

Overview

Dear Customer:

Thank you for choosing the Hiwonder Raspberry Pi 4B Board for your DIY development projects. Raspberry Pi is a versatile tool that can deliver amazing results in a short amount of time. However, we understand that as a beginner, you may require systematic instructions for effective guidance and to quickly master the basics.

To help you get started, we have prepared a comprehensive manual consisting of four chapters - Preface, Introduction, Basic Operations, Basic Programming, and Extended Course. This manual provides step-by-step guidance to help you get familiar with the Raspberry Pi development environment and master the basic concepts of Raspberry Pi development.

All the examples and instructions provided in the manual are specifically designed for Raspberry Pi 4B boards. However, some parts of the content may also be applicable to Raspberry Pi 3B and 3B+.

We sincerely appreciate your support and cooperation in choosing Hiwonder Raspberry Pi 4B Board. We hope that our manual will be of great help to you in accomplishing your DIY development goals.

catalogue

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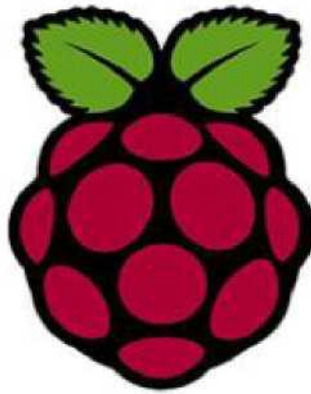
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Preface

Section 1 Raspberry Pi Introduction

Raspberry Pi, short for RPi or RasPi/RPI, is approximately credit-card sized computer and developed by UK Raspberry Pi Foundation. It devotes to helping children around the world to learn programming and be able to understand how the computers work.

Keyboard, mouse and network cable can connect to Raspberry Pi. And it has a TV output interface for video analog signals and an HDMI high-definition video output interface. Raspberry Pi is suitable for people in all ages, which can be used to learn Python programming. At the same time, it has the capacity to do what you expect the computer to do, from browsing the web, playing high-definition video to creating spreadsheet, processing words and playing games!



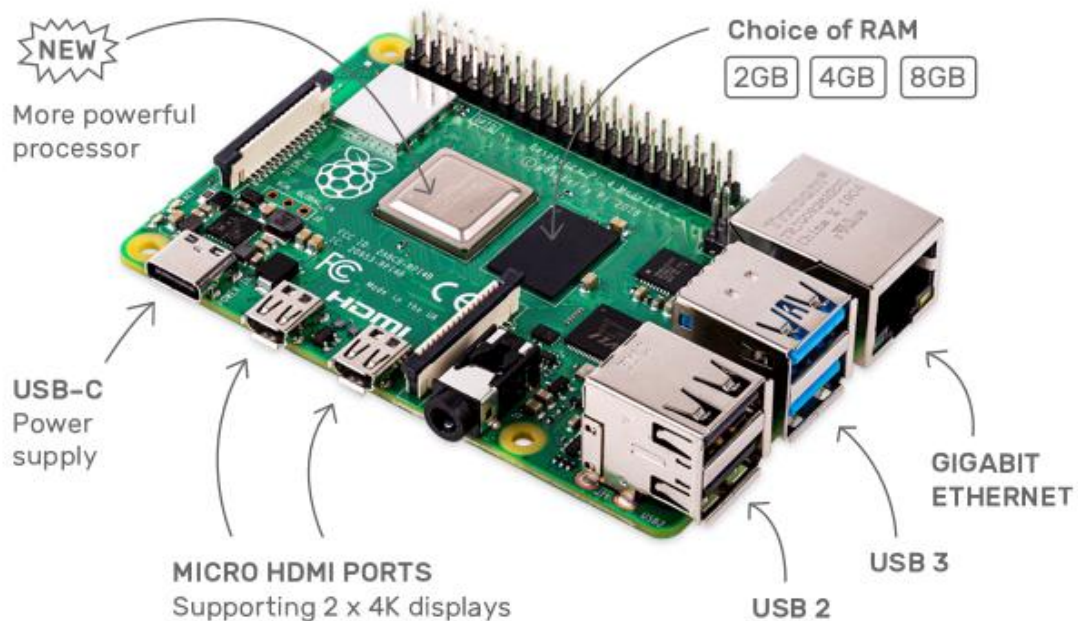
1. Raspberry Pi family

There are many versions and the table below shows a brief description of each

version of Raspberry Pi.

No.	Model	Instruction
1	A	256MB version, no Ethernet port.
2	A+	4 USB ports is reduced to 1 port.
3	B	512MB version with 100M wired Ethernet port.
4	B+	Compared with B, it has lower power consumption, more pins and USB ports. USB Micro SD socket.
5	2B	The performance is six times as that of B+. 1G of memory and four USB2.0 ports.
6	3B	802.11 b/g/n wireless network card, Bluetooth 4.1 adapter, equipped with 64-bit quad-core processor.
7	3B+	5Ghz dual-band WiFi, USB Gigabit Ethernet, Bluetooth 4.2 adapter and processor upgrade.
8	4B	Processor upgrade , Bluetooth 5.0 adapter, upgrade two USB2.0 interfaces to USB3.0, support 4K, Type C power supply port, support 4K dual display, true Gigabit Ethernet (network port reachable).

2. The structure and characteristics of Raspberry Pi



From the structure distribution, Raspberry Pi is small but complete. It has all functions of a computer but smaller than the computer.

Features:

- 1) Strong operating performance
- 2) Open-source hardware and usability
- 3) The tools are free.
- 4) It can be used as a low-cost development platform and a troubleshooting tool
- 5) No network needed for opening all apps
- 6) Small as a credit card.

Based on these advantages, people tend to choose Raspberry Pi to learn programming skills, build hardware projects, carry out home automation projects, and even use them in industrial applications.

3. The application of Raspberry Pi

1) Web Server

The Raspberry Pi can stay around the clock without cooling fans or a lot of power. It transfers things fast via Internet or LAN.

2) Laptop

The Raspberry Pi is considered as “brain” of the laptop. With a computer screen, it can turn into a Laptop.

3) Home theater set-top box

With many free OS, Raspberry Pi can work as a set-up box streaming your favourite content.

4) Game emulator

RetroPie OS is free for any Raspberry Pi. You can use it to play the games such as Game boy, arcade and SNES.

5) Monitor

With an external camera, a simple monitoring system can be built.

6) Wi-Fi extender

If the Wi-Fi signal is weak in corners of your house, Raspberry Pi can turn into an extender to tackle this problem. On the Raspberry Pi's built-in Wi-Fi, only a USB Wi-Fi adaptor is required to repeat the signal.

7) Music streamer and multi-room audio

Combine suitable software and Raspberry Pis to create a low-cost sound system playing music in your home.

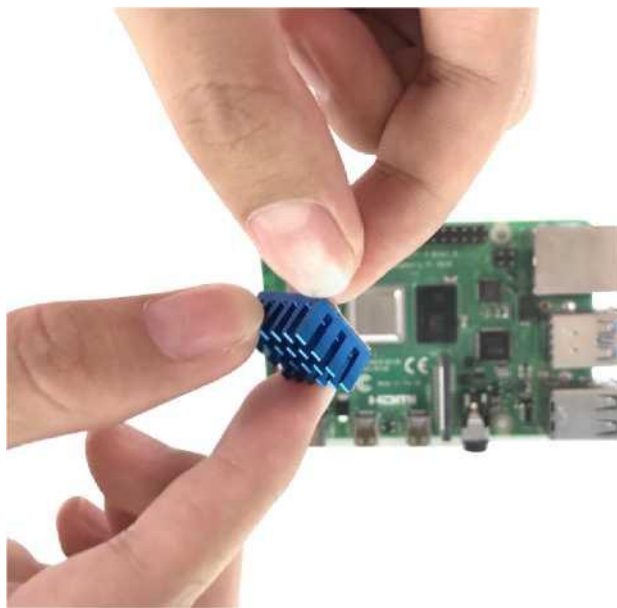
As mentioned above, Raspberry Pi is not only a small development tool, but also a “caring companion” in daily life.

4. The installation of heat sink

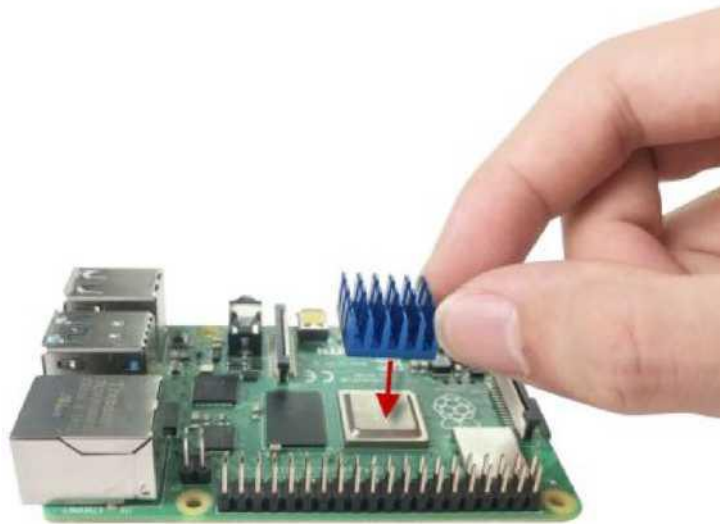
This section only takes the installation of a single heat sink to the Raspberry Pi CPU as example. You can also check the video in folder “2. Basic Lesson->2. Accessories Installation”.

The installation is as follow:

- 1) Peel off the sticker on the back of the heat sink.



- 2) Paste the heat sink on the CPU as figure shown below.



5. The installation of case and fan

Reminder: for the detailed tutorial of assembly and disassembly , please refer to the video in folder “2.Basic Lesson ->2.Accessories Installation”.

The installation is as follow:

- 1) Take out the Raspberry Pi and the bottom acrylic plate.



2) Install the Raspberry Pi to the acrylic plate. Please note that the pin header of Raspberry Pi needs to correspond to the grove of the Acrylic plate during installation.



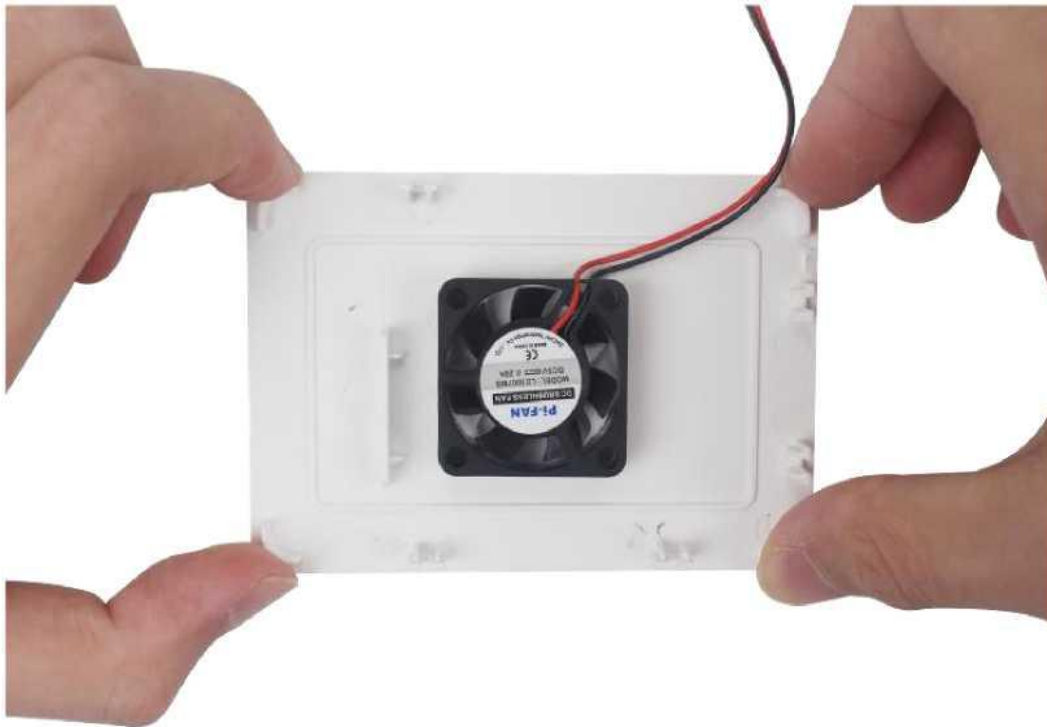
3) After the Raspberry Pi is installed to the acrylic plate, take out the acrylic protective case.



4) Install the acrylic protective case from top to bottom on the acrylic plate with Raspberry Pi. When installing, please ensure the interfaces on Raspberry Pi should aim at the corresponding slots on the case.



5) Install the cooling fan on the back of the white acrylic plate and the label on the cooling fan facing downward. Please make sure the holes of the cooling fan is aligned with the holes of the acrylic plate.



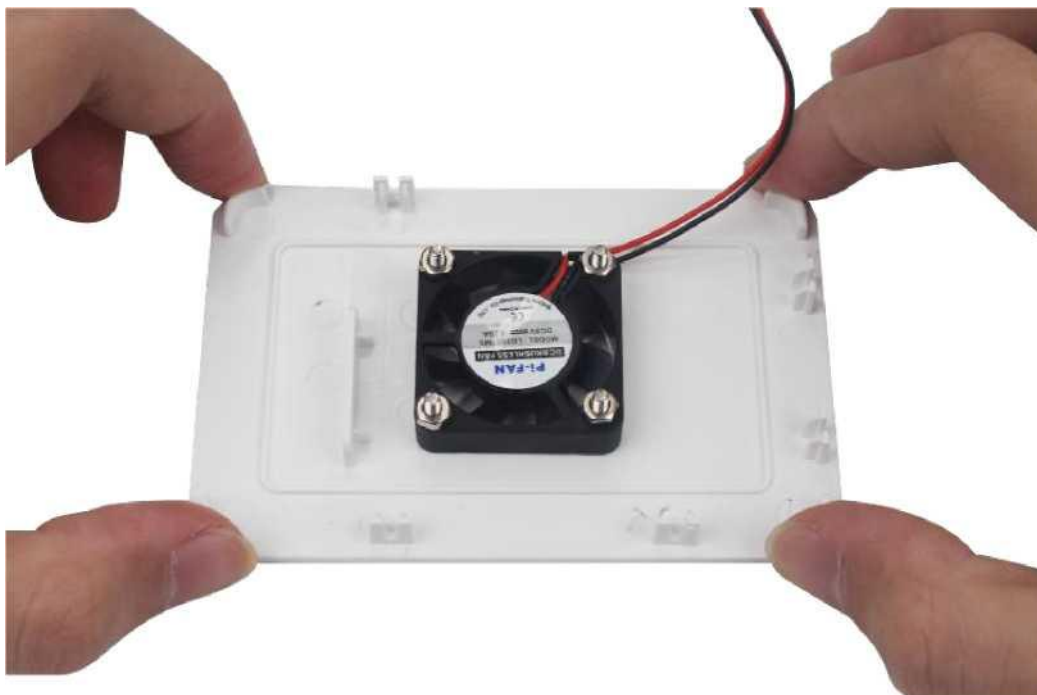
6) Insert a screw into the screw holes on acrylic plate and cooling fan.



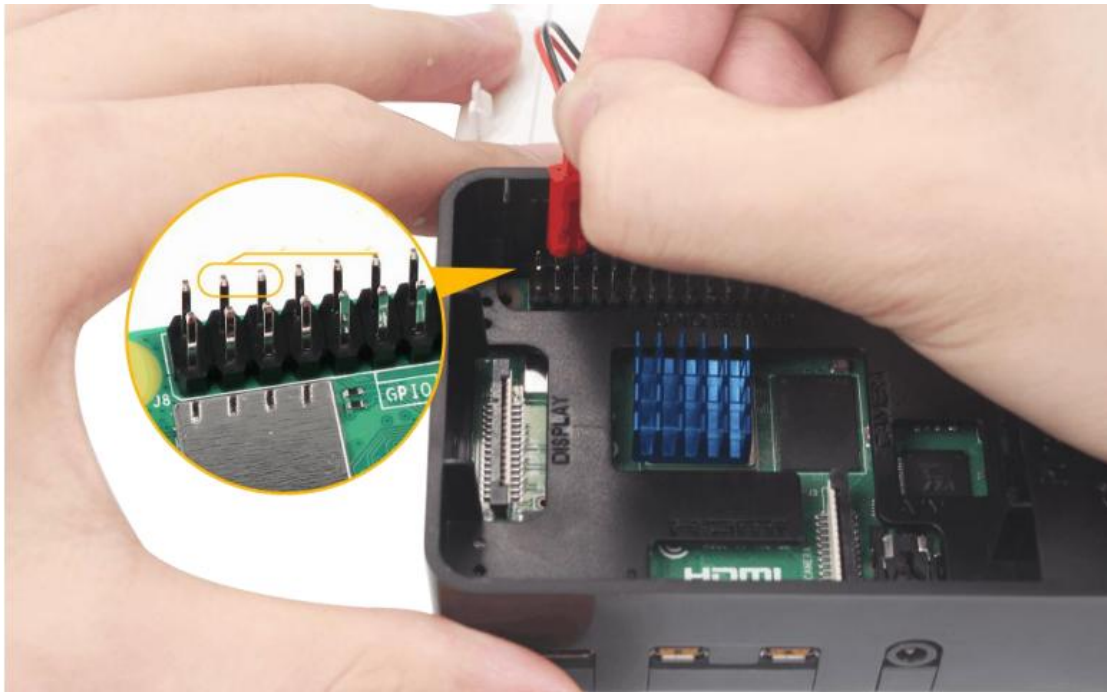
7) Tighten them with screwdriver.



8) Install the rest screws in the same way. The installation effect is as follow:



9) Connect the power cable (red) of the cooling fan and the ground wire (black) to the pins of the Raspberry Pi. Connect the red one to the second pin and and the black one to the third pin from right to left.



10) Install the white acrylic plate from top to bottom on the protective acrylic case.

Please pay attention that the convex pillars on white acrylic plate should aim at the socket of the acrylic protective case during installation.

Note: It is normal that these two cases are not completely fitted. For development needs, there will be gap between them for wiring.



11) Finally, insert the SD card into the card slot on the side of the acrylic plate. And the text side of SD card should face the bottom of the acrylic plate.



Basic Operation

Section 1 Download and burn common system images

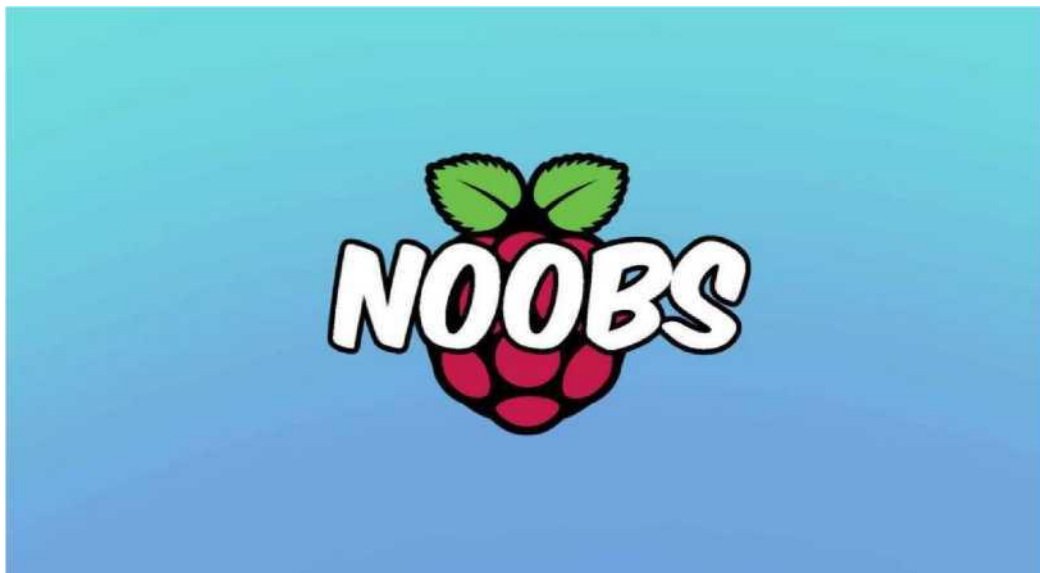
1. Introduction to mainstream Raspberry Pi OS

As mentioned in the previous chapter, the Raspberry Pi is a micro-compute, so how can a computer runs without an operating system?

There are many distributions suitable for Raspberry Pi, which can meet the needs of different people. If you only require a certain aspect of function, you can choose a third-party system. In the following, several distributions will be listed so that you can choose the most suitable one.

1) NOOBS

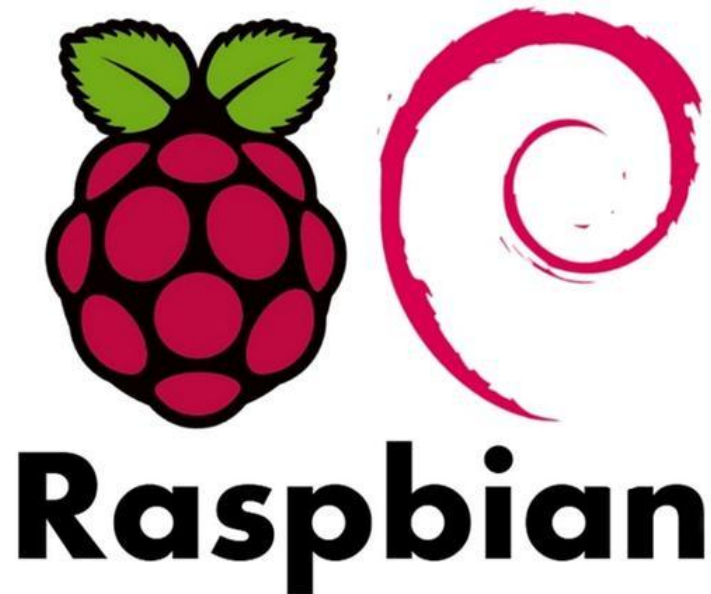
The official recommended system “New Out of Box System” is a multi-system boot manager. It contains all the files of the operating system so that you can install the system directly without network. Do not forget to update the system after the installation.



2) Raspbian

Raspbian is the most widely used system and should be your first choice. This

system is very safe and stable and with abundant software, which is suitable for novice and expert.



3) Windows IoT Core

Windows IoT is the Internet of Things operating system under the Microsoft ecosystem, which has supported the Raspberry Pi since its released. However, it should be noted that this version is different from the previous Windows version, and the hardware not only can run on the x86 architecture, but also can run on the ARM architecture.



Windows 10 IoT Core

4) Ubuntu MATE

Ubuntu MATE is based on the desktop environment MATE, which is an official

derivative of Ubuntu Linux. It is the latest platform for smart devices running the same software stored locally or dependent on the cloud.



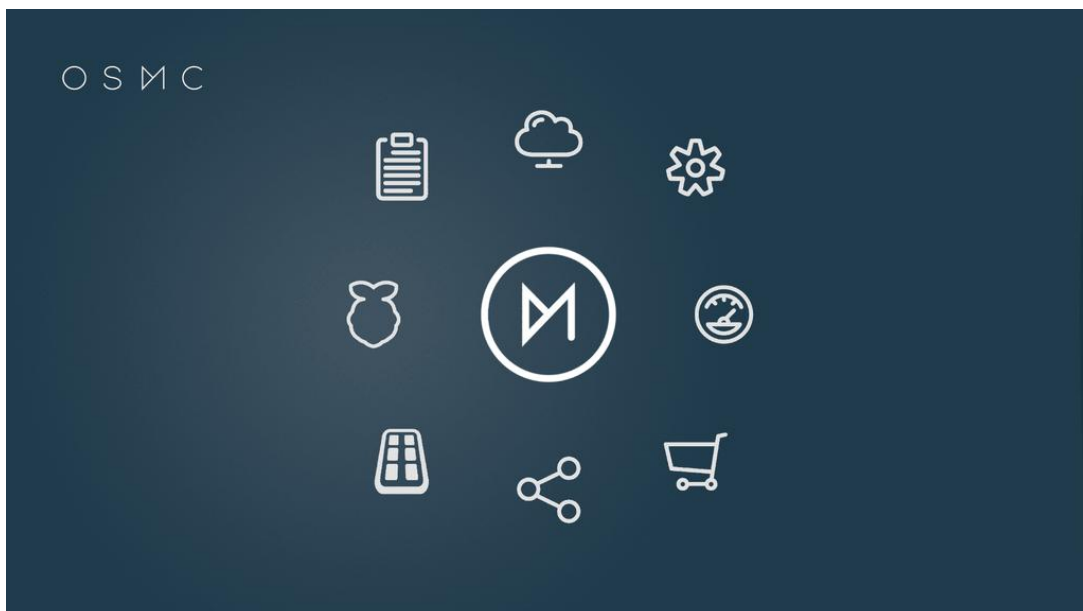
5) Kali Linux

Kali Linux is a Debian-based Linux distribution designed for digital forensics and penetration testing. Kali is pre-installed with a lot of penetration software so that users can run Kali Linux via hard disk, liveCD or live USB. There are 32-bit and 64-bit images, which can be used for the X86 instruction set, as well as images based on the ARM architecture.



6) OSMC

Open Source Media Center(OSMC) is an audio and video system officially recommended by the Raspberry Pi, which can play local and Internet resources. The purpose is to build a multimedia center (home high-definition TV broadcast platform) with the TV.



These are the most common Raspberry Pi distribution systems. In the

following operation, we will take Raspbian as example.

2. Preparation

Step 1: Hardware

- 1) Card reader



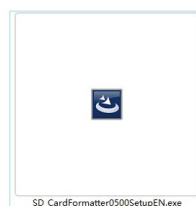
- 2) 32G SD card (The memory of SD card needs 8G or above.)



- 3) A computer with internet

Step 2: Software

- 1) SD Card Formatter (go to folder 4.Appendix/3.Tools/1. SD card formatting tool, click to install)



- 2) Image Burning Tool: Win32DiskImager (go to folder 4.Appendix/3.Tools/1. Image Burning tool, click to open)

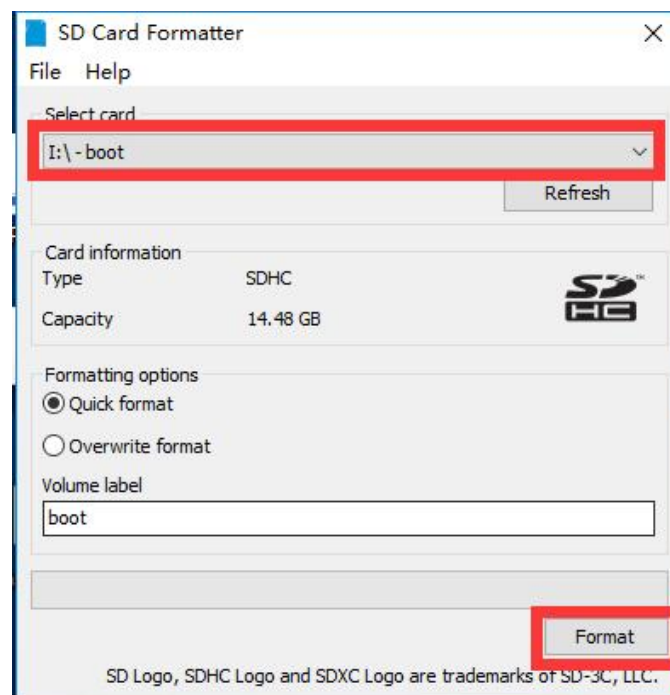


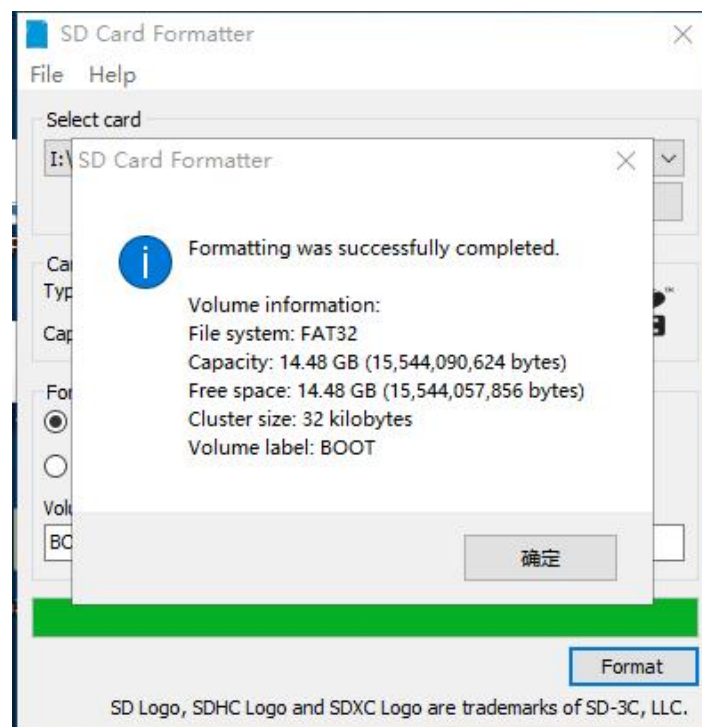
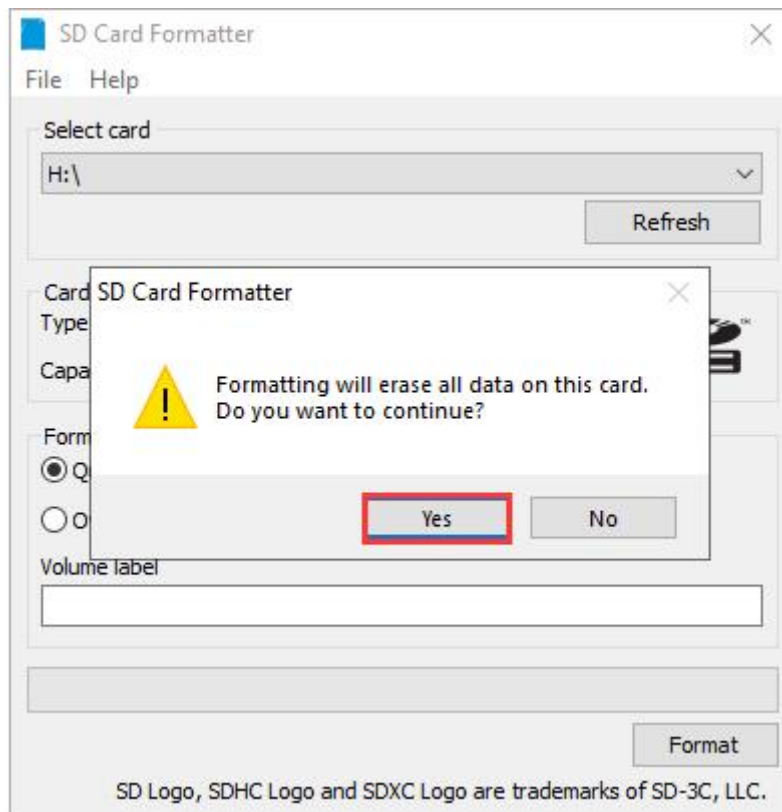
Step 3: Initialize the SD card (note: you need to format the SD card first before burning the image).

