

Welcome

Thank you for choosing Freenove products!

About Battery

First, read the document [About_Battery.pdf](#) in the unzipped folder.

If you did not download the zip file, please download it and unzip it via link below.

https://github.com/Freenove/Freenove_4WD_Smart_Car_Kit_for_Raspberry_Pi/archive/master.zip

Get Support and Offer Input

Freenove provides free and responsive product and technical support, including but not limited to:

- Product quality issues
- Product use and build issues
- Questions regarding the technology employed in our products for learning and education
- Your input and opinions are always welcome
- We also encourage your ideas and suggestions for new products and product improvements

For any of the above, you may send us an email to:

support@freenove.com

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Please follow the following safety precautions when using or storing this product:

- Keep this product out of the reach of children under 6 years old.
- This product should be used only when there is adult supervision present as young children lack necessary judgment regarding safety and the consequences of product misuse.
- This product contains small parts and parts, which are sharp. This product contains electrically conductive parts. Use caution with electrically conductive parts near or around power supplies, batteries and powered (live) circuits.
- When the product is turned ON, activated or tested, some parts will move or rotate. To avoid injuries to hands and fingers, keep them away from any moving parts!
- It is possible that an improperly connected or shorted circuit may cause overheating. Should this happen, immediately disconnect the power supply or remove the batteries and do not touch anything until it cools down! When everything is safe and cool, review the product tutorial to identify the cause.
- Only operate the product in accordance with the instructions and guidelines of this tutorial, otherwise parts may be damaged or you could be injured.
- Store the product in a cool dry place and avoid exposing the product to direct sunlight.
- After use, always turn the power OFF and remove or unplug the batteries before storing.

About Freenove

Freenove provides open source electronic products and services worldwide.

Freenove is committed to assist customers in their education of robotics, programming and electronic circuits so that they may transform their creative ideas into prototypes and new and innovative products. To this end, our services include but are not limited to:

- Educational and Entertaining Project Kits for Robots, Smart Cars and Drones
- Educational Kits to Learn Robotic Software Systems for Arduino, Raspberry Pi and micro:bit
- Electronic Component Assortments, Electronic Modules and Specialized Tools
- **Product Development and Customization Services**

You can find more about Freenove and get our latest news and updates through our website:

<http://www.freenove.com>

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Raspberry Pi® is a trademark of Raspberry Pi Foundation (<https://www.raspberrypi.org/>).

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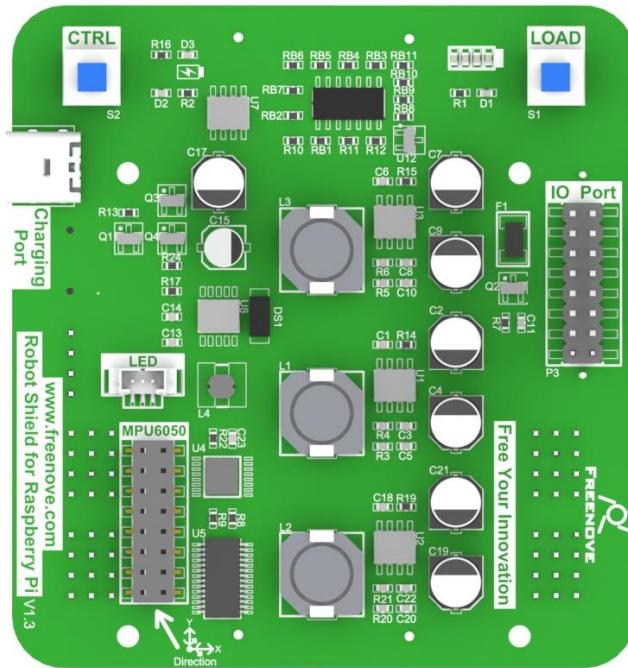
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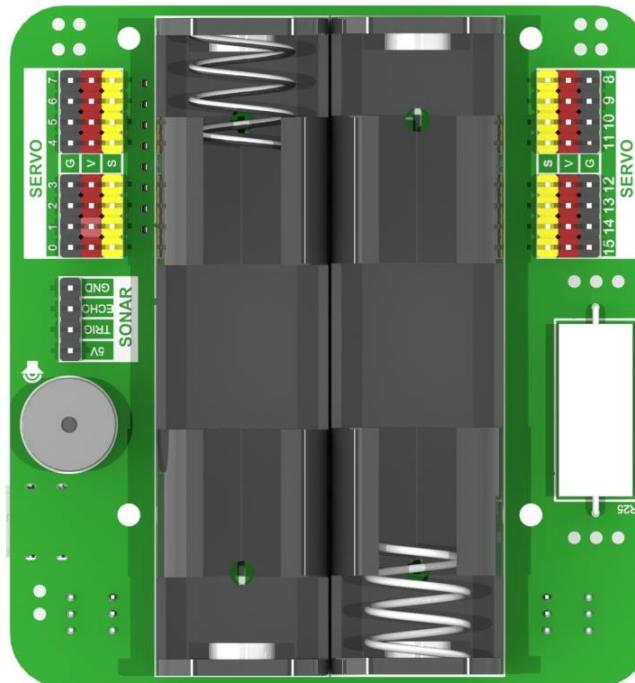
If you have any concerns, please feel free to contact us at support@freenove.com

Robot Shield for Raspberry Pi

Top



Bottom

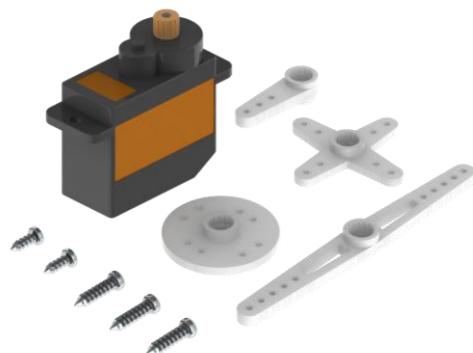


Machinery Parts

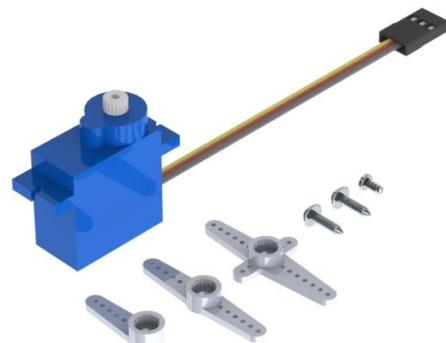
M2.5*14+6 Copper Standoff  x5 Freenove	M2.5*14 Copper Standoff  x5 Freenove	M2.5*8 Screw  x10 Freenove
M2*14 Screw  x32 Freenove	M3*12 Screw  x22 Freenove	M1.2*7 Self-tapping Screw  x60 Freenove
M2 Nut  x32 Freenove	M3 Nut  x22 Freenove	M1.4*4 Self-tapping Screw  x12 Freenove

Transmission Parts

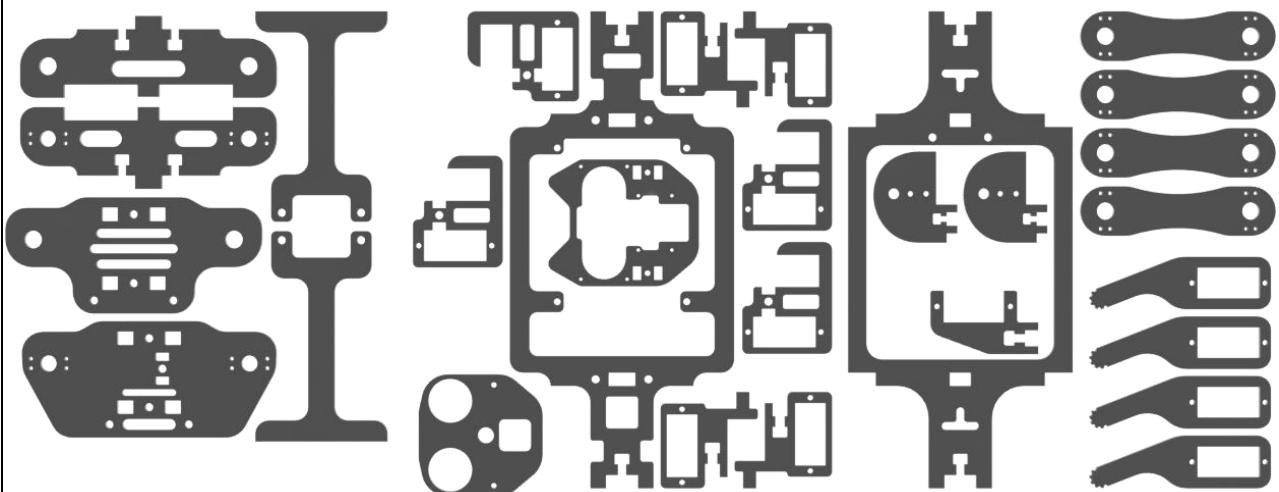
ES08MA II servo package x12



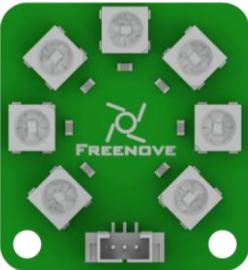
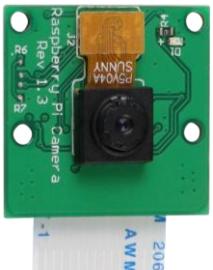
S90 servo package x1



Acrylic Parts



Electronic Parts

LED module	Camera	HC-SR04 ultrasonic module	Connector
			
Jumper wire F/F(4) for ultrasonic module			
10cm 3Pin LED cable (same direction)			
25cm 15Pin camera cable (reversed direction)			

Tools

Cross screwdriver (3mm) x1 Cross screwdriver (2mm) x1	Cable tidy x80cm	Red ball
		

Self-prepared Parts

Two 18650 lithium batteries without protection board.

The continuous discharge current >3A

It is not easy to find proper battery on Amazon. **Search 18650 3.7V high drain on eBay** or other websites.



Raspberry Pi (Recommended model: Raspberry 4B / 3B+/ 3A+ /3B) x1



Preface

Welcome to use Freenove 4WD Smart Car Kit for Raspberry Pi. Following this tutorial, you can make a very cool smart car with many functions.

This kit is based on Pi Raspberry, a popular control panel, so you can share and exchange your experience and design ideas with many enthusiasts all over the world. The parts in this kit include all electronic components, modules, and mechanical components required for making the smart car. And all of them are packaged individually. There are detailed assembly and commissioning instructions in this book.

And if you encounter any problems, please feel free to contact us for fast and free technical support.

support@freenove.com

The contents in this book can help enthusiasts with little technical knowledge to make a smart car. If you are very interested in Raspberry Pi, and want to learn how to program and build the circuit, please visit our website www.freenove.com or contact us to buy the kits designed for beginners:

Freenove Basic\LCD1602\Super\Ultrasonic\RFID\Ultimate Starter Kit for Raspberry Pi

Raspberry Pi Introduction

Raspberry Pi (called RPi, RPI, RasPi, the text these words will be used alternately later), a micro-computer with size of a card, quickly swept the world since its debut. It is widely used in desktop workstation, media center, smart home, robots, and even the servers, etc. It can do almost anything, which continues to attract fans to explore it. Raspberry Pi used to be running with Linux system and along with the release of windows 10 IoT. We can also run it with Windows. Raspberry Pi (with interfaces USB, network, HDMI, camera, audio, display and GPIO), as a microcomputer, can be running in command line mode and desktop system mode. Additionally, it is easy to operate just like Arduino, and you can even directly operate the GPIO of CPU.

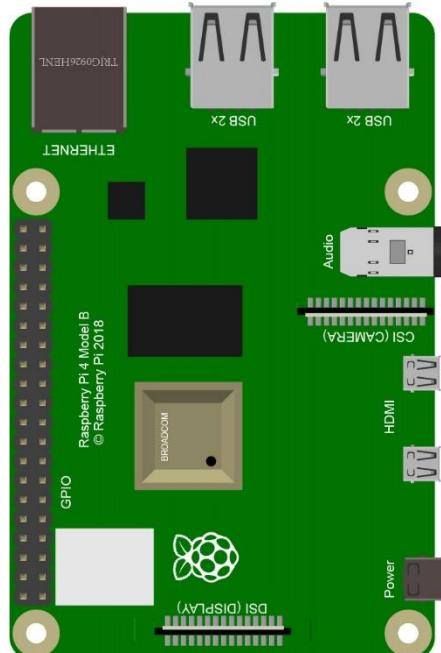
So far, Raspberry Pi has developed to the fourth generation. Changes in versions are accompanied by increase and upgrades in hardware. A type and B type, the first generation of products, have been stopped due to various reasons. Other versions are popular and active and the most important is that they are consistent in the order and number of pins, which makes the compatibility of peripheral devices greatly enhanced between different versions.

Below are the raspberry pi pictures and model pictures supported by this product.

