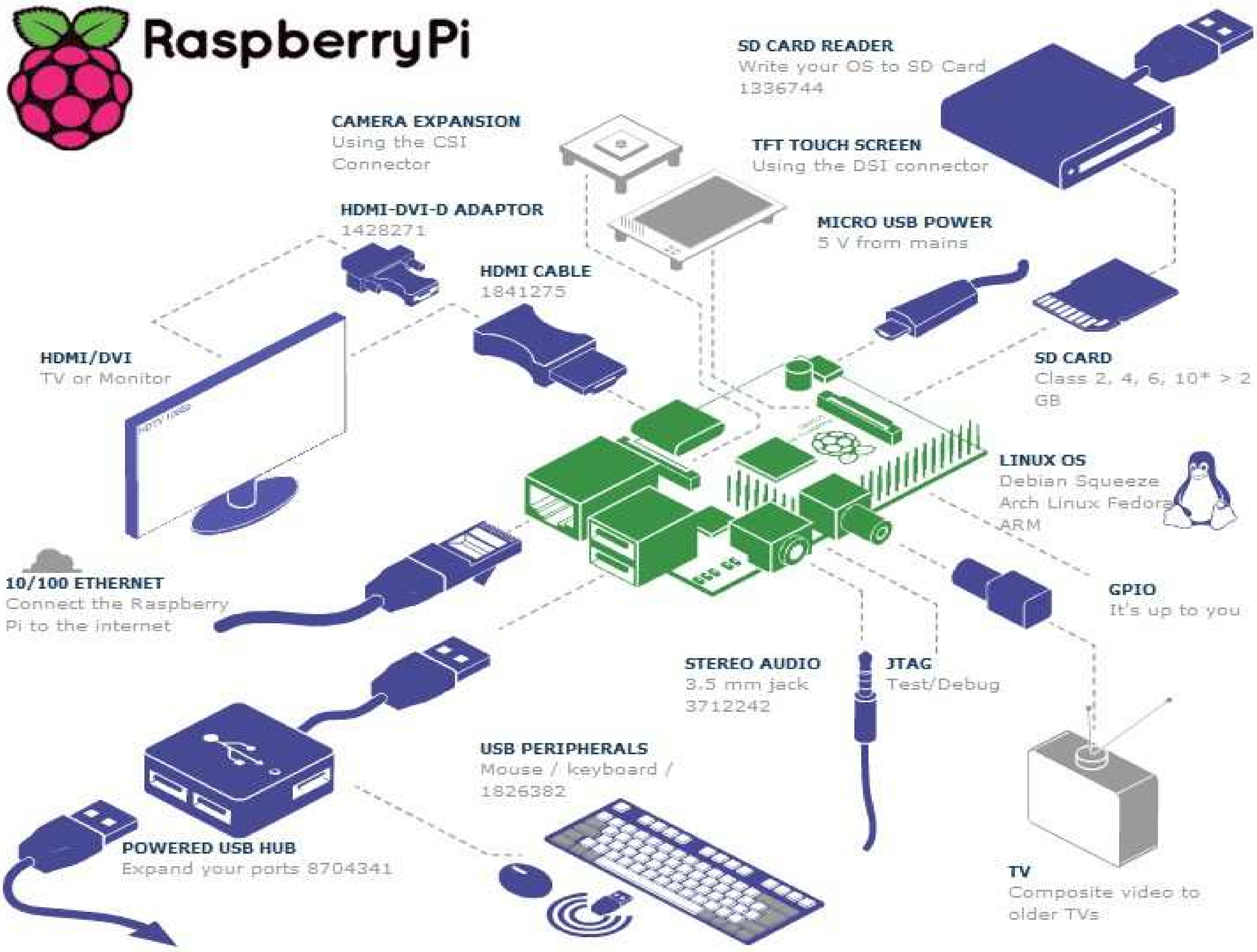
Interfacing with the Raspberry Pi

- **Things that you should never do:**
  - Do not shut the RPi down by pulling out the USB power supply.
  - Do not place a powered RPi on metal surfaces. **Short circuit**
  - GPIO pins are 3.3 V tolerant. Do not connect a circuit that is powered at 5 V.
  - Do not connect circuits that apply power to the GPIO header while the RPi is not powered on. **reverse current flow**.

RaspberryPi



SD CARD READER
Write your OS to SD Card
1336744

CAMERA EXPANSION
Using the CSI
Connector

TFT TOUCH SCREEN
Using the DSI connector

HDMI-DVI-D ADAPTOR
1428271

MICRO USB POWER
5 V from mains

HDMI CABLE
1841275

HDMI/DVI
TV or Monitor

SD CARD
Class 2, 4, 6, 10* > 2
GB

LINUX OS
Debian Squeeze
Arch Linux Fedora
ARM

10/100 ETHERNET
Connect the Raspberry
Pi to the internet

GPIO
It's up to you

STEREO AUDIO
3.5 mm jack
3712242

JTAG
Test/Debug

USB PERIPHERALS
Mouse / keyboard /
1826382

POWERED USB HUB
Expand your ports 8704341

TV
Composite video to
older TVs

Interfacing with the Raspberry Pi

- **Raspberry Pi Software**
  - The main open source Linux distributions used on RPi board include Raspbian,
  - Ubuntu, and Arch Linux
  - Raspbian is a version of Debian that is released specifically for the RPi
  - Raspbian extends Debian with RPi-specific tools and software packages

Interfacing with the Raspberry Pi

- **Remote Access via Secure Shell (SSH)**
  - SSH is a **network protocol** for **secure encrypted communication** between network devices
  - Use an SSH terminal client to connect to **SSH server** running on **port 22** of RPi
  - Only have access to command line not full desktop environment
  - For a full remote desktop, use **Virtual Network Computing (VNC)**
    - VNC is a graphical desktop sharing system that allows you to remotely control the desktop interface of one computer from another computer or mobile device

Interfacing with the Raspberry Pi

- **Remote Access via Secure Shell (SSH)**
  - Enable SSH
    - Launch *Raspberry Pi Configuration* from the *Preferences* menu
    - Navigate to the *Interfaces* tab
    - Select *Enabled* next to *SSH*
    - Click *OK*
  - Set up client
    - SSH using Windows 10/11
    - To connect to your Pi from a different computer, copy and paste the following

      command into the terminal window

```
ssh pi@<IP>
```

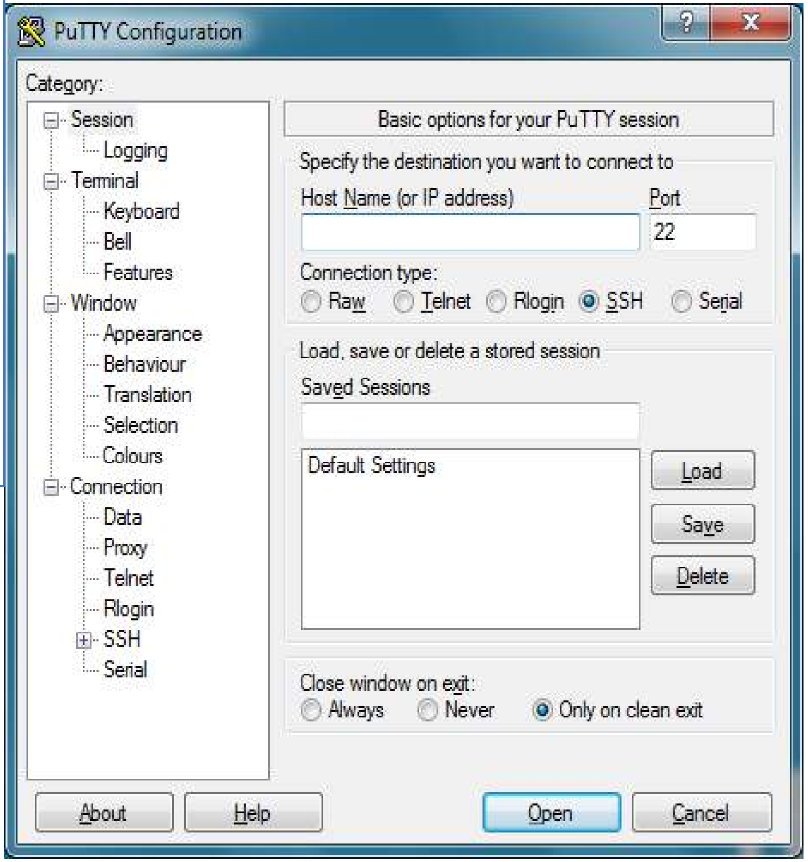
default name : pi

password : raspberry

```
ssh ikram@192.168.1.5
```

Interfacing with the Raspberry Pi

- **Secure Shell Connections Using PuTTY**
  - PuTTY is a free, open source terminal emulator, serial console, and SSH client that you can also use to connect to the RPi over the network
    - It supports serial and SSH connections
    - It installs an application called *psftp* that enables you to transfer files to and from the RPi over the network from your desktop computer



PuTTY Configuration

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address):

Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

Load, save or delete a stored session

Saved Sessions

Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

Task 01

You are required to install **Raspberry Pi OS** on a **Raspberry Pi 4** and set it up with **a mouse, keyboard**, and **monitor**.

Task: Install **Raspberry Pi OS** and ensure it **boots properly**.