1) Insert SD card into card reader, connect it to computer and open the SD Card Formatting Tool



2) Open the installed SD Card Formatter, select the SD memory card to be burned into the image as shown in the figure below. Fill in the name "boot" under the "Volume label" label, and click the "Format" button. Click "Yes" and "OK" in the pop-up reminder box, and wait for the formatting to complete.





3) Next step is to burn the image.

3. Download Official Image



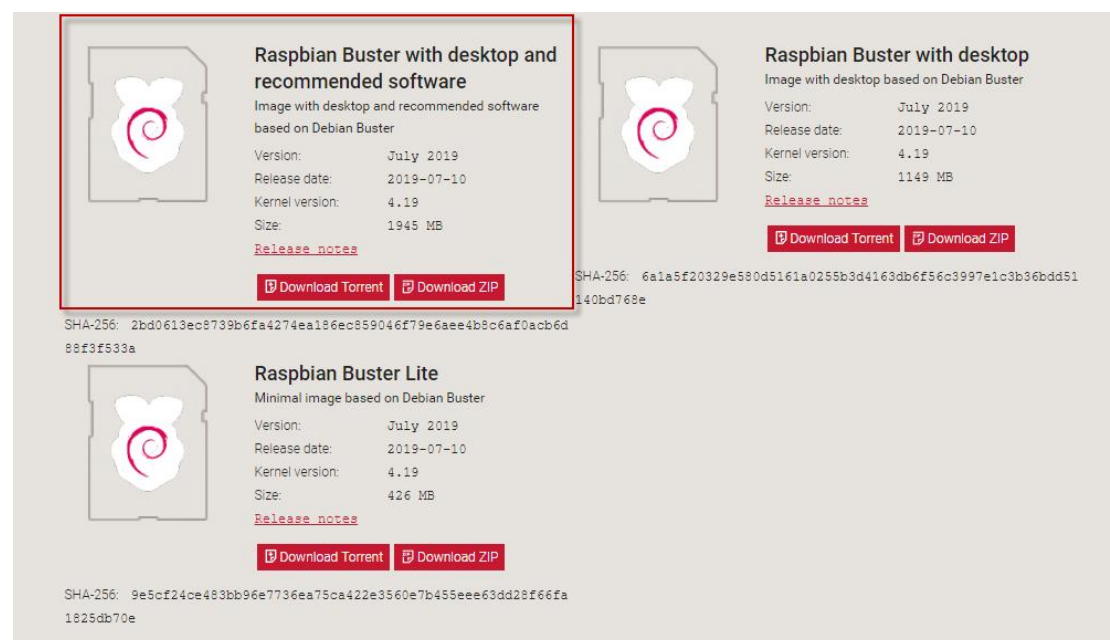
Scan the QR code to download

Or open a web browser and then go to the following URL:

“<https://www.raspberrypi.org/downloads/raspbian/>”.

There are three versions for your choice but we recommend the first one which is user-friendly.

(**Tip:** It is recommended to download the Torrent file on the left side of the icon below, and then use the Thunder tool to download the resource.)



Version	Release date	Kernel version	Size
Raspbian Buster with desktop and recommended software	July 2019	2019-07-10	4.19
Raspbian Buster with desktop	July 2019	2019-07-10	4.19
Raspbian Buster Lite	July 2019	2019-07-10	4.19

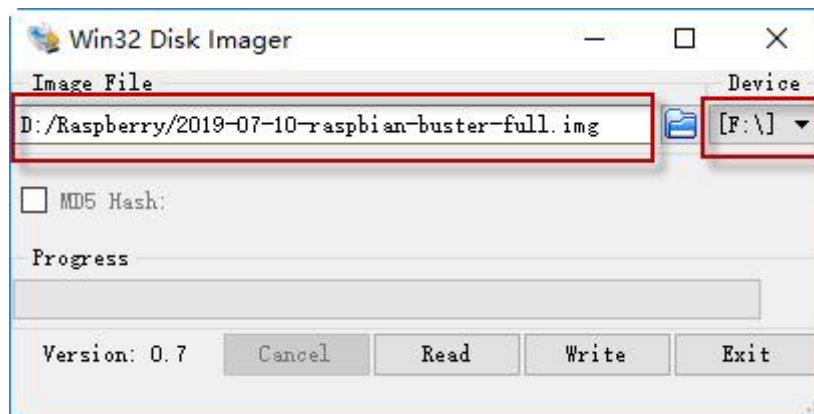
For the beginner, you'd better choose the version recommended because the content in this manual is based on this version.

4. Image Burning Method

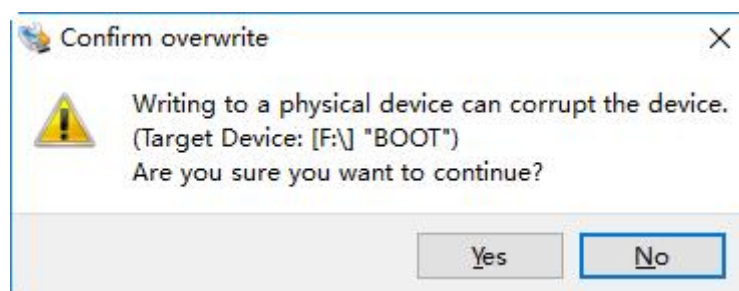
1) After extracting the image , double-click the "Win32DiskImager.exe" file.

Name	Date modified	Type	Size
Changelog.txt	2018/7/4 11:51	Text Document	2 KB
GPL-2	2018/7/4 11:51	File	18 KB
LGPL-2.1	2018/7/4 11:51	1 File	26 KB
libgcc_s_dw2-1.dll	2018/7/4 11:51	Application exten...	116 KB
libstdc++-6.dll	2018/7/4 11:51	Application exten...	958 KB
mingwm10.dll	2018/7/4 11:51	Application exten...	47 KB
QtCore4.dll	2018/7/4 11:51	Application exten...	2,825 KB
QtGui4.dll	2018/7/4 11:51	Application exten...	9,916 KB
README.txt	2018/7/4 11:51	Text Document	3 KB
Win32DiskImager.exe	2018/7/4 11:51	Application	84 KB

2) Click the button of the folder icon in the pop-up page, and then find the location of the image file and select it, and then click (▼) to select the SD card volume to be burned.



3) After completing the above steps, click the "Write" button to start burning. Click "Yes" to continue the next step when the confirmation box pops up . (If an error is reported, there may be Chinese in the path of the image file, and it needs to be modified to a path without Chinese.)



4) The programming progress will be displayed on the interface. After the writing is completed, a pop-up window will prompt "Write Successful". Click "OK", and then the word "Done" will also appear. Close all software to complete the image writing. (If you are prompted to format, please do not format)



Section 2 The settings of Raspberry Pi system

1. Preparation

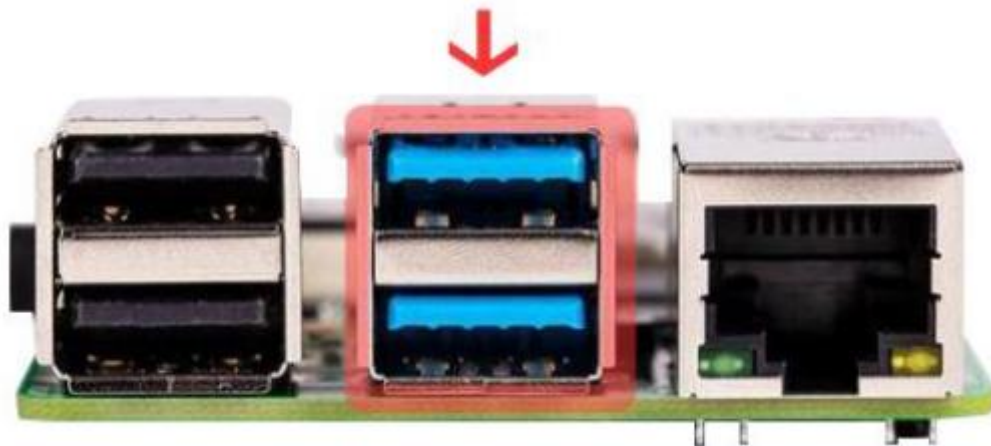
Before starting Raspberry Pi, you need to assemble first, and install operating system, and then wiring.

Firstly, prepare a computer monitor, a set of keyboard and mouse, and Micro-HDMI cable. Please choose an HDMI-to-VGA or HDMI-to-DVI cable for connecting the monitor according to your monitor interface.

1) Insert the SD card that has written image into Raspberry Pi. Please insert the SD card in the same direction as the figure shown below.



2) Then connect the keyboard and mouse into the USB interfaces of Raspberry Pi. Different from 3B/3B+ boards, there are 4 USB interfaces in 4B. Among them, two blue interfaces are USB 3.0.



3) Connect the monitor to HDMI port of Raspberry Pi with HDMI cable.



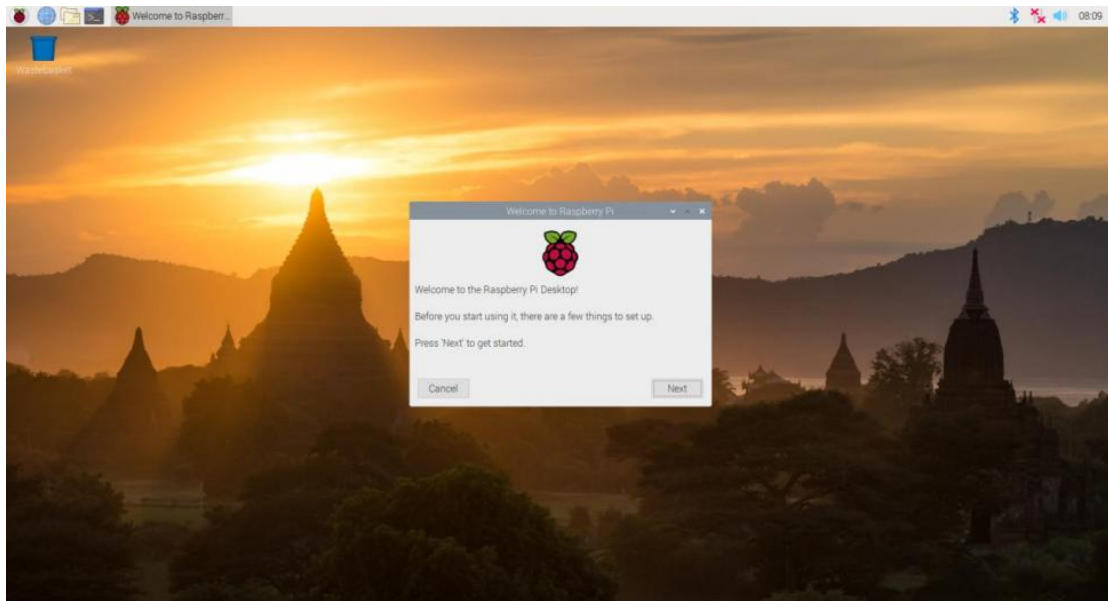
4) After connecting the power cable, switch on the Raspberry Pi. 4B uses Type-C power port and supports larger power input (5V 3A) so that the Raspberry Pi can not be drove after connecting to the USB port of your computer.



2. Start Raspberry Pi

After powering up the Raspberry Pi, the red power indicator lights up and the green signal indicator keeps flashing continuously, which means the system has been started. If a monitor is connected to Raspberry Pi, you will find that there is short clip of boot animation.

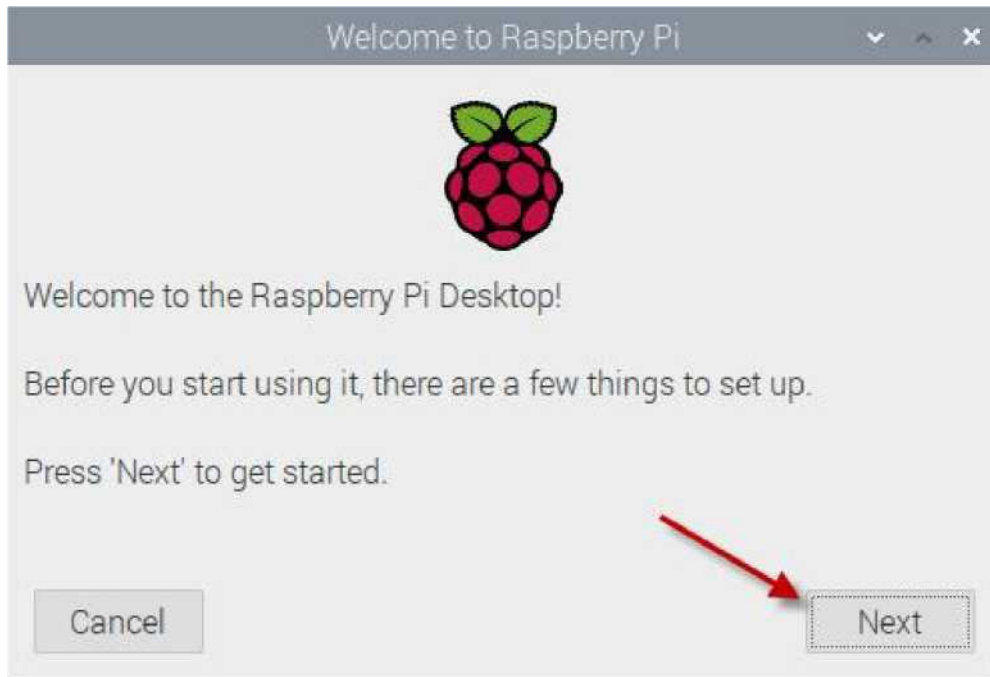
After starting, the interface of “Welcome to the Raspberry Pi Desktop!” can be viewed, as the figure shown below:



3. Initialization

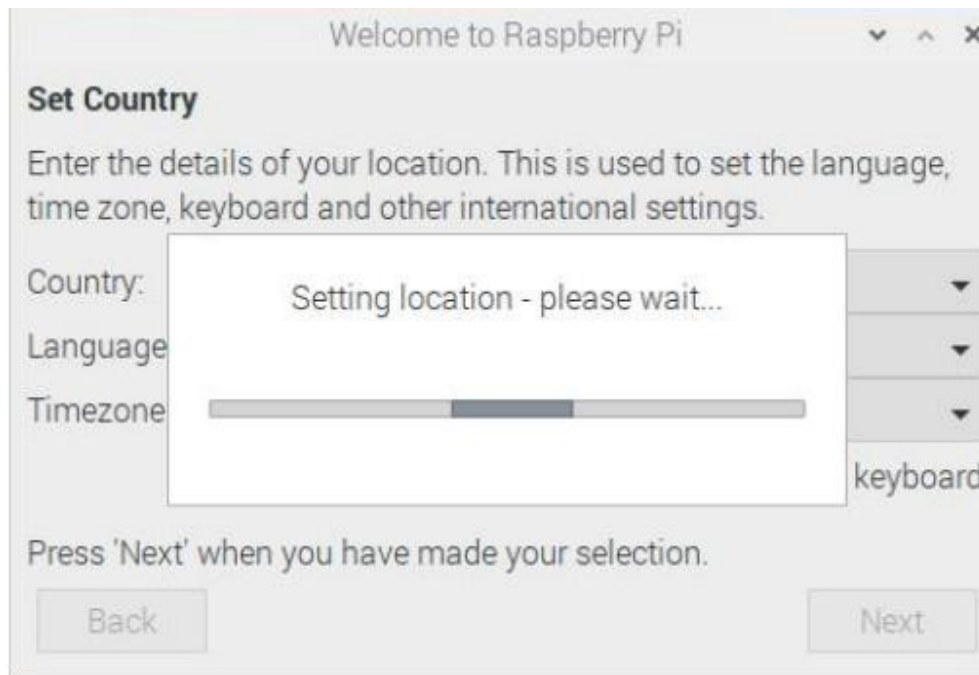
New system needs to be initialized for the first start. The specific operation steps is as follow:

- 1) Click “Next” in the interface.

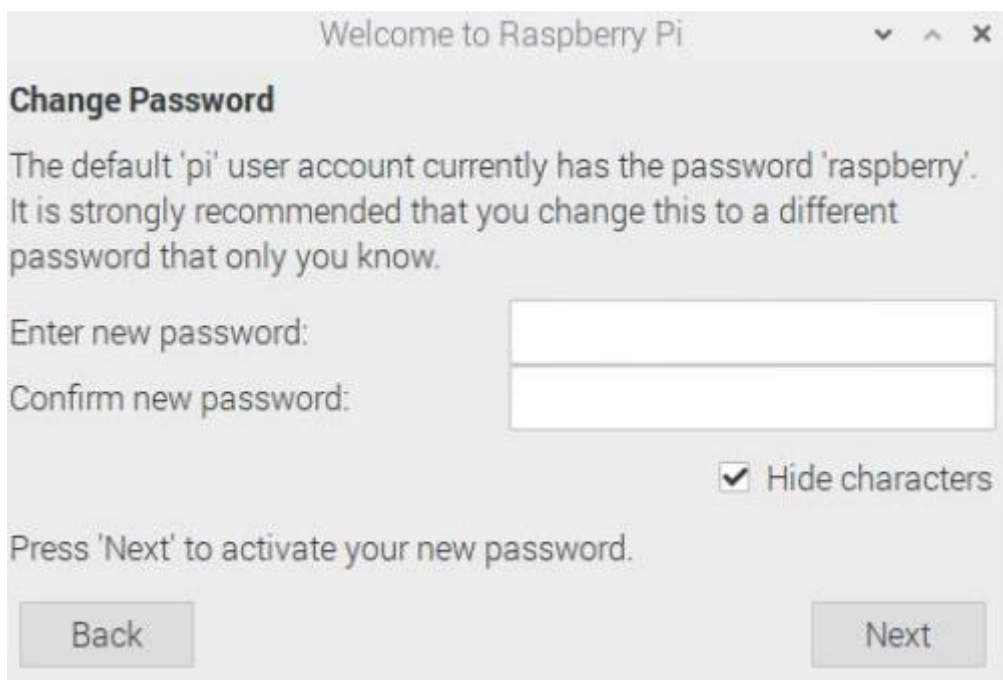


2) In "Set Country" interface, take selecting country as "China", language as "Chinese", timezone as "Shanghai" as example. There are two options below and it is recommended to check "Use US Keyboard". If do not check, it defaults to use English language. After everything is correct, click "Next" to save the settings automatically.





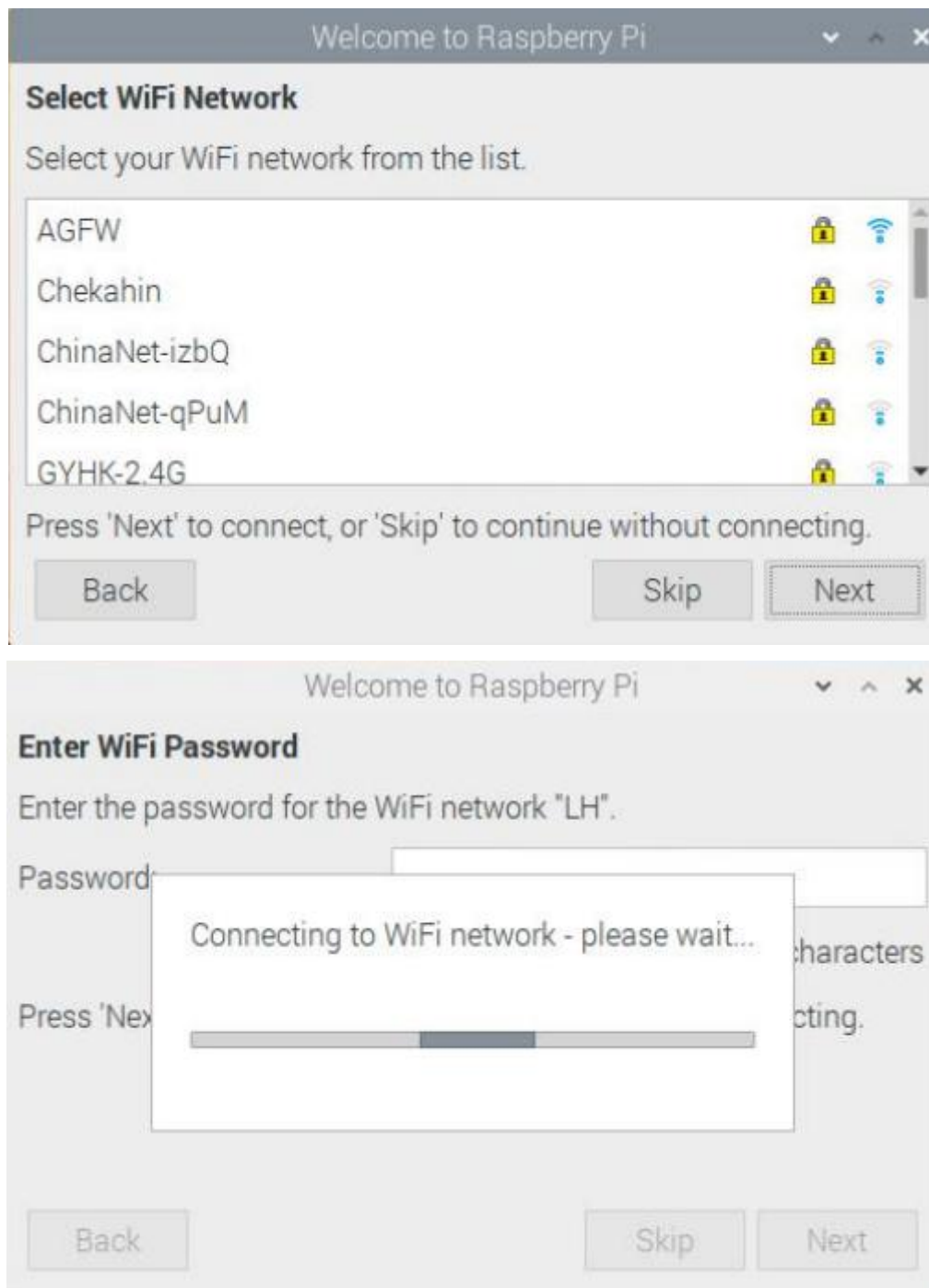
3) Then it will prompt to set password. You can set new password for Raspberry Pi or skip this step. If you skip this step, the default password is “raspberry”. In VNC remote connection or some setting, the system will prompt to enter password. Please enter the default password in the following operation.



4) If the prompt below appears indicating your screen has a black border at the edges, you can tick the option framed below and click “Next”. If no black border at the edges, you can click “Next” directly. The settings will take effect after the device is restarted.



5) If there is Wi-Fi hotspot, you can directly select the corresponding WiFi network in the following interface to connect. If there is no Wi-Fi or require direct connection, you can skip this step first. Here, connect Wi-Fi, enter corresponding WiFi password and click “Next” to connect.



6) Because Raspbian has some preinstalled software, the interface will prompt whether to update software to the latest version. You can click "Skip".



Section 3 Remote desktop connection

1. Preface and preparation

This section applies to the scenario where the Raspberry Pi 4B does not have a separate display to connect. You need to configure the Wi-Fi network before booting the Raspberry Pi, and then log in remotely via SSH or VNC.

SSH is a network protocol (the default port number is 22), used for encrypted login between computers, and remote controlling through the command line. VNC remotely controls in the form of a graphical desktop. Users can choose according to their own needs.

Note: The use of VNC must be based on SSH. It can be used by enabling the configuration service (the system turns off the VNC service by default), so SSH cannot be achieved directly (unless there is another screen for the Raspberry Pi 4B). The method in this section is for reference only.

Before starting, please prepare the following tools:

- 1) Smart phone
- 2) Computer (Laptop is the best or a desktop computer with a USB wireless network card)
- 3) Card reader and SD card with Raspberry Pi system image
- 4) Putty tool (remote login tool, please go to the folder “4.Appendix/3.Tools/3. Remote Connection Tool”)



- 5) VNC Tool (please go to the folder “4.Appendix/4.Tools/3. Remote Connection Tool”, and install the remote connection tool)

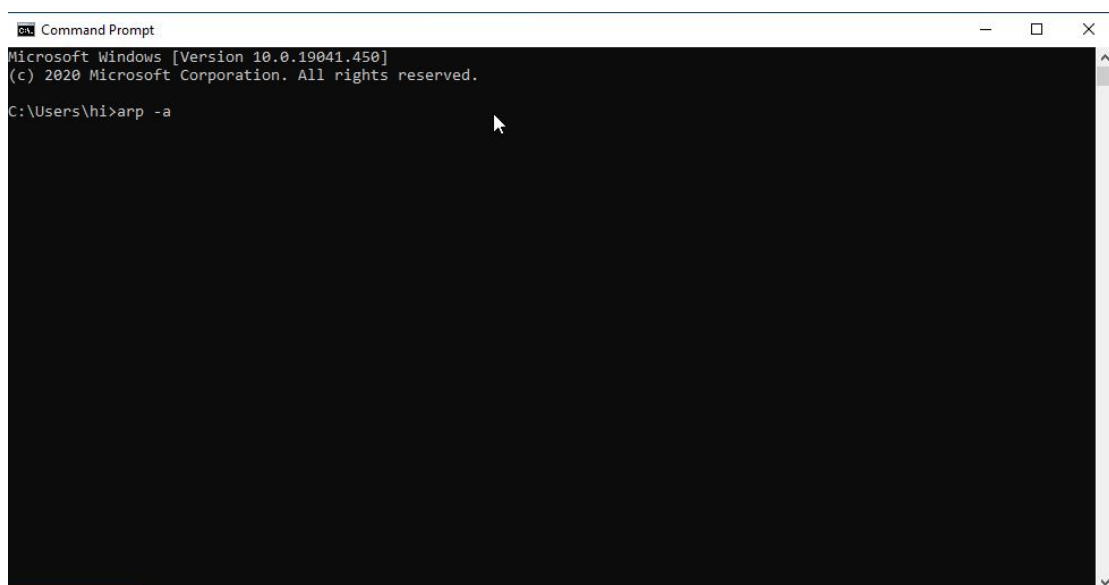


After preparation, the operation steps are as follow:

- 1) Establish a hotspot on your phone. The name of hotspot is Hiwonder and the password is 123456789.