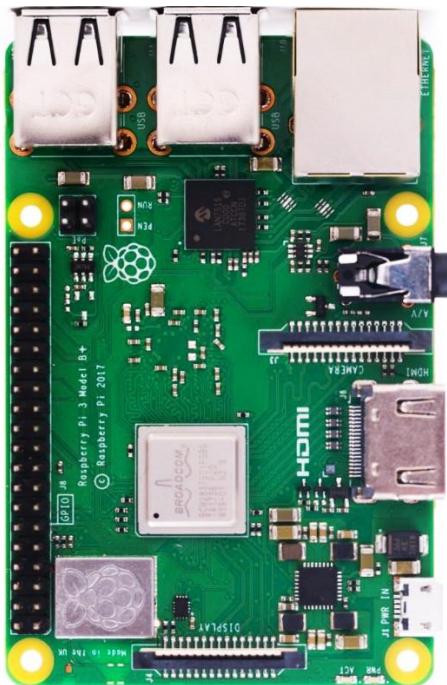
Practicality picture of Raspberry Pi 4 Model B:



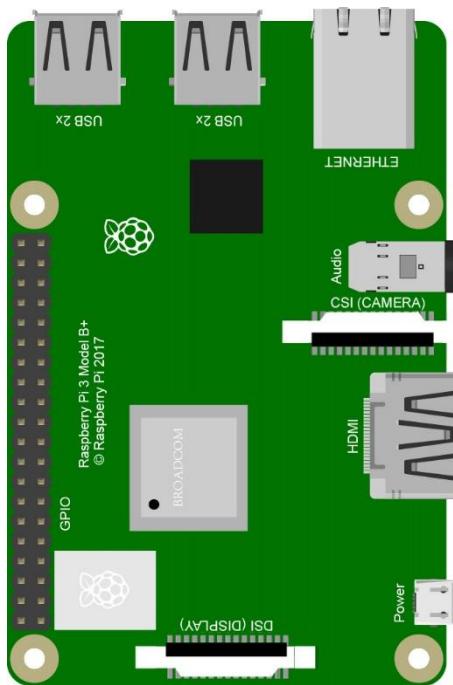
Model diagram of Raspberry Pi 4 Model B:



Practicality picture of Raspberry Pi 3 Model B+ :



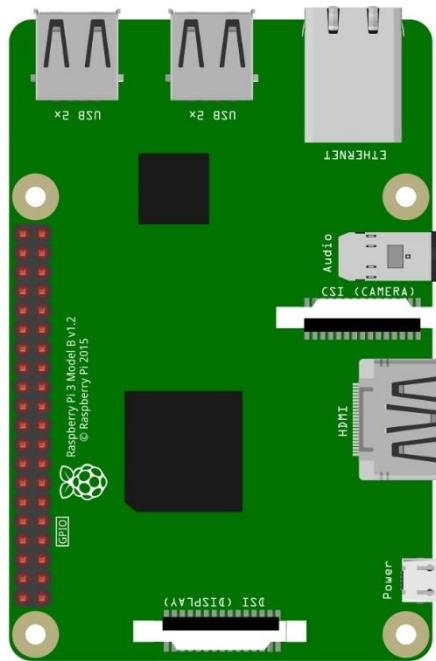
Model diagram of Raspberry Pi 3 Model B+ :



Practicality picture of Raspberry Pi 3 Model B:



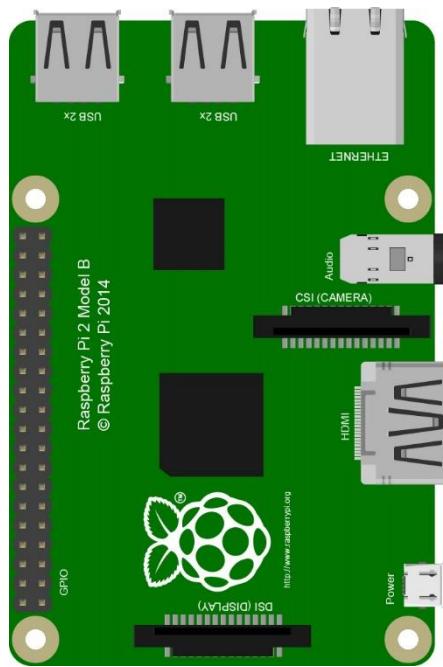
Model diagram of Raspberry Pi 3 Model B:



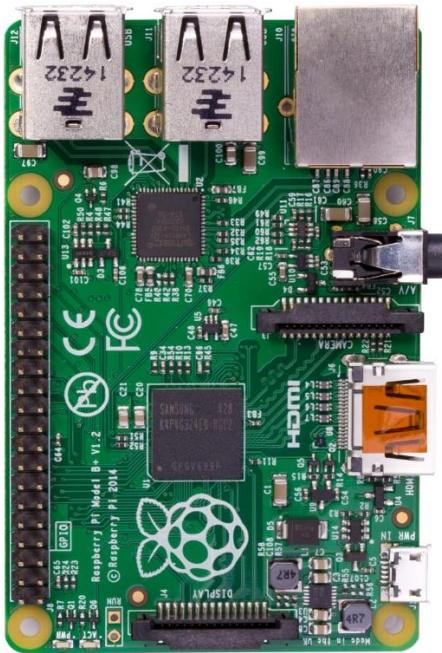
Practicality picture of Raspberry Pi 2 Model B:



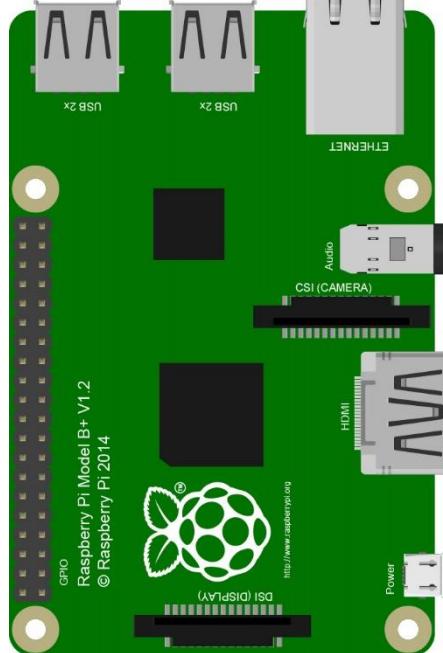
Model diagram of Raspberry Pi 2 Model B:



Practicality picture of Raspberry Pi 1 Model B+:



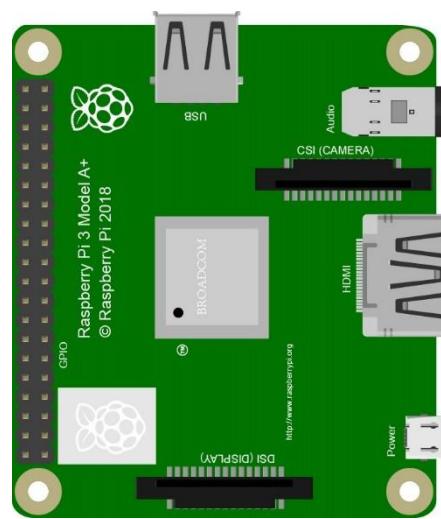
Model diagram of Raspberry Pi 1 Model B+:



Practicality picture of Raspberry Pi 3 Model A+:



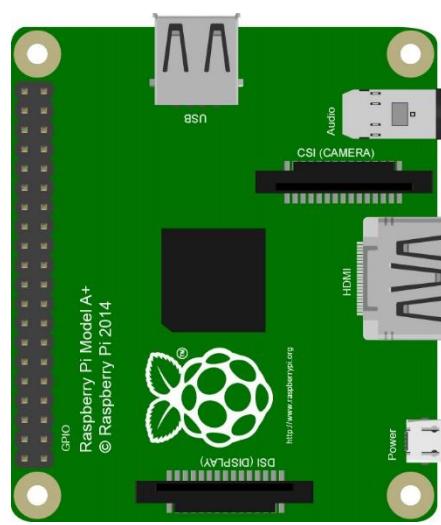
Model diagram of Raspberry Pi 3 Model A+:



Practicality picture of Raspberry Pi 1 Model A+:



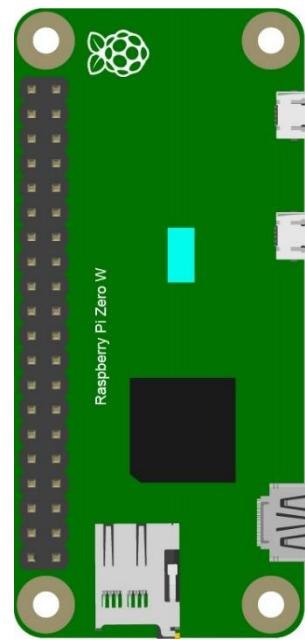
Model diagram of Raspberry Pi 1 Model A+:



Practicality picture of Raspberry Pi Zero W:



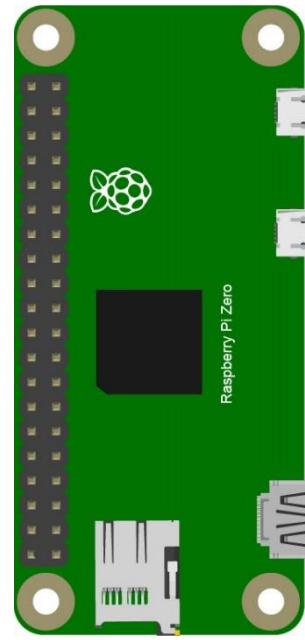
Model diagram of Raspberry Pi Zero W:



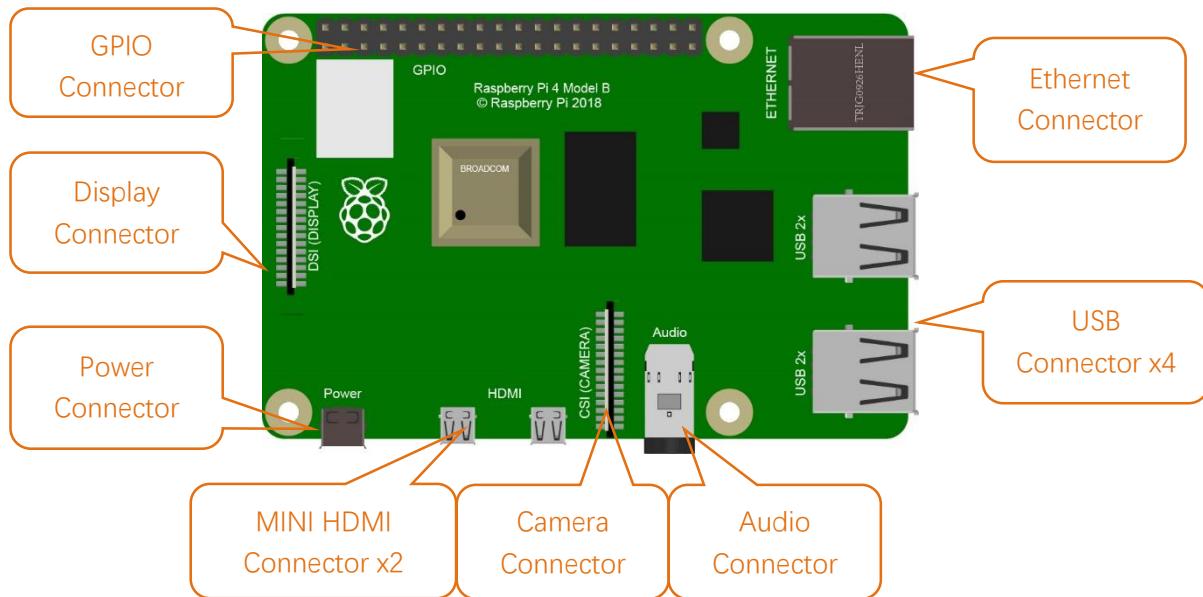
Practicality picture of Raspberry Pi Zero:



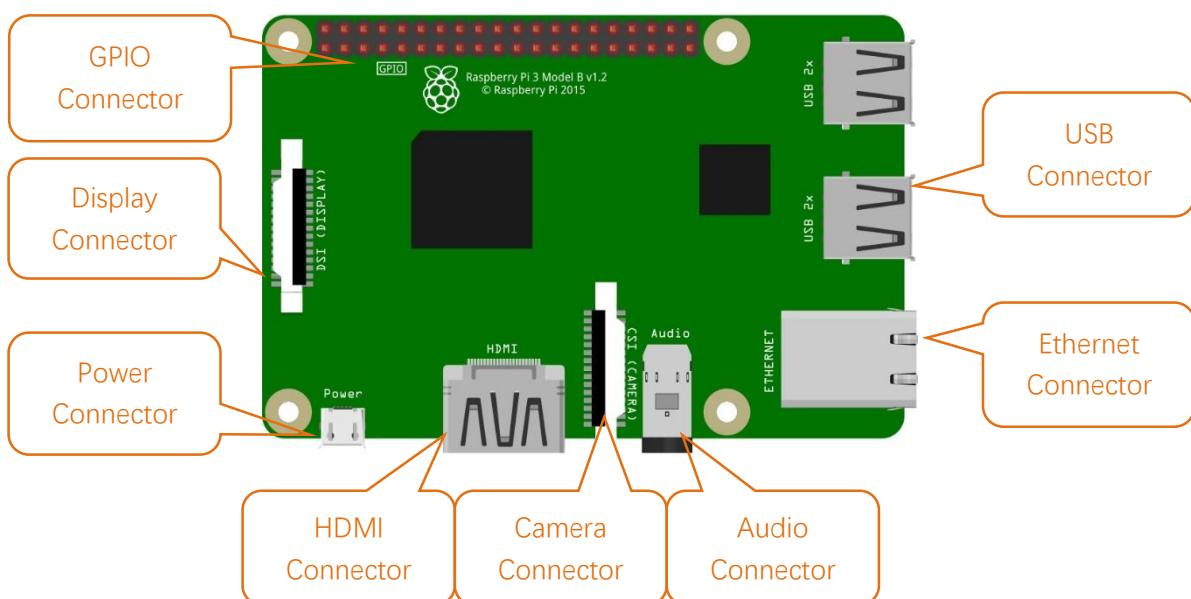
Model diagram of Raspberry Pi Zero:



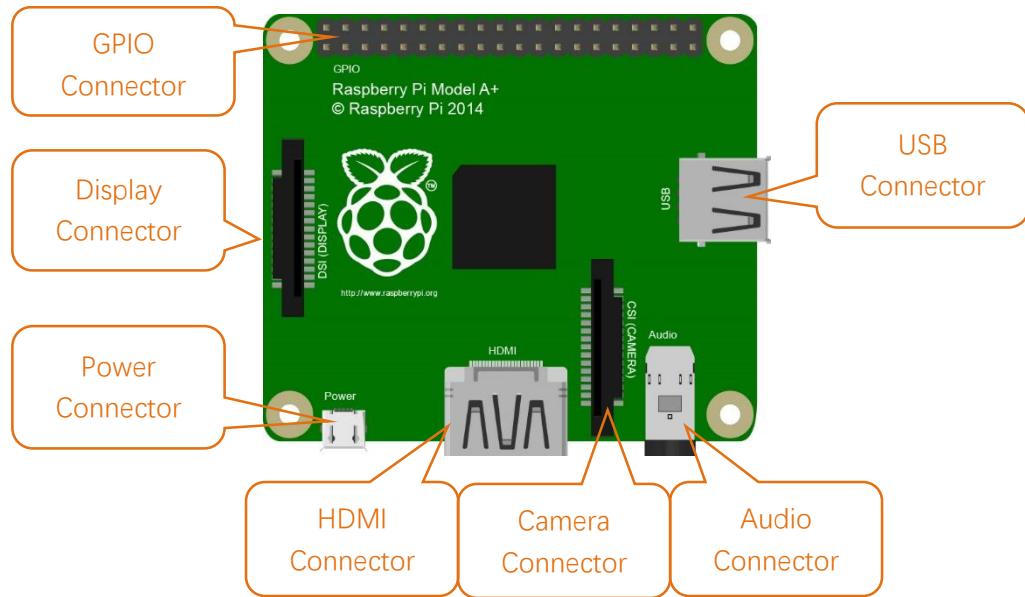
Hardware interface diagram of RPi 4B is shown below:



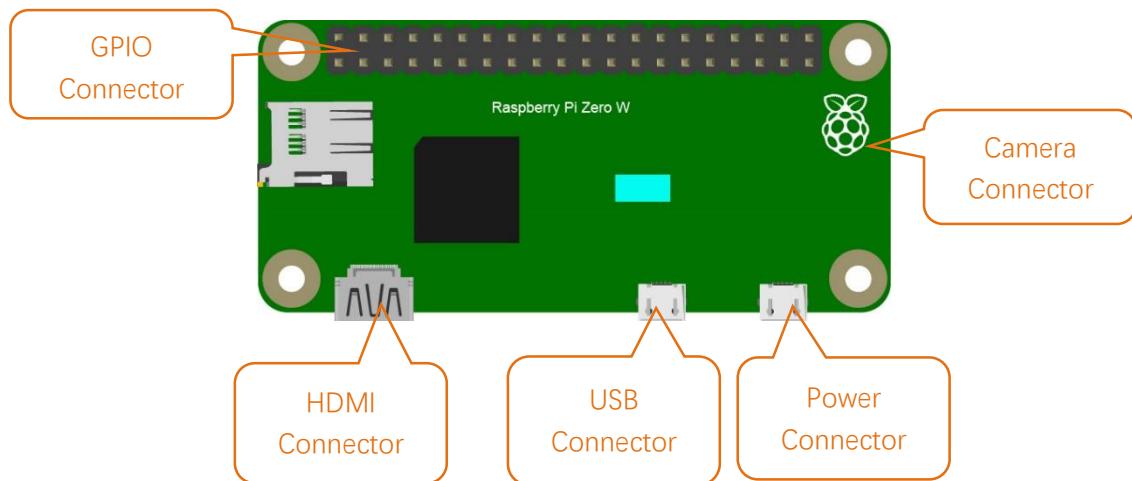
Hardware interface diagram of RPi 3B+/3B/2B/1B+ are shown below:



Hardware interface diagram of RPi 3A+/A+ is shown below:



Hardware interface diagram of RPi Zero/Zero W is shown below:



GPIO

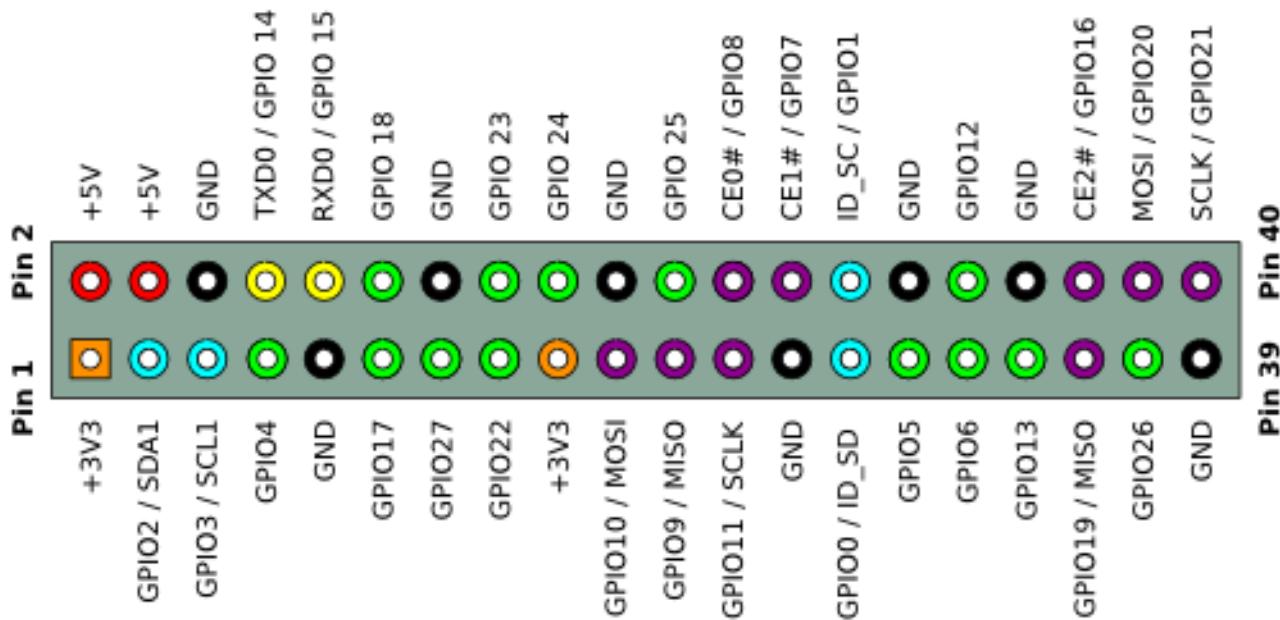
GPIO: General purpose input/output. We will introduce the specific feature of the pins on the Raspberry Pi and what you can do with them. You can use them for all sorts of purposes. Most of them can be used as either inputs or outputs, depending on your program.

When programming the GPIO pins there are 3 different ways to refer to them: GPIO numbering, physical numbering, WiringPi GPIO Numbering.

BCM GPIO Numbering

Raspberry Pi CPU use BCM2835/BCM2836/BCM2837of Broadcom. GPIO pin number is set by chip manufacturer. These are the GPIO pins as that computer recognizes. The numbers are unordered and don't make any sense to humans. You will need a printed reference or a reference board that fits over the pins.

Each pin is defined as below:



For more details about pin definition of GPIO, please refer to <http://pinout.xyz/>

PHYSICAL Numbering

Another way to refer to the pins is by simply counting across and down from pin 1 at the top left (nearest to the SD card). This is 'physical numbering', as shown below:



WiringPi GPIO Numbering

Different from the previous mentioned two kinds of GPIO serial numbers, RPi GPIO serial number of the WiringPi was renumbered. Here we have three kinds of GPIO number mode: based on the number of BCM chip, based on the physical sequence number and based on wiringPi. The correspondence between these three GPIO numbers is shown below:

wiringPi Pin	BCM GPIO	Name	Header	Name	BCM GPIO	wiringPi Pin	
—	—	3.3v	1 2	5v	—	—	For A+, B+, 2B, 3B, 3B+, 4B, Zero
8	R1:0/R2:2	SDA	3 4	5v	—	—	For Pi B
9	R1:1/R2:3	SCL	5 6	0v	—	—	
7	4	GPIO7	7 8	TxD	14	15	
—	—	0v	9 10	RxD	15	16	
0	17	GPIO0	11 12	GPIO1	18	1	
2	R1:21/R2:27	GPIO2	13 14	0v	—	—	
3	22	GPIO3	15 16	GPIO4	23	4	
—	—	3.3v	17 18	GPIO5	24	5	
12	10	MOSI	19 20	0v	—	—	
13	9	MISO	21 22	GPIO6	25	6	
14	11	SCLK	23 24	CE0	8	10	
—	—	0v	25 26	CE1	7	11	
30	0	SDA.0	27 28	SCL.0	1	31	
21	5	GPIO.21	29 30	0V			
22	6	GPIO.22	31 32	GPIO.26	12	26	
23	13	GPIO.23	33 34	0V			
24	19	GPIO.24	35 36	GPIO.27	16	27	
25	26	GPIO.25	37 38	GPIO.28	20	28	
		0V	39 40	GPIO.29	21	29	

(For more details, please refer to <https://projects.drogon.net/raspberry-pi/wiringpi/pins/>)

You can also use the following command to view their correspondence.

```
gpio readall
```

Pi 3 Model B GPIO Pinout												
BCM	wPi	Name	Mode	V	Physical	V	Mode	Name	wPi	BCM		
		3.3v			1 2			5v				
2	8	SDA.1	ALT0	1	3 4			5V				
3	9	SCL.1	ALT0	1	5 6			0v				
4	7	GPIO. 7	IN	1	7 8	1	ALT5	TxD	15	14		
		0v			9 10	1	ALT5	RxD	16	15		
17	0	GPIO. 0	IN	0	11 12	0	IN	GPIO. 1	1	18		
27	2	GPIO. 2	IN	0	13 14			0v				
22	3	GPIO. 3	IN	0	15 16	0	IN	GPIO. 4	4	23		
		3.3v			17 18	0	IN	GPIO. 5	5	24		
10	12	MOSI	ALT0	0	19 20			0v				
9	13	MISO	ALT0	0	21 22	0	IN	GPIO. 6	6	25		
11	14	SCLK	ALT0	0	23 24	1	OUT	CE0	10	8		
		0v			25 26	1	OUT	CE1	11	7		
0	30	SDA.0	IN	1	27 28	1	IN	SCL.0	31	1		
5	21	GPIO.21	IN	1	29 30			0v				
6	22	GPIO.22	IN	1	31 32	0	IN	GPIO.26	26	12		
13	23	GPIO.23	IN	0	33 34			0v				
19	24	GPIO.24	IN	0	35 36	0	IN	GPIO.27	27	16		
26	25	GPIO.25	IN	0	37 38	0	IN	GPIO.28	28	20		
		0v			39 40	0	IN	GPIO.29	29	21		

For more details about wiringPi, please refer to <http://wiringpi.com/>.

Chapter 0 Raspberry Pi Preparation

Install a System

Firstly, install a system for your RPi.

Component List

Required Components

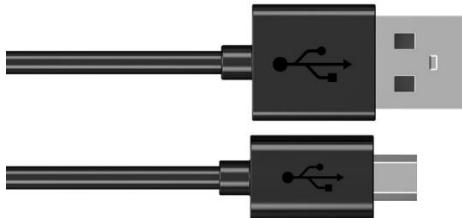
Raspberry Pi 4B / 3B+/ 3B / 3A+ (Recommended)



5V/3A Power Adapter. Different versions of Raspberry Pi have different power requirements.



Micro USB Cable x1



Micro SD Card (TF Card) x1, Card Reader x1



This robot also supports the following versions of the Raspberry Pi, but **additional accessories** need to be prepared by yourself.

Raspberry	Additional accessories
Raspberry Pi Zero W	Camera cable(>25cm) for zero w, 15 Pin 1.0mm Pitch to 22 Pin 0.5mm https://www.amazon.com/dp/B076Q595HJ/
Raspberry Pi Zero 1.3	wireless network adapter, Camera cable(>25cm) for zero w, 15 Pin 1.0mm Pitch to 22 Pin 0.5mm, OTG cable (USB Type micro B to USB Type A)
Raspberry Pi 2 Model B	wireless network adapter
Raspberry Pi 1 Model A+	wireless network adapter
Raspberry Pi 1 Model B+	wireless network adapter

Power requirement of different versions of Raspberry Pi is shown in following table:

Product	Recommended PSU current capacity	Maximum total USB peripheral current draw	Typical bare-board active current consumption
Raspberry Pi Model A	700mA	500mA	200mA
Raspberry Pi Model B	1.2A	500mA	500mA
Raspberry Pi Model A+	700mA	500mA	180mA
Raspberry Pi Model B+	1.8A	600mA/1.2A (switchable)	330mA
Raspberry Pi 2 Model B	1.8A	600mA/1.2A (switchable)	350mA
Raspberry Pi 3 Model B	2.5A	1.2A	400mA
Raspberry Pi 3 Model A+	2.5A	Limited by PSU, board, and connector ratings only.	350mA
Raspberry Pi 3 Model B+	2.5A	1.2A	500mA
Raspberry Pi 4 Model B	3.0A	1.2A	600mA
Raspberry Pi Zero W	1.2A	Limited by PSU, board, and connector ratings only.	150mA
Raspberry Pi Zero	1.2A	Limited by PSU, board, and connector ratings only	100mA

For more details, please refer to <https://www.raspberrypi.org/help/faqs/#powerReqs>

In addition, RPi also needs a network cable used to connect it to wide area network.