Verification: Woon-in Choi (T.A) will check your setup before the start of Thursday's class.

Due Date: Thursday, 01:00 PM

-

Interfacing with the Raspberry Pi

Basic Linux Commands

COMMAND	DESCRIPTION
whoami	Returns who you are currently logged in as
uptime	Returns how long the system has been running
top	Lists all of the processes and programs executing
ls	List files
pwd	Print the working directory
ps	Lists the processes currently running on the RPi
ifconfig	Shows network information
cd	Change directory
mkdir	Make a directory
rm	Delete a file
cp	Copy a file or directory
mv	Move a file or directory
touch	Create an empty file or update the modification date of an existing file
more	View the contents of a file

Interfacing with the Raspberry Pi

Basic Linux Commands

COMMAND	DESCRIPTION
nano filename,	Terminal text editors, modify, create file CTRL+ x, Y, Enter save and exit.
vim filename	Terminal text editors, modify, create file Esc, :wq enter, save and exit :q! exit without saving
date	Prints date and time
sudo	Used to perform system administration commands
sudo apt install *package*	Install a package
sudo apt update	Update the package index
sudo apt upgrade	Upgrade the packages on your system
apt-get download *package*	Download a package to the current directory
sudo apt remove *package*	Remove a package

Interfacing with the Raspberry Pi

Basic Linux Commands

COMMAND	DESCRIPTION
sudo shutdown - h now	Shuts down the board correctly
sudo shutdown - h +5	Delay by five minutes
sudo reboot	Reset and reboot the board correctly

Interfacing with the Raspberry Pi

- C program on Raspberry Pi

```
#include <stdio.h>
int main() {
   printf("Hello");
}
```

Install gcc

```
sudo apt-get update
sudo apt-get install build-essential
```

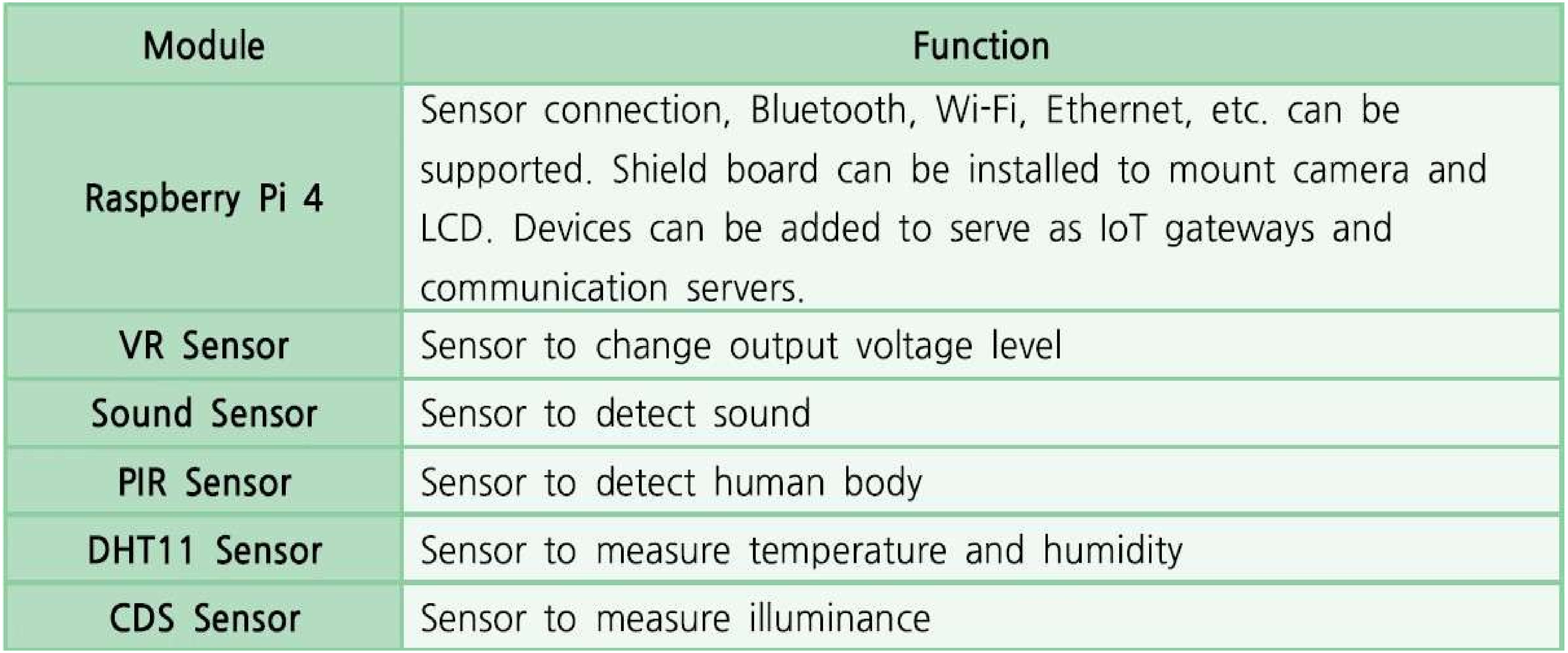
`gcc example.c -o example`	Compile C program
`chmod +x example`	get permission for executing the program
`./example`	execute the program

Task : Find the Factorial of a Number

- Write a C program that allows the user to input a number and then calculates the factorial of that number. The program should also check if the input is a valid positive integer and handle invalid inputs.
- **Input a number** from the user.
- **Check if the number is positive** using an **if-else** statement.
  - If the number is positive, calculate its **factorial** using a **for loop**.
  - If the number is not positive, display an error message.
- Use a **while loop** to repeatedly ask the user for a valid input until they enter a positive integer.
- Display the result of the factorial.

IoT Smart Server

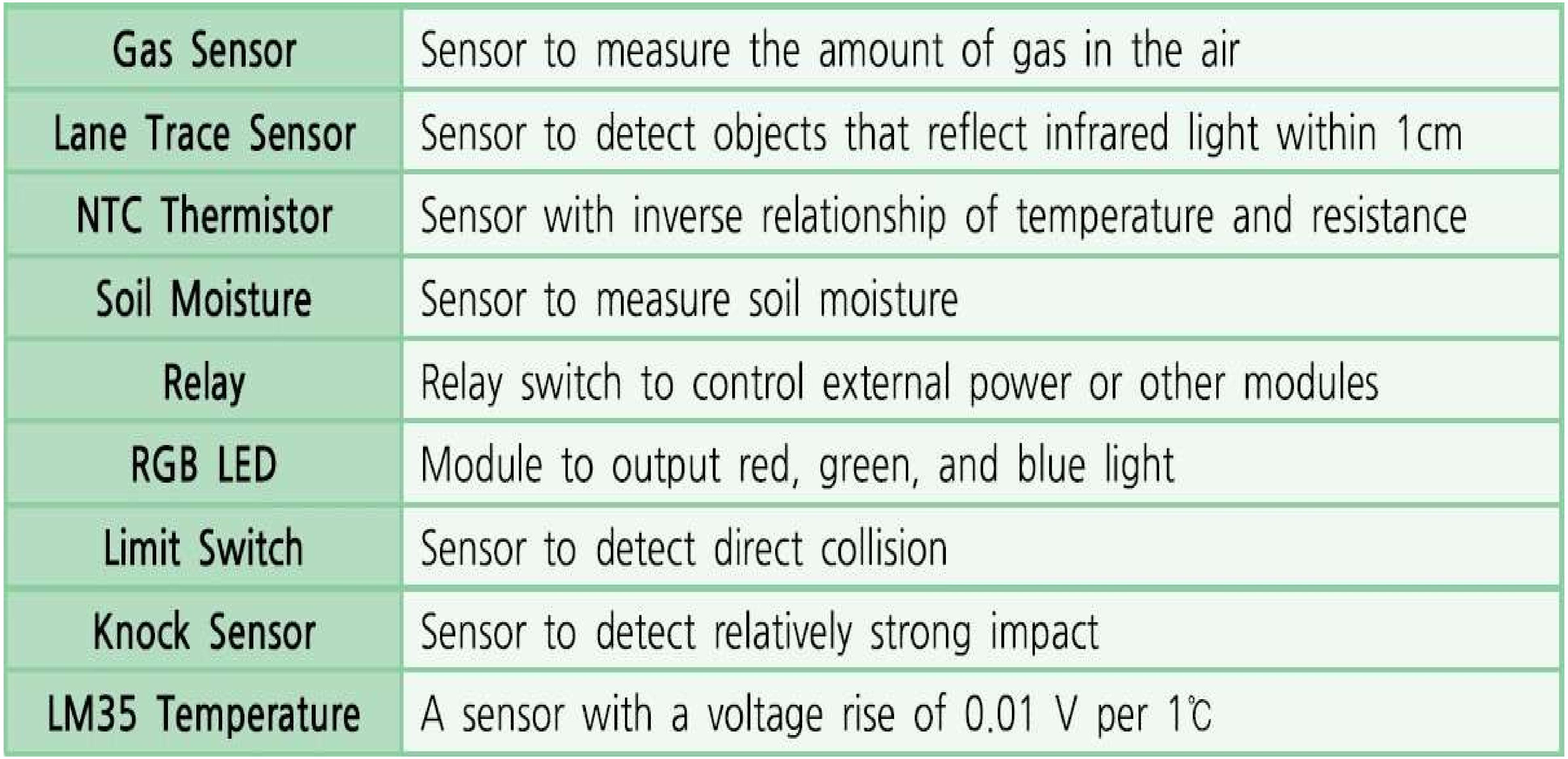
IoT Smart Server



Module	Function
Raspberry Pi 4	Sensor connection, Bluetooth, Wi-Fi, Ethernet, etc. can be supported. Shield board can be installed to mount camera and LCD. Devices can be added to serve as IoT gateways and communication servers.
VR Sensor	Sensor to change output voltage level
Sound Sensor	Sensor to detect sound
PIR Sensor	Sensor to detect human body
DHT11 Sensor	Sensor to measure temperature and humidity
CDS Sensor	Sensor to measure illuminance