2) Connect the computer to the hotspot established just now. After connecting, enter "CMD" to open the command prompt. Then input "arp -a" command to check the new computer IP.



```

Command Prompt
192.168.11.92      40-b0-76-82-39-5d      dynamic
192.168.11.114     00-e0-4c-62-0f-e4      dynamic
192.168.11.130     00-e0-4c-63-0a-82      dynamic
192.168.11.149     00-e0-70-28-77-56      dynamic
192.168.11.150     00-cf-e0-52-f0-5e      dynamic
192.168.11.152     b0-5a-da-c4-5e-72      dynamic
192.168.11.161     00-e0-4c-66-24-36      dynamic
192.168.11.166     00-e0-70-26-bf-b9      dynamic
192.168.11.179     00-e0-70-26-b9-be      dynamic
192.168.11.189     00-e0-4c-0c-5d-bd      dynamic
192.168.11.194     00-cf-e0-43-e6-c2      dynamic
192.168.11.195     00-e0-4c-71-18-2f      dynamic
192.168.11.255     ff-ff-ff-ff-ff-ff      static
224.0.0.22         01-00-5e-00-00-16      static
224.0.0.251        01-00-5e-00-00-fb      static
224.0.0.252        01-00-5e-00-00-fc      static
239.255.255.250    01-00-5e-7f-ff-fa      static
255.255.255.255    ff-ff-ff-ff-ff-ff      static

Interface: 172.20.10.8 --- 0x18
Internet Address    Physical Address      Type
172.20.10.1         ee-44-63-97-07-64     dynamic
172.20.10.15        ff-ff-ff-ff-ff-ff     static
224.0.0.22          01-00-5e-00-00-16     static
224.0.0.251         01-00-5e-00-00-fb     static
224.0.0.252         01-00-5e-00-00-fc     static
239.255.255.250     01-00-5e-7f-ff-fa     static
255.255.255.255     ff-ff-ff-ff-ff-ff     static

C:\Users\hi>

```

3) Insert the card reader into the computer, and then click "boot" drive letter, which is the "/boot" directory of the Raspberry Pi.



4) Use the Notepad tool to fill in the content according to the following reference format, and then name it "wpa_supplicant.conf" (Tip: Enter the following content, save and exit the file first, then rename the file. You need to replace all file names including txt with the name above. If there is a pop-up prompt, select "Yes"), and then save it to the "boot" drive letter.

```
country=CN
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1

network={
    ssid="Hiwonder"
    psk="123456789"
    key_mgmt=WPA-PSK
    priority=1
}
```

#ssid: Wi-Fi name, take "Hiwonder" as example.

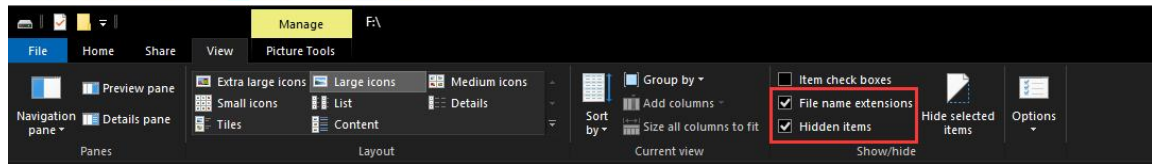
#psk: Wi-Fi password, take "123456789" as example.

Wi-Fi generally uses WPA encryption. If your Wi-Fi with WEP encryption, please modify the code to:

```
network={
    ssid="Your Wi-Fi name
(ssid) "
    key_mgmt=NONE
    wep_key0="Your Wi-Fi
password"
}
```

5) Raspberry Pi disables the ssh service by default, so you need to create a file to start this service. Please follow the method in the previous steps to create another new file named "ssh" (lower case and no txt as the suffix). The content of the file can be empty.

6) We can click "File name extensions" and "Hidden items" to check whether the suffix name meets the requirements



7) Start the Raspberry Pi and wait for the boot to complete. If the phone receives a new device connection, it means that the Raspberry Pi is successfully connected. Then use the CMD command line to check the IP of the Raspberry Pi. Enter the “arp -a” command again, you can find that there is a dynamic IP address “172.20.10.9” (example IP), which is the IP address of the Raspberry Pi. (If do not appear, please go to “2.Basic Lesson/ 5. IP Checking Method” to use other methods to check the IP of Raspberry Pi.)

```

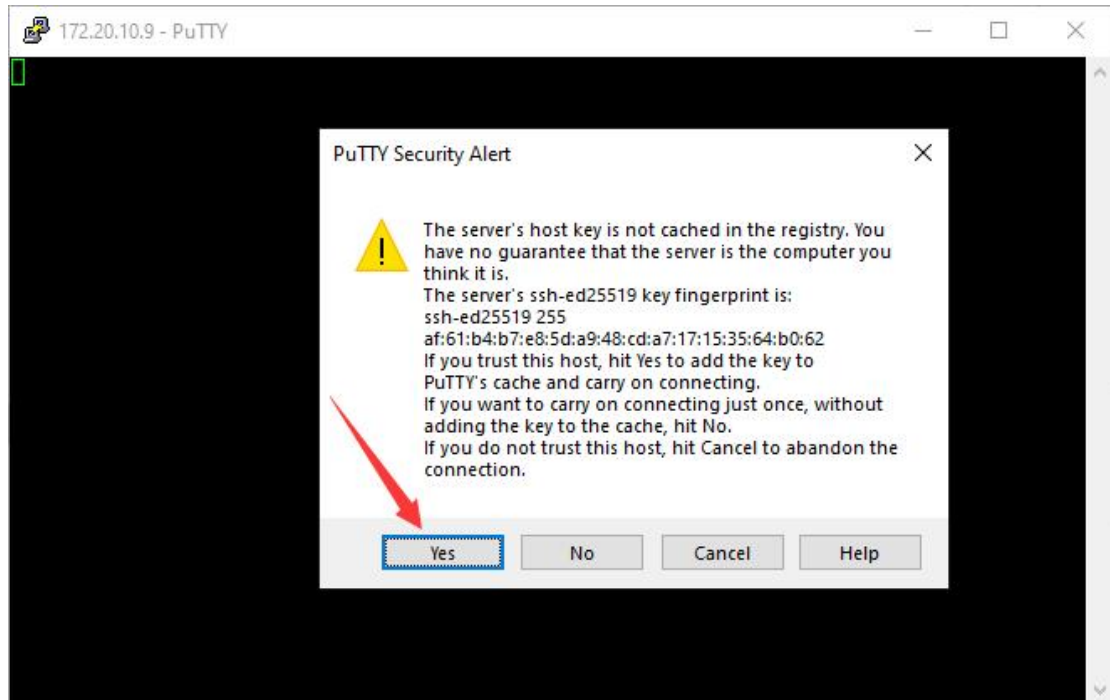
C:\>arp -a

239.255.255.250    01-00-5e-7f-ff-fa    static
255.255.255.255    ff-ff-ff-ff-ff-ff    static

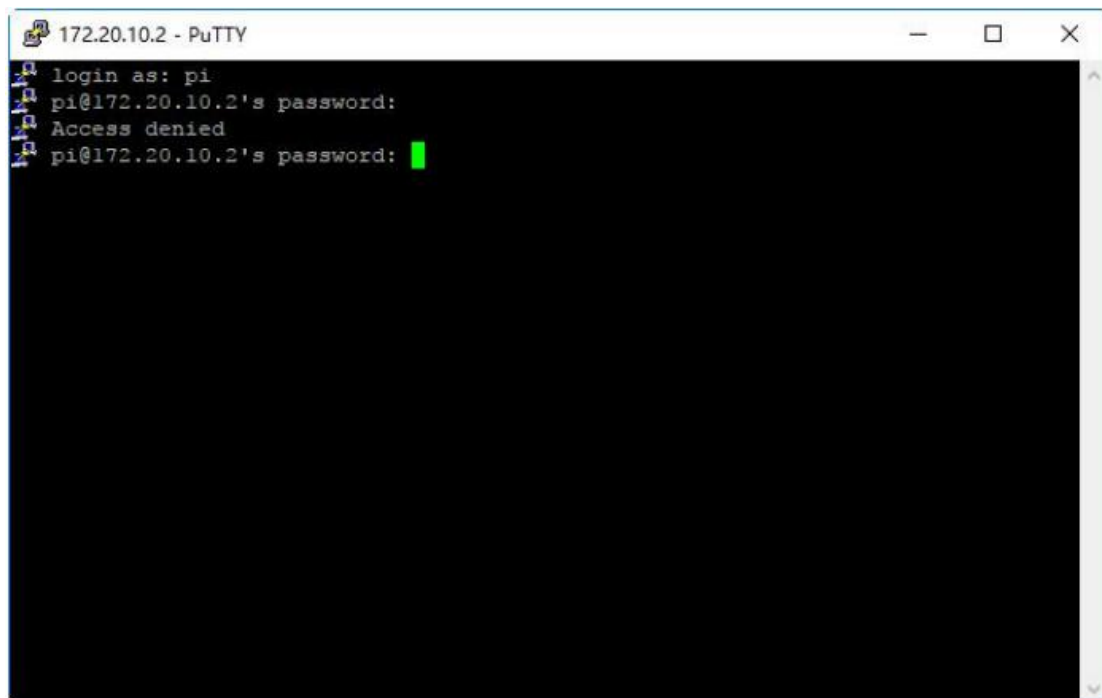
Interface: 172.20.10.7 --- 0x1b
Internet Address  Physical Address      Type
172.20.10.1       ee-44-63-97-07-64     dynamic
172.20.10.9       dc-a6-32-b7-46-2a     dynamic
172.20.10.15      ff-ff-ff-ff-ff-ff     static
224.0.0.22        01-00-5e-00-00-16     static
224.0.0.251       01-00-5e-00-00-fb     static
224.0.0.252       01-00-5e-00-00-fc     static
239.255.255.250   01-00-5e-7f-ff-fa     static
255.255.255.255   ff-ff-ff-ff-ff-ff     static
  
```

2. SSH Operation

1) Open the Putty software, enter the recorded Raspberry Pi IP “172.20.10.2”, and remain the computer and Raspberry Pi under the same network. A security alert will appear when logging in for the first time, just click the “Yes”.



2) Enter account name and password in the pop-up window and then press "Enter". The default account name is **pi** and the password is **raspberrypi**. Please note that there will be no visual display when you enter the password. If the password is wrong, the prompt shown below will appear.



3) After entering the password successfully, the system interface is shown in the figure below:


```
pi@raspberrypi: ~  
login as: pi  
pi@172.20.10.2's password:  
Access denied  
pi@172.20.10.2's password:  
Linux raspberrypi 4.19.57-v7l+ #1244 SMP Thu Jul 4 18:48:07 BST 2019 armv7l  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Thu Aug 29 16:43:28 2019  
  
SSH is enabled and the default password for the 'pi' user has not been changed.  
This is a security risk - please login as the 'pi' user and type 'passwd' to set  
a new password.  
  
pi@raspberrypi:~ $
```

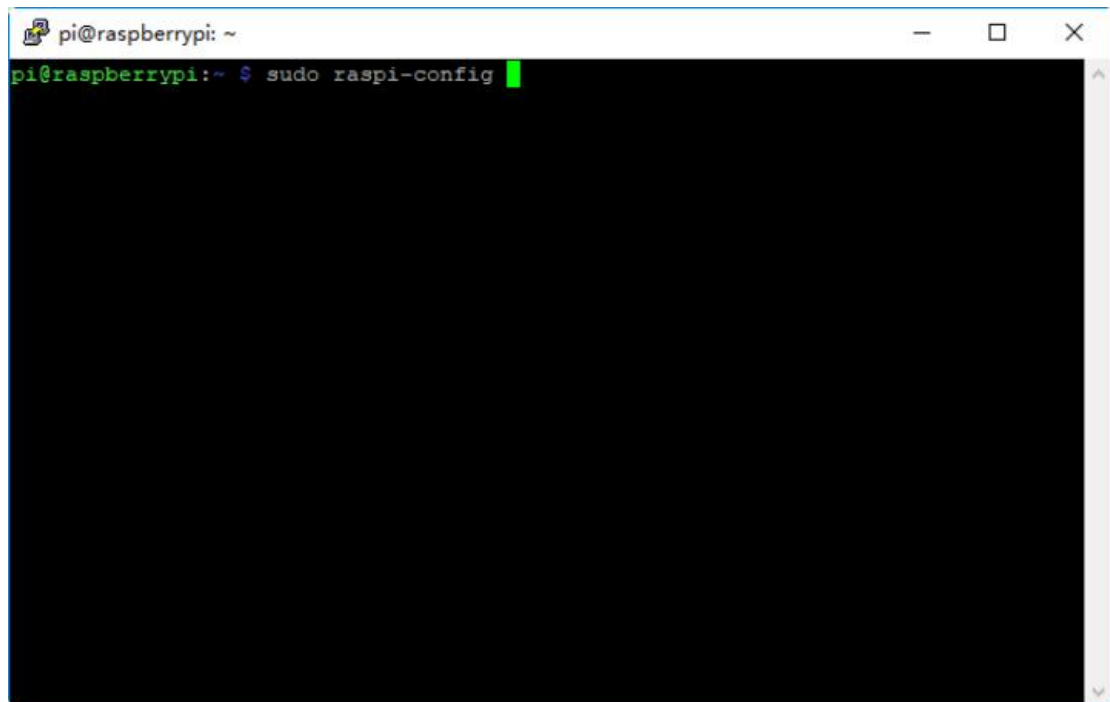
4) In the Raspberry Pi system, we can control with the command line. Check the file with the “ls” command.

```
pi@raspberrypi: ~  
login as: pi  
pi@172.20.10.2's password:  
Linux raspberrypi 4.19.57-v7l+ #1244 SMP Thu Jul 4 18:48:07 BST 2019 armv7l  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Thu Aug 29 19:24:54 2019  
  
SSH is enabled and the default password for the 'pi' user has not been changed.  
This is a security risk - please login as the 'pi' user and type 'passwd' to set  
a new password.  
  
pi@raspberrypi:~ $ ls  
Desktop    Downloads  Music      Public     Videos  
Documents  MagPi      Pictures   Templates  
pi@raspberrypi:~ $
```

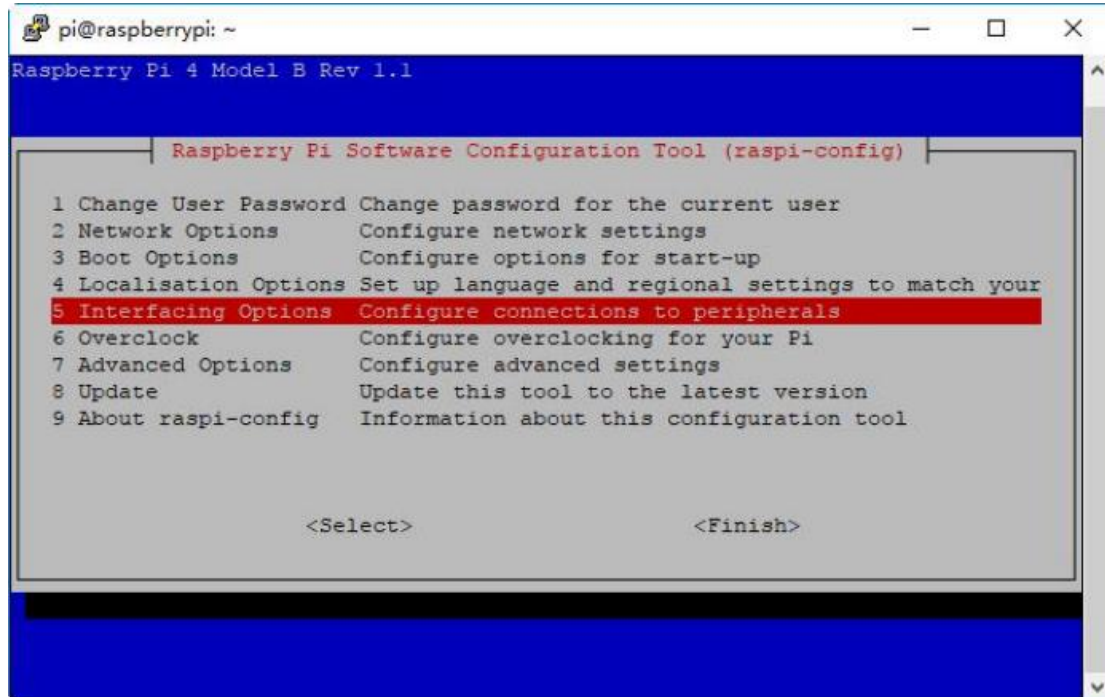

3. VNC Operation

If you are unfamiliar with command line control, you can remotely control the Raspberry Pi through other screen (your computer), which resembles the operation on Windows. In this way, you can control Raspberry Pi through a graphical desktop.

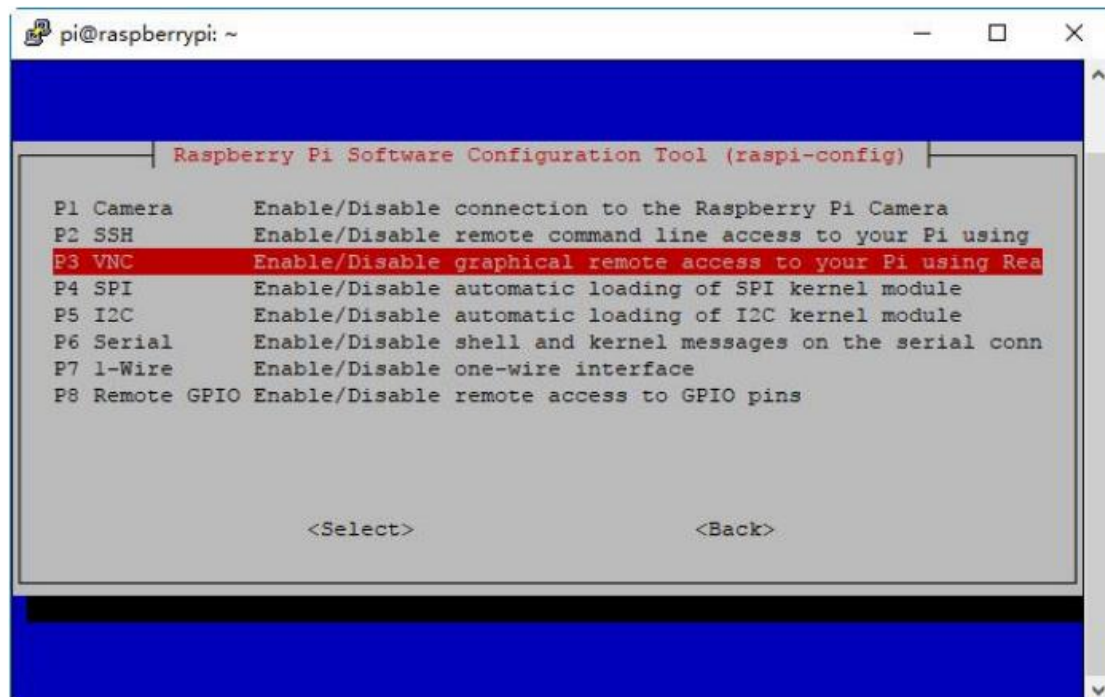
1) Enter “sudo raspi-config” in the SSH interface to go into the configuration interface.



2) In this interface, you can press “↑↓” key to select, “Enter” to confirm and “Esc” back to last step. Select according to the figures below.



Configuration options

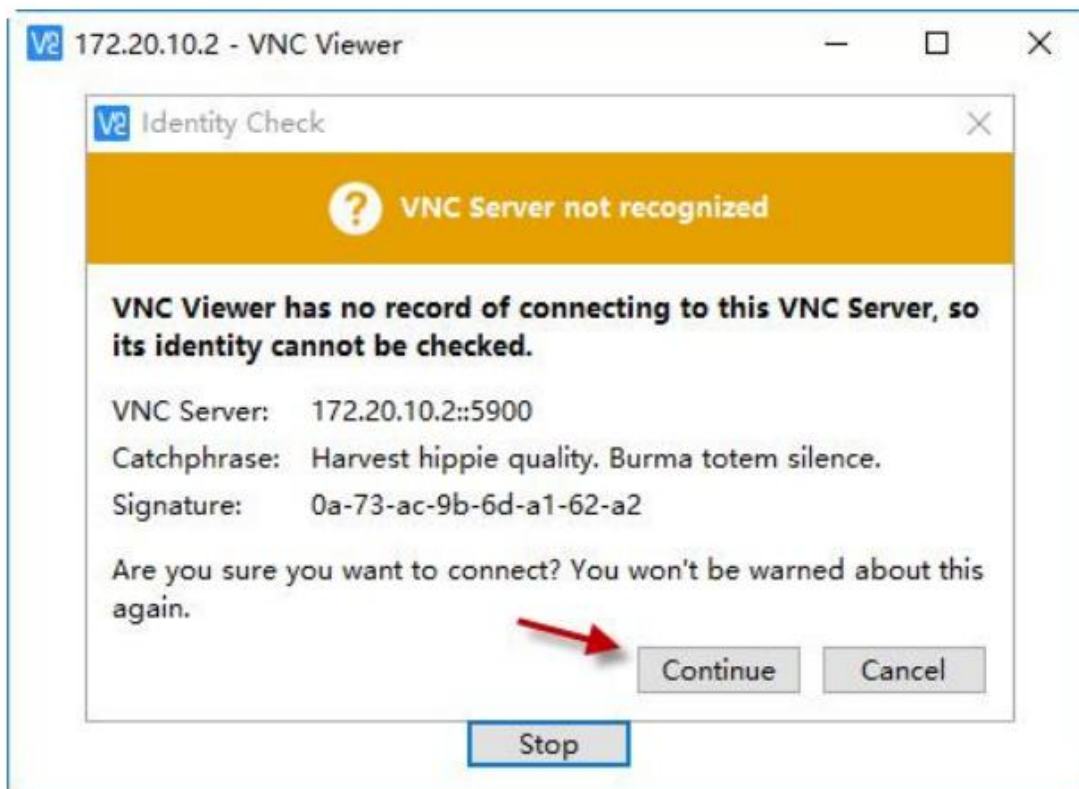
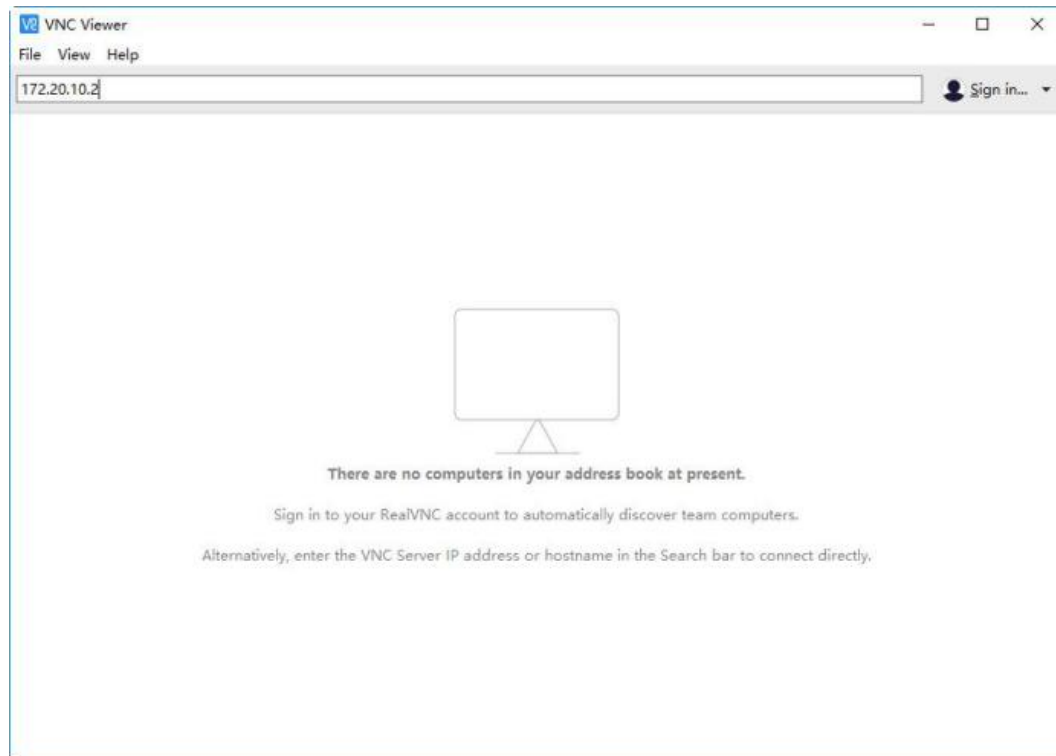


Enable VNC service



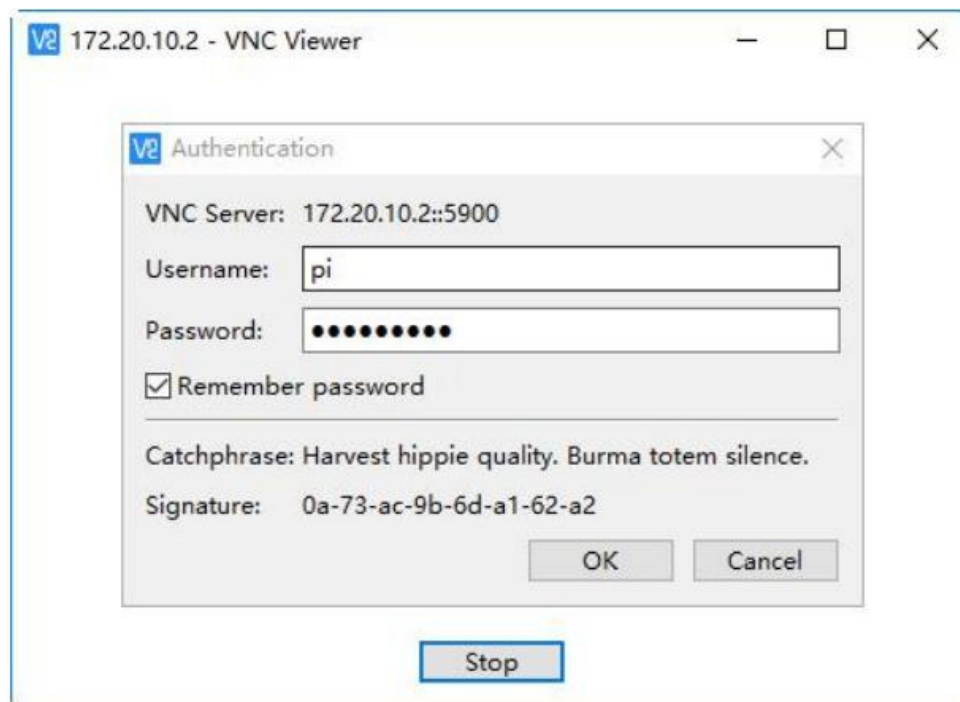
Start confirmation

- 3) As shown in above figure, the VNC service prompt is successfully started. Press the "Enter" key to click "OK", and then the screen will automatically return to the main configuration interface. Then press "Esc" key to exit.
- 4) Exit Putty and open the installed VNC.
- 5) Enter Raspberry Pi IP "172.20.10.2" in the VNV Viewer and press "Enter". Click "Continue" if prompted that it is not a secure connection.