All of these components are necessary. Among them, the power supply is required at least 5V/2.5A, because lack of power supply will lead to many abnormal problems, even damage to your RPi. So power supply with 5V/2.5A is highly recommend. SD Card Micro (recommended capacity 16GB or more) is a hard drive for RPi, which is used to store the system and personal files. In later projects, the components list with a RPi will contains these required components, using only RPi as a representative rather than presenting details.

Optional Components

Under normal circumstances, there are two ways to login to Raspberry Pi: using independent monitor, or remote desktop to share a monitor with your PC.

Required Accessories for Monitor

If you want to use independent monitor, mouse and keyboard, you also need the following accessories.

- 1.Display with HDMI interface
- 2.Mouse and Keyboard with USB interface

As to Pi Zero and Pi Zero W, you also need the following accessories.

1. Micro-HDMI to HDMI converter wire.
2. Micro-USB to USB-A Receptacles converter wire (Micro USB OTG wire).
3. USB HUB.
4. USB transferring to Ethernet interface or USB Wi-Fi receiver.

For different Raspberry Pi, the optional items are slightly different. But all of their aims are to convert the special interface to standard interface of standard Raspberry Pi.

Item	Pi Zero	Pi Zero W	Pi A+	Pi 3A+	Pi B+/2B	Pi 3B/3B+/4B
Monitor	Yes	Yes	Yes	Yes	Yes	Yes
Mouse	Yes	Yes	Yes	Yes	Yes	Yes
Keyboard	Yes	Yes	Yes	Yes	Yes	Yes
Micro-HDMI to HDMI cable	Yes	Yes	No	No	No	No
Micro-USB to USB-A OTG cable	Yes	Yes	No	No	No	No
USB HUB	Yes	Yes	Yes	Yes	No	No
USB transferring to Ethernet interface	select one from two or select two from two	optional	select one from two or select two from two	optional	Internal Integration	Internal Integration
USB Wi-Fi receiver		Internal Integration		Internal Integration	optional	

Required Accessories for Remote Desktop

If you don't have an independent monitor, or you want to use a remote desktop, first you need to login to Raspberry Pi through SSH, then open the VNC or RDP service. So you need the following accessories.

Item	Pi Zero	Pi Zero W	Pi A+	Pi 3A+	Pi B+/2B	Pi 3B/3B+/4B
Micro-USB to USB-A OTG cable	Yes	Yes	No	NO		
USB transferring to Ethernet interface	Yes	Yes	Yes			

Raspberry Pi OS

Official Method

It is recommended to use this method.

You can follow the official method to install the system for raspberry pi

<https://projects.raspberrypi.org/en/projects/raspberry-pi-setting-up/2>

In this way, the system will be download **automatically** via the application.

Download system manually (optional)

After installing the Imager Tool in **link above**. You can also download the system **manually** first.

Visit RPi official website (<https://www.RaspberryPi.org/>), click “Downloads” and choose to download “Raspberry Pi OS”. Raspberry Pi OS supported by RPI is an operating system based on Linux, which contains a number of contents required for RPi. We recommended Raspberry Pi OS to beginners. All projects in this tutorial are operated under the Raspberry Pi OS.

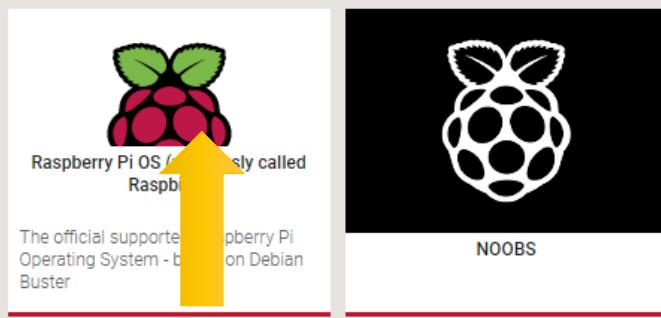
Downloads

Raspberry Pi OS (previously called Raspbian) is our official operating system for **all** models of the Raspberry Pi.

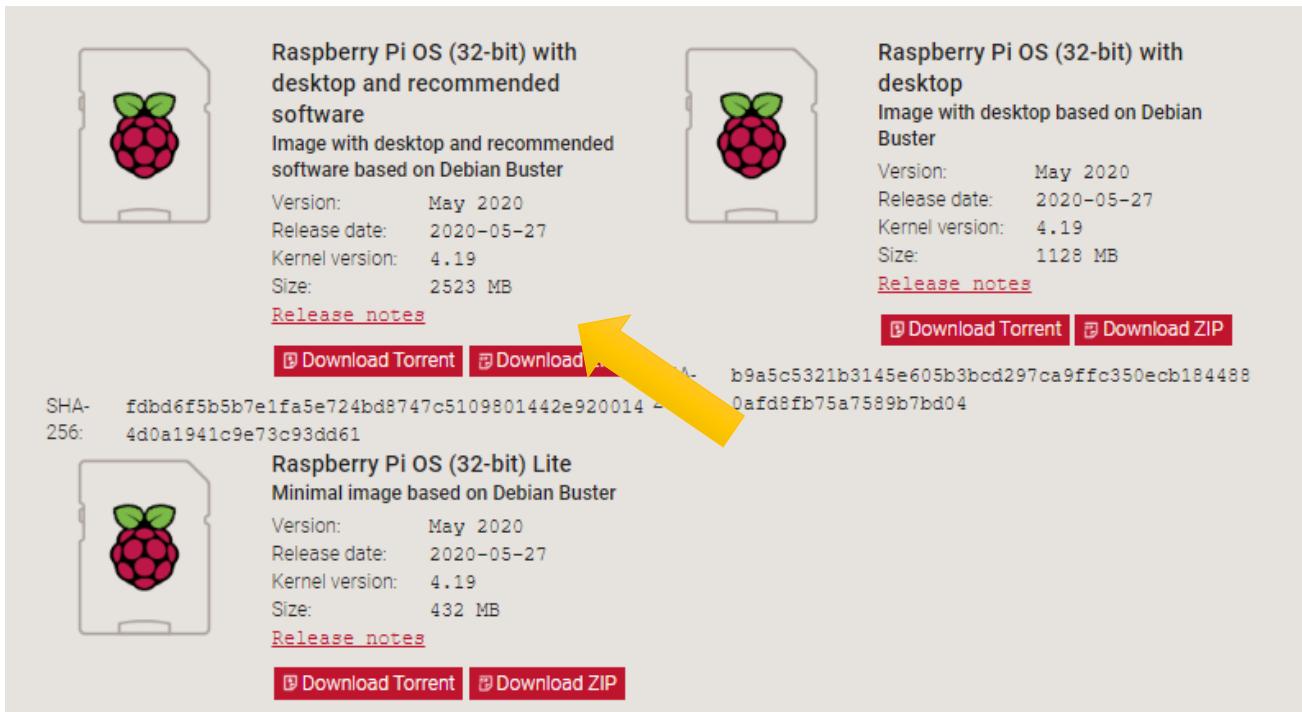
Use **Raspberry Pi Imager** for an easy way to install Raspberry Pi OS and other operating systems to an SD card ready to use with your Raspberry Pi:

- [Raspberry Pi Imager for Windows](#)
- [Raspberry Pi Imager for macOS](#)
- [Raspberry Pi Imager for Ubuntu](#)

Alternatively, use the links below to download OS images which can be manually copied to an SD card.



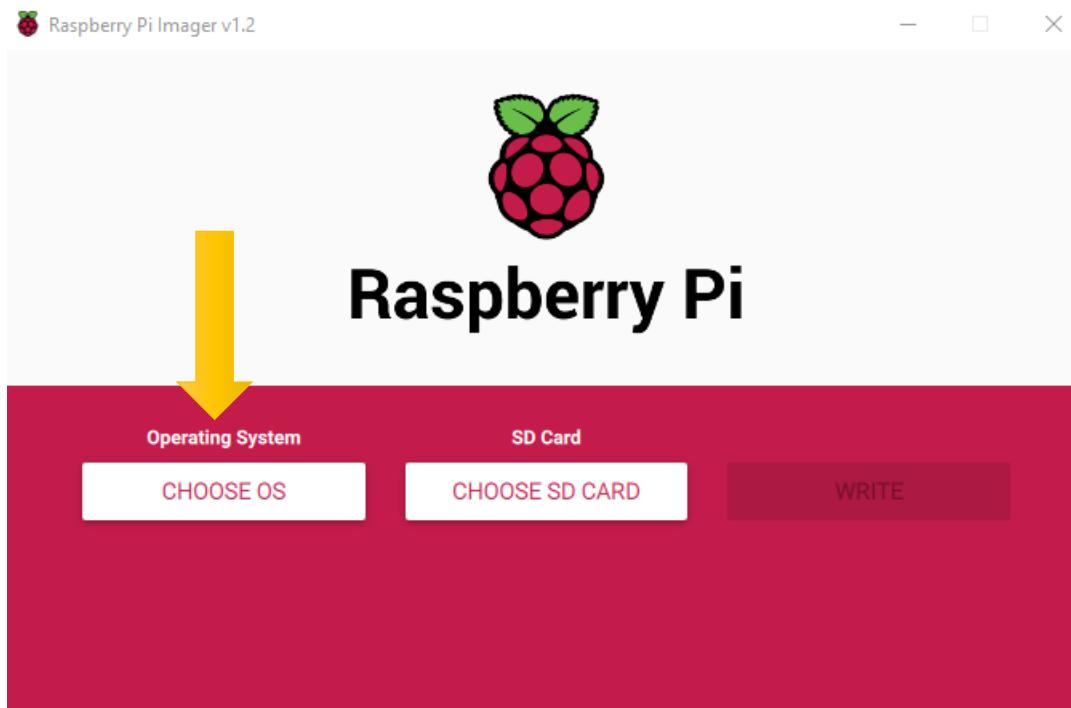
<https://www.raspberrypi.org/downloads>

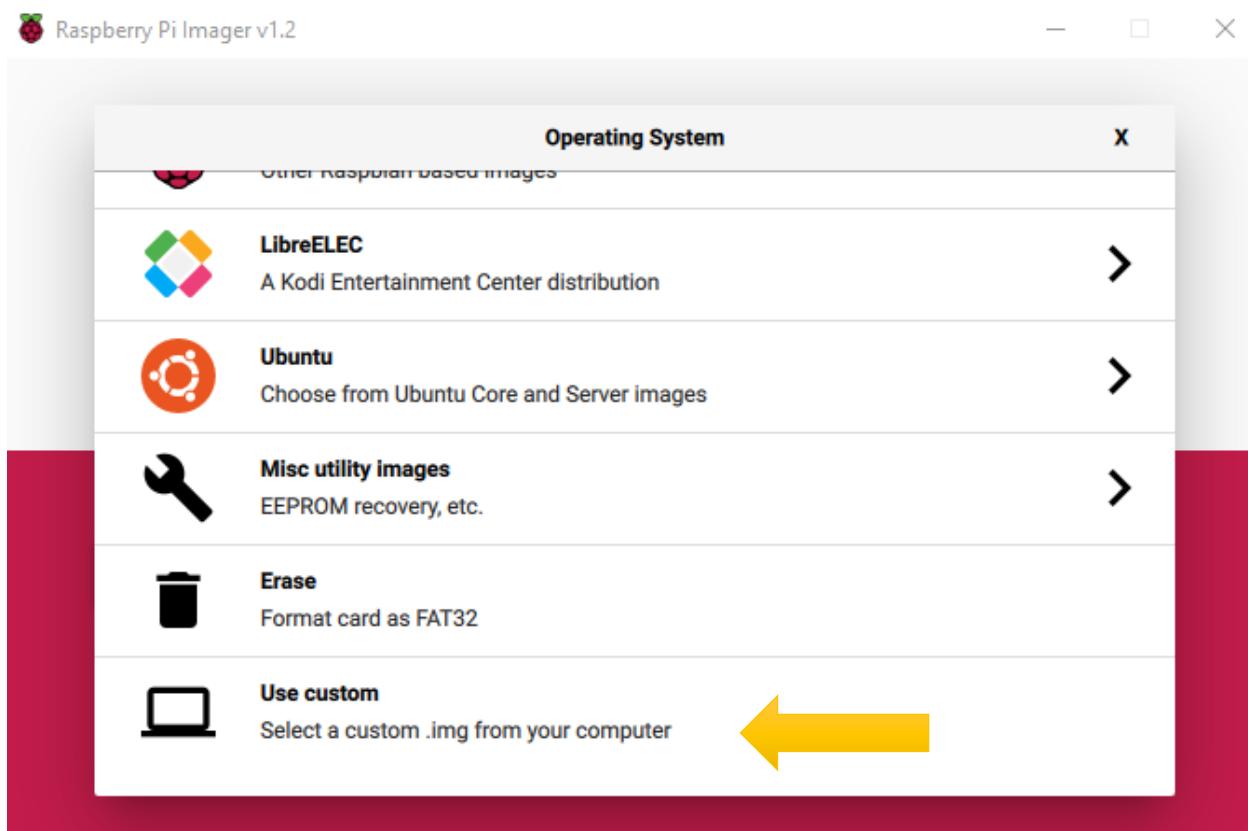


After the zip file is download.