Ultrasonic Sensor	Sensor to use Ultrasonic waves to measure the distance of objects
Buzzer Module	Sound to generate sound
DC Motor	DC Motor to be used as actuator
Step Motor	Step Motor to be used as actuator
LED Module	Module to output light
Laser Module	Module to output hign-density light (laser)
Input Shield	Module to be used for button input
Flammable Sensor	Sensor to detect flame
Reed Sensor	Sensor to detect magnetic force
Mercury Sensor	Sensor to detect tilt by mercury in class tube
Tilt Sensor	Sensor to detect tilt
Optocoupler Sensor	Sensor to detect presence of objects
Touch Sensor	Sensor to detect capacitive touch
Shock Sensor	Sensor to detect physical impact
PSD Sensor	Sensor to detect objects by infrared
Dust Sensor	Sensor to measure the amount of dust in the air

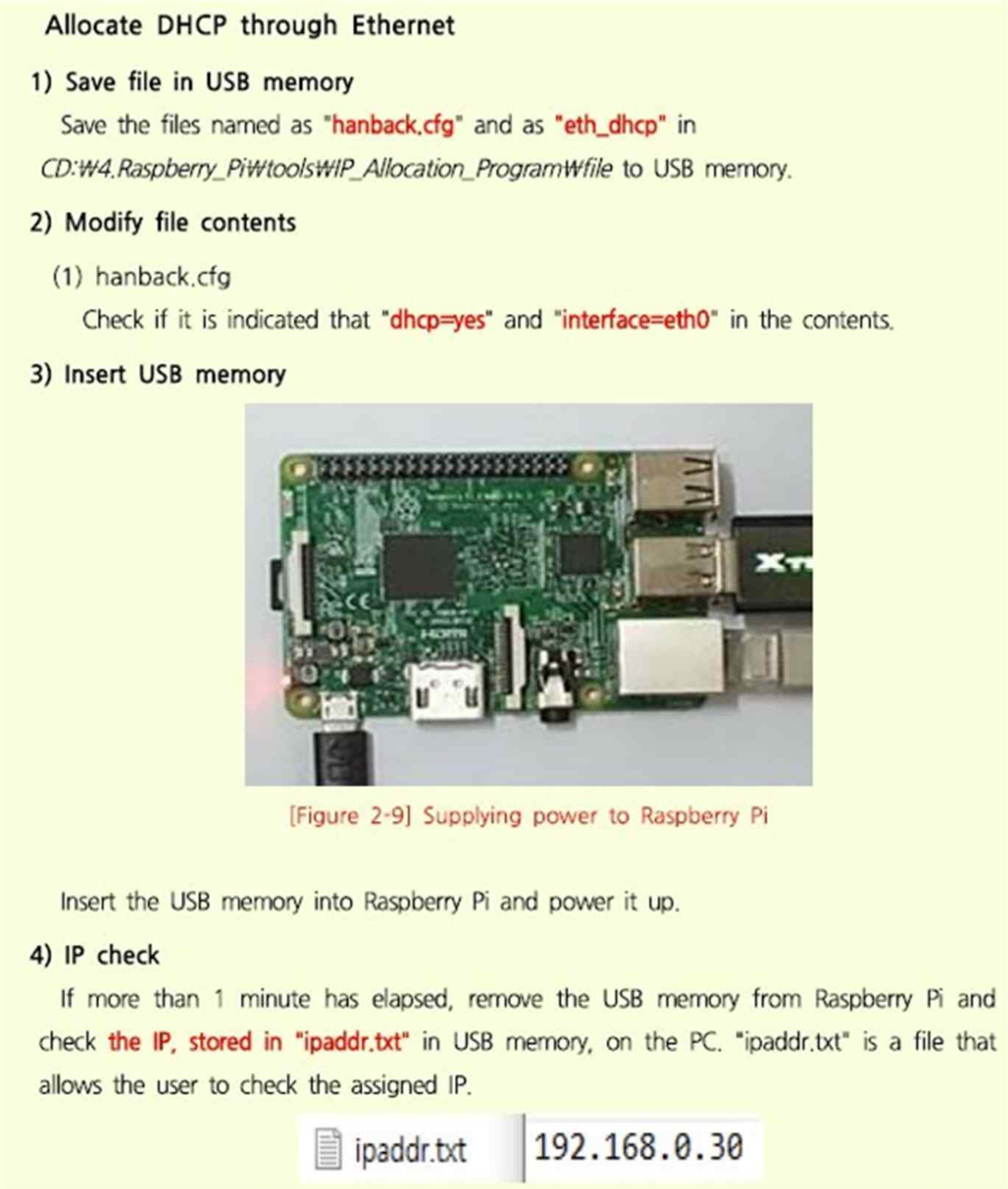
IoT Smart Server



Gas Sensor	Sensor to measure the amount of gas in the air
Lane Trace Sensor	Sensor to detect objects that reflect infrared light within 1cm
NTC Thermistor	Sensor with inverse relationship of temperature and resistance
Soil Moisture	Sensor to measure soil moisture
Relay	Relay switch to control external power or other modules
RGB LED	Module to output red, green, and blue light
Limit Switch	Sensor to detect direct collision
Knock Sensor	Sensor to detect relatively strong impact
LM35 Temperature	A sensor with a voltage rise of 0.01 V per 1℃

IoT Smart Server

- Network Configuration
  - Raspbian provided by Hanbaek Electronics is able to set IP with USB memory
  - Does not work if images are downloaded from Raspberry official website



Allocate DHCP through Ethernet

1) Save file in USB memory

Save the files named as "**hanback.cfg**" and as "**eth_dhcp**" in *CD:₩4.Raspberry_Pi₩tools₩IP_Allocation_Program₩file* to USB memory.

2) Modify file contents

(1) hanback.cfg

Check if it is indicated that "**dhcp=yes**" and "**interface=eth0**" in the contents.

3) Insert USB memory

[Figure 2-9] Supplying power to Raspberry Pi

Insert the USB memory into Raspberry Pi and power it up.

4) IP check

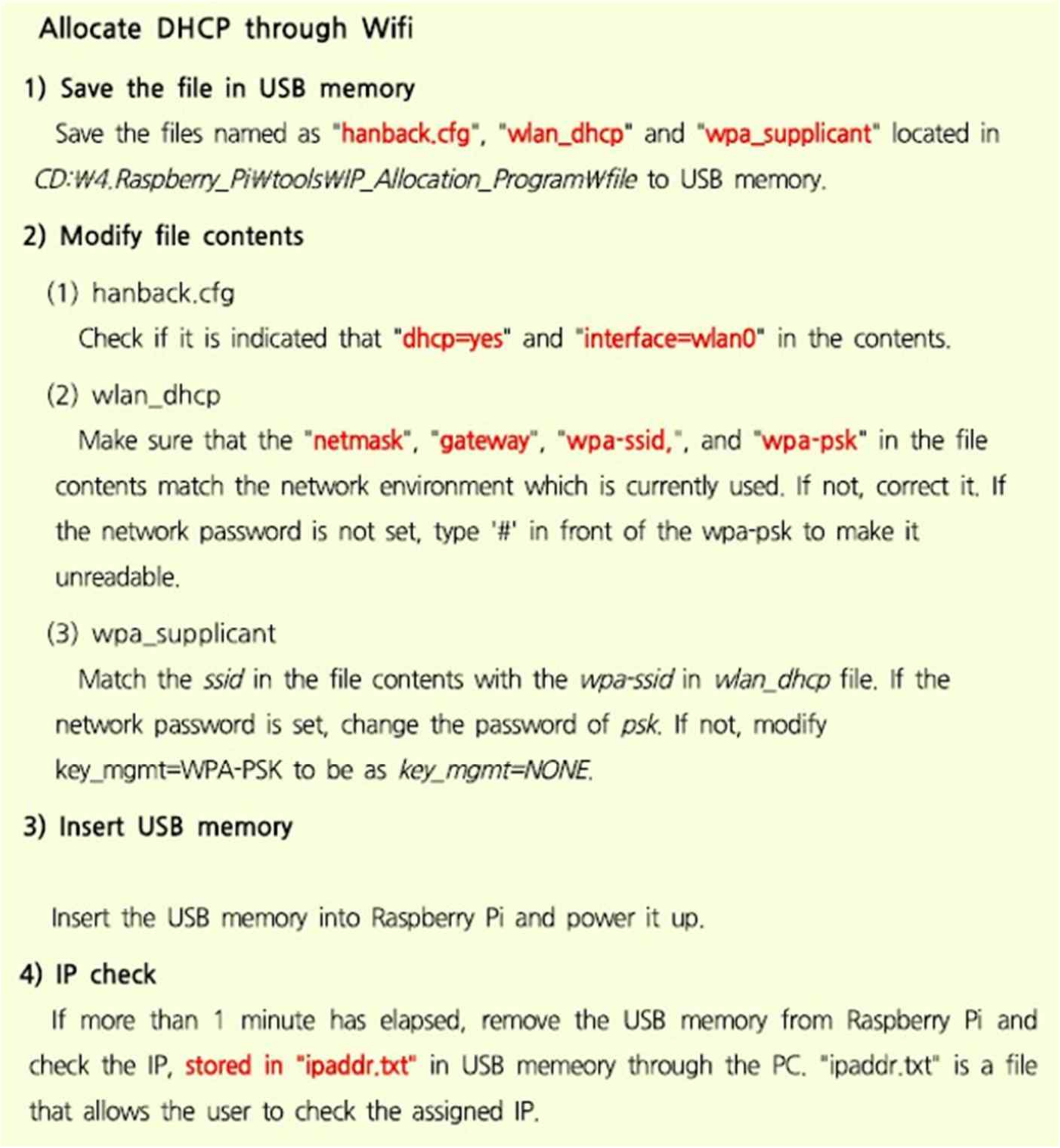
If more than 1 minute has elapsed, remove the USB memory from Raspberry Pi and check **the IP, stored in "ipaddr.txt"** in USB memory, on the PC. "ipaddr.txt" is a file that allows the user to check the assigned IP.