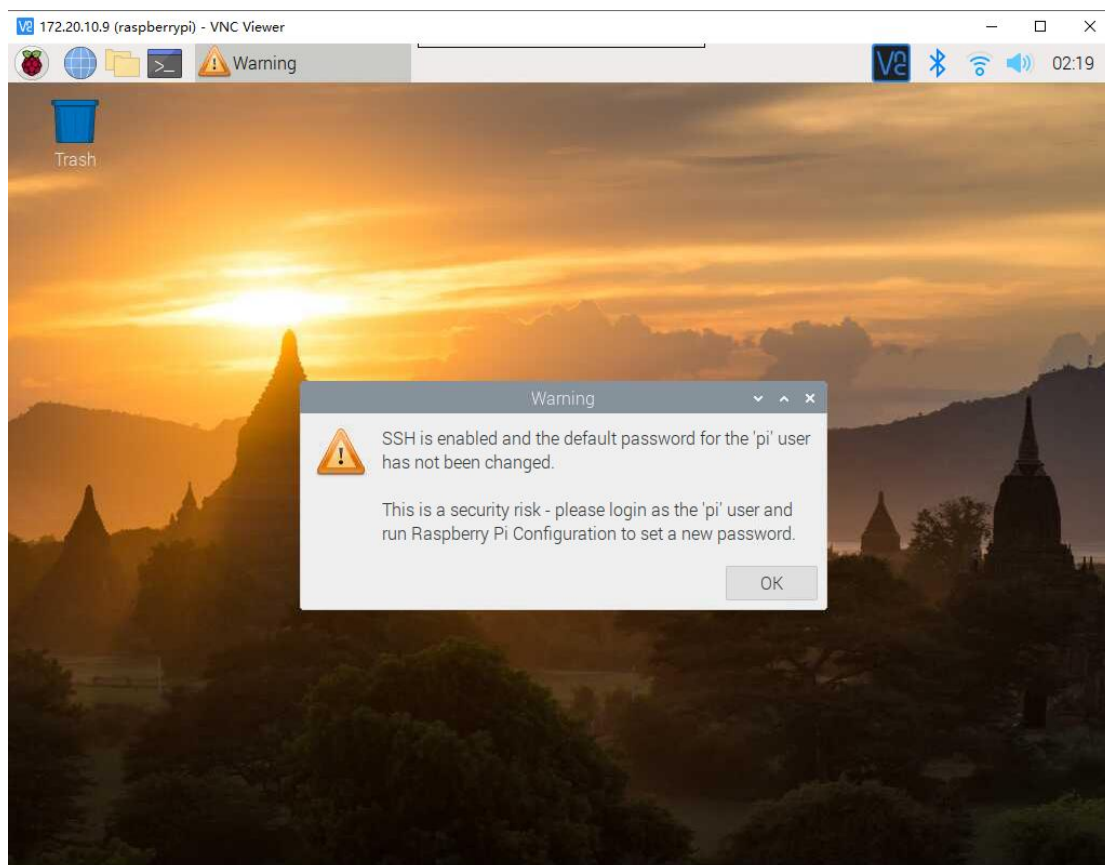


6) Enter password “raspberry” in the prompt window. If you’re required to enter the account, please enter “pi”. Check the remember password box, and then click “OK” to remotely open the desktop of Raspberry Pi. (If it is a black

screen with only a mouse cursor, you can try to repeat the above operation after restarting the Raspberry Pi.)



Enter account and password



Successful login

Section 4 Modify and correct the time of Raspberry Pi system

1. Why to correct the time

The Raspberry Pi has installed NTP service (Network Time Protocol) by default to obtain the time provided by NTP server on the internet. However, after a power failure or shutdown due to various reasons, the Raspberry Pi does not have CMOS battery like the laptop or desktop computer, so the time may stay at the time before shutdown.

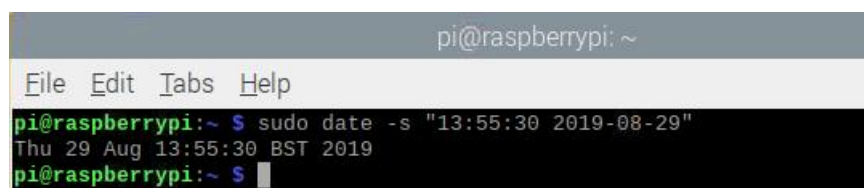
If such problem occurs, you modify and correct the time of Raspberry Pi system according to the below operation.

2. The method of time modification

2.1 Set the time manually

If you just want to view the time, enter “date” command, while setting the time manually requires super administrator privileges.

For example, if the time is set to 2019/8/29 13:55:30, you can enter the commands below:




```
pi@raspberrypi: ~  
File Edit Tabs Help  
pi@raspberrypi:~ $ sudo date -s "13:55:30 2019-08-29"  
Thu 29 Aug 13:55:30 BST 2019  
pi@raspberrypi:~ $
```

The Raspberry Pi itself needs to rely on NTP to synchronize the time. If your Raspberry Pi cannot connect to the network to obtain the time, this method can only be used.

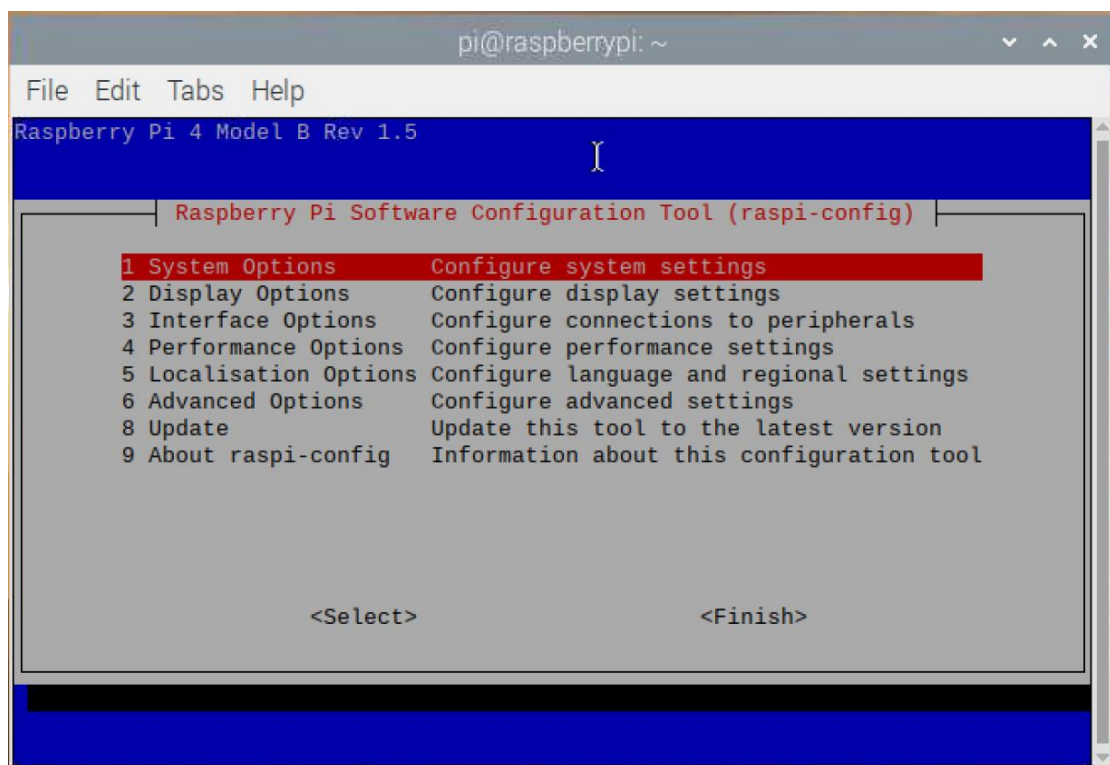
2.2 Set Time with Network

- 1) Turn on Raspberry Pi.
- 2) After starting the Raspberry Pi, click icon or press “Ctrl+Alt+T” to enter LX terminal interface.
- 3) Enter “sudo raspi-config” command in the LX terminal.



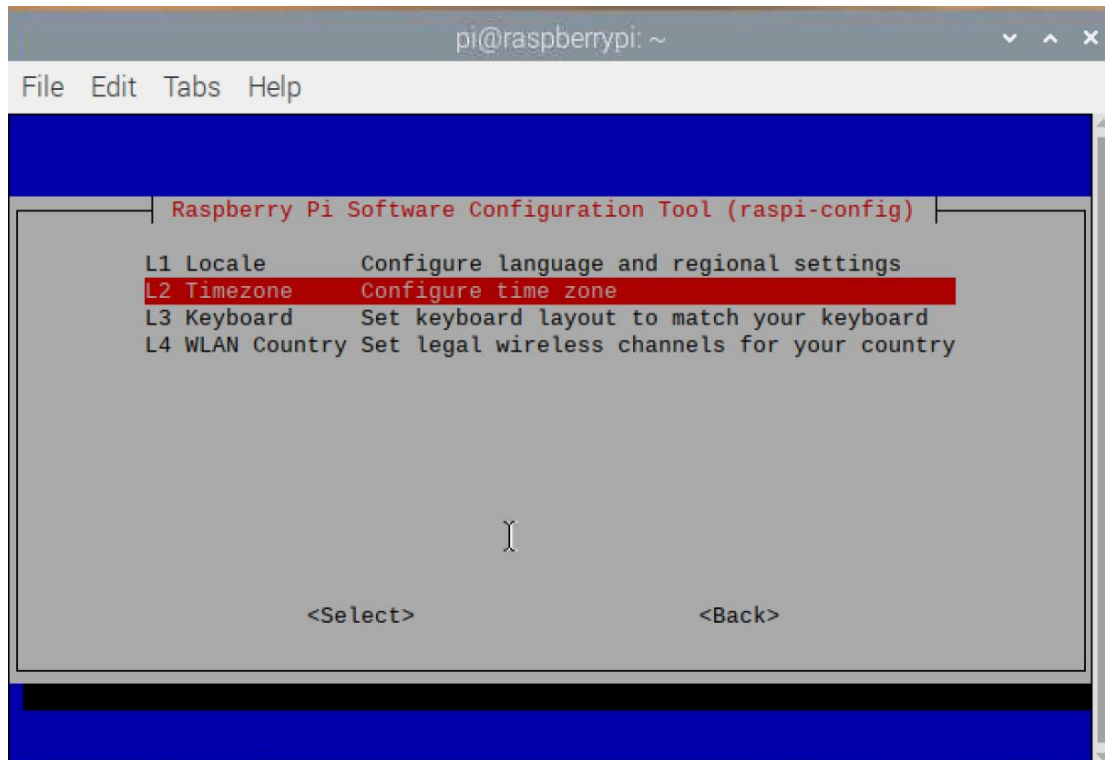
```
pi@raspberrypi: ~  
File Edit Tabs Help  
pi@raspberrypi:~ $ sudo raspi-config
```

- 4) In the blue configuration interface below, you can find that the model of Raspberry Pi above is 4B. You can select with “↑↓” key, and then press “Enter”.



```
pi@raspberrypi: ~  
File Edit Tabs Help  
Raspberry Pi 4 Model B Rev 1.5  
Raspberry Pi Software Configuration Tool (raspi-config)  
1 System Options      Configure system settings  
2 Display Options     Configure display settings  
3 Interface Options   Configure connections to peripherals  
4 Performance Options Configure performance settings  
5 Localisation Options Configure language and regional settings  
6 Advanced Options    Configure advanced settings  
8 Update              Update this tool to the latest version  
9 About raspi-config  Information about this configuration tool  
  
<Select>              <Finish>
```

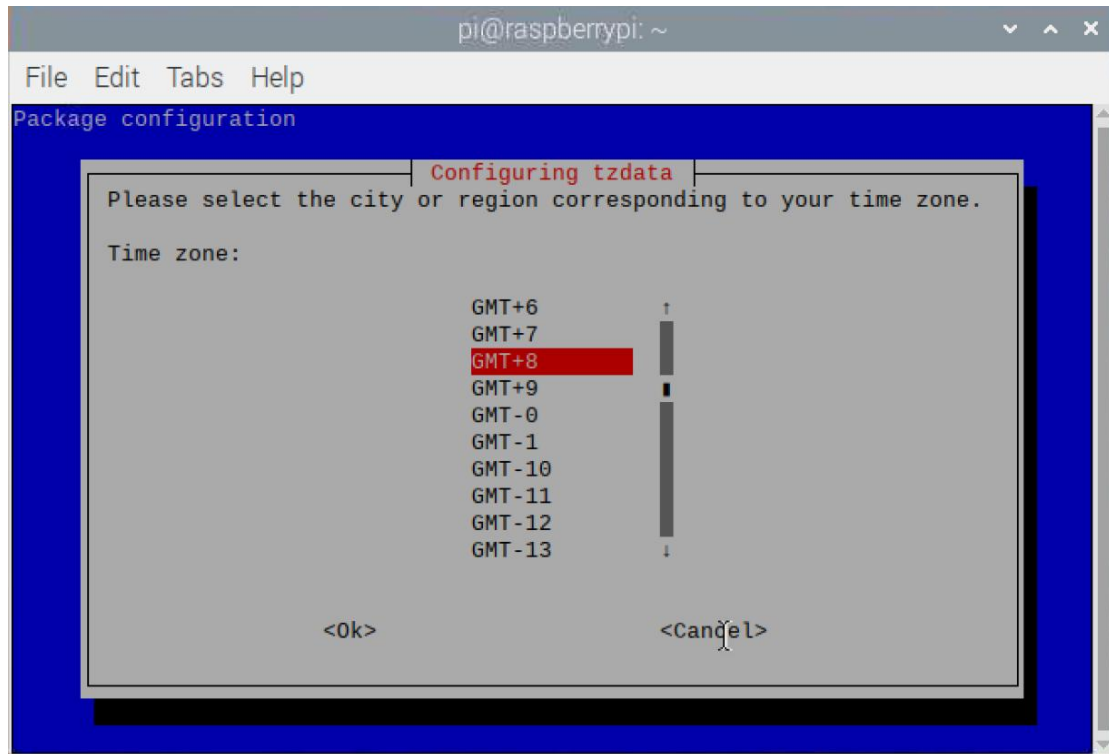
- 5) After entering the below interface, select “I2 Change Timezone” to set timezone and correct time.



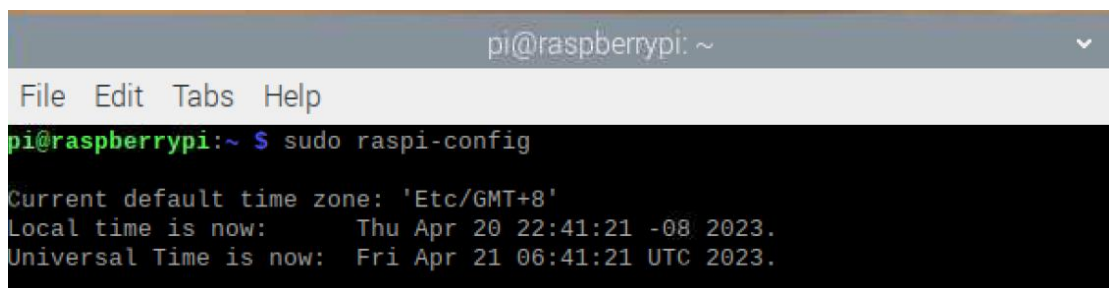
6) Select "Etc" for geographic area, and then press "Enter".



7) Select GMT+8 for time zone, and then press "Enter".



8) Now, the setting has been completed. The screen will first switch to the LX terminal interface as the figure shown below, and then jump to the blue configuration interface. At this time, click “finish” to exit.



Section 5 System Directory Instruction

Computer is a combination of the complex hardware and software. To manage the complex hardware and software, the operating system was born.

The operating system not only provides an interface for users to interact with computer system, but also needs to perform basic tasks such as managing and configuring memory, prioritizing system resources, controlling input and out device, operating the network, and managing the file system.

From the user's perspective, the operating system is regarded as a translator, which can translate the user's command into the language that the computer can understand, and arrange the computer to execute the command.

Raspberry Pi uses Linux system. In Linux operating system, user send commands to the computer by entering various commands, which means the user controls the computer through a single control command.

In fact, we can also control the computer by clicking the graphical icon. On the other hand, Linux is an open-source system so it has a higher degree of freedom and can customize the system according to your requirements, which is the reason why Linux system become the preferred operating system for programmer

On the other hand, as Linux is an open source system, it has more freedom and the system can be customized according to your requirements.

Therefore, the system directory refers to the directory where the main files of the operating system are stored. Knowing the functions of these directories will be of great help in using the system.

1. Open system directory

- 1) Turn on Raspberry Pi, and open LX terminal.
- 2) According to the red line part shown in the figure below, enter the command "cd .." and the command "ls" in turn (**Note:** there is a space between cd and ..), and then press "Enter".)

```
pi@raspberrypi:~ $ cd ..
pi@raspberrypi:/home $ cd ..
pi@raspberrypi:/ $ ls
ActionGroups  boot.bak    dev  lib      mnt  root  srv  usr
bin           create_ap   etc  lost+found  opt  run   sys  var
boot         debootstrap home  media     proc sbin  tmp
pi@raspberrypi:/ $
```

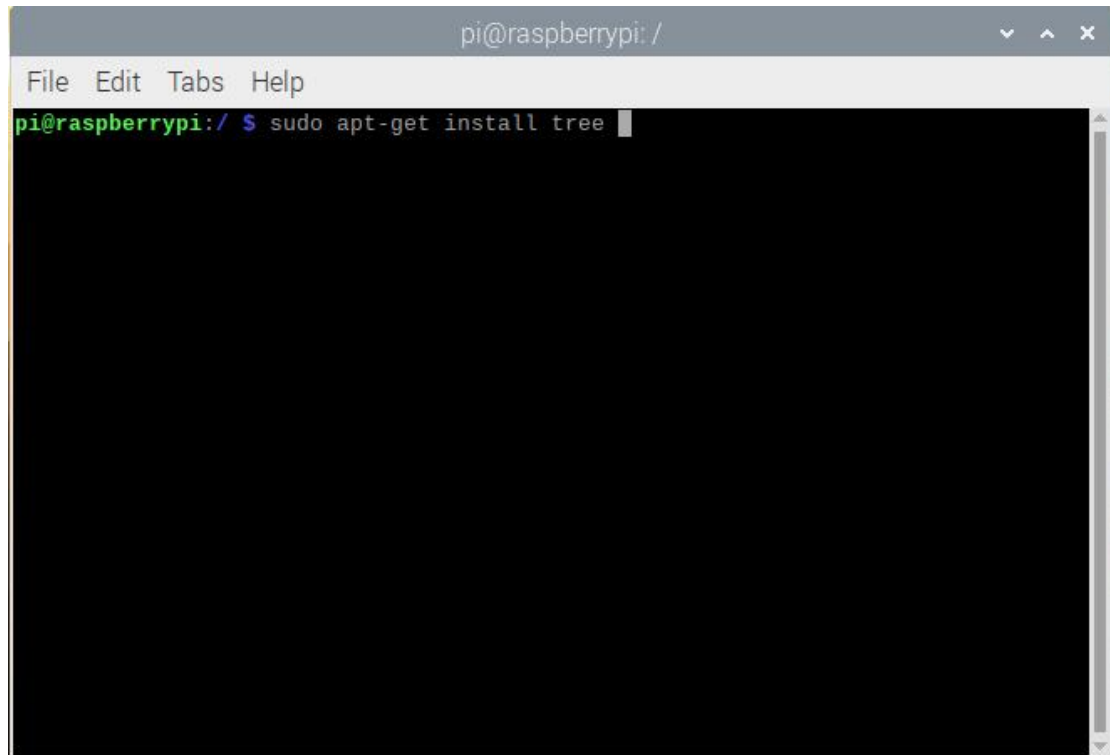
3) The Linux operating system is completely based on files and file systems, and any information is stored in the form of files, which are defined by file names and paths. In Linux system, the directory is a tree structure and “/” represents the root of the tree, which is known as tree directory.

```
pi@raspberrypi:~ $ cd ..
pi@raspberrypi:/home $ cd ..
pi@raspberrypi:/ $ ls
ActionGroups  boot.bak    dev  lib      mnt  root  srv  usr
bin           create_ap   etc  lost+found  opt  run   sys  var
boot         debootstrap home  media     proc sbin  tmp
pi@raspberrypi:/ $
```

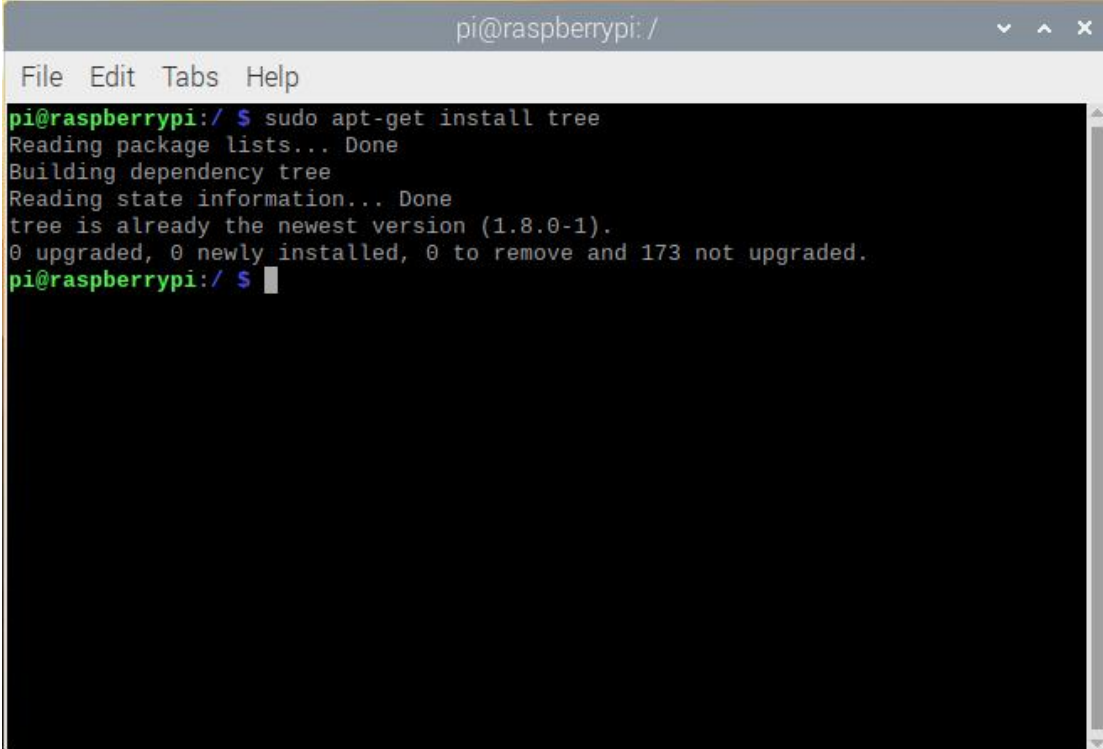
2. Check system directory

We can check the system directory in Linux through command. As Raspberry Pi is in tree structure, the tree diagram is used here to help you better understand. The specific steps are as follows:

- 1) Enter the command below: “sudo apt-get install tree” to install software.

A screenshot of a terminal window on a Raspberry Pi. The window title is 'pi@raspberrypi: /'. The menu bar shows 'File', 'Edit', 'Tabs', and 'Help'. The terminal text shows the command 'pi@raspberrypi:/ \$ sudo apt-get install tree' with a cursor at the end of the line. The rest of the terminal area is black and empty.

```
pi@raspberrypi:/ $ sudo apt-get install tree
```



```
pi@raspberrypi: /
File Edit Tabs Help
pi@raspberrypi:/ $ sudo apt-get install tree
Reading package lists... Done
Building dependency tree
Reading state information... Done
tree is already the newest version (1.8.0-1).
0 upgraded, 0 newly installed, 0 to remove and 173 not upgraded.
pi@raspberrypi:/ $
```

2) After installing, you can use related tree commands.

tree: all the files are displayed in the form of tree diagram.

tree-L N: all the folders are displayed in the form of tree diagram and the subfolders are displayed to the N level. There is a space between “tree” and “-”, and between “L” and “n”. “N” needs to be replaced by number indicating the number of the folder levels.

3) Enter the “tree -L1” command and press “Enter” to display the 1st level of subfolder of the directory, as the figure shown below.


```

pi@raspberrypi: /
File Edit Tabs Help
pi@raspberrypi:/ $ tree -L 1
.
├── bin
├── boot
├── dev
├── etc
├── home
├── lib
├── lost+found
├── media
├── mnt
├── opt
├── proc
├── root
├── run
├── sbin
├── srv
├── sys
├── tmp
├── usr
└── var

19 directories, 0 files
pi@raspberrypi:/ $

```

The function of the main directories is recorded in the following form:

Directory	Function
bin	store Linux common command
boot	store Linux starting file
dev	store Linux peripheral
etc	store all kinds of configuration files and sub-directory required by system management.
home	store main directory
lib	store shared library
media	provide regular mount points of all mobile devices
mnt	temporary files mount points
proc	store information about system resources
root	the home directory of the root user
sbin	store unessential and unimportant system binary file and web application tool
sys	store kernel, firmware and system-related file
tmp	Store temporary files
usr	store user file, game, graphics file, library, and various other users, management commands and files.
var	stores an ever-expanding and frequently-modified directory

Section 6 Use Raspberry Pi as Wireless Router

Raspberry Pi 4B comes with wired and wireless network cards. It not only can connect to external networks by wired and wireless network cards, but also configure itself as a wireless router.

1. Preparation

- 1) A smart phone
- 2) A network cables

2. Configuration method

To lower difficulty, the creste_ap project on Github is used to start the AP function of Raspberry Pi wireless network adapter.

- 1) Start Raspberry Pi, and connect the network cable. **Note:** Please confirm Raspberry Pi has enabled WiFi and is not connected to any WiFi. (If the Raspberry Pi automatically connects to the previously saved WiFi, right-click the WIFI name and select “Yes” in the pop-up interface to disconnect.) At the same time, please do not click “Turn off” on internet option in the upper right corner. (otherwise this function will affect the implementation.)