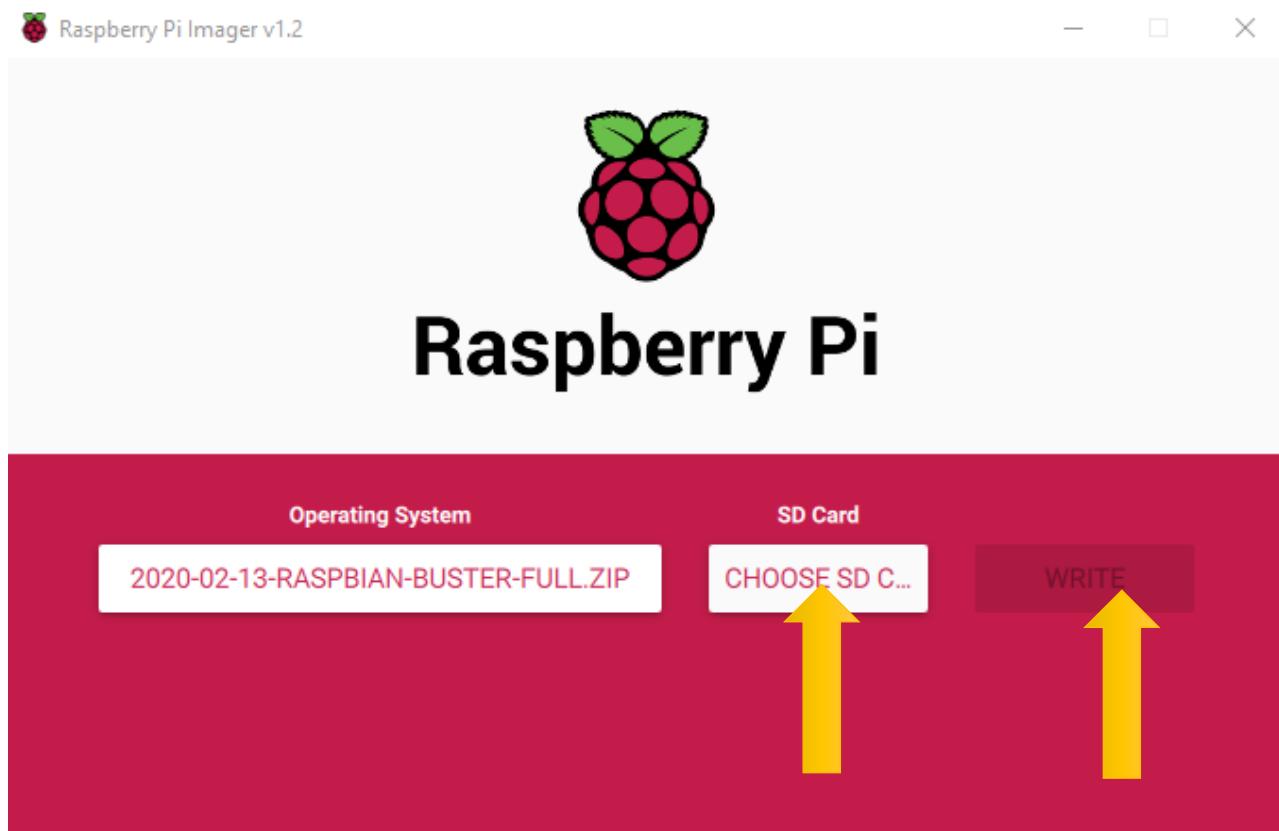
Write System to Micro SD Card

First, put your **Micro SD card** into card reader and connect it to USB port of PC. Then open imager toll, choose Choose system that you just download in Use custom.





Choose the SD card. Then click "WRITE".



Start Raspberry Pi

If you don't have a spare monitor, please jumper to next section. If you have a spare monitor, please follow steps in this section.

After the system is written successfully, take out Micro SD Card and put it into the card slot of RPi. Then connect RPi to screen through the HDMI, to mouse and keyboard through the USB port, to network cable through the network card interface and to the power supply. Then your RPi starts initially. Later, you need to enter the user name and password to login. The default user name: pi; password: raspberry. Enter and login. After login, you can enter the following interface.



Now, you have successfully installed the Raspberry Pi OS for your RPi.

Then you can connect WiFi on the right corner.

Now you can jumper to [VNC Viewer](#).

Remote desktop & VNC

After you log in Raspberry Pi, please use VNC Viewer to connect Raspberry Pi for this robot. Other remote ways may not support GUI.

If you have logged in Raspberry Pi please skip to [VNC Viewer](#).

If you don't have a spare display, mouse and keyboard for your RPi, you can use a remote desktop to share a display, keyboard, and mouse with your PC. Below is how to use remote desktop under the Windows and mac OS.

Enable SSH

Under the latest version of Raspberry Pi OS, SSH is closed by default. So you need to open it first. After write system, **create a folder named “ssh” under generated boot disk of Micro SD Card**, then the SSH connection will be opened.

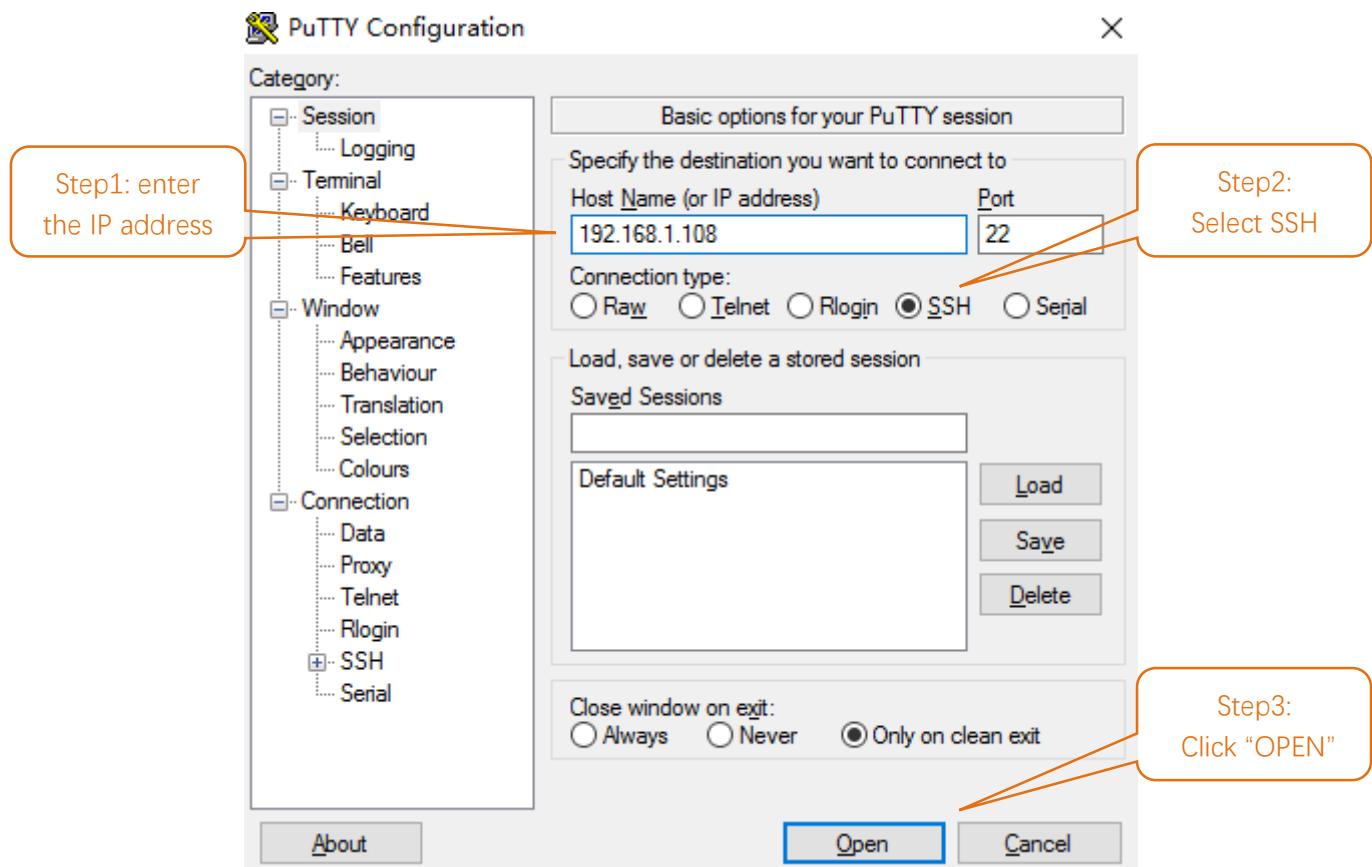
Windows OS Remote Desktop

The windows built-in application remote desktop corresponds to the Raspberry Pi xrdp service.

Download the tool software Putty. Its official address: <http://www.putty.org/>

Or download it here: <http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html>

Then use net cable to connect your RPi to the routers and ensure your PC and your RPi are in the same LAN. Then put the system Micro SD Card prepared before into the slot of the RPi and turn on the power supply waiting for starting RPi. Later, enter router client to inquiry IP address named “raspberry pi”. For example, I have inquired to my RPi IP address, and it is “192.168.1.108”. Then open Putty, enter the address, select SSH, and then click "OPEN", as shown below:



There will appear a security warning at first login. Just click "YES".

PuTTY Security Alert

⚠ WARNING - POTENTIAL SECURITY BREACH!

The server's host key does not match the one PuTTY has cached in the registry. This means that either the server administrator has changed the host key, or you have actually connected to another computer pretending to be the server.

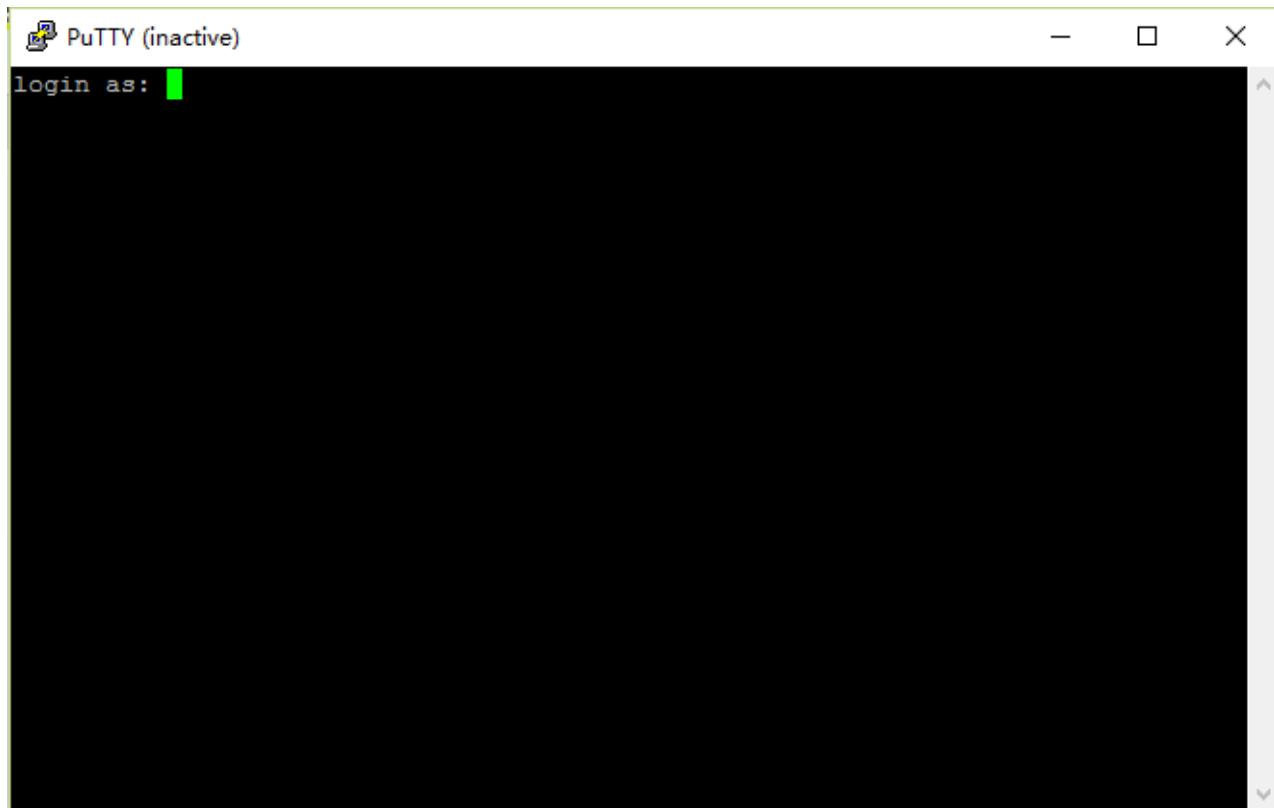
The new rsa2 key fingerprint is:
`ssh-rsa 2048 7ae1:50:ba:dc:01:87:1b:a5:f9:d2:d4:12:d6:fe:ab`

If you were expecting this change and trust the new key, hit Yes to update PuTTY's cache and continue connecting.