ipaddr.txt

```
192.168.0.30
```

IoT Smart Server

- Network Configuration
  - Raspbian provided by Hanbaek Electronics is able to set IP with USB memory
  - Does not work if images are downloaded from Raspberry official website



Allocate DHCP through Wifi

1) Save the file in USB memory

Save the files named as "hanback.cfg", "wlan_dhcp" and "wpa_supplicant" located in *CD:W4.Raspberry_PiWtoolsWIP_Allocation_ProgramWfile* to USB memory.

2) Modify file contents

(1) hanback.cfg

Check if it is indicated that "dhcp=yes" and "interface=wlan0" in the contents.

(2) wlan_dhcp

Make sure that the "netmask", "gateway", "wpa-ssid,", and "wpa-psk" in the file contents match the network environment which is currently used. If not, correct it. If the network password is not set, type '#' in front of the wpa-psk to make it unreadable.

(3) wpa_supplicant

Match the *ssid* in the file contents with the *wpa-ssid* in *wlan_dhcp* file. If the network password is set, change the password of *psk*. If not, modify key_mgmt=WPA-PSK to be as *key_mgmt=NONE*.

3) Insert USB memory

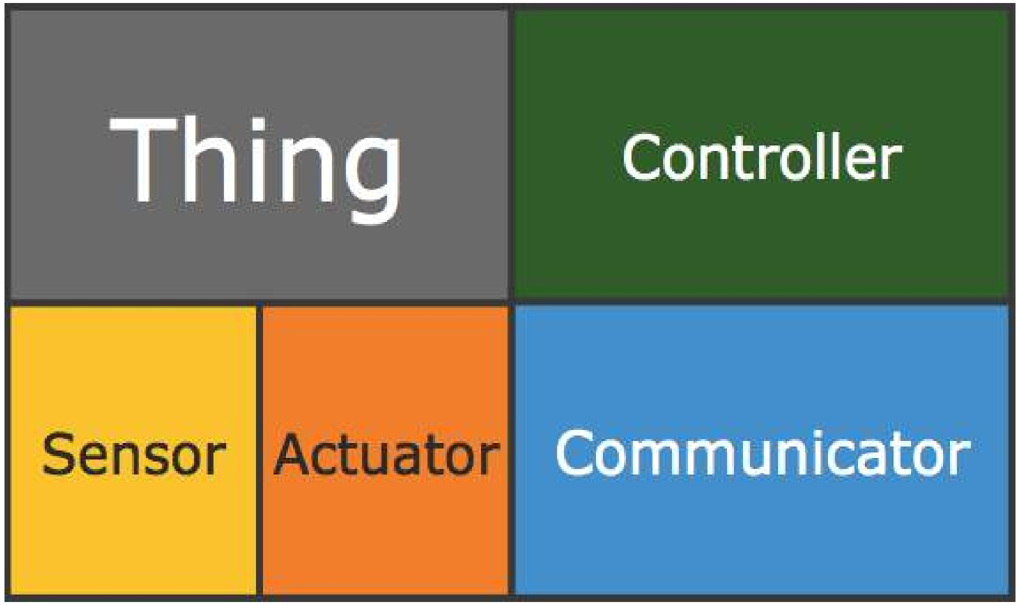
Insert the USB memory into Raspberry Pi and power it up.

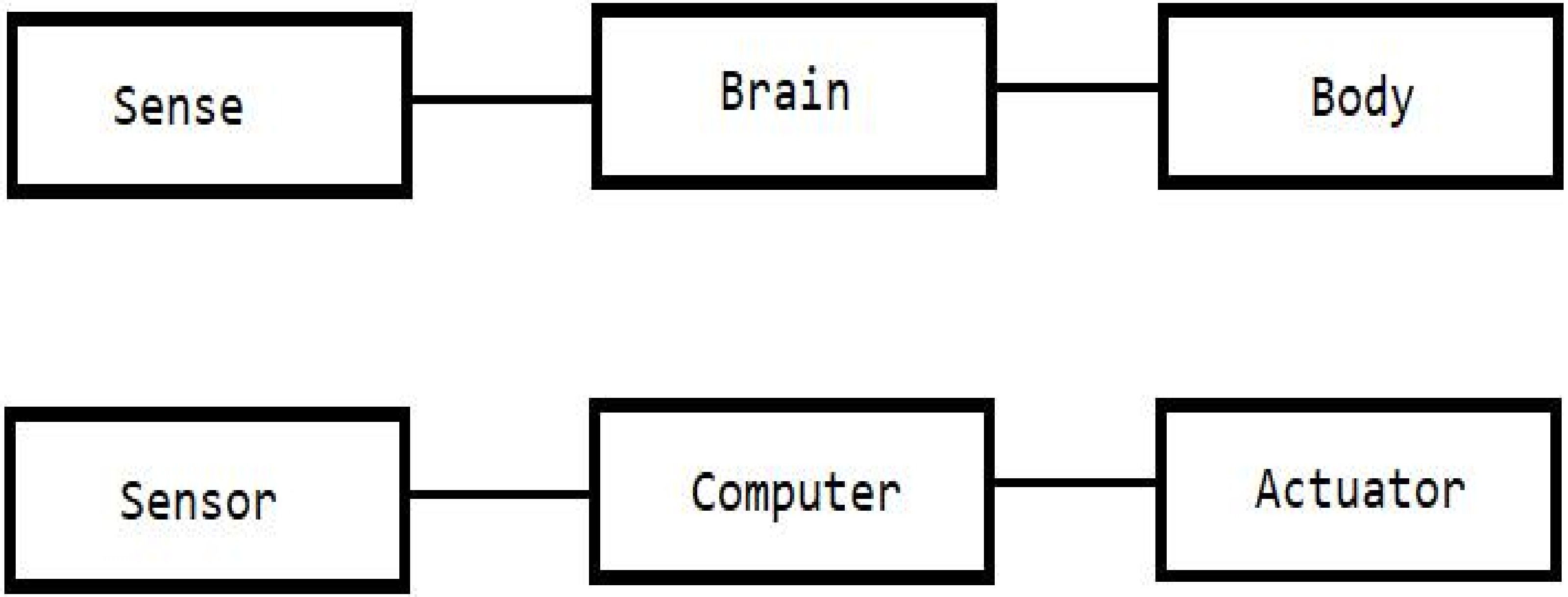
4) IP check

If more than 1 minute has elapsed, remove the USB memory from Raspberry Pi and check the IP, stored in "ipaddr.txt" in USB memeory through the PC. "ipaddr.txt" is a file that allows the user to check the assigned IP.