- 2) Open LX terminal, enter “git clone https://github.com/oblique/create_ap” command to clone the code to the Raspberry Pi. (If fail to download, please check whether the network is smooth or add sudo before the above command git and leave a space.)

```
pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ git clone https://github.com/oblique/create_ap
Cloning into 'create_ap'...
remote: Enumerating objects: 1072, done.
remote: Counting objects: 100% (3/3), done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 1072 (delta 0), reused 0 (delta 0), pack-reused 1069
Receiving objects: 100% (1072/1072), 357.79 KiB | 1.05 MiB/s, done.
Resolving deltas: 100% (591/591), done.
pi@raspberrypi:~ $
```

3) After the clone is complete, enter “cd create_ap/” command to switch to “create_ap” directory.

```
File Edit Tabs Help
pi@raspberrypi:~ $ git clone https://github.com/oblique/create_ap
Cloning into 'create_ap'...
remote: Enumerating objects: 1072, done.
remote: Counting objects: 100% (3/3), done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 1072 (delta 0), reused 0 (delta 0), pack-reused 1069
Receiving objects: 100% (1072/1072), 357.79 KiB | 1.05 MiB/s, done.
Resolving deltas: 100% (591/591), done.
pi@raspberrypi:~ $ cd create_ap/
pi@raspberrypi:~/create_ap $
```

4) Enter “sudo make install” command to install the clone program.

```
pi@raspberrypi:~ $ cd create_ap/
pi@raspberrypi:~/create_ap $ sudo make install
install -Dm755 create_ap /usr/bin/create_ap
install -Dm644 create_ap.conf /etc/create_ap.conf
[ ! -d /lib/systemd/system ] || install -Dm644 create_ap.service /usr/lib/systemd/system/create_ap.service
[ ! -e /sbin/openrc-run ] || install -Dm755 create_ap.openrc /etc/init.d/create_ap
install -Dm644 bash_completion /usr/share/bash-completion/completions/create_ap
install -Dm644 README.md /usr/share/doc/create_ap/README.md
pi@raspberrypi:~/create_ap $
```

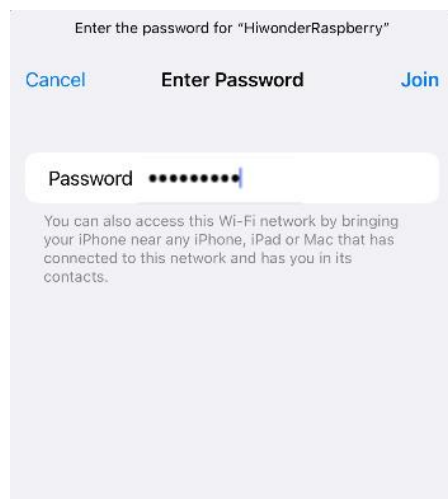
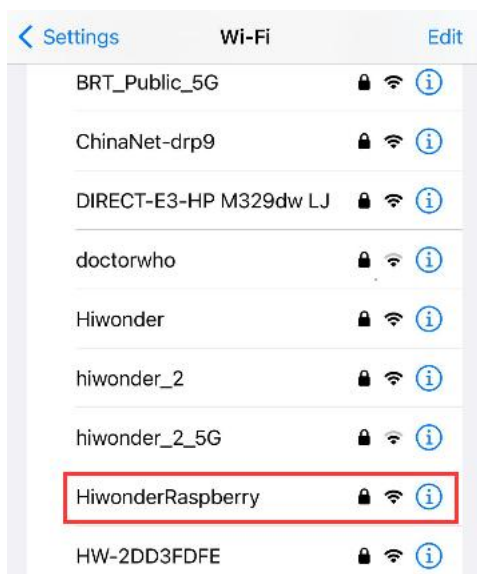
5) Enter “sudo apt-get install util-linux procps hostapd iproute2 iw haveged dnsmasq” command and install the libraries that environment relies on. (If the prompt “Would you like to continue executing? 【Y/n】 Input “y” and press “Enter”)

```
pi@raspberrypi:~/create_ap $ sudo apt-get install util-linux procs hostapd iproute2 iw haveged dnsmasq
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

6) Then configure Wi-Fi. The format of configuration command is “sudo create_ap wlan0 eth0+hotspot name+password”. A process will be started after configuration. (Take “sudo create_ap wlan0 eth0 HiwonderRaspberry 123456789” as example)

```
pi@raspberrypi:~/create_ap $ sudo create_ap wlan0 eth0 HiwonderRaspberry 123456789
WARN: brmfmac driver doesn't work properly with virtual interfaces and
it can cause kernel panic. For this reason we disallow virtual
interfaces for your adapter.
For more info: https://github.com/oblique/create_ap/issues/203
WARN: Your adapter does not fully support AP virtual interface, enabling --no-virt
Config dir: /tmp/create_ap.wlan0.conf.Zxp0qtdB
PID: 1313
Sharing Internet using method: nat
hostapd command-line interface: hostapd_cli -p /tmp/create_ap.wlan0.conf.Zxp0qtdB/hostapd_ctrl
Configuration file: /tmp/create_ap.wlan0.conf.Zxp0qtdB/hostapd.conf
wlan0: Could not connect to kernel driver
Using interface wlan0 with hwaddr dc:a6:32:00:4a:d8 and ssid "HiwonderRaspberry"
wlan0: interface state UNINITIALIZED->ENABLED
wlan0: AP-ENABLED
```

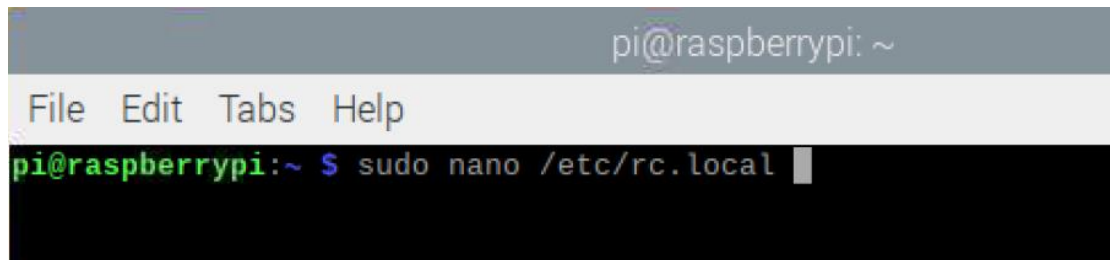
7) After configuration is complete, you can search for this WiFi on your phone, and then enter password to connect to this WiFi. Now, you can test whether the network is available. (If you need to disable this WiFi, you can directly press “Ctrl+C” in the last step.)



8) Now, Raspberry Pi wireless router is set. After Raspberry Pi shuts down, you need to configure again. The next section will explain how to set auto-start.

3. Set Auto-Start

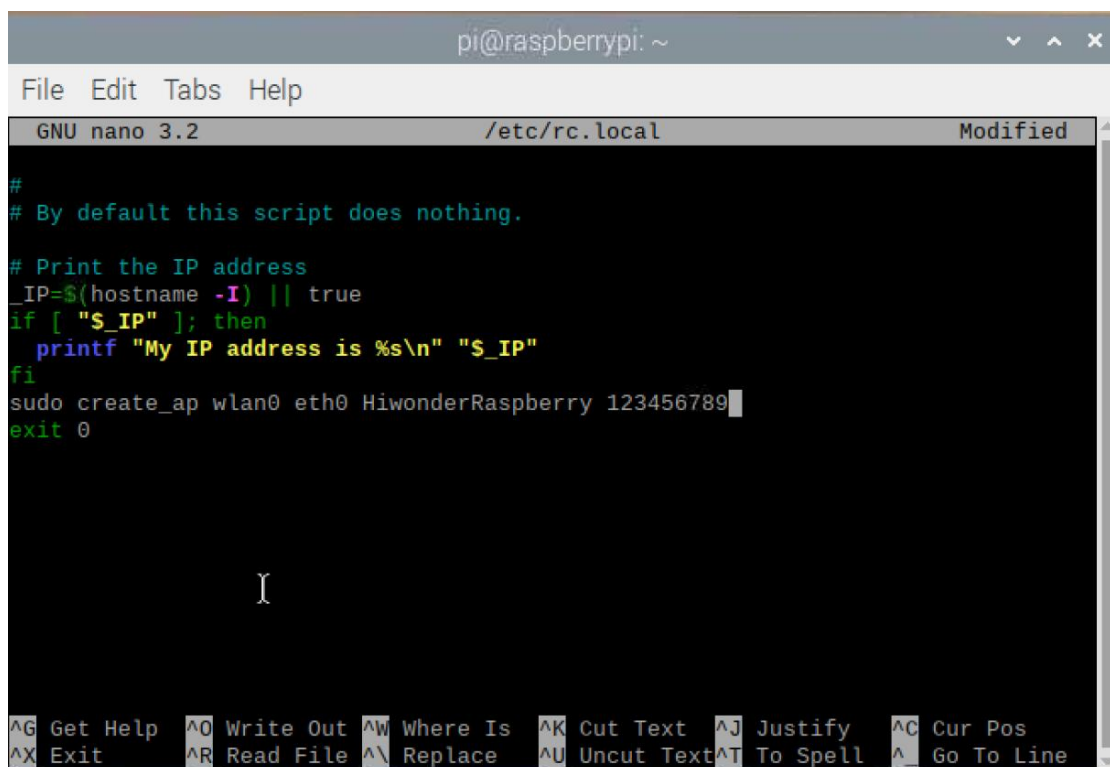
1) Open LX terminal and enter “sudo nano /etc/rc.local” command to edit file.



```
pi@raspberrypi: ~  
File Edit Tabs Help  
pi@raspberrypi:~ $ sudo nano /etc/rc.local
```

2) After entering the edit mode, input the following content before “exit 0”:

```
sudo create_ap wlan0 eth0 HiwonderRaspberry 123456789
```



```
pi@raspberrypi: ~  
File Edit Tabs Help  
GNU nano 3.2 /etc/rc.local Modified  
#  
# By default this script does nothing.  
# Print the IP address  
_IP=$(hostname -I) || true  
if [ "$_IP" ]; then  
    printf "My IP address is %s\n" "$_IP"  
fi  
sudo create_ap wlan0 eth0 HiwonderRaspberry 123456789  
exit 0  
  
I  
  
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos  
^X Exit ^R Read File ^\ Replace ^U Uncut Text ^T To Spell ^_ Go To Line
```

3) Press “Ctrl+X” and “Y”, and then “Enter” to exit.


```

pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 3.2 /etc/rc.local Modified
#
# By default this script does nothing.
# Print the IP address
_IP=$(hostname -I) || true
if [ "$_IP" ]; then
    printf "My IP address is %s\n" "$_IP"
fi
sudo create_ap wlan0 eth0 HiwonderRaspberry 123456789
exit 0
Save modified buffer? (Answering "No" will DISCARD changes.)
Y Yes
N No ^C Cancel
  
```

4) Enter “sudo reboot”command to restart Raspberry Pi.

```

pi@raspberrypi:~ $ sudo nano /etc/rc.local
pi@raspberrypi:~ $ sudo reboot
  
```

5) After the Raspberry Pi is started, and then search for Wi-Fi on your phone. The WiFi shown in the picture can be searched.

AGFW	🔒	📶	ℹ️
ChinaNet-qPuM	🔒	📶	ℹ️
David	🔒	📶	ℹ️
FCFSJC	🔒	📶	ℹ️
GYHK-2.4G	🔒	📶	ℹ️
GYHK-5G	🔒	📶	ℹ️
HiwonderRaspberry	🔒	📶	ℹ️
HP-Print-BE-LaserJet Pro MFP		📶	ℹ️

Section 7 File transfer

This chapter is about how to transfer the files between RaspberryPi and computer with **Winscp**.

1. Winscp installation

The installation package can be found in “4.Appendix->3.Tools->4.File Transferring Tool ”.

2. Import file to RaspberryPi

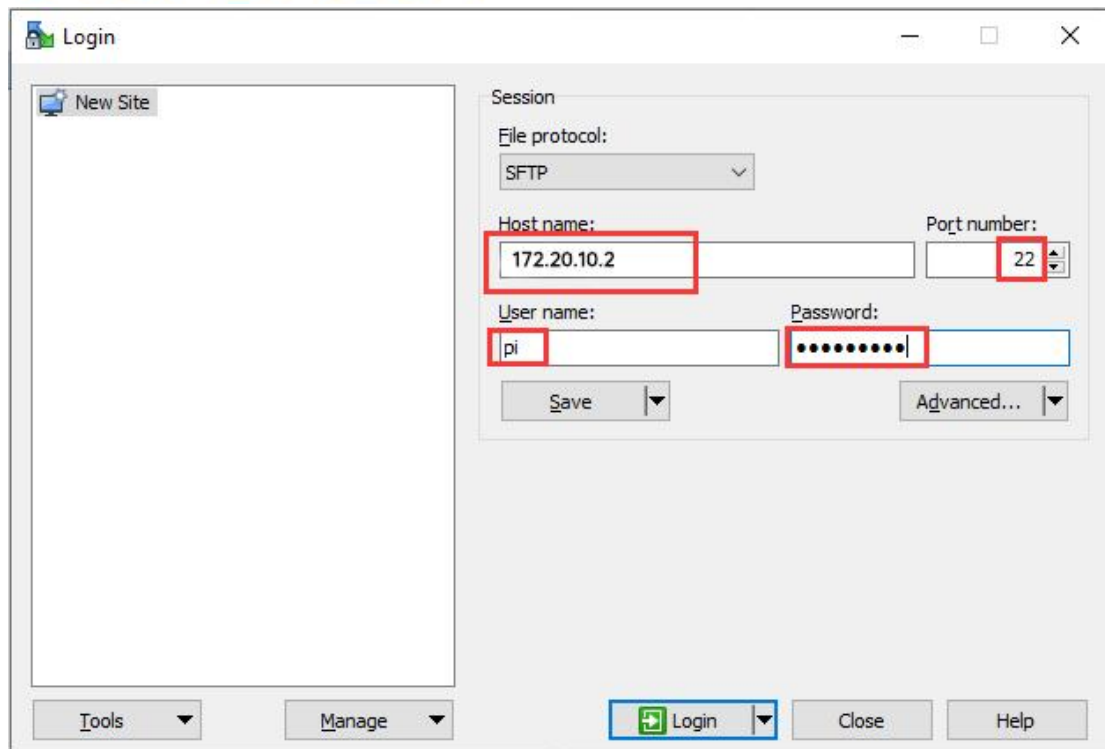
1) Firstly, turn on the RaspberryPi. And connect to the same Wi-Fi as the computer. For how to operate and acquire IP, please refer to chapter “3.

Remote Desktop Connection”

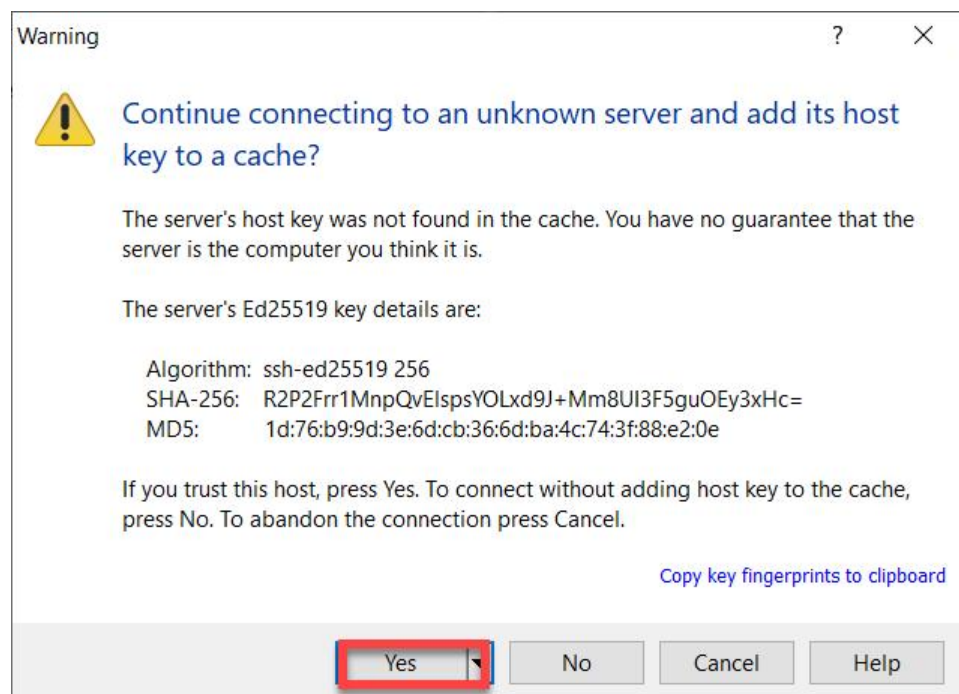
2) Open Winscp after installation.



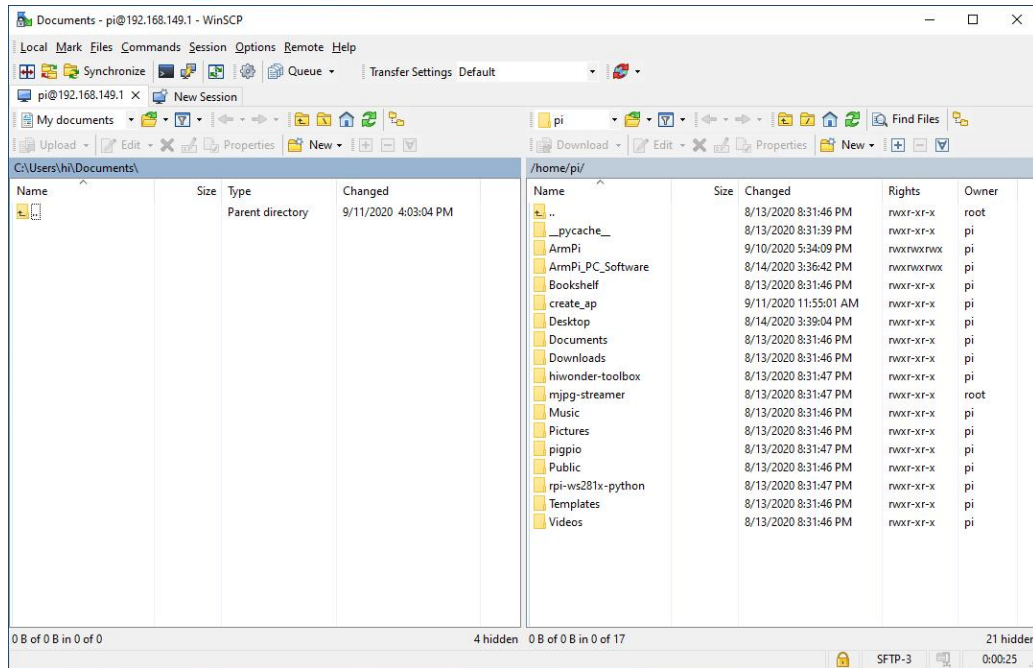
3) The interface below will appear in Winscp. And, the demonstration is performed under the situation where RaspberryPi connects to the same Wi-Fi as the computer. The master name is **172.20.10.2**, username is **pi**, and password is **raspberry**.



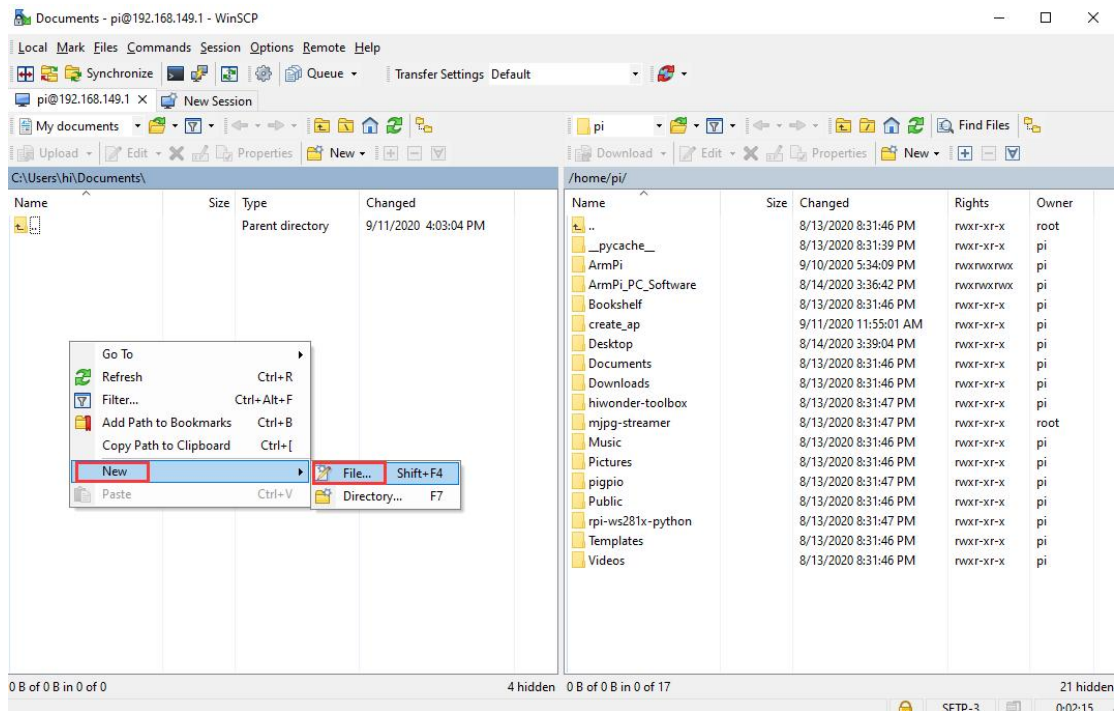
4) The window of “safety warning” will pop up for the first connection, and just click “Yes”.

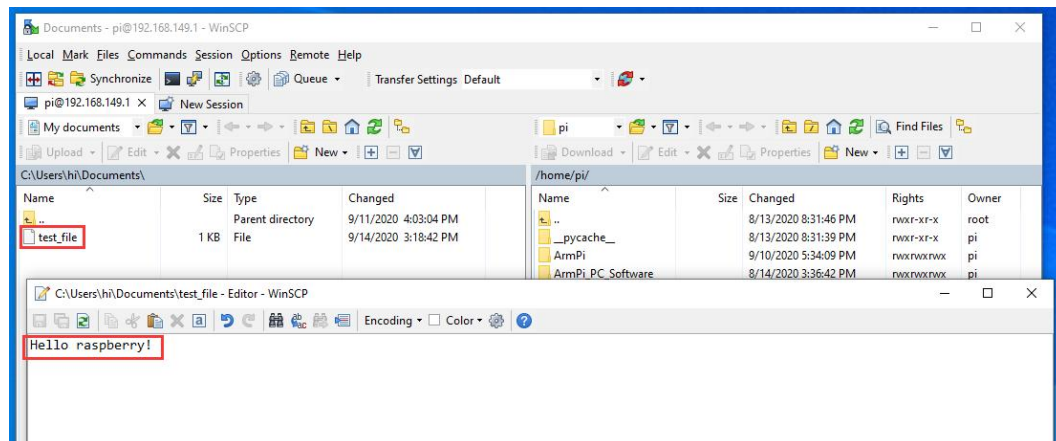


5) After successful connection, the directory and files of computer are at the left side, and those of RaspberryPi are at the right side.

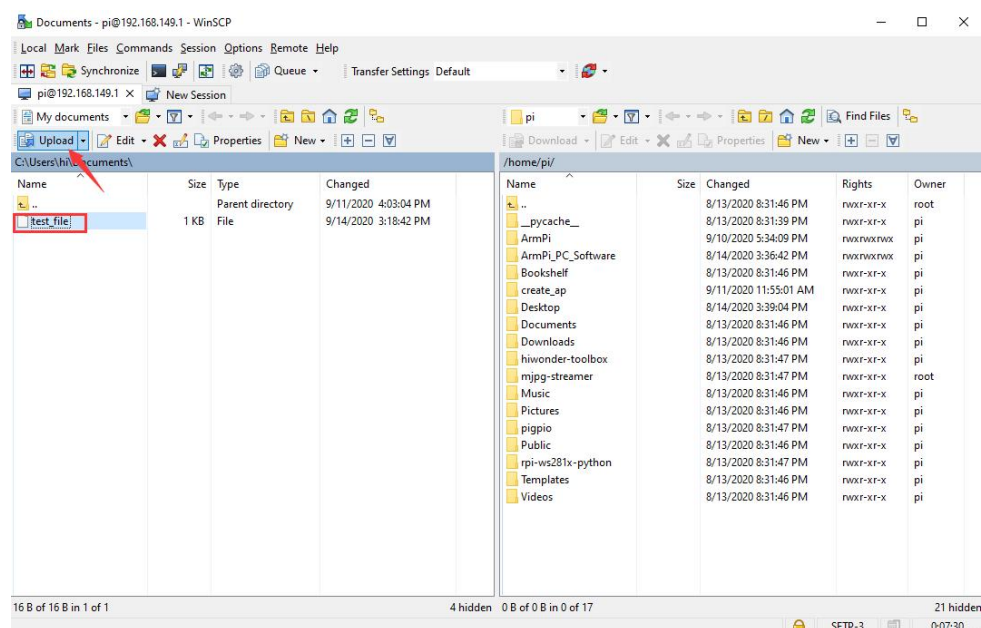


6) Right click at the left interface and select “New” to create a file named “Transfer File”. And enter the words “Hello raspberry!”, and save.

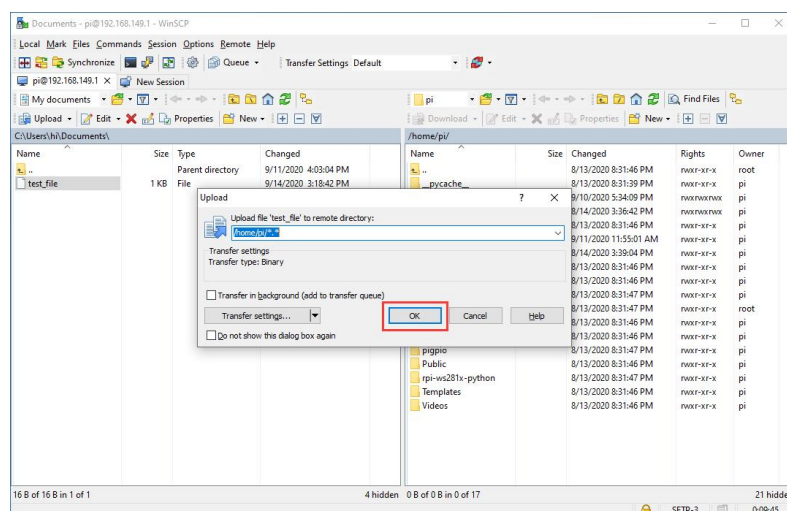




7) Select this file, and click “Upload” button.

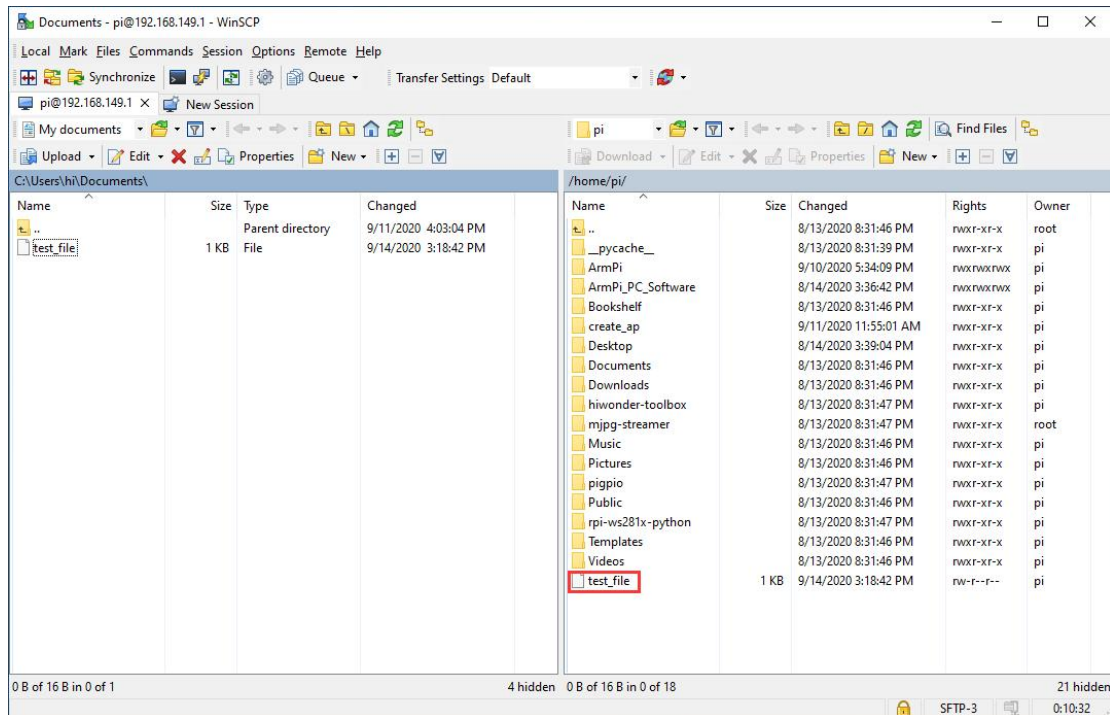


8) Select the path where the file is transferred to. Then click “OK”.

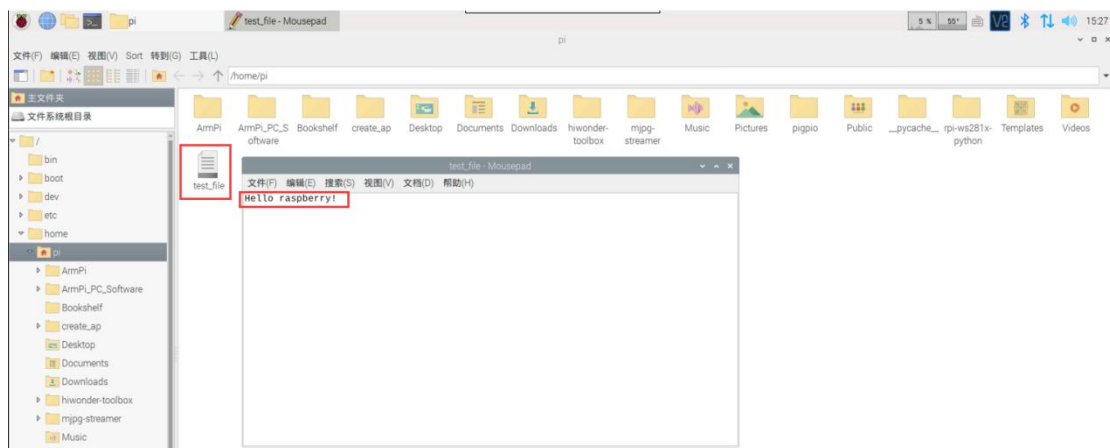


9) After a while, the file is transferred successfully, which can be checked at

the right interface.



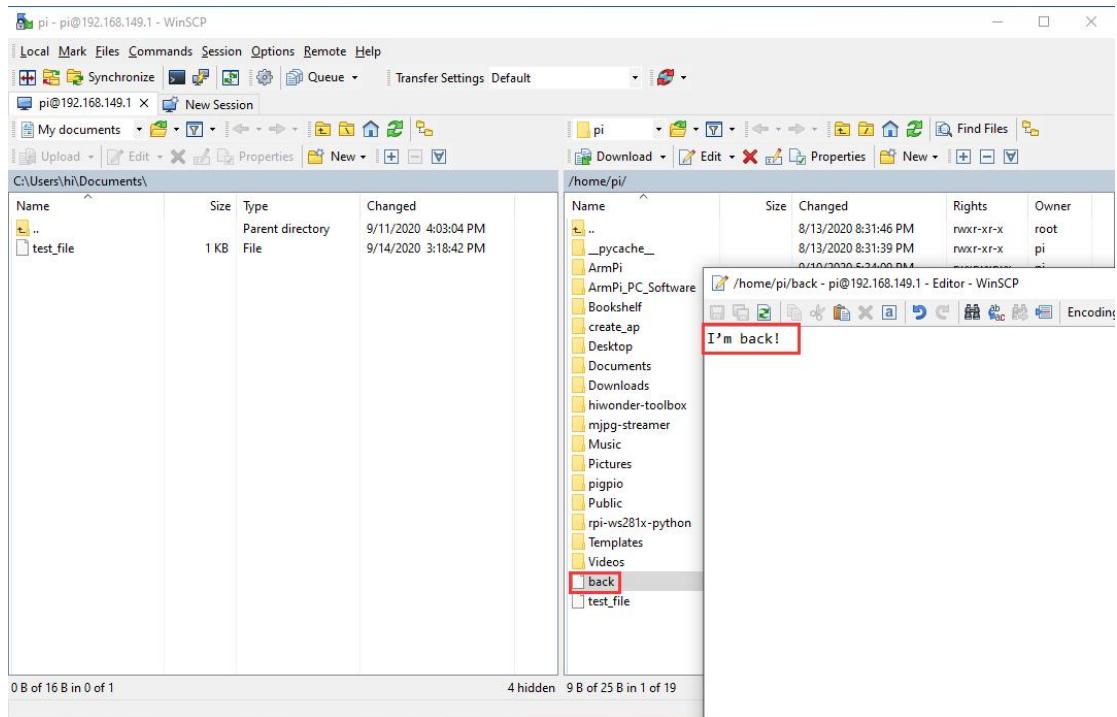
10) Next, login RaspberryPi system through VNC or SSH to verify. For how to login, please refer to **“3. Remote Desktop Connection”**. Here, use VNC to login RaspberryPi system. From the below picture, you can find that “Transfer File” has been already transferred to RaspberryPi system.



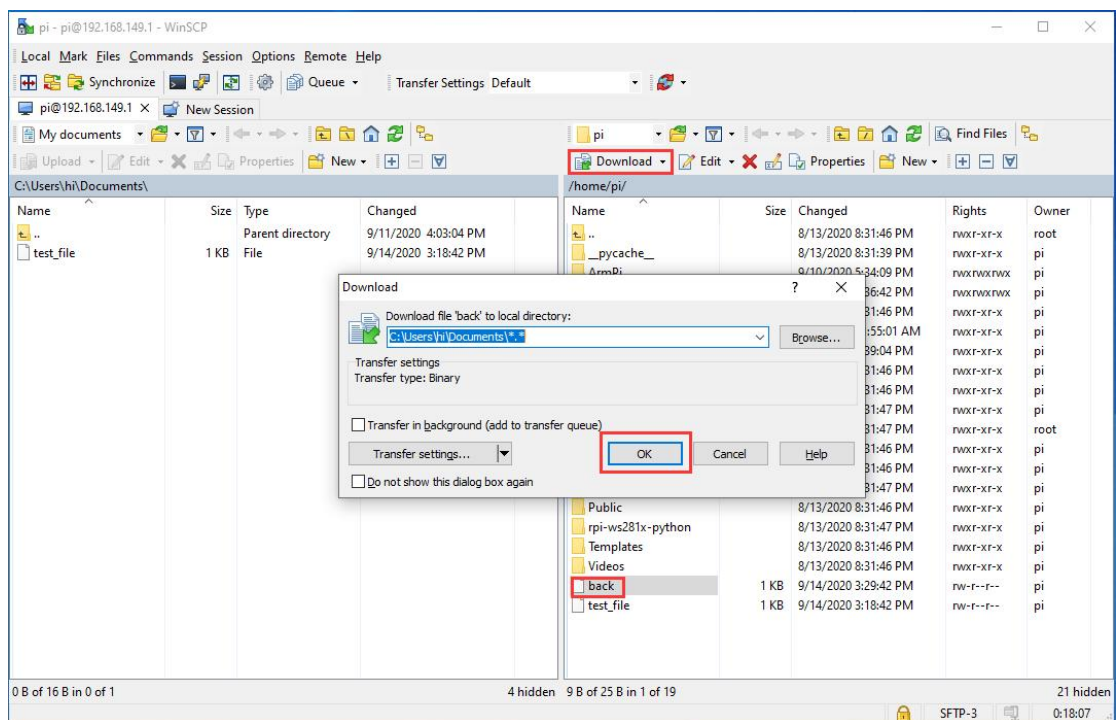
3. Export file from RaspberryPi

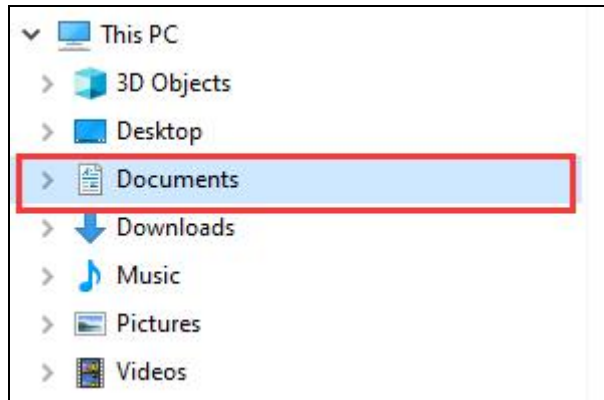
In the same way, export the file from RaspberryPi.

1) Right click at the right interface and select “New” to create a file named “back”. And enter the words “I’m back!”, and save.

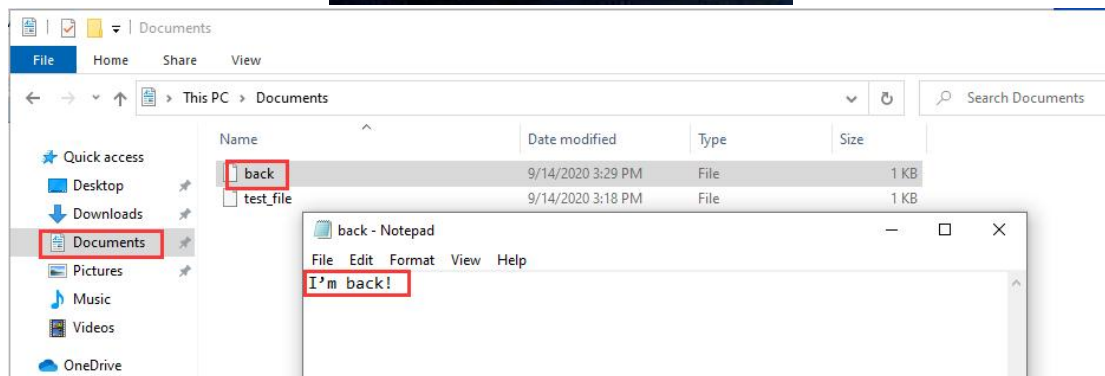
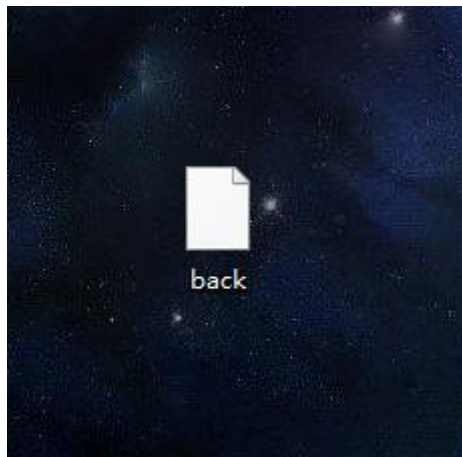


2) Select this file. Then click “download” button. And select the path where the file is transferred to. After selection, click “OK”. In order to facilitate searching, we put the file on the computer desktop.





3) Move to the computer desktop, and open “back” file with “Notepad”. The content is the same as that on RaspberryPi.



Section 8. RaspberryPi system backup

1. The meaning of system backup

To avoid some unexpected situation, such as file and data loss or damage, it is recommended to copy the data of RaspberryPi SD card to other storage

device in advance, so that the system can be recovered and restored immediately, which can save time and energy.

2. Methods to backup

Generally, there are three ways to backup, and you can check the features of them in the table below.

Platform	Tool	Advantage	Disadvantage
Windows	Win32DiskImager、 WinImager	It is easy to make system image	It takes long time to make system image
Raspbian(Linux)	Command line, script	The generated image file is in small size and will not occupy the storage of computer	Difficult operation
Raspbian(Linux)	SD Card Copier	Highly efficient. As long as you insert it to computer, you can use it at once.	The image file cannot be generated, and it is difficult to batch

2.1 Use third-party software to make image under Windows

1) Firstly, create a blank file with **.img suffix**. It is recommended to use

WinImager software. And you can search the usage instruction on Internet.

2) Insert the SD card with system image, and select the corresponding drive letter of SD card.

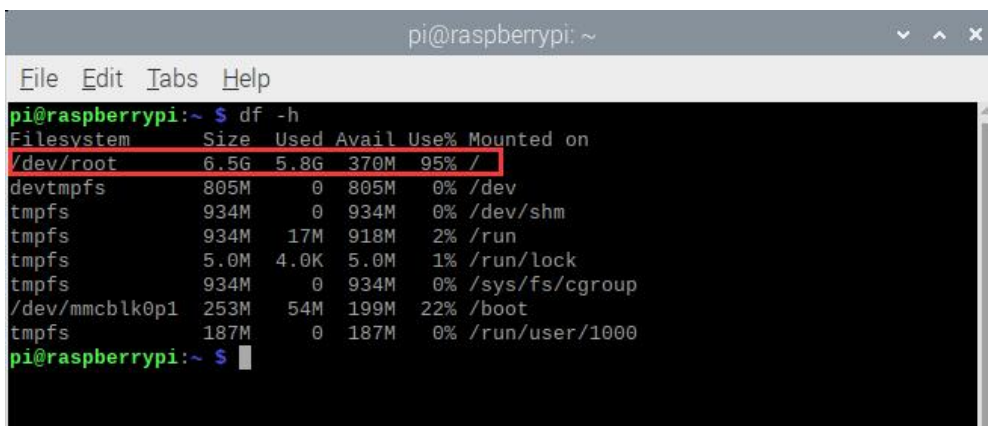
3) Open Win32DiskImager tool, and click “Read”. Then the file in SD card can be converted into image.

2.2 Use command line under Linux

1) Turn on RaspberryPi, and open LX terminal. Firstly, enter the following commands in sequence to install the required software. Please always select “y” in prompt box.