If you want to carry on connecting but without updating the cache, hit No.

If you want to abandon the connection completely, hit Cancel. Hitting Cancel is the ONLY guaranteed safe choice.

Then there will be a login interface (RPi default user name: **pi**; the password: **raspberry**). When you enter the password, there will be **no display** on the screen. This is normal. After the correct input, press “Enter” to confirm.



Then enter the command line of RPi, which means that you have successfully login to RPi command line mode.

```
pi@raspberrypi: ~
login as: pi
pi@192.168.1.108's password:

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.

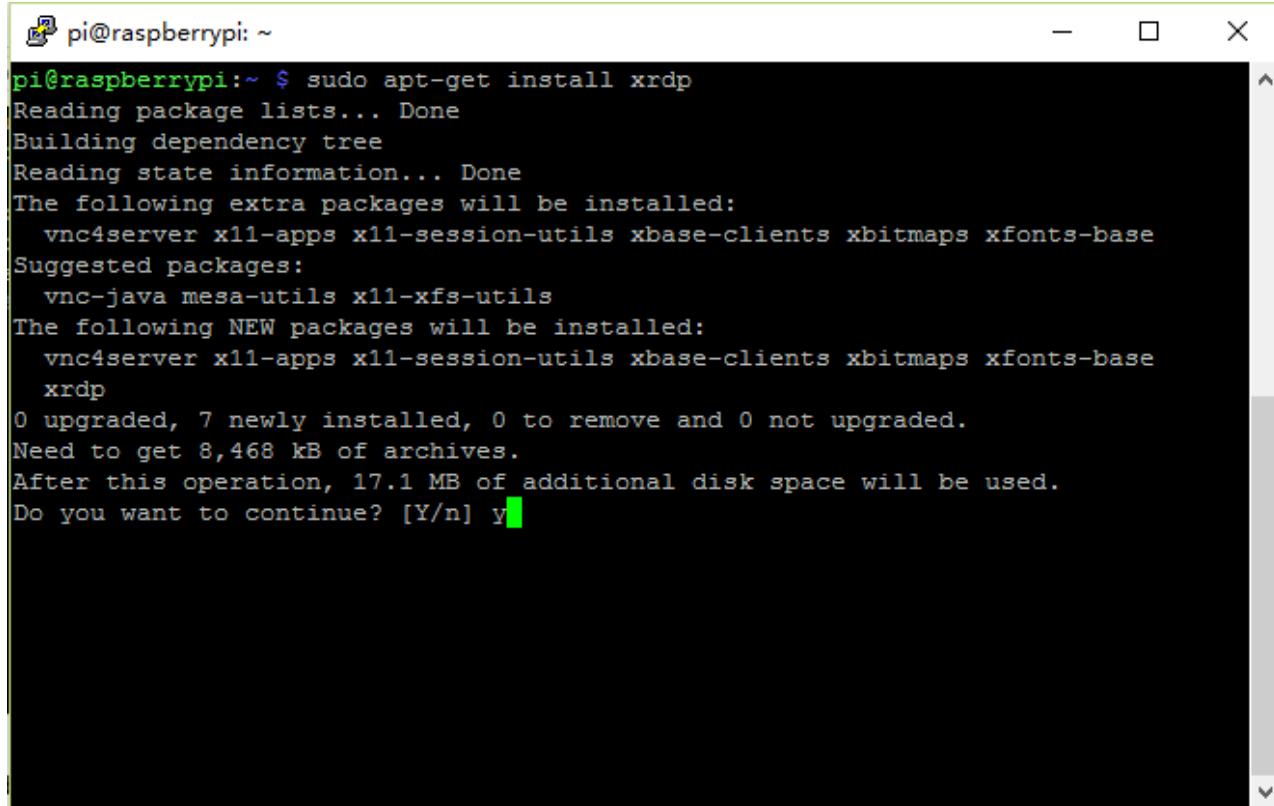
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue May 10 23:51:04 2016
pi@raspberrypi:~ $
```

If you want to use built-in Remote Desktop Connection under Windows, you need install xrdp service on Raspberry Pi.

Next, install a xrdp service, an open source remote desktop protocol(xrdp) server, for RPi. Type the following command, then press enter to confirm:

```
sudo apt-get install xrdp
```

Later, the installation starts.



A screenshot of a terminal window titled "pi@raspberrypi: ~". The window contains the output of the command "sudo apt-get install xrdp". The text shows the package manager reading lists, building dependency trees, and listing packages to be installed, including vnc4server, x11-apps, x11-session-utils, xbase-clients, xbitmaps, xfonts-base, vnc-java, mesa-utils, and x11-xfs-utils. It also lists suggested packages like vnc4server, x11-apps, x11-session-utils, xbase-clients, xbitmaps, xfonts-base, and xrdp. The message indicates 0 upgraded, 7 newly installed, 0 to remove, and 0 not upgraded, with a total download size of 8,468 kB. After this operation, 17.1 MB of additional disk space will be used. The question "Do you want to continue? [Y/n]" is displayed at the bottom, with the letter 'y' highlighted in green.

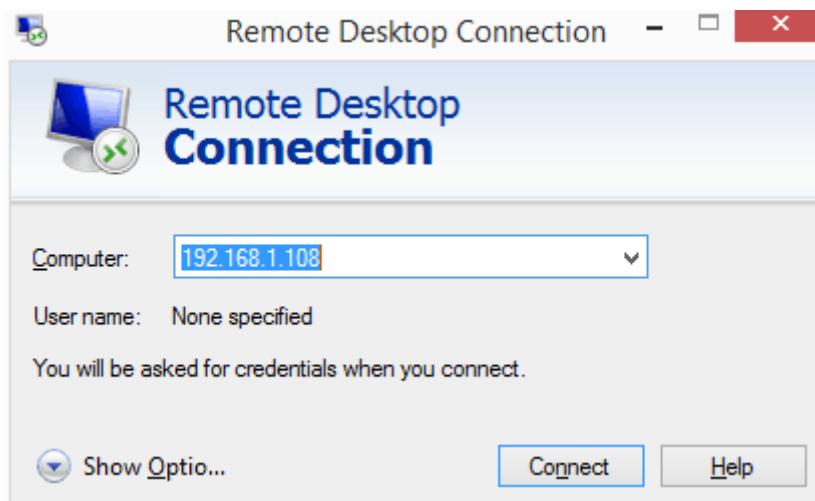
```
pi@raspberrypi:~ $ sudo apt-get install xrdp
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  vnc4server x11-apps x11-session-utils xbase-clients xbitmaps xfonts-base
Suggested packages:
  vnc-java mesa-utils x11-xfs-utils
The following NEW packages will be installed:
  vnc4server x11-apps x11-session-utils xbase-clients xbitmaps xfonts-base
    xrdp
0 upgraded, 7 newly installed, 0 to remove and 0 not upgraded.
Need to get 8,468 kB of archives.
After this operation, 17.1 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
```

Enter "Y", press key "Enter" to confirm.

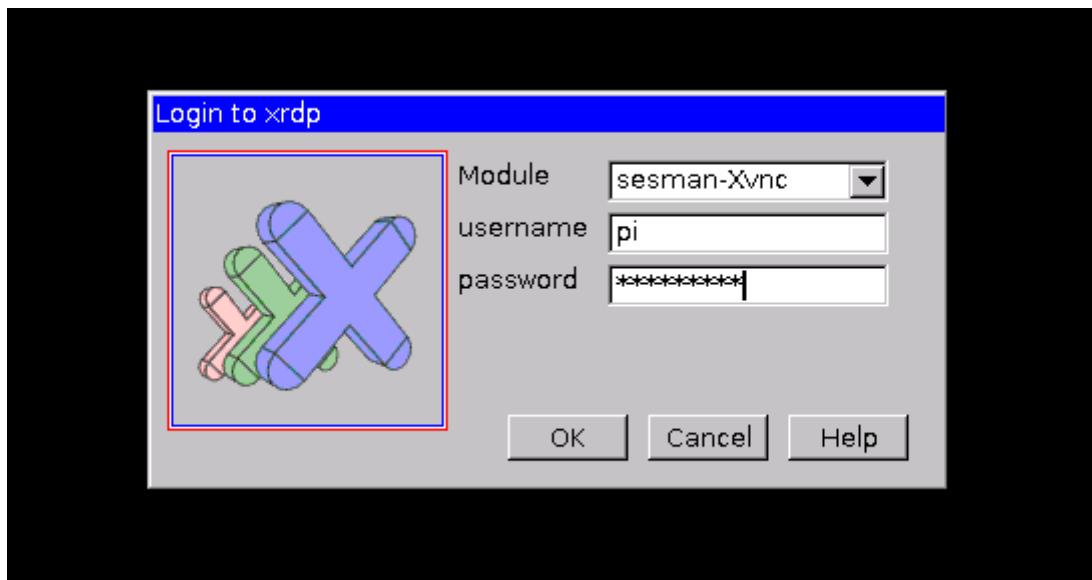
After the installation is completed, you can use Windows remote desktop applications to login to your RPi.

Login to Windows remote desktop

Use "WIN+R" or search function, open the remote desktop application "mstsc.exe" under Windows, enter the IP address of RPi and then click "Connect".



Later, there will be xrdp login screen. Enter the user name and password of RPi (RPi default user name: pi; password: raspberry) and click "OK".



Later, you can enter the RPi desktop system.



Here, you have successfully used the remote desktop login to RPi.

Raspberry Pi 4B/3B+/3B integrates a Wi-Fi adaptor. You can use it to connect to your Wi-Fi. Then you can use the wireless remote desktop to control your RPi. This will be helpful for the following work. Raspberry Pi of other models can use wireless remote desktop through accessing an external USB wireless card.



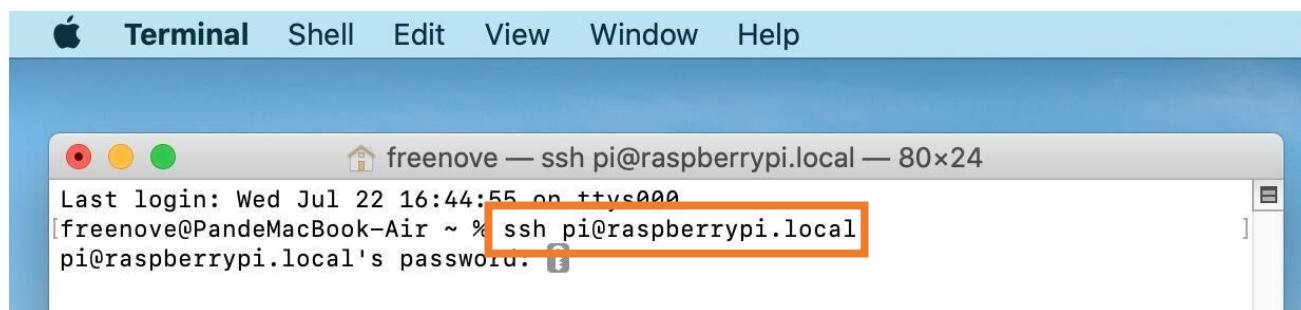
MAC OS Remote Desktop

Connect your pi to the the router via a network cable.

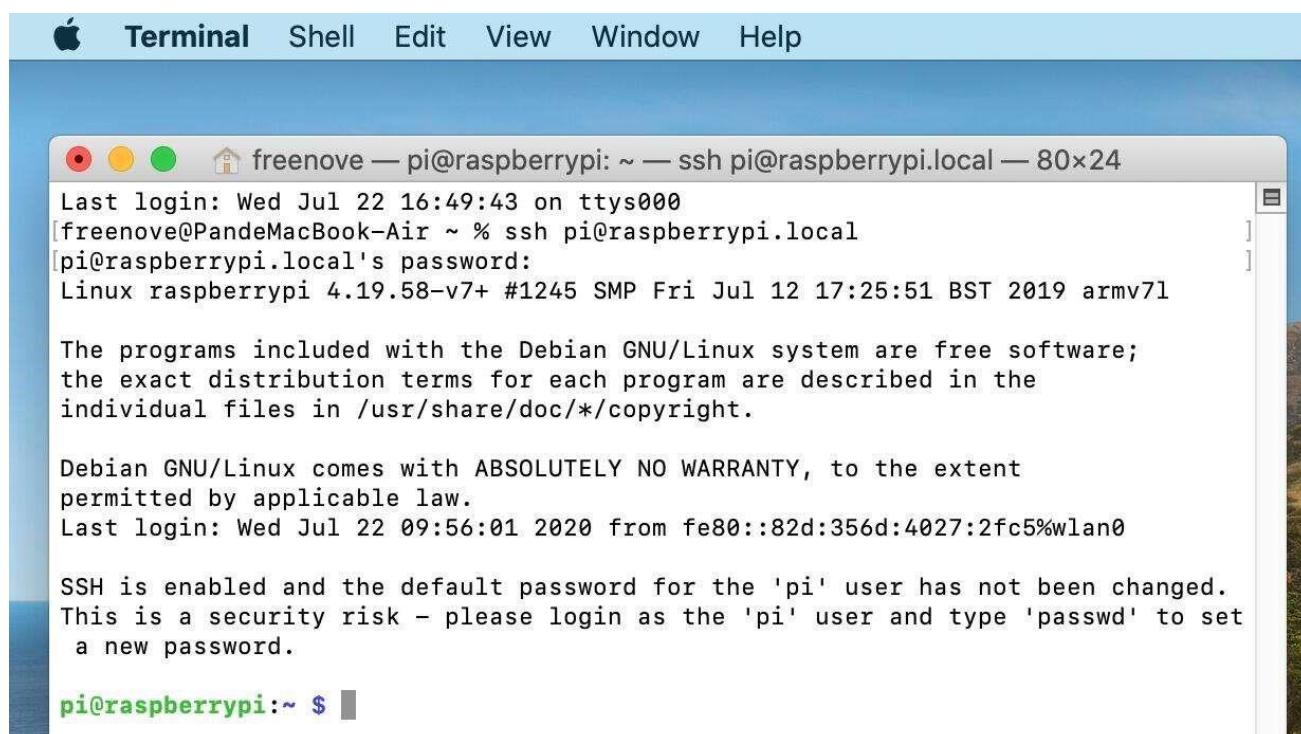
Open the terminal and type following command.

```
ssh pi@raspberrypi.local
```

The password is **raspberry** by default, case sensitive.