Access and Control of IoT Devices

- IoT Devices
  - Exchange data with other connected devices and applications
  - Send the data to centralized servers or cloud-based application for processing
  - Perform some tasks locally and other tasks within the IoT infrastructure




Sense
Brain
Body
Sensor
Computer
Actuator

Access and Control of IoT Devices

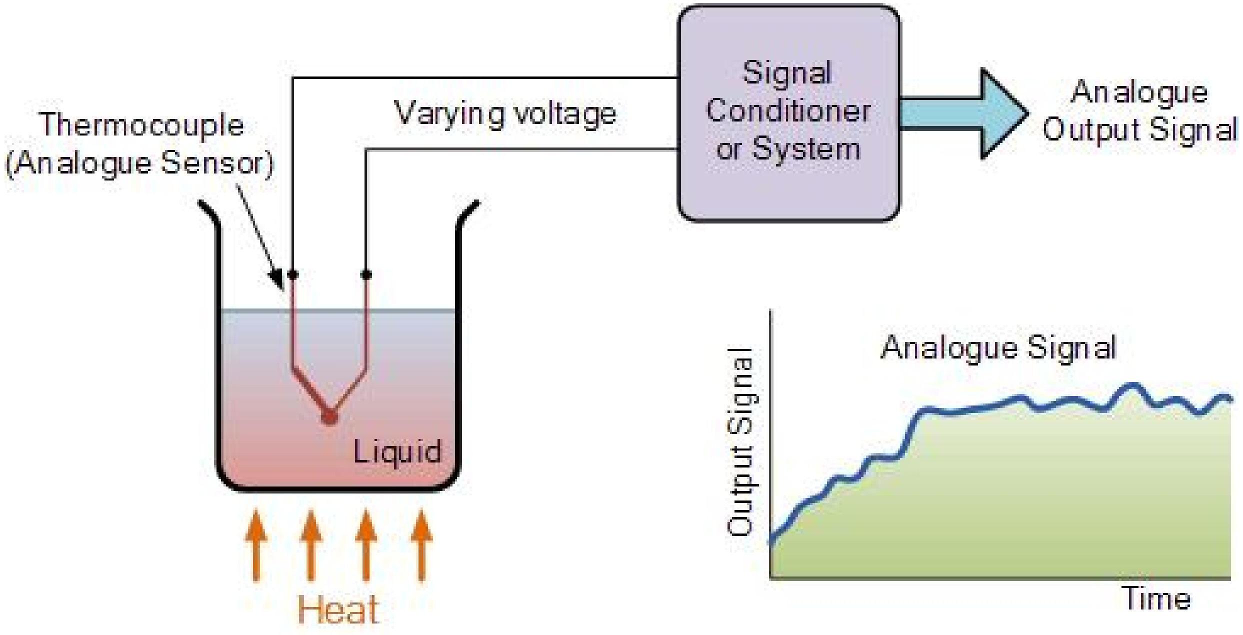
- Transducer
  - A transducer is any device which converts one form of energy into another
    - Microphone converts sound energy into electrical energy
    - Loudspeaker converts electrical energy into sound energy
    - Solar cell converts light into electricity
    - Motor converts electrical energy into mechanical energy
    - Light bulb converts electrical energy into visible light and heat

Access and Control of IoT Devices

- **Sensors**
  - A transducer converts one form of energy into another while the sensor that the transducer is part of converts the output of the transducer to a readable format
    - The light bulb converts electrical energy into light and heat but it does not quantify how much light or heat
    - A battery converts chemical energy into electrical energy but it does not quantify exactly how much electrical energy is being converted

Access and Control of IoT Devices

- **Analog sensors**
  - Analogue sensors produce a continuous output signal or voltage which is generally proportional to the quantity being measured.
  - Physical quantities such as temperature, speed, pressure, displacement, and strain are all analogue quantities as they tend to be continuous in nature.



Access and Control of IoT Devices

- **Digital sensors**
  - Digital sensors produce a discrete digital output signals or voltages that are a digital representation of the quantity being measured
  - Digital sensors produce a binary output signal in form of logic 1 or logic 0

Access and Control of IoT Devices

- Active sensors
  - Emit energy of their own and then sense the response of the environment to that energy
    - Radio Detection and Ranging (RADAR)
- Passive sensors
  - Passive sensors simply receive energy that is produced external to the sensing device
    - A standard camera is embedded with a passive sensor—it receives signals in the form of light and captures them on a storage device

Sensor types	Sensor description	Examples
Position	A position sensor measures the position of an object	Potentiometer Proximity sensor
Occupancy and motion	Occupancy sensors detect the presence of people and animals in a surveillance area, while motion sensors detect movement of people and objects	Electric eye RADAR
Velocity and acceleration	Velocity sensors indicates how fast an object moves along a straight line or how fast it rotates. Acceleration sensors measure changes in velocity.	Accelerometer Gyroscope
Force	Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond a threshold.	Force gauge Touch sensor
Pressure	Pressure sensors are related to force sensors and measure the force applied by liquids or gases. Pressure is measured in terms of force per unit area.	Barometer Piezometer

Source: Deloitte analysis

Sensor types	Sensor description	Examples
Flow	Flow sensors detect the rate of fluid flow. They measure the volume or velocity of fluid that has passed through a system in a given period of time.	Mass flow sensor Water meter
Acoustic	Acoustic sensors measure sound levels and convert that information into digital or analog data signals.	Microphone Hydrophone
Humidity	Humidity sensors detect humidity (amount of water vapor) in the air or a mass.	Hygrometer Soil moisture sensor
Light	Light sensors detect the presence of light	Infrared sensor Photodetector Flame detector
Radiation	Radiation sensors detect radiations in the environment. Radiation can be sensed by scintillating or ionization detection.	Scintillator Neutron detector

Source: Deloitte analysis

Sensor types	Sensor description	Examples
Temperature	Temperature sensors measure the amount of heat or cold that is present in a system. They can be broadly of two types: contact and non-contact. Contact temperature sensors need to be in physical contact with the object being sensed. Non-contact sensors do not need physical contact, as they measure temperature through convection and radiation.	Thermometer Temperature gauge
Chemical	Chemical sensors measure the concentration of chemicals in a system.	Breathalyzer Smoke detector
Biosensors	Biosensors detect various biological elements such as organisms, tissues, cells, enzymes, antibodies, and nucleic acids.	Blood glucose biosensor Electrocardiograph

List of sensors

Source: Deloitte analysis

Access and Control of IoT Devices

- **Actuator**
  - Actuator is a device that converts an electrical signal into action, often by converting the signal to nonelectrical energy, such as motion
    - A simple example of an actuator is an electric motor that converts electrical energy into mechanical energy

Access and Control of IoT Devices

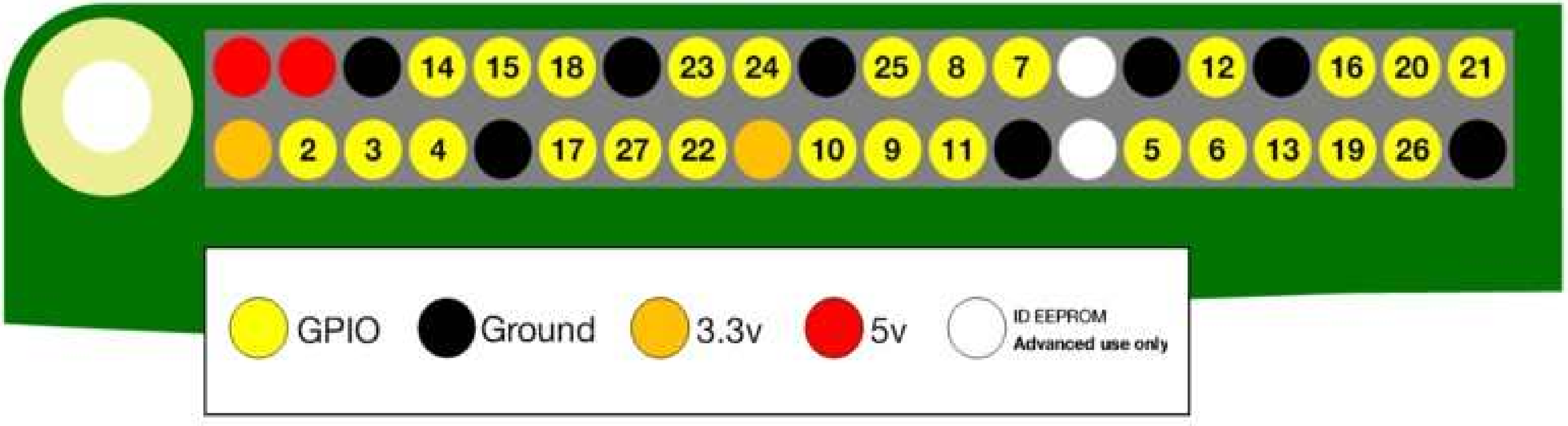
- **Actuator Types**
  - Hydraulic actuator uses hydraulic power to facilitate mechanical operation
  - Electric actuator is a mechanical device used to convert electricity into kinetic energy in either a single linear or rotary motion
  - Mechanical actuator mechanical actuator functions to execute movement by converting one kind of motion, such as rotary motion, into another kind, such as linear motion
  - Pneumatic actuator converts energy typically in the form of compressed air into mechanical motion
  - Thermal actuator is a type of non-electric motor made of components such as a piston and a thermal sensitive material capable of producing linear motion in response to temperature changes.