```
sudo apt-get install dosfstools
sudo apt-get install dump
sudo apt-get install parted
sudo apt-get install kpartx
```

2) Enter command “df -h” to check the actual storage occupied by RaspberryPi, and then determine the size of generated file. And you only need to check the remaining storage of root. Note: df and -h are separated by a space.



```
pi@raspberrypi:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/root        6.5G  5.8G  370M  95% /
devtmpfs        805M    0  805M   0% /dev
tmpfs           934M    0  934M   0% /dev/shm
tmpfs           934M   17M  918M   2% /run
tmpfs           5.0M   4.0K  5.0M   1% /run/lock
tmpfs           934M    0  934M   0% /sys/fs/cgroup
/dev/mmcblk0p1  253M   54M  199M  22% /boot
tmpfs           187M    0  187M   0% /run/user/1000
pi@raspberrypi:~$
```

3) Enter “**sudo nano backup.sh**” command to create script file called “backup”. For example, copy the following content to the blank area.

```
#!/bin/sh

sudo dd if=/dev/zero of=raspberrypi.img bs=1MB count=7500

sudo parted raspberrypi.img --script -- mklabel msdos

sudo parted raspberrypi.img --script -- mkpart primary fat32 8192s 122879s

sudo parted raspberrypi.img --script -- mkpart primary ext4 122880s -1

loopdevice=`sudo losetup -f --show raspberrypi.img`

device=`sudo kpartx -va $loopdevice | sed -E 's/.*(loop[0-9])p.*/\1/g' | head -1`

device="/dev/mapper/${device}"

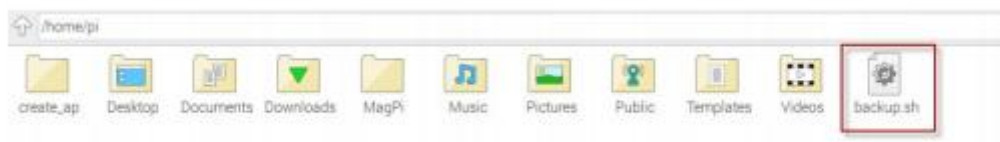
partBoot="${device}p1"

partRoot="${device}p2"

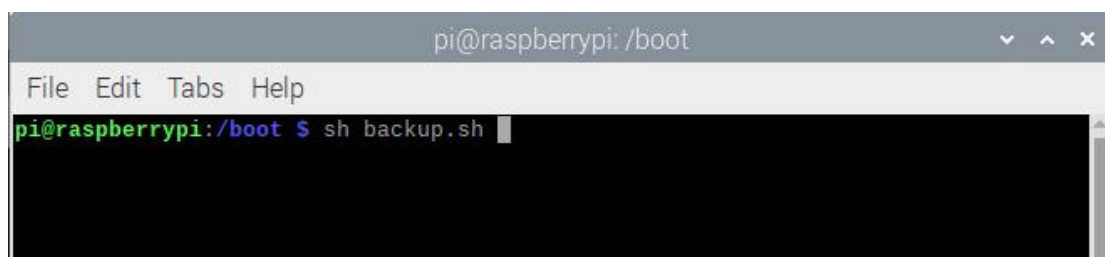
sudo mkfs.vfat $partBoot
```

4) Having copied the commands, press “Ctrl+X” key. Then you will be prompted whether to save the content, and you need to press “Y” key to confirm and press Enter to exit.

5) Having exited, enter “**sudo chmod 777 backup.sh**” command, and give the file a permission for all users to read, write and execute.



6) If need to execute the script to enable the backup function, enter “**sh backup.sh**” command.



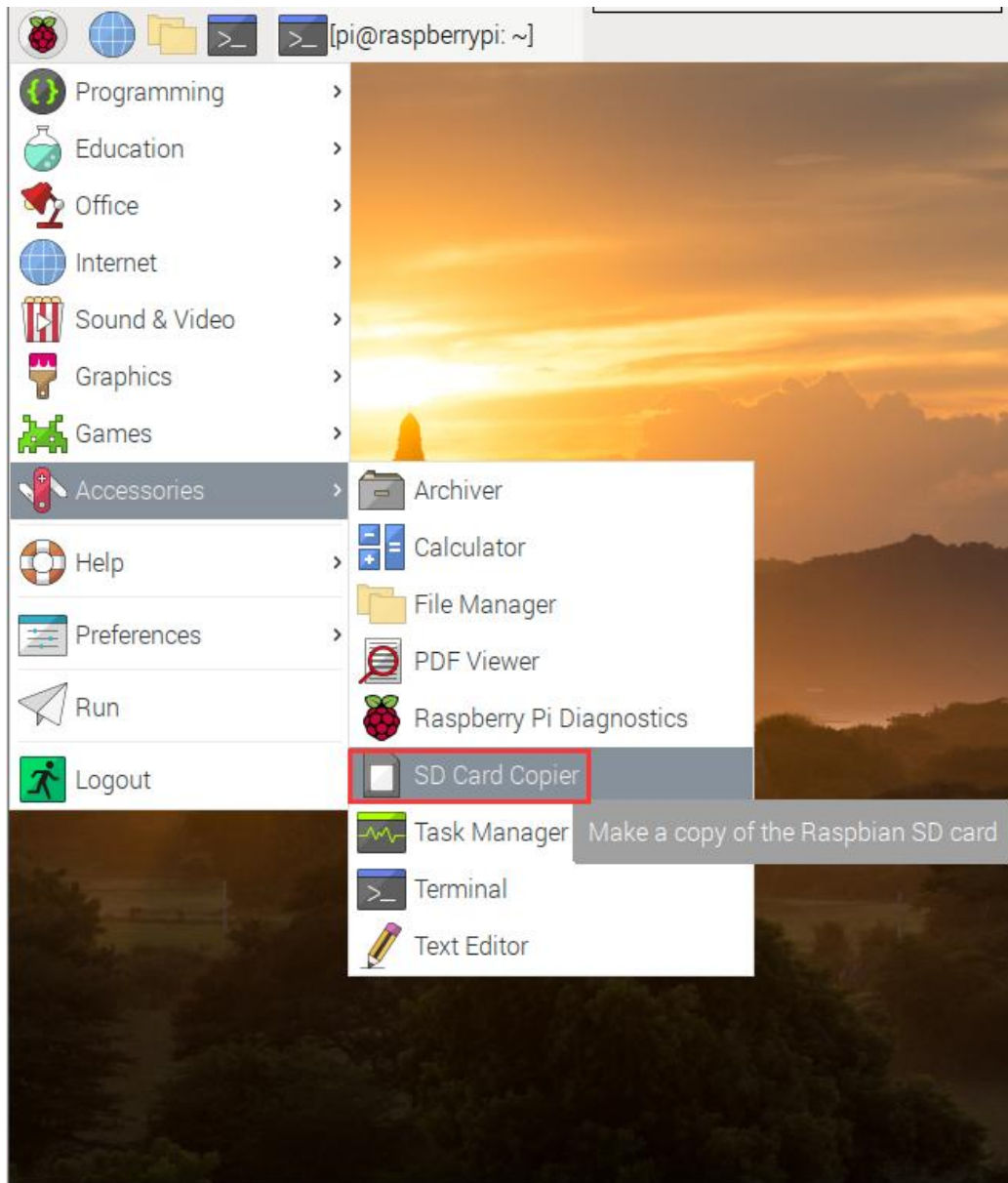
7) After execution, the backup file is generated.



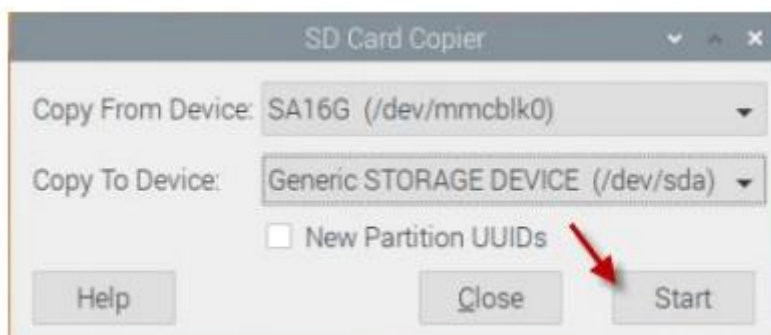
2.3 SD Card Copier tool

1) Insert the blank SD card into the card reader, and insert the card reader into the USB interface of RaspberryPi.

2) After turning on the RaspberryPi, click the RaspberryPi icon at upper left corner. Then select “accessory” and open “SD Card Copier” tool.



3) Select the SD card with image in “**Copy From Device**” bar. It is stored in the path, dev/mmcblk0. In “Copy To Device” bar, select new SD card which is saved in the path /dev/sda. Based on your own requirement, select “New Partition UUIDs” or not. This option will not affect the actual effect.



Section 9. Correct way to turn off Raspberry Pi

Although Raspberry Pi works as mini computer, it is not equipped with power switch as PC computer. Directly unplugging the power cord after using will cause damage to the data of SD card. SD card serves as the Raspberry Pi system, and ample files are stored in this “Raspberry Pi system”. In order to avoid data loss and SD card damage caused by direct power off, it is recommended to power off the Raspberry Pi in safer way.

When you need to power off the Raspberry Pi, open LX terminal interface and enter “**sudo shutdown -h now**”. It should be noted that “-h” will suspend the system. Of course, “-h” can be deleted from the command, and Raspberry Pi will be powered off immediately. “sudo halt” command can also be used to shut down the Raspberry Pi, which is shorter and performs the same function as before.

If want to make the device shut down at specific time, enter “sudo shutdown -h 30”, and the device will shut down after 30 minutes. If want the time more specific, you can enter the specific time, for example “sudo shutdown -h 12:30”.

Enter command “sudo reboot”, and then the device will reboot. Or you can enter “shutdown -r now” to make Raspberry Pi reboot right now. If want to make it reboot at set time, such as 13:30:20, you can enter “shutdown -r 13:30:20”.

Basic programming

Section 1 Common Linux command

The system used for the Raspberry Pi in the tutorial is Raspbian, a Linux distribution. Linux command is used to manage the Linux system. For Linux system, CPU, memory, disk drive, etc. are files, and the commands of system management are its core.

1. Linux command

Through the previous learning, we have already master some basic Linux commands. For Linux freshman, it is difficult to memorize a large amount of Linux commands. However, only getting command of 10 more commands enables you to fully experience Raspberry Pi.

In this section, ten more Linux commands will be introduced, and operation based on these commands will be performed for you to check the running effect.

Command	Full name	Meaning
ls	List	List the file in the current directory
cd	Change Directory	Switch the directory
pwd	Print Working Directory	Display the working directory
ping	Packet Internet Groper	Test the network connection
Shut down	Shut down	Shut down the Raspberry Pi
reboot	Reboot	Reboot the Raspberry Pi
cp	Copy	Copy
rm	Remove	delete
mkdir	Make directory	Create directory
man command	Manual	Show the help information of command

echo	Echo	Display the input content on the terminal interface
Find	Find	Function of searching
mv	Move	Rename or cut
date	Date	Read the data or time of the system

Reminder: the commands should be case sensitive in Linux system.

2. Operation based on Linux commands

1) Turn on RaspberryPi. Then press “Ctrl+Alt+T” or click the terminal icon at upper left corner to enter the terminal interface.



2) Enter the first command “pwd” which is used to display the currently working directory. And you can find that we are in **/pi** folder under the **/home** directory.

```

pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ pwd
/home/pi
pi@raspberrypi:~ $

```

3) Next, enter command “ls”. “ls” command is used to list the file information under the current directory. Parameter “ls -l” and “ls -a” can be used to obtain the file permission, modify the date, etc.

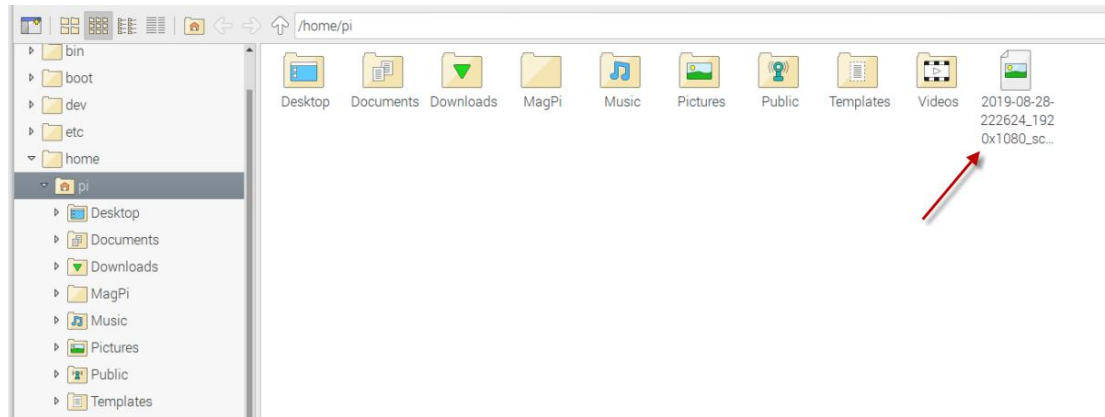
```

pi@raspberrypi:~ $ pwd
/home/pi
pi@raspberrypi:~ $ ls
Desktop  Downloads  Music      Public     Videos
Documents MagPi      Pictures   Templates
pi@raspberrypi:~ $

```


4) Click “PrtSC” or “PRTSCR” key, and the current image will be captured.

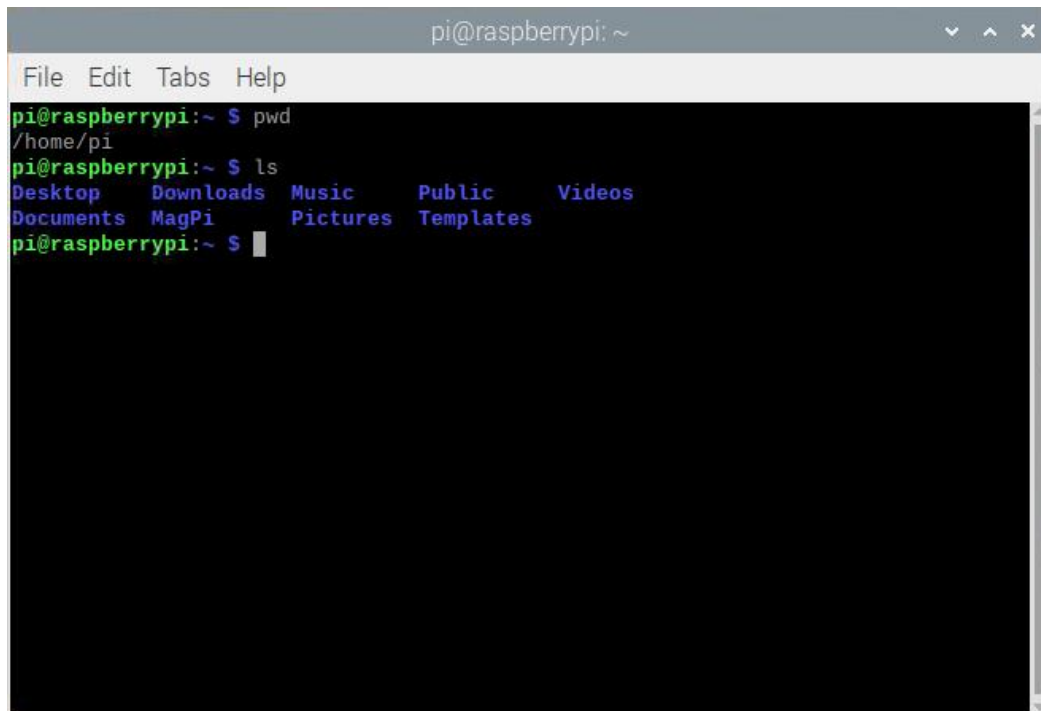
The captured image will be saved in **/home/pi**. And you can click  , file manager, to find the photo.



2) In the same way, capture three pictures randomly and drag them directly into the **/Pictures** file shown above.

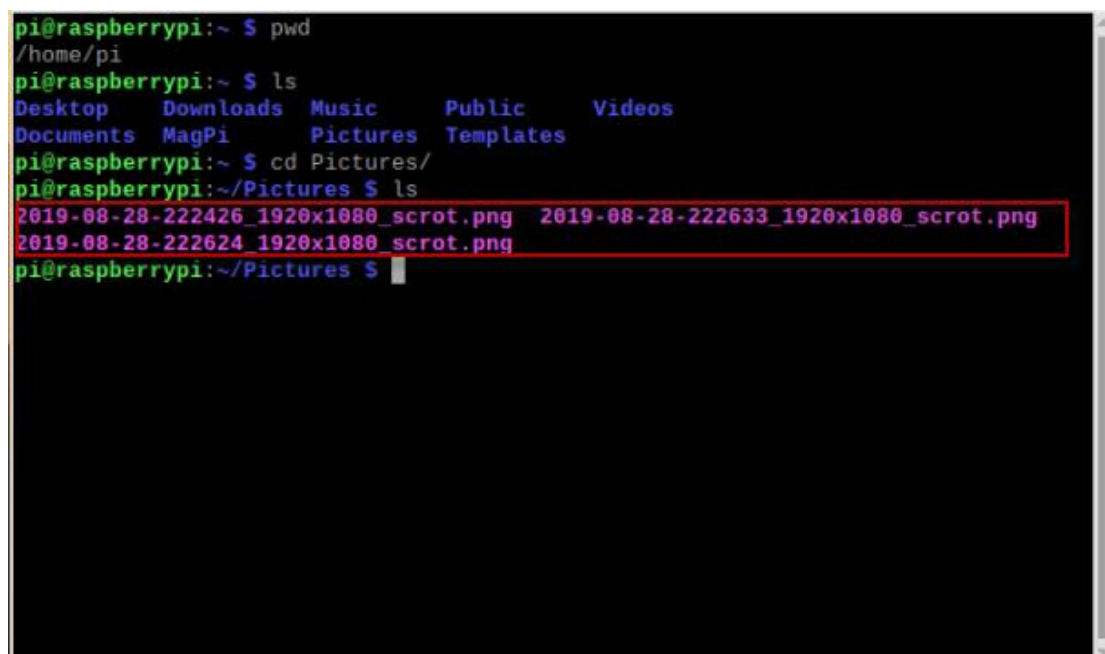
3) Back to LX interface, and enter “cd” command to switch to the folder **/Pictures** where the games locate.

Tips: In Linux system, “Tab” key can be used to assist in command input. “Tab” key can automatically complement the command, file name or file path. For example, when you want to switch to **/Pictures** directory, you can enter command “cd Pict” and press “Tab” key. Then the command will be automatically completed as “cd Pictures/”. Whenever you press “Tab” key, the file name will be completed fully in the command line if the characters do not overlap that of other files. If there is an overlap, the file names starting with these characters will be displayed at current directory.