You may need to type **yes** during the process.



When you see **pi@raspberrypi:~ \$**, you have logged in Pi successfully. Then you can skip to next section.

You can also use the IP to log in Pi.

Enter router client to inquiry IP address named "raspberry pi". For example, I have inquired to my RPi IP address, and it is "192.168.1.131".

Open the terminal and type following command.

```
ssh pi@192.168.1.131
```

The screenshot shows a macOS Terminal window titled "freenove — pi@raspberrypi: ~ — ssh pi@192.168.1.131 — 81x44". The terminal output is as follows:

```
[freenove@PandeMacBook-Air ~ % ssh pi@192.168.1.131
The authenticity of host '192.168.1.131 (192.168.1.131)' can't be established.
ECDSA key fingerprint is SHA256:95hc76ISxQ/+z9TGG57136senETX60yaAaqds1ENpE4.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.1.131' (ECDSA) to the list of known hosts.
[pi@192.168.1.131's password:
Linux raspberrypi 4.19.58-v7+ #1245 SMP Fri Jul 12 17:25:51 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: Wed Jul 22 09:56:32 2020 from fe80::82d:356d:4027:2fc5%wlan0

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:~ $ sudo raspi-config
```

Below the terminal, a window titled "Raspberry Pi Software Configuration Tool (raspi-config)" is displayed. The menu options are:

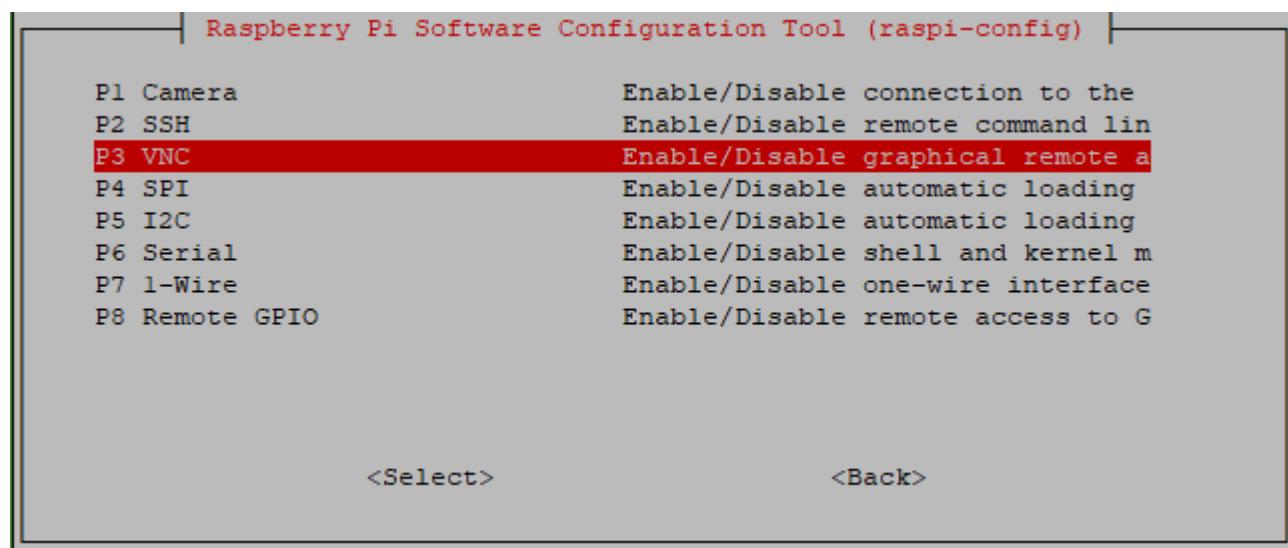
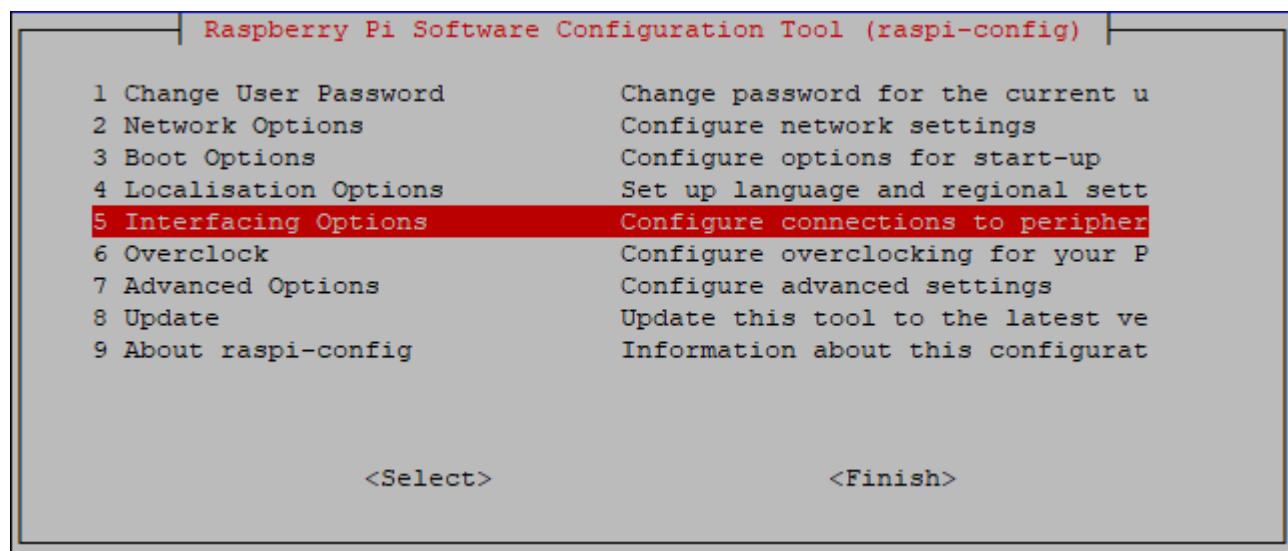
- 1 Change User Password Change password for the current user
- 2 Network Options Configure network settings
- 3 Boot Options Configure options for start-up
- 4 Localisation Options Set up language and regional settings to match your
- 5 Interfacing Options Configure connections to peripherals
- 6 Overclock Configure overclocking for your Pi
- 7 Advanced Options Configure advanced settings
- 8 Update Update this tool to the latest version
- 9 About raspi-config Information about this configuration tool

At the bottom of the window, there are two buttons: "<Select>" and "<Finish>".

VNC Viewer & VNC

Type the following command. And select 5 Interfacing Options → P3 VNC → Yes → OK → Finish. Here Raspberry Pi may need be restarted, and choose ok. Then open VNC interface.

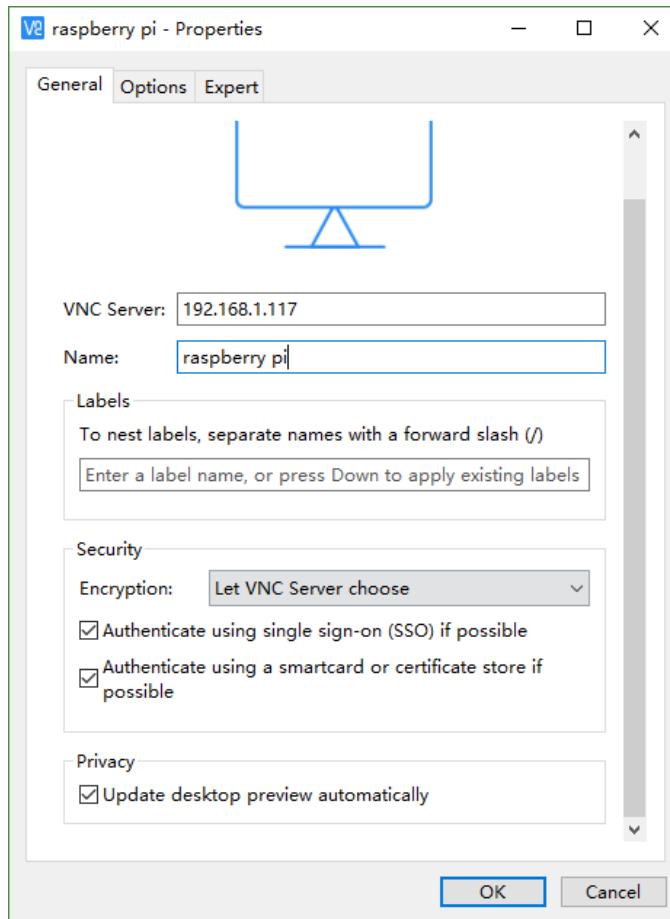
```
sudo raspi-config
```



Then download and install VNC Viewer according to your computer system by click following link:

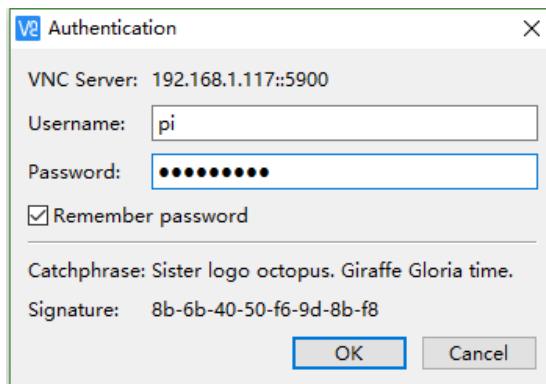
<https://www.realvnc.com/en/connect/download/viewer/>

After installation is completed, open VNC Viewer. And click File → New Connection. Then the interface is shown below.

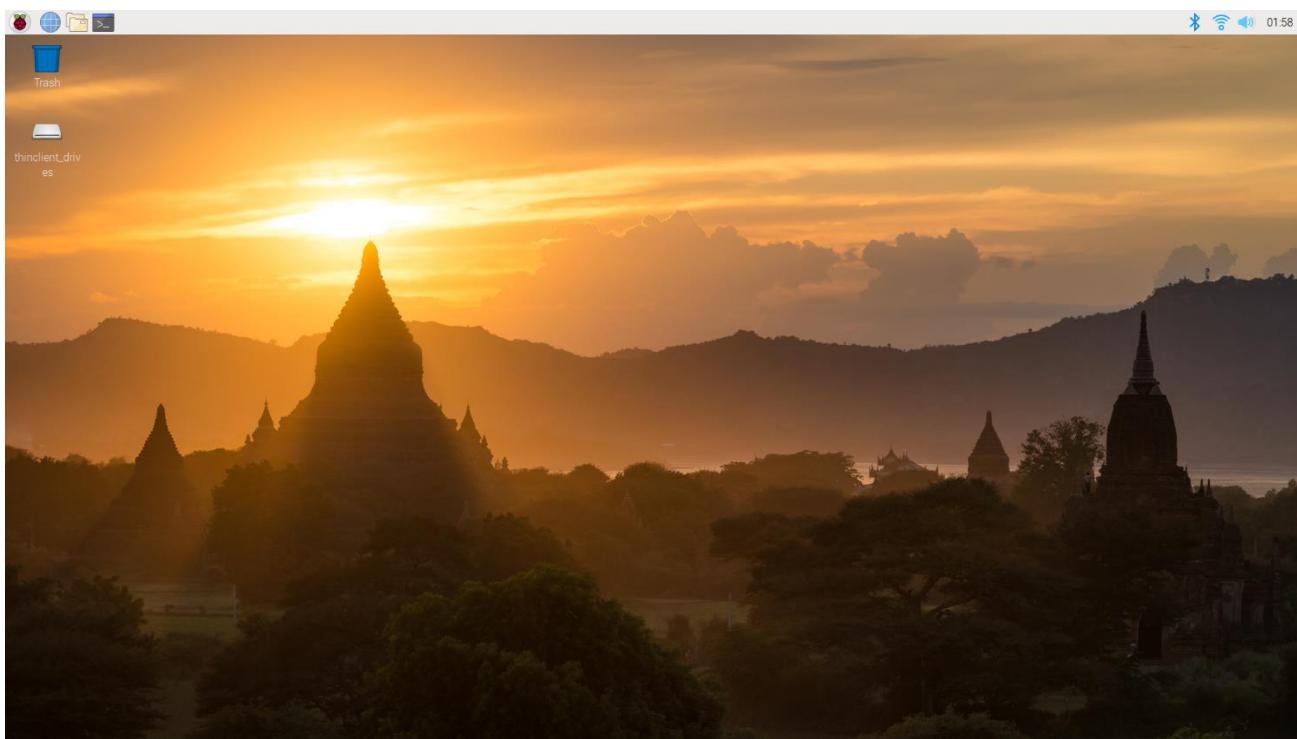


Enter ip address of your Raspberry Pi and fill in a Name. And click OK.