Access and Control of IoT Devices

- GPIO stands for General Purpose Input-Output
  - Enable RPi to communicate with the external world
  - GPIO pins can be used as
    - Inputs to receive data
      - button or sensor
    - Outputs to react to data
      - LED or buzzer
  - GPIO pins

Access and Control of IoT Devices

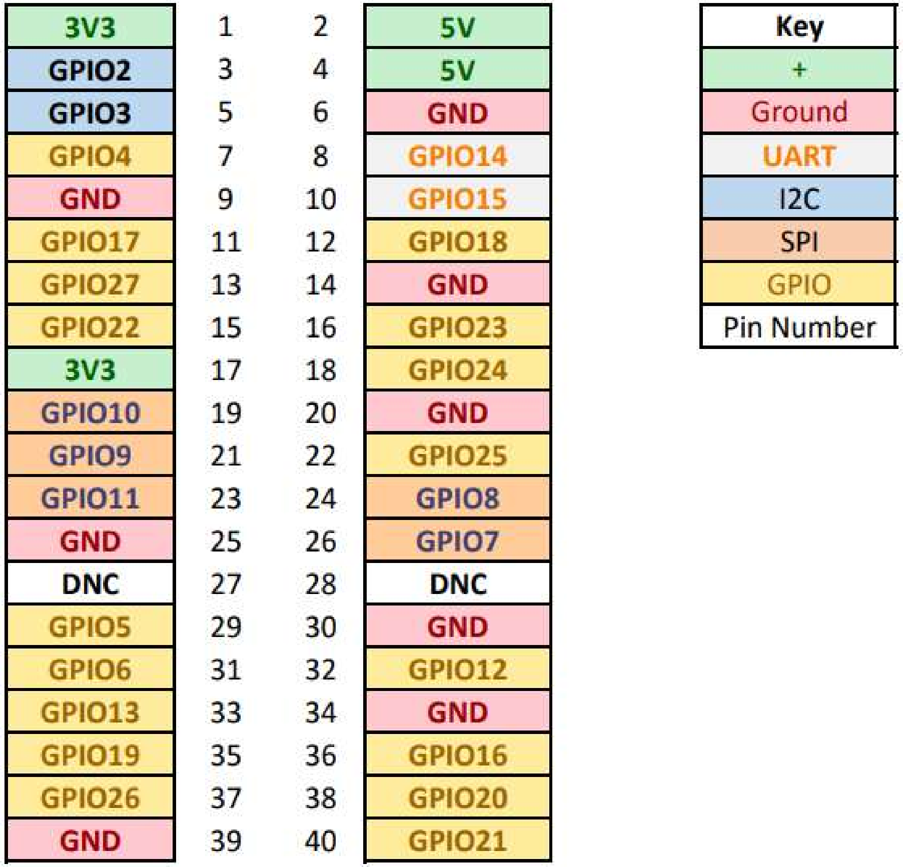
- GPIO stands for General Purpose Input-Output
    - 26 pins are programmable and controllable
    - The first two pins in the top left are labelled as 5v
    - Two 3.3v pins
    - Eight pins are labelled as ground pins



Access and Control of IoT Devices

GPIO stands for General Purpose Input-Output

- I2C (Inter-Integrated Circuit) pins allow you to connect and talk to hardware modules that support I2C Protocol
- SPI (Serial Peripheral Interface Bus) pins can be used to connect and talk to SPI devices



3V3	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
3V3	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

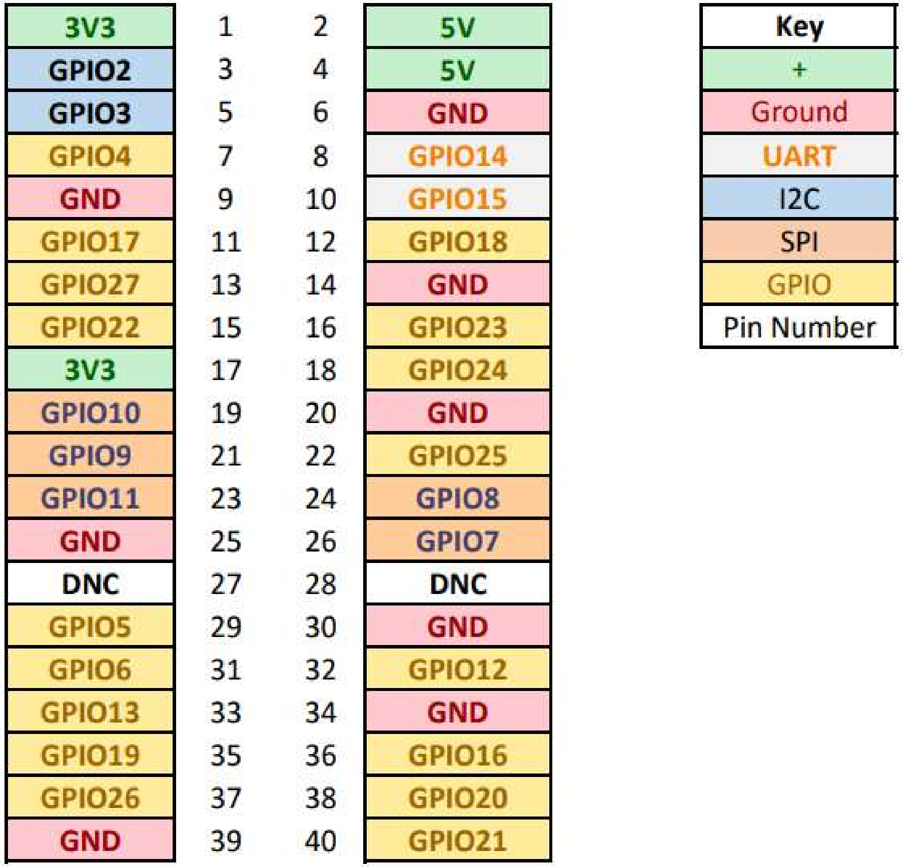
Key
+
Ground
UART
I2C
SPI
GPIO
Pin Number

Access and Control of IoT Devices

GPIO stands for General Purpose Input-Output

- UART (Universal asynchronous receiver transmitter) is an asynchronous serial communication protocol, meaning that it takes bytes of data and transmits the individual bits in a sequential fashion

- DNC stands for do not connect

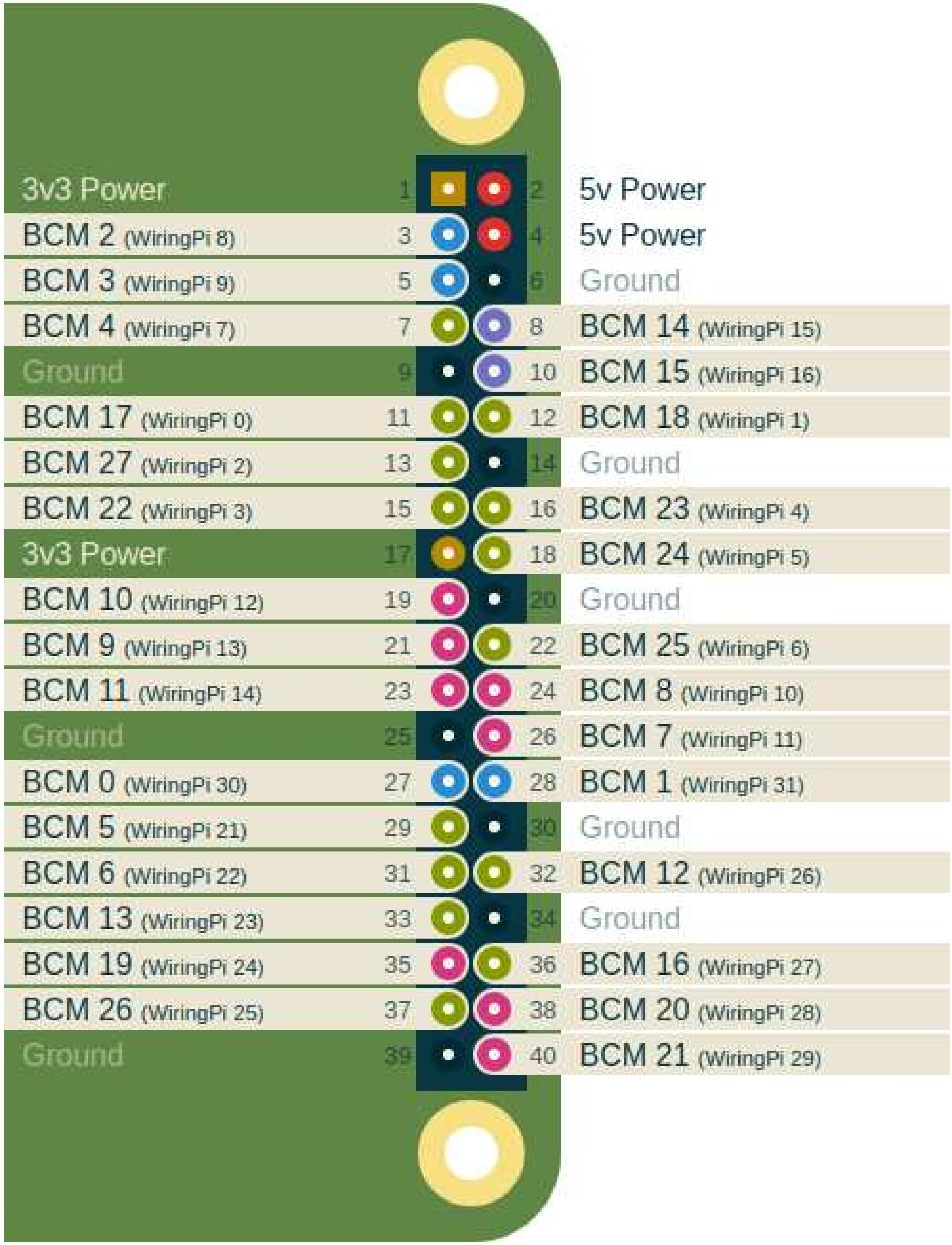


3V3	1	2	5V
GPIO2	3	4	5V
GPIO3	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3V3	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7
DNC	27	28	DNC
GPIO5	29	30	GND
GPIO6	31	32	GPIO12
GPIO13	33	34	GND
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
GND	39	40	GPIO21