```
pi@raspberrypi: ~  
File Edit Tabs Help  
pi@raspberrypi:~ $ pwd  
/home/pi  
pi@raspberrypi:~ $ ls  
Desktop Downloads Music Public Videos  
Documents MagPi Pictures Templates  
pi@raspberrypi:~ $
```

4) Now, the directory is switched to the directory where the captured photo is stored. And you can enter “ls” command to check the files under this directory.

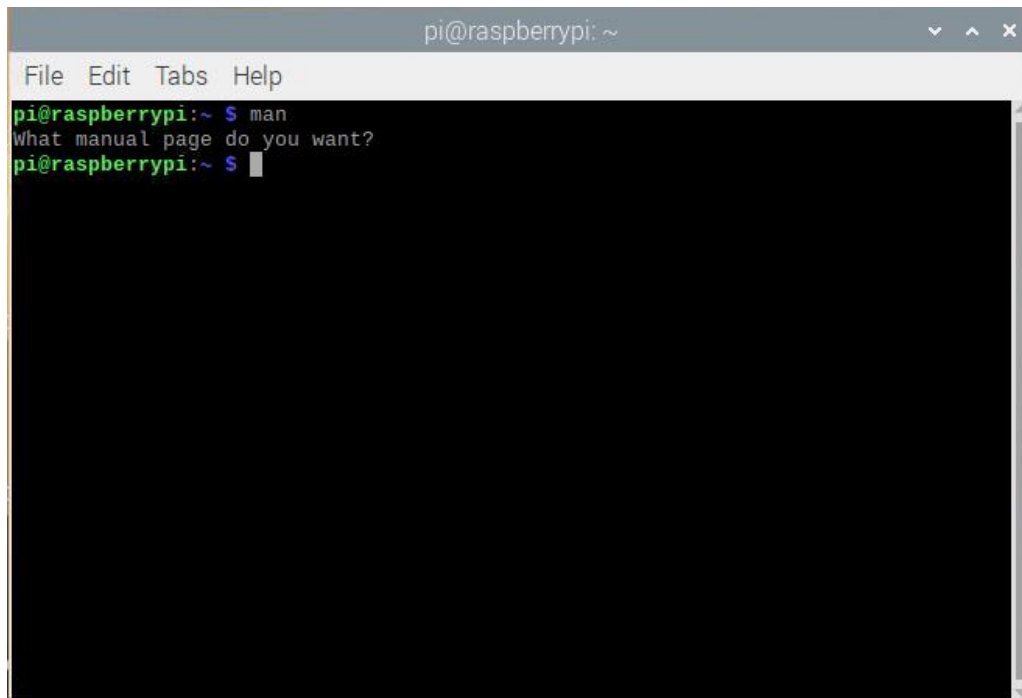


```
pi@raspberrypi:~ $ pwd  
/home/pi  
pi@raspberrypi:~ $ ls  
Desktop Downloads Music Public Videos  
Documents MagPi Pictures Templates  
pi@raspberrypi:~ $ cd Pictures/  
pi@raspberrypi:~/Pictures $ ls  
2019-08-28-222426_1920x1080_scrot.png 2019-08-28-222633_1920x1080_scrot.png  
2019-08-28-222624_1920x1080_scrot.png  
pi@raspberrypi:~/Pictures $
```

8) The files whose name starts with “2019-08-28” and end with “.png” are the captured images. In this way, you directly find the required project or file.

9) Next, enter “man” command. “man” is short for manual. Whenever you forget some command or parameters, you just need to enter “man” command,

and then follow the prompt to input the content you want to search. Then you can get the answer.

A screenshot of a terminal window titled 'pi@raspberrypi: ~'. The window has a menu bar with 'File', 'Edit', 'Tabs', and 'Help'. The terminal shows the command 'man' being entered, followed by the prompt 'What manual page do you want?'. The prompt is followed by a cursor and a space, indicating the user is about to enter a search term.

```
pi@raspberrypi:~ $ man
What manual page do you want?
pi@raspberrypi:~ $
```

10) For example, enter command “man cp” to check the meaning of “cp”. Then press Enter, and the meaning of “cp” command will be displayed, as shown in the red frame.

A screenshot of a terminal window showing the command 'man cp' being entered. The text 'man cp' is highlighted with a red rectangular box.

```
pi@raspberrypi:~ $ man cp
```

```

pi@raspberrypi: ~
File Edit Tabs Help
CP(1) User Commands CP(1)
NAME
  cp - copy files and directories
SYNOPSIS
  cp [OPTION]... [-I] SOURCE DEST
  cp [OPTION]... SOURCE... DIRECTORY
  cp [OPTION]... -t DIRECTORY SOURCE...
DESCRIPTION
  Copy SOURCE to DEST, or multiple SOURCE(s) to DIRECTORY.

  Mandatory arguments to long options are mandatory for short options
  too.

  -a, --archive
      same as -dR --preserve=all

  --attributes-only
      don't copy the file data, just the attributes

  --backup[=CONTROL]
Manual page cp(1) line 1 (press h for help or q to quit)

```

11)Keep scrolling down, and you will find “DESCRIPTION” which is the detailed description about this command.

```

DESCRIPTION
  Copy SOURCE to DEST, or multiple SOURCE(s) to DIRECTORY.

  Mandatory arguments to long options are mandatory for short options
  too.

  -a, --archive
      same as -dR --preserve=all

  --attributes-only
      don't copy the file data, just the attributes

  --backup[=CONTROL]
      make a backup of each existing destination file

  -b      like --backup but does not accept an argument

  --copy-contents
      copy contents of special files when recursive

  -d      same as --no-dereference --preserve=links
Manual page cp(1) line 10 (press h for help or q to quit)

```

Tip: you can turn the page through the shortcut key, and you can check the function of shortcut key as below.

Function	Shortcut key
----------	--------------

Flip back the screen	SPACE
Flip forward the screen	B
Flip back a line	ENTER
Flip forward a line	K
Return to terminal	:Q

Besides the above commands and keys, there are some special control keys in Linux system.

Key	Function
↑	History of the commands
Tab	Autocomplete
Ctrl+C	Stop running the program
Ctrl+D	Exit the terminal interface
Ctrl+A	Move the cursor to the beginning of this line
Ctrl+X	Move the cursor to the end of this line

Section 2. Instruction of vi editor

1. Introduction to vi modes

There are three modes, including command mode, insert mode and last line mode. For detailed introduction, you can refer to the table below.

Mode	Introduction	Function
Command mode	Default mode	Move the cursor and delete the character
Insert mode	Enter this mode through entering command “i” in “command mode”	Enter character in this mode. And you can return to command mode by pressing “ESC”
Last line mode	Enter this mode through entering command “:” in “command mode”	Save the file, exit Vi, set Vi and search

In “insert mode”, you can edit the content of the file. In “command mode”, you can check and delete the code. In “last line mode”, you can save the file and exit the editor.

2. Basic operation of vi

Mode	Key function
Command mode	“i”----switch to “insert mode”
	“x”----delete the character pointed by the cursor
	“.”----switch to last line mode
	“Enter”----go the next line
	Letter keys + “Shift” key----input character
	“Back Space”----delete a character

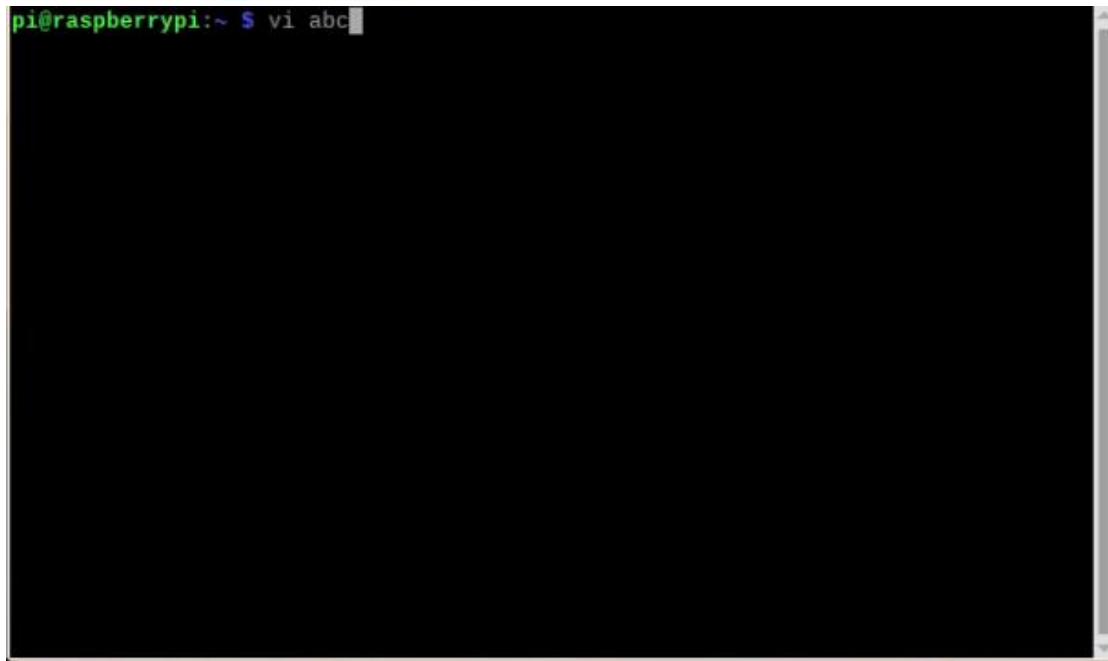
Insert mode	before the cursor
	“Del”----delete a character after the cursor
	Direction key----move the cursor in the text
	“Home/End”----move the cursor to the beginning/ End of the line
	“Page up/Page down”----flip the page
	“Insert”----switch the cursor into enter/ switch mode. The cursor will transform to vertical line/ underline
Last line mode	“q”----quit the program
	“w”----save the file
	“wq”----save and quit
	“q”----force quit without saving

3. Practical operation

- 1) Turn on raspberryPi and open LX terminal
- 2) The preinstalled vi editor in the system is not the complete version, so you need to enter this command “**sudo apt-get install -y vim**” to install vi editor of complete version.

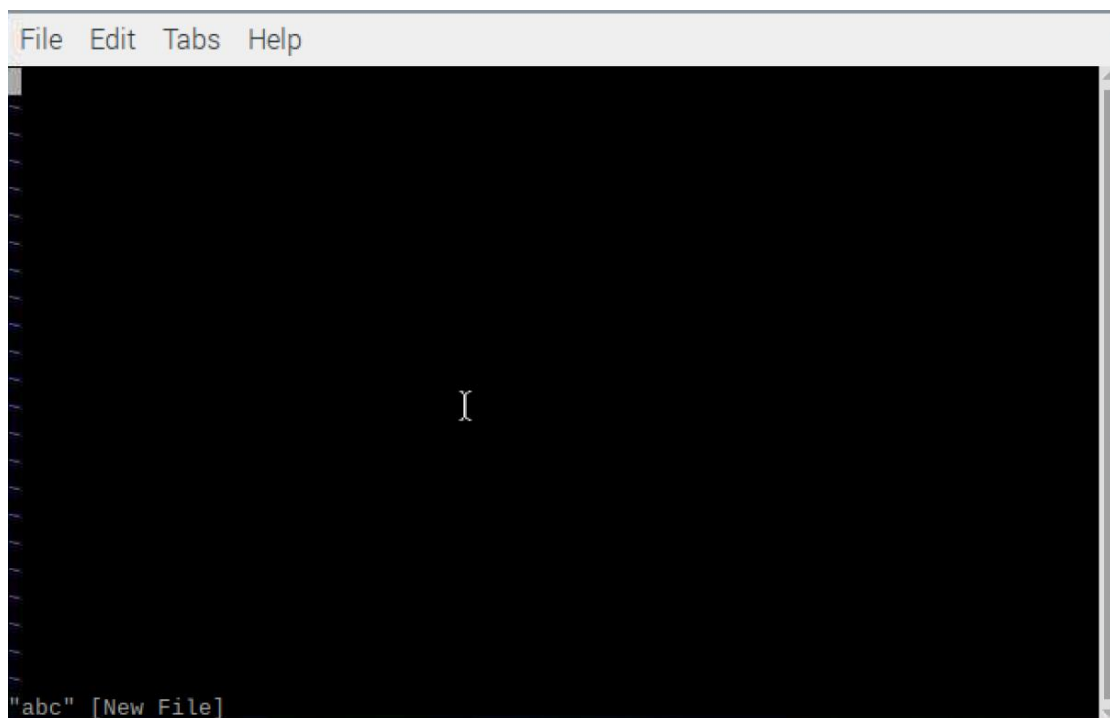
```
File Edit Tabs Help
pi@raspberrypi:~ $ sudo apt-get install -y vim
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

- 3) Enter “**vi and file name you want to edit**” to enter vi editor. Take creating text file called “**abc**” for example. The input format is as follow.



```
pi@raspberrypi:~ $ vi abc
```

4) Press “Enter”. Then a new file named “abc” is created, and you can enter the editor.



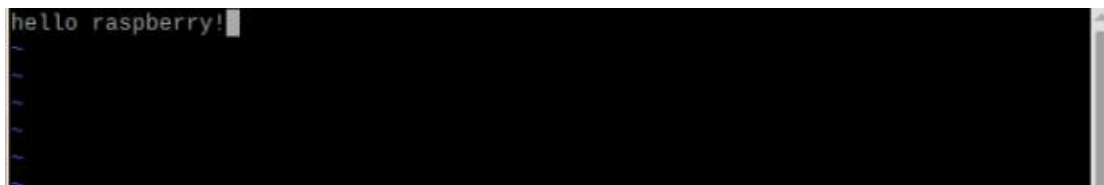
```
File Edit Tabs Help

"abc" [New File]
```

5) The default mode is **command mode** when you enter the file. You can enter the “Insert mode” by press “i” key, and prompt of “**--Insert--**” will appear at the lower left corner.

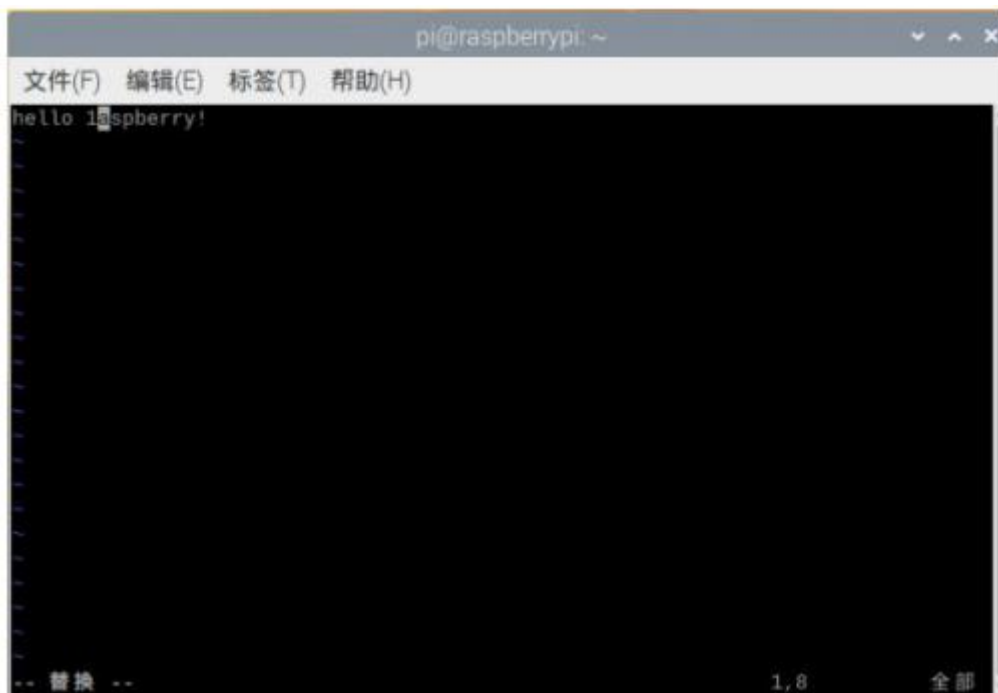


6) Input “**hello raspberry!**”.



7) “**Insert**” key can be used to switch cursor and replace the character.

Replace “r” in “raspberry” with “1”, and then press “Del” key to delete.



8) After experiencing “Insert mode”, you can switch to “last line mode”. Press “ESC” to exit “Insert mode”, and then press “.” key and input “wq”.

9) Press “Enter” key to save and exit the terminal. Next, input “ls” command to check whether the “abc” file is created successfully.

10) From the interface, you can find that “abc” file is built. Then enter command “**cat abc**” to check the content of the file.

Section 3. Python under Raspberry Pi environment

Python is one of the computer programming languages which aim at making the computer work, such as download MP3, edit a file. However, CPU can only

execute machine instruction. Although there is huge difference between different programming languages, all of them are required to be translated into the machine instruction that can be executed by CPU.

The amount of code written by different programming language to complete the task is also different. To complete a task, C language needs to write 1000 lines of codes, Java needs to write 100 lines, while Python only needs to write 20 lines.

The Python compiler has version 2.x and version 3 or above. Pay attention that version 2.x was no longer be maintained after 2020, so Python3 and above are recommended.

2. Write simple Python program

In Raspberry Pi, you can use vi editor to write Python program. You can follow the below steps to operate.

- 1) Turn on Raspberry Pi and open VNC.
- 2) Press “**Ctrl+Alt+T**” or click the terminal icon at upper left corner to enter the terminal interface.
- 3) Create a Python file, and remember to add “.py” to the end of file name. For example, enter “**vi hellopython.py**” and press “Enter”.



```
pi@raspberrypi:~ $ vi hellopython.py
```

- 4) In vi editor, press “i” key to enter “**Insert mode**”. Then input “`print('hellopython')`”. “**print()**” is the output function of Python, which can be used to output text, characters, etc.



```
print('hellopython')
```

- 5) Having input, press “Esc” key to exit “Insert mode”. Next, enter command

```
print('hellopython')
```

```
pi@raspberrypi:~ $ vi hellopython.py
pi@raspberrypi:~ $ ls
Desktop  Downloads  MagPi  Pictures  Templates
Documents hellopython.py Music  Public  Videos
pi@raspberrypi:~ $
```

It is easy to run Python program. As Python3 compiler has already been installed, you only need to enter “Python3 file name” to run Python program. For example, enter “python3 hellopython.py” command in LX terminal to run this file, and then press Enter. The result of program running will be displayed on the interface.

```
pi@raspberrypi:~ $ vi hellopython.py
pi@raspberrypi:~ $ ls
Desktop    Downloads      MagPi  Pictures  Templates
Documents  hellopython.py Music    Public    Videos
pi@raspberrypi:~ $ python3 hellopython.py
hellopython
pi@raspberrypi:~ $
```


Section 4 C++ under Raspberry Pi environment

1. C++ description

C++ is a programming language developed on the basis of C language. It is adept at Object Oriented Programming as well as Procedural Programming.

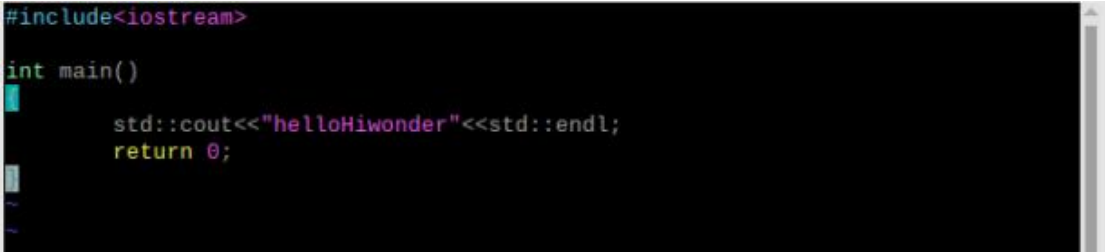
2. Write simple C++ program

- 1) Turn on Raspberry Pi and open VNC.
- 2) Press “**Ctrl+Alt+T**” or click the terminal icon at upper left corner to enter terminal interface.
- 3) Create a C++ file and please remember to add “.cpp” at the end of the file name. For example, enter “**vi helloHiwonder.cpp**” and press **Enter** to create a file.



```
pi@raspberrypi:~ $ vi helloHiwonder.cpp
```

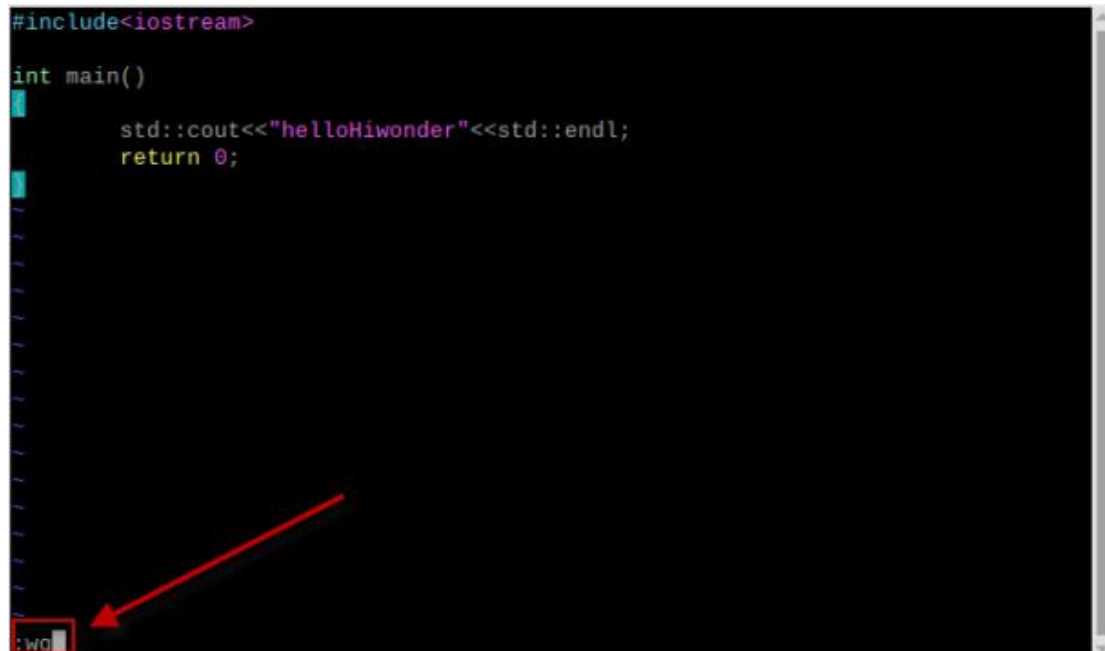
- 4) In vi editor, press “i” key to enter “Insert mode”, and then enter “**std::cout<<”helloHiwonder”<<std::endl;**” which is used to output “**helloHiwonder**” and then go to the next line.



```
#include<iostream>

int main()
{
    std::cout<<"helloHiwonder"<<std::endl;
    return 0;
}
```

- 5) Having entered, press “Esc” to exit “Insert mode”, and then input command “:wq”, and press **Enter**.



```
#include<iostream>

int main()
{
    std::cout<<"helloHiwonder"<<std::endl;
    return 0;
}
```

6) Enter “ls” command to check whether “helloHiwonder.cpp” file is created successfully or not.



```
pi@raspberrypi:~ $ vi helloHiwonder.cpp
pi@raspberrypi:~ $ ls
Desktop  Downloads  MagPi  Pictures  Templates
Documents helloHiwonder.cpp Music  Public  Videos
pi@raspberrypi:~ $
```

3. Run C++ program

As Python is interpreted language, the Python program can directly be ran by interpreter, Python3. For C++ program, it is necessary to convert the source code into executable program through compiler. Therefore, we need to install the compiling system first, convert source code, and then run the program. Next, take steps to install the compiler.

1)Enter “**sudo apt-get install build-essential**” in the terminal, and press Enter. Then the compiling system will be installed automatically. Note: The image system has been installed by default.

```
File Edit Tabs Help
pi@raspberrypi:~ $ sudo apt-get install build-essential
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.6).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

2) After confirming the compiling system is installed successfully, convert the source program into executable file. Take converting “helloHiwonder.cpp” for example. Firstly, input “g++ helloHiwonder.cpp -o helloHiwonder2” and press Enter. Please wait for the compilation to be completed, and then you will obtain a executable file named “helloHiwonder2”.

```
File Edit Tabs Help
pi@raspberrypi:~ $ sudo apt-get install build-essential
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.6).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
pi@raspberrypi:~ $ g++ helloHiwonder.cpp -o HelloHiwonder2
```

3) Enter “ls” and press Enter to check the generated file “helloHiwonder2”.

```
pi@raspberrypi:~ $ ls
Desktop  Downloads  helloHiwonder.cpp  Music  Public  Videos
Documents  helloHiwonder2  MagPi  Pictures  Templates
```

4) Input “./helloHiwonder2” and press Enter to execute this file.

```
pi@raspberrypi:~ $ ls
Desktop  Downloads  helloHiwonder.cpp  Music  Public  Videos
Documents  helloHiwonder2  MagPi  Pictures  Templates
pi@raspberrypi:~ $ ./helloHiwonder2
helloHiwonder
pi@raspberrypi:~ $
```

Expanded courses

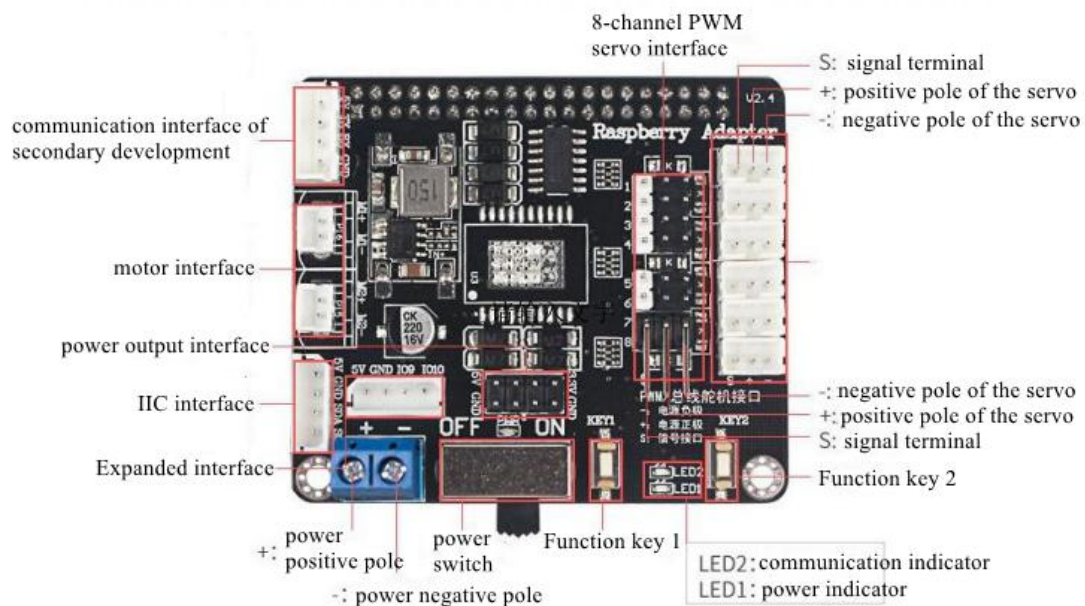
Section 1 External accessory of Raspberry Pi development

Some external accessories will be required in some Raspberry Pi development project. Some common external accessories are listed below.

1. Expansion board

Generally, in order to facilitate the connection of other sensors and actuators, expansion board is needed.

Functions of the interfaces on Hiwonder Raspberry Pi expansion board are as follow.



This expansion board involves 5 features.

- 1) Built-in 8-channel PWM servo interface with over current protection to protect the servo
- 2) Built-in single serial bus port circuit for controlling the serial servo directly

3) Two-channel programmable LED can display the working status of the system

4) IIC and UART interface are reserved for sensor expansion

Name	Function	Explanation
LED1	Display the working status	Quick flash every 2s
LED2	Display status of WIFI connection	LED will be always on by default
KEY1	Reset WiFi	Long press it until LED1 stops flashing in LAN mode.
KEY2	Shut down	Long press it for 3s or until LED1 and LED2 stop flashing, and then Raspberry Pi will shut down. After Raspberry Pi shuts down, light of LED1 and LED2 is dim. Please wait for the green LED on RaspberryPi stops flashing and goes out, and then you can cut off the power.

Note: Please remove the Raspberry Pi from the shell first, and then install the expansion board. The Raspberry Pi with the expansion board installed cannot install on the shell due to its size.

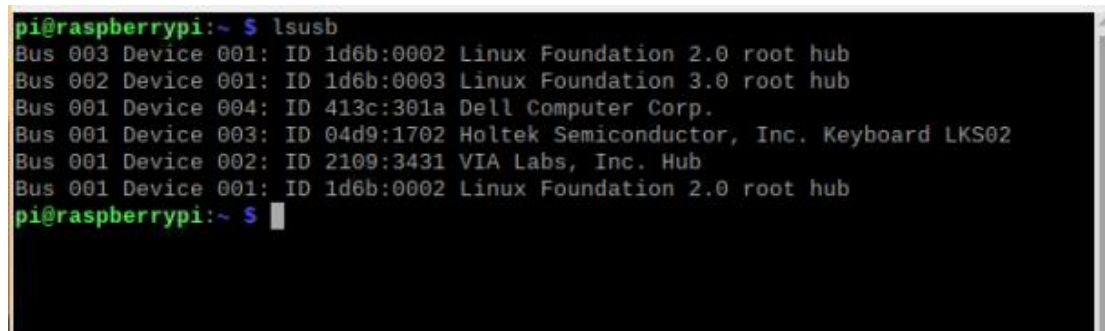
2. Camera

Camera is one of the most commonly used accessories in Raspberry Pi development. Raspberry Pi serves as “brain” and camera works as “eye”. Camera will be used in photographing, video filming and image recognition. Generally, there are two kinds of Raspberry Pi camera, including USB camera and CSI camera.

It is easy to install the camera module. Just insert the USB end of the camera cable into the USB interface of Raspberry Pi. Pay attention the camera is not hot plugging, so please insert the camera before turning on the Raspberry Pi. After the camera is connected, please check whether the camera can be recognized successfully. And visit Raspberry Pi through VNC and judge whether the camera is recognized or not in these two ways.

Method 1: test through command

1) Firstly, open LX terminal. Before inserting the camera into the Raspberry Pi, enter command “**lsusb**” to check the device connection. At this time, only the monitor, mouse and keyboard are inserted.