Then on the VNC Viewer panel, double-click new connection you just created, and the following dialog box pops up.



Enter username: **pi** and Password: **raspberry**. And click OK.

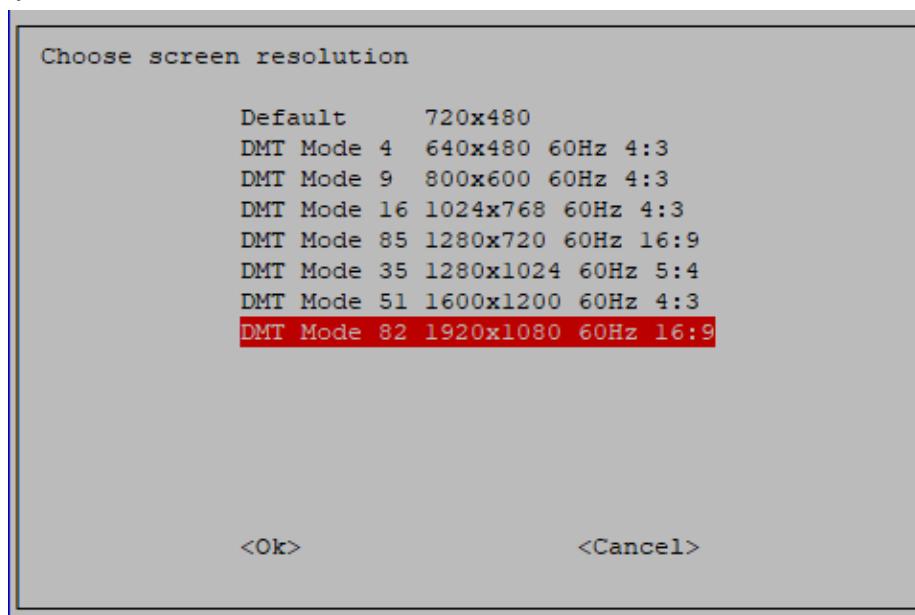


Here, you have logged in to Raspberry Pi successfully by using VNC Viewer

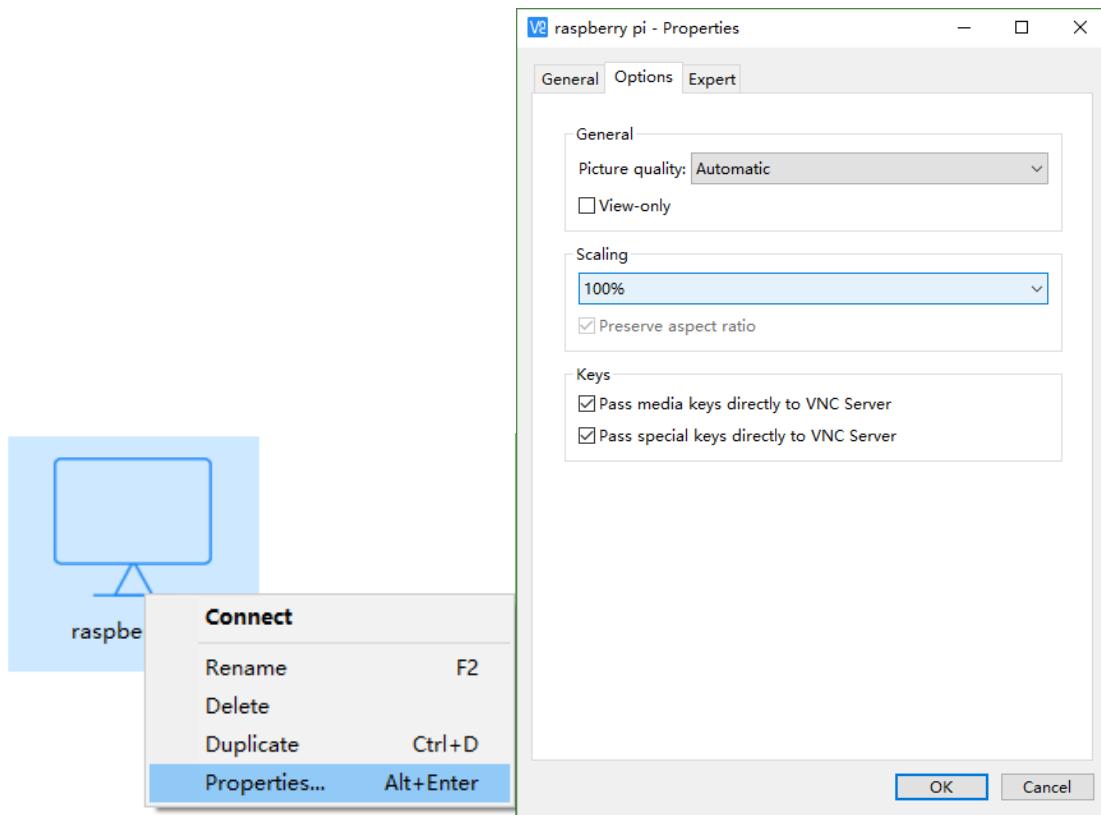
If the resolution ratio is not great or there is just a **little window**, you can set a proper resolution ratio via steps below.

```
sudo raspi-config
```

Select 7 Advanced Options→A5 Resolution→proper resolution ratio (set by yourself)→OK→Finish. And then reboot Raspberry Pi.



In addition, your VNC Viewer window may zoom your Raspberry Pi desktop. You can change it. On your VNC View control panel, click right key. And select Properties->Options label->Scaling. Then set proper scaling.



Here, you have logged in to Raspberry Pi successfully by using VNC Viewer and operated proper setting.

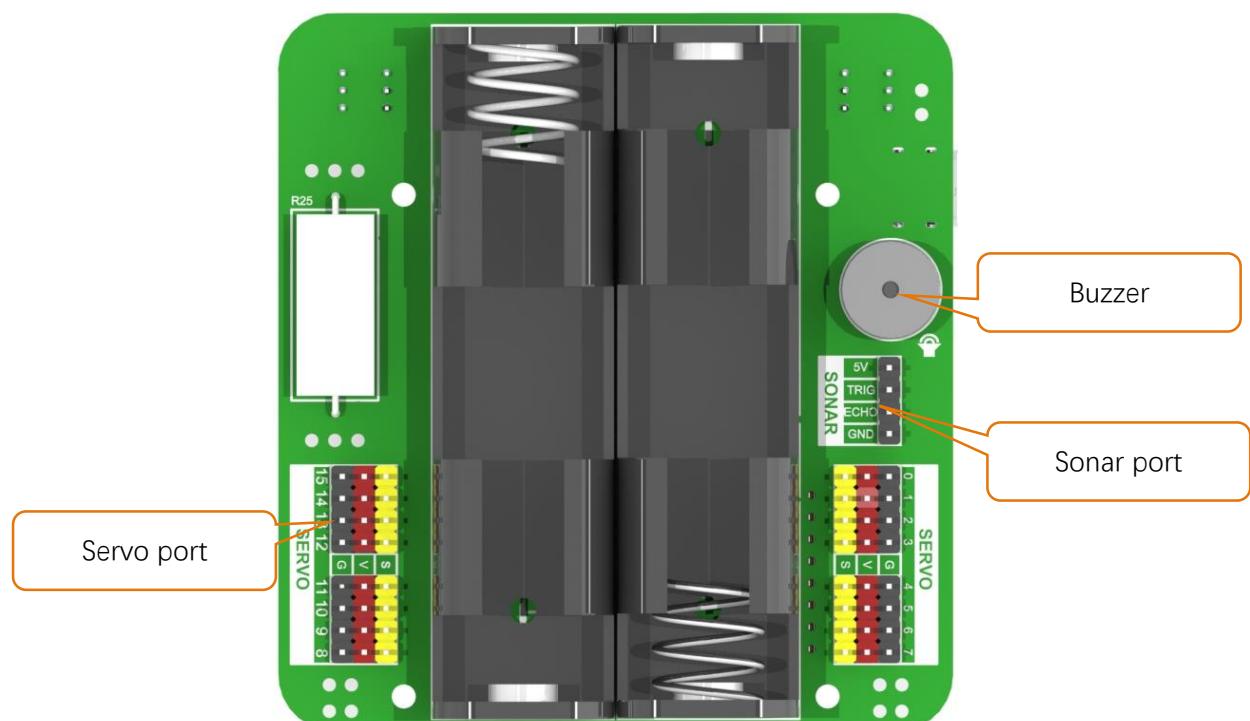
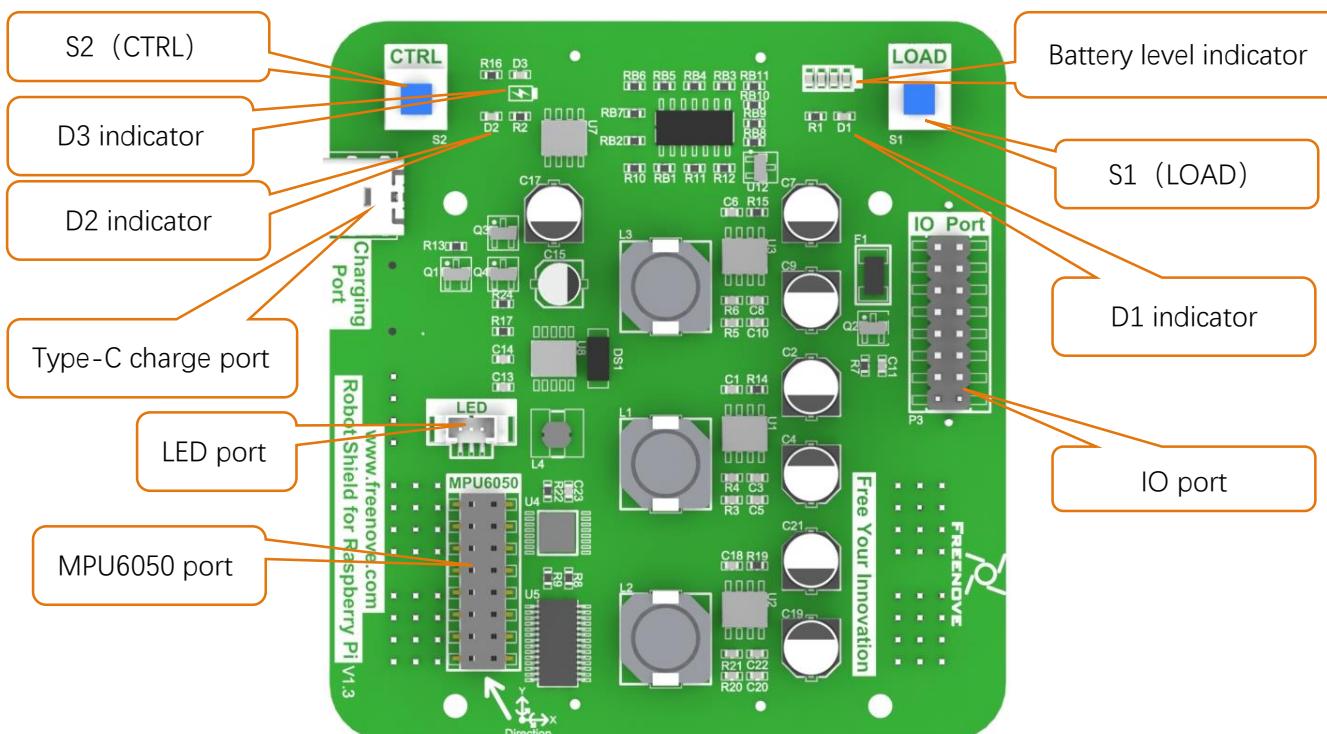
Raspberry Pi 4B/3B+/3B integrates a Wi-Fi adaptor. If you did not connect Pi to WiFi. You can connect it to wirelessly control the robot.



Robot Shield for Raspberry Pi

Shield Introduction

The shield is connected to the Raspberry Pi through the IO Port on the board. The positioning holes on the board are suitable for the Raspberry Pi. The features and functions are as follows.



- **Robot Shield board:** It need two 18650 3.7v batteries. It has charger function.
- **S1(LOAD) Switch:** It mainly controls the power supply of servos, buzzer, ultrasonic module and LED module. The D1 indicator will light up when S1 is pressed.
- **S2(CTRL) Switch:** It mainly controls the power of chips such as PCF9685, ADS7830 and Raspberry Pi. The D2 indicator will light up when S2 is pressed.
- **Type-C port:** It is used to connect cable for charging. It only works when S1 and S2 are turned off.
- **LED port:** It is used to connect LED module which is controlled by Raspberry Pi.
- **MPU6050 port:** It is used to connect MPU6050 which is controlled by Raspberry Pi.
- **Battery level indicator:** It consists of four LEDs. When the battery power decreases gradually, the LEDs will be gradually turned off.
- **IO port:** It is used to connect shield with Raspberry Pi conveniently.
- **Servo port:** There are 16 servo ports with control accuracy of 0.09 degrees.
- **Sonic module port:** The interface of HC-SR04 Ultrasound Module is provided.
- **Buzzer:** It is directly controlled by raspberry pi, which is turned on at high level and off at low level.

Charging Function (necessary for using charging function)

Description