Key
+
Ground
UART
I2C
SPI
GPIO
Pin Number

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



3v3 Power	1	2	5v Power
BCM 2 (WiringPi 8)	3	4	5v Power
BCM 3 (WiringPi 9)	5	6	Ground
BCM 4 (WiringPi 7)	7	8	BCM 14 (WiringPi 15)
Ground	9	10	BCM 15 (WiringPi 16)
BCM 17 (WiringPi 0)	11	12	BCM 18 (WiringPi 1)
BCM 27 (WiringPi 2)	13	14	Ground
BCM 22 (WiringPi 3)	15	16	BCM 23 (WiringPi 4)
3v3 Power	17	18	BCM 24 (WiringPi 5)
BCM 10 (WiringPi 12)	19	20	Ground
BCM 9 (WiringPi 13)	21	22	BCM 25 (WiringPi 6)
BCM 11 (WiringPi 14)	23	24	BCM 8 (WiringPi 10)
Ground	25	26	BCM 7 (WiringPi 11)
BCM 0 (WiringPi 30)	27	28	BCM 1 (WiringPi 31)
BCM 5 (WiringPi 21)	29	30	Ground
BCM 6 (WiringPi 22)	31	32	BCM 12 (WiringPi 26)
BCM 13 (WiringPi 23)	33	34	Ground
BCM 19 (WiringPi 24)	35	36	BCM 16 (WiringPi 27)
BCM 26 (WiringPi 25)	37	38	BCM 20 (WiringPi 28)
Ground	39	40	BCM 21 (WiringPi 29)

Access and Control of IoT Devices

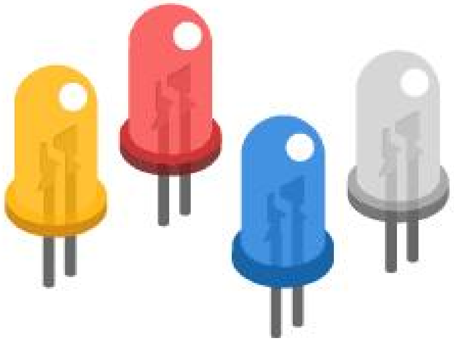
- **GPIO Libraries**
  - The easiest way to work with Raspberry Pi GPIO is to use a library
    - WiringPi GPIO access library written in C
    - RPIO advanced GPIO library
    - Pigpio a module to interface with the GPIO
    - RPi.GPIO a very popular GPIO library
    - gpiozero A simple interface to GPIO devices

Access and Control of IoT Devices

LED Control

- A light releasing diode is an electric component that emits light when the electric current flows through it

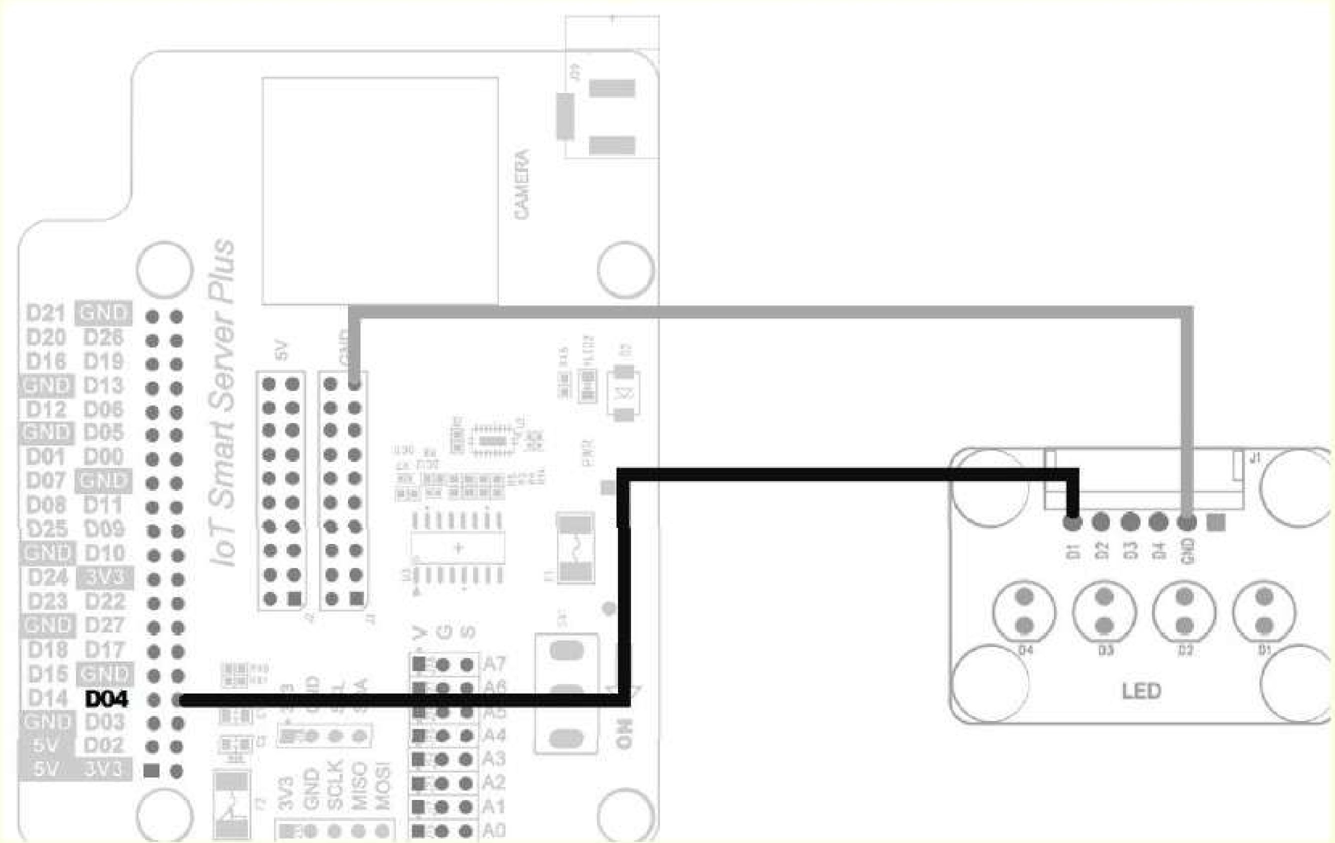
Shape of LED Module	Category	Description
	Configuration	4 units of RED LED 5PI
	Allowable Voltage and Current Consumption	2.0~5V, 20mA
	Operating Voltage	3.3V~5V
Modules to be output using LED		



〈Table 3-2〉 Pin connection for Raspberry Pi and LED Module

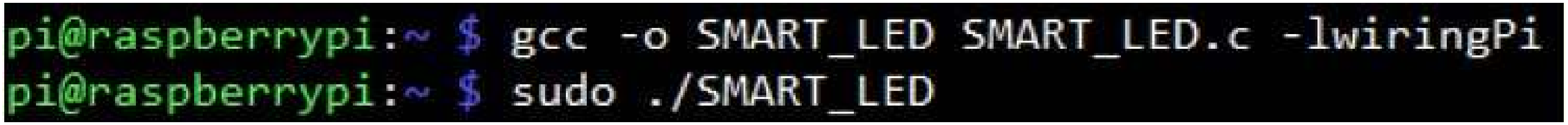
GPIO	Wiring Pi Pin No.	Pin Info.	LED Module Pin No.
4	7	GPIO	D1

Connect without applying power to the Raspberry Pi



[Figure 3-4] Pin Connections for LED Module

```c
#include <wiringPi.h>

#define PIN 7

int main(void)  {

        if(wiringPiSetup() == -1)
           return 1;
        pinMode(PIN,OUTPUT);
        digitalWrite(PIN,HIGH);
        delay(500);
        digitalWrite(PIN,LOW);

}
```

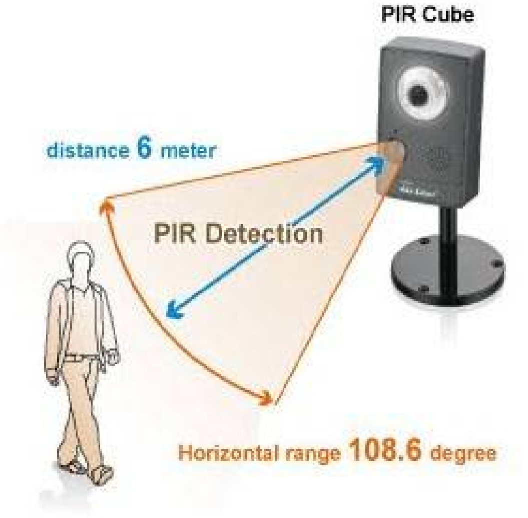


```
pi@raspberrypi:~ $ gcc -o SMART_LED SMART_LED.c -lwiringPi
pi@raspberrypi:~ $ sudo ./SMART_LED
```

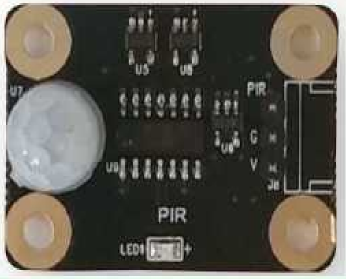
Access and Control of IoT Devices

- **Human or animal detection using PIR sensor**
  - Passive infrared sensor is an electronic sensor that measures infrared (IR) light radiating from objects
    - Any object with temperature is constantly radiating infrared rays
    - When an object passes the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again
    - The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection.