```
pi@raspberrypi:~ $ lsusb
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 001 Device 004: ID 413c:301a Dell Computer Corp.
Bus 001 Device 003: ID 04d9:1702 Holtek Semiconductor, Inc. Keyboard LKS02
Bus 001 Device 002: ID 2109:3431 VIA Labs, Inc. Hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
pi@raspberrypi:~ $
```

2) Shunt down the Raspberry Pi and insert the camera. Then boot up the Raspberry Pi and enter command “**lsusb**” again.


```
pi@raspberrypi:~ $ lsusb
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 001 Device 005: ID 413c:301a Dell Computer Corp.
Bus 001 Device 004: ID 04d9:1702 Holtek Semiconductor, Inc. Keyboard LKS02
Bus 001 Device 003: ID 038f:6001
Bus 001 Device 002: ID 2109:3431 VIA Labs, Inc. Hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
pi@raspberrypi:~ $
```

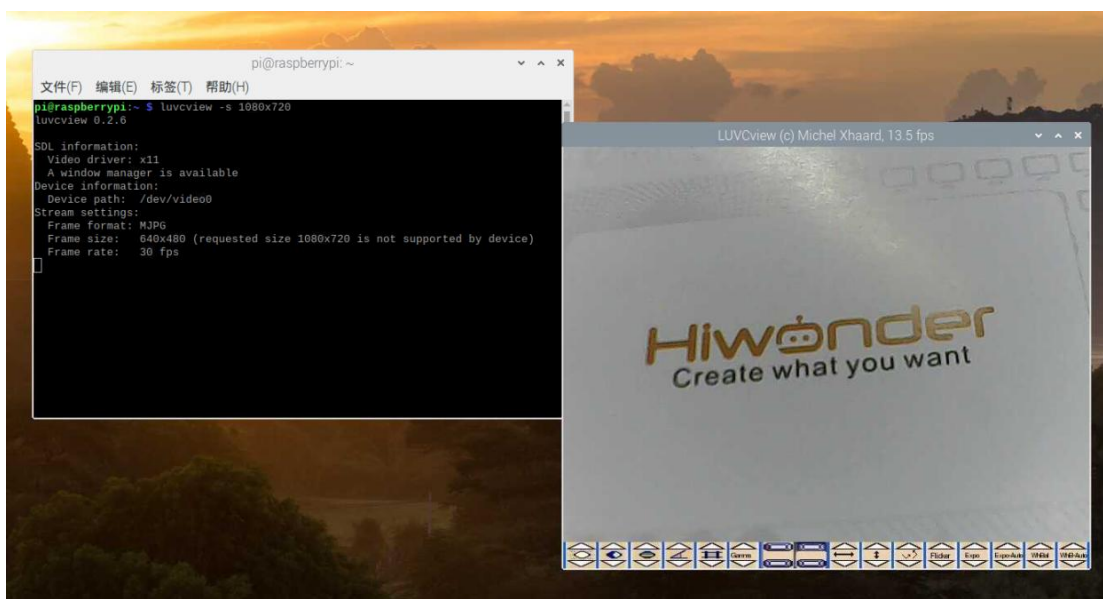
3) From the picture above, you can find that the camera is recognized successfully, and the camera ID is also displayed here.

Method 2: test with the tool

1) Turn on LX terminal, and enter command “**sudo apt-get install luvview**” to install the tool, **luvview**.

```
pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ sudo apt-get install luvview
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

2) After installation, enter “**luvview -s 1080x720**” command to test. 1080x720 is the video resolution.



3. Power

Power, serving as “heart”, plays an important role in Raspberry Pi.

There are a few kinds of ways to power Raspberry Pi 4B.

Method 1: powered by power adaptor

The specification of power adaptor of Raspberry Pi is 5V, 3A. And USB interface of computer cannot drive the power adaptor. Pay attention that insufficient current will cause lots of problem, therefore the power adaptor must be 5V, 3A.

Method 2: powered by GPIO interface

GPIO interface of Raspberry Pi can receive the input direct current. Connect positive electrode of 5V current to pin 2 and negative electrode to pin6. There is no fuse for GPIO power supply. When the voltage or current is too high, it is easy to burn Raspberry Pi directly.

Method 3: powered by Ethernet cable. Only Raspberry Pi 4B and 3B+ can be powered in this way

Raspberry Pi of version 4B and 3B+ involve POE function, and you only need to add POE Ethernet module. After the module is added, you can use the Ethernet cable to power Raspberry Pi.

Method 4: powered by expansion board

Actually, Raspberry Pi expansion board can power the Raspberry Pi. Just install the expansion board on Raspberry Pi, and then connect the lithium battery to the negative and positive electrode of expansion board.

Section 2 Field of Raspberry Pi

1. Internet of Things

Hardware plays an important role in IOT system. There are 40 pins on Raspberry Pi for development, which means that GPIO, I2C, SPI, PWM, UART, etc., can be used to realize Internet of Things.

Raspberry Pi works as mini computer controller, hence it serves as network storage or mini WebServer. Raspberry Pi is not only cheaper and smaller than computer, but also offers great development source and platform to ARM embedded interface driver development, system tailoring, porting, and upper-level applications. Systems including Debian, Win10 IoT, Android, as well as GPIO, Python libraries, etc., are treasure for developers and makers. What's more, Wi-Fi modules, Bluetooth modules, sensor modules and motor control module can be connected to the open pins. Powerful kernel, sensors and network connection can realize a variety of IoT development platforms. Raspberry Pi can be used as a data concentrator to collect surrounding sensor signals and connect to the cloud to achieve IoT applications, such as automatic air conditioning temperature and humidity adjustment, automatic irrigation, smart meters, smart home management, etc. Now there are many geeks who have developed a variety of Raspberry Pi games, and even automatic drone control.

As a development platform and ecosystem, Raspberry Pi has great potential in the development of IoT.

2. Artificial Intelligence

Artificial intelligence, AI, has been the craze in recent years, which includes voice recognition, image recognition, machine learning, etc. Maybe you have experienced other robots, but Raspberry Pi is fundamentally different from the controller of other robot. As Raspberry Pi has a complete operating system and supports Python programming, you can use Python language on Raspberry Pi development software to control the sensors of the robot. What's

more, as it is a microcomputer, it can run algorithms related to AI, such as running SVM, which can easily classify data.

Section 3 Raspberry Pi product

1. Image recognition

1.1 SpiderPi Smart vision hexapod robot

Loaded with 2DOF pan-tilt and HD camera, SpiderPi can survey the surroundings in real-time, and transmit the image data to phone and PC. Equipped with ultrasonic sensor, tilt sensor and voltage display module, it can realize self-balancing, quick turning, color recognition, color tracking, ultrasonic obstacle avoidance, line following, etc.



1.2 TonyPi AI smart vision humanoid robot

TonyPi is loaded with 2 DOF pan-tilt and HD camera and support Python programming. It also supports AI image recognition which can realize color recognition, vision auto shooting, line following and other games. Besides, it is equipped with high voltage serial bus servo and voltage display enabling you

to check the battery level of the robot. And it is equipped with lipo battery of large capacity for longer working time. TonyPi can execute the built-in action groups, such as do push-up.



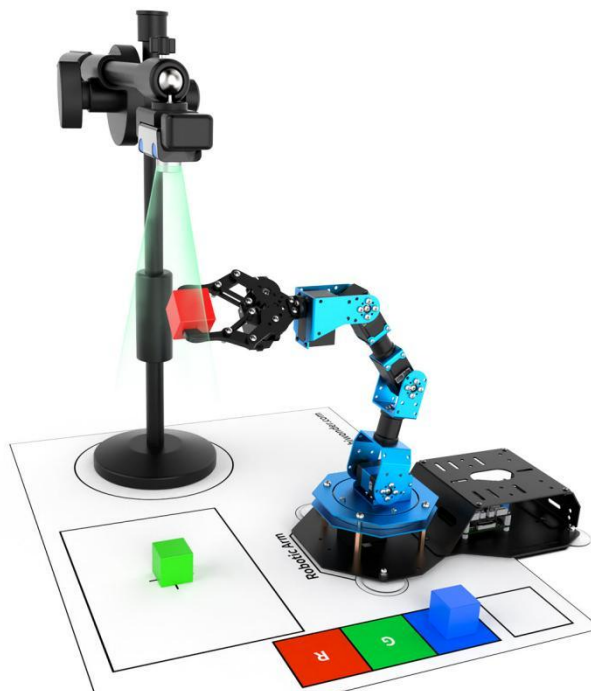
1.3 AlienPi intelligent vision quadruped robot

AlienPi is a combination of intelligent vision and intelligent games. It not only can realize multiple recognition function, such as QR code, gesture, color recognition, but also can perform line following, remote monitoring, image transmitting.



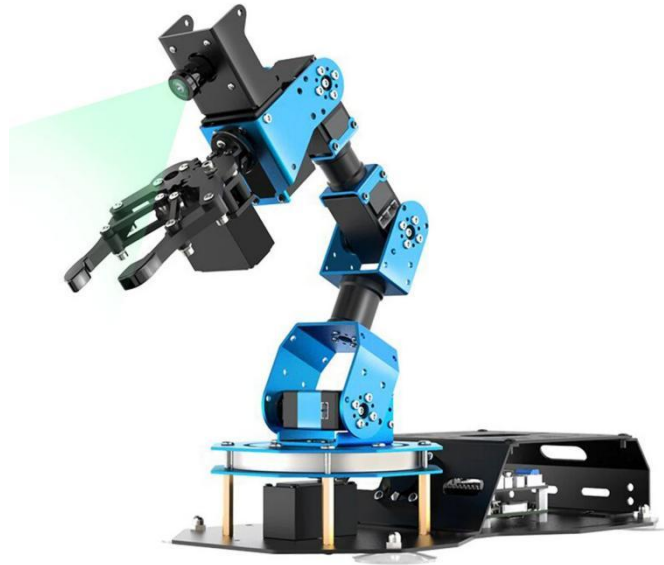
1.4 ArmPi smart vision robotic arm

With OpenCV as its core, equipped with inverse kinematics, computer vision and Python programming, ArmPi can realize image recognition, remote control, transmit camera image, color sorting, tracking, picking, block stacking and other creative games.



1.5 ArmPi FPV smart vision robotic arm

Processed images with OpenCV, loaded HD 120 degrees camera, ArmPi FPV has ROS operation system, built-in MoveIt and supports Python program. AI vision games such as facial recognition, goods picking, etc., and open source are provided for your learning.

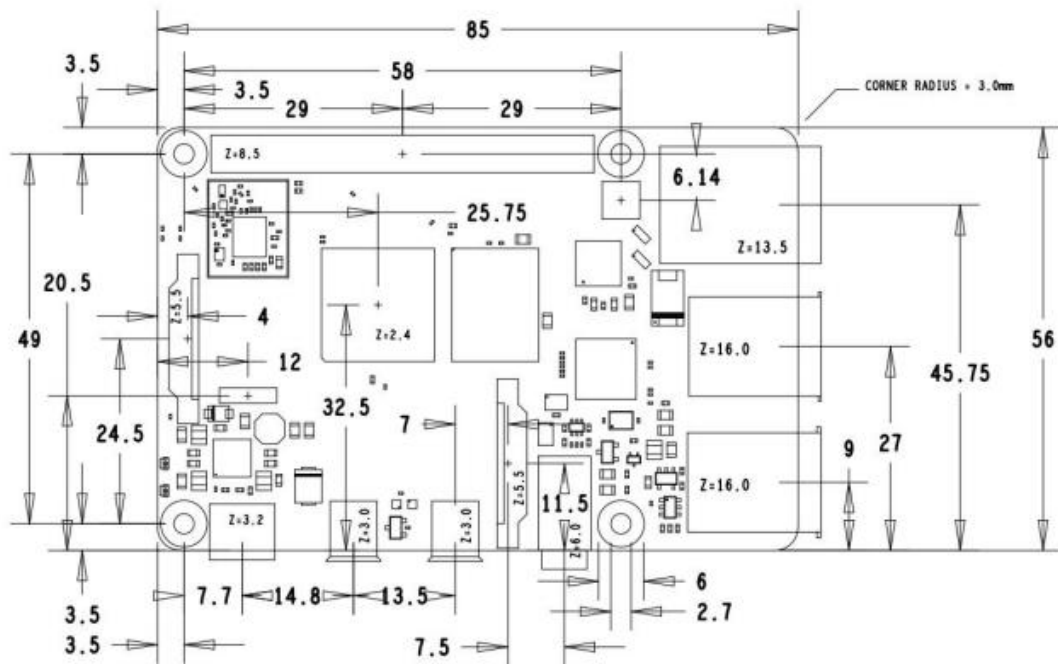


Section 4 Appendix and Q & A

1. Raspberry Pi 4B pin and code

wiringPi Code	BCM code	Function name	Physical pin BOARD code		Function name	BCM code	wiring Pi code
		3.3V	1	2	5V		
8	2	SDA. 1	3	4	5V		
9	3	SCL. 1	5	6	G N D		
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	G N D		
3	22	GPIO. 3	15	16	GPIO. 4	23	4
		3.3V	17	18	GPIO. 5	24	5
12	10	MOSI	19	20	G N D		
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	G N D		
22	6	GPIO. 22	31	32	GPIO. 2 6	12	26
23	13	GPIO. 23	33	34	G N D		
24	19	GPIO. 24	35	36	GPIO. 2 7	16	27
25	26	GPIO. 25	37	38	GPIO. 2 8	20	28
		GND	39	40	GPIO. 2 9	21	29

2. Raspberry Pi 4B dimension



3. Pin mapping table of Raspberry Pi expansion board

Expansion board interface	RaspberryPi Pin	Expansion board interface	RaspberryPi Pin	Expansion board interface	RaspberryPi Pin
Servo1	GPIO12	Servo5	GPIO19	LED1	GPIO24
Servo2	GPIO16	Servo6	GPIO13	LED2	GPIO23
Servo3	GPIO20	Servo7	GPIO5	KEY1	GPIO25
Servo4	GPIO21	Servo8	GPIO6	KEY2	GPIO22

4. Camera parameter

Model	hv3808
Product name	usb camera

Sensor type	CMOS
Sensor pixel	30,0000 pixel
Maximum resolution	640x480
Frame rate	30fps@YUV
Response rate	3.3V/LUX-SEC
Dynamic range	69dB
Signal noise ratio	39dB
Minimum illuminance	0.1LUX (colorful)
Working temperature	-20℃ ~ +75℃
Relative temperature	5 ~ 95%RH
Storage temperature	-30℃ ~ +80℃
Board diameter	28mm
Interface	USB2.0
Focus	Manual focusing
Picture format	MJPEG,YUV
Drive	No need for driving
Protocol	Support UAC1.0 and UVC1.1/1.5
Additional function	Built-in microphone

FAQ

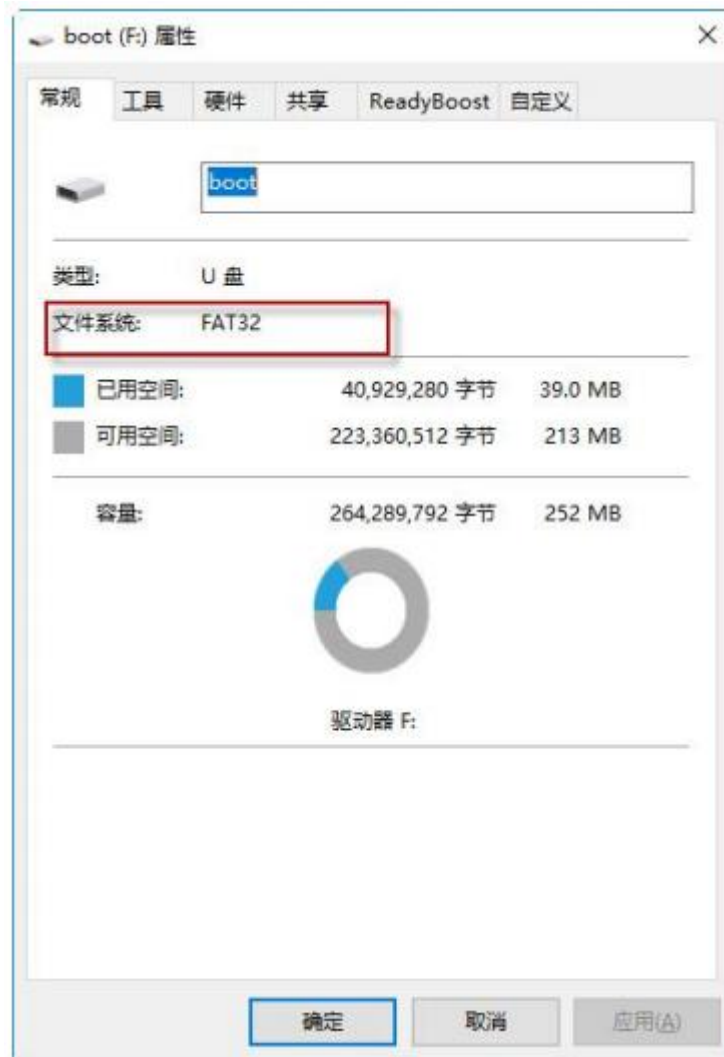
Q1: Why the inserted monitor, mouse and keyboard cannot boot up after the Raspberry Pi boots up?

A1: Monitor, mouse, and keyboard are not warm booting when computer is powered on. They need to be inserted in cold booting, while U disk and card reader are warm booting.

Q2: The original storage of my SD card is 8G, but why the storage shrink to

tens or hundreds of MB after burning?

A2: This is a normal phenomenon. SD card with burned Raspberry Pi system is divided into two partitions, including a FAT32 Boot partition and a or some Ext4 Linux primary partition. As Windows can only recognize FAT32 partition, this situation appears.



Q3: After the Raspberry Pi boots up, there are some warning signs on the monitor and what are they?

A3: Different signs have different meanings.

(1) Colored block/ lightning sign

This sign appears for the reason that power supply is insufficient. And insufficient power supply is caused by the following situation.

- A. The power supply does not meet the required standard, 5V 3A.
- B. The quality of the USB cable used is poor
- C. Power supply through GPIO interface causes unstable power and crash
- D. There are too much sensors loaded on GPIO interface.

(2) Yellow block/ thermometer sign

This sign indicates there is something wrong in heat dissipation. Heat dissipation problem will influence service life of Raspberry Pi, or even burn out it. Therefore you need to install cooling fan or heat sink.

Q4: Why some characters cannot be typed or get typed wrongly on Raspberry Pi system?

A4: Because American keyboard, **US**, isn't selected and the default keyboard is British keyboard, **GB**, in system initialization settings.

Solution:

- (1) Turn on Raspberry Pi, and click the Raspberry Pi icon at upper left corner. Then select "keyboard and mouse" in drop-down menu.



2) Click keyboard layout to enter the keyboard settings interface.



3) Please select the option according to the picture below.



4) Click “OK” and exit. Then reboot Raspberry Pi, and the settings will take effect.

Q5: why black screen occurs after connecting to VNC?

A5: It is normal that black screen occurs after VNC connection. The black screen will last for 5s. If it last more than 5s, you deal with this problem in these ways.

- 1) Reboot. Most of black screen can be tackled through rebooting.
- 2) If the problem still isn't solved after several reboot, there maybe something wrong in Raspberry Pi or memory card. You can remove the memory card, and use clean tissue to wipe it. After that, reinsert the memory card. If the Raspberry Pi cannot boot up, please download the image again.

Q6: Why can't I connect to SSH/VNC remotely according to the tutorial?

A6: You can take below steps to figure out the problem.

- 1) Check whether Raspberry Pi connects to the network successfully.
- 2) Whether the IP, user name and password are entered correctly in SSH/VNC interface. Whether the port number is modified or not. The default port number is 22.
- 3) Whether the SSH/VNC service is turned on in Raspberry Pi. If you are prompted with "connection refused" in SSH, it means that SSH service is not turned on. Generally, it is because the file name is with suffix, and you can use **"Windows PowerShell"** to create file. And enter this command **"new-item ssh -type file"** to create file.

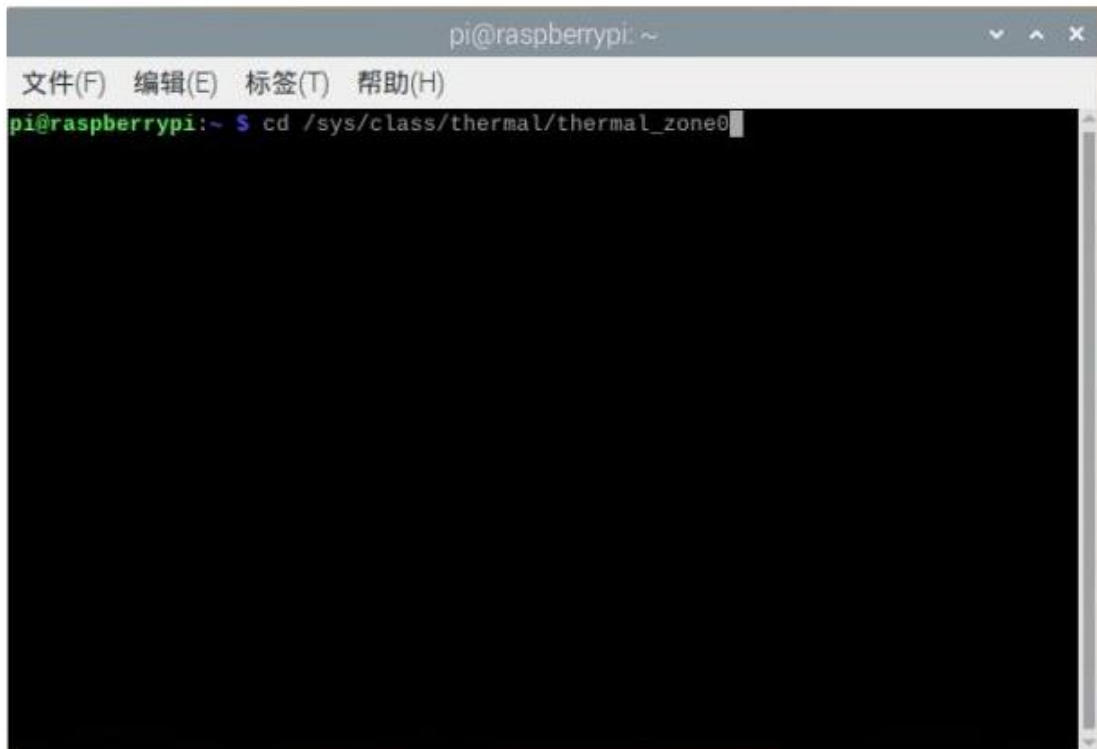
Q7: Can Raspberry Pi increase memory?

A7: No, it can't. Memory is PoP package installed on CPU/GPU and cannot be removed. Although the internal memory cannot be expanded, the external RAM can be expanded by adding an external RAM chip.

Q8: What's the normal temperature range when Raspberry Pi is working, and how to check the current temperature of Raspberry Pi?

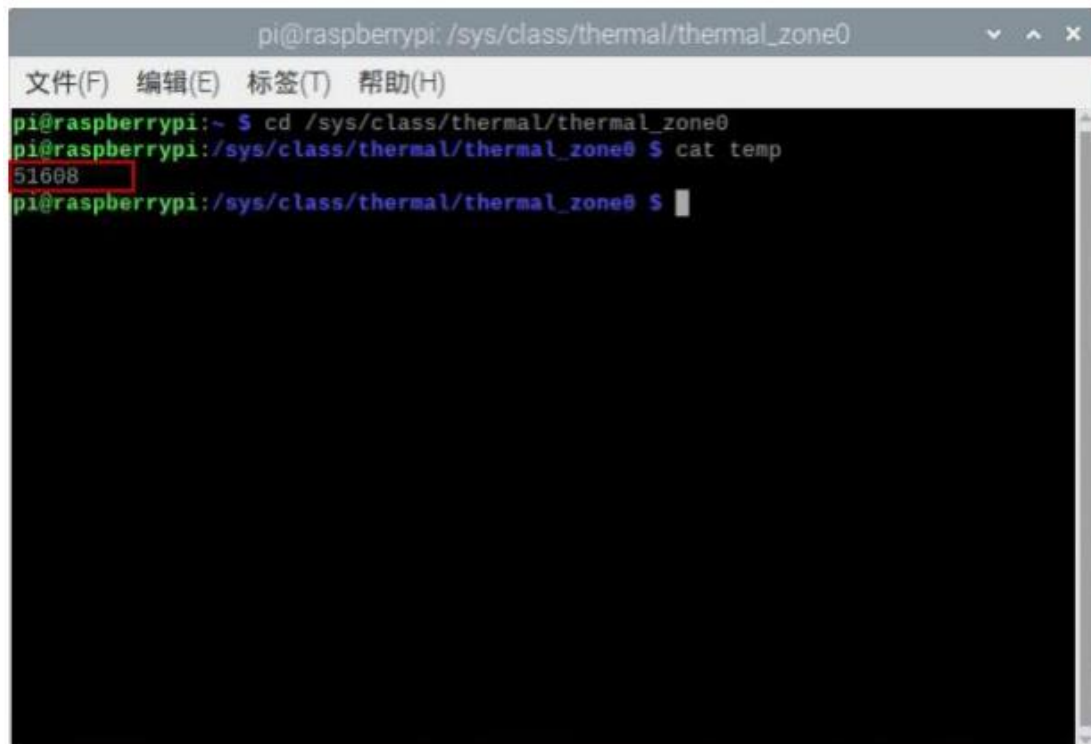
A8: The chips used in Raspberry Pi are all commercial grade. The temperature of the chips under different situation is different. In general indoor environment or outdoor environment not lower than 0℃, temperature of LAN and USB chip LAN9512 ranges from 0 to 70℃, and core chip is -40-85℃. You can check the temperature of Raspberry Pi through command line.

- 1) Open LX terminal, and enter command “cd /sys/class/thermal/thermal_zone0” to enter the operating directory.



```
pi@raspberrypi:~ $ cd /sys/class/thermal/thermal_zone0
```

- 2) Enter “cat temp” command to check the returned value of Raspberry Pi.



```
pi@raspberrypi:/sys/class/thermal/thermal_zone0 $ cat temp
51608
pi@raspberrypi:/sys/class/thermal/thermal_zone0 $
```

3) The returned value, 51608, divided by 1000 is the current temperature of CPU, so the current temperature is 51°C.