PIR sensors are commonly used in security alarms and automatic lighting applications



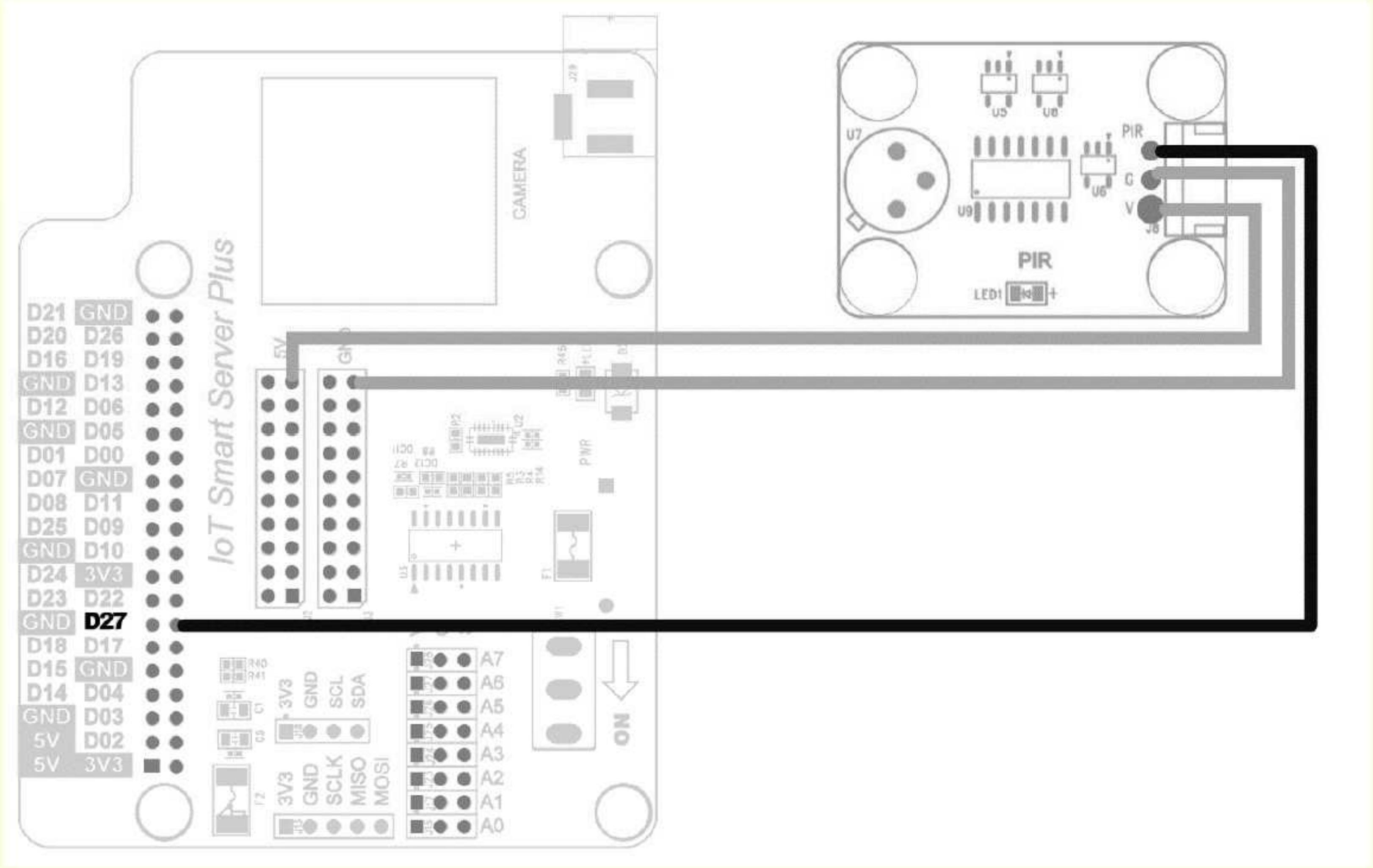
〈Table 3-3〉 Specification of human detection sensor

Shape of human detection sensor	Category	Description
	Infrared Sensor	RE200B
	Detection Range	110 degree
	Operating Voltage	3.3V
	I/O Pin	1 unit of 3-pin header (2.54mm pitch)

〈Table 3-4〉 Pin connection for Raspberry Pi and PIR Sensor

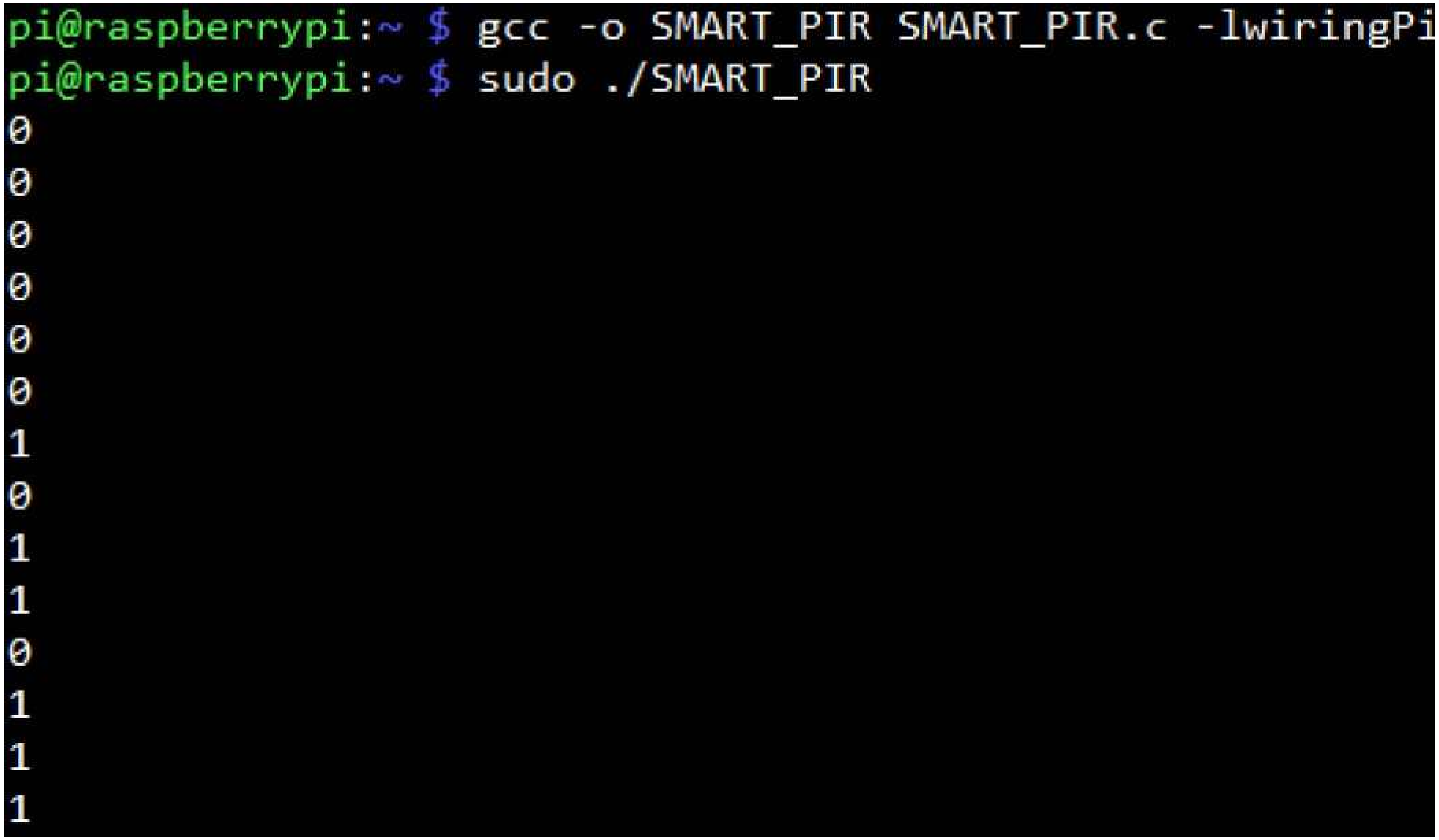
GPIO	Wiring Pi Pin No.	Pin Info.	PIR Sensor Pin No.
27	2	GPIO	PIR

Connect PIR sensor module without applying power to RPi



[Figure 3-9] Pin Connections for PIR Sensor

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

#define PIN 2

int main(void)    {

        int pir, i;

        if(wiringPiSetup() == -1) return 1;
        pinMode(PIN,INPUT);

        for(i=0; i<20; i++){
            pir = digitalRead(PIN);
            printf("%d\n",pir);
            delay(100);
        }
}
```



```
pi@raspberrypi:~ $ gcc -o SMART_PIR SMART_PIR.c -lwiringPi
pi@raspberrypi:~ $ sudo ./SMART_PIR
0
0
0
0
0
0
1
0
1
1
0
1
1
1
```

Any Questions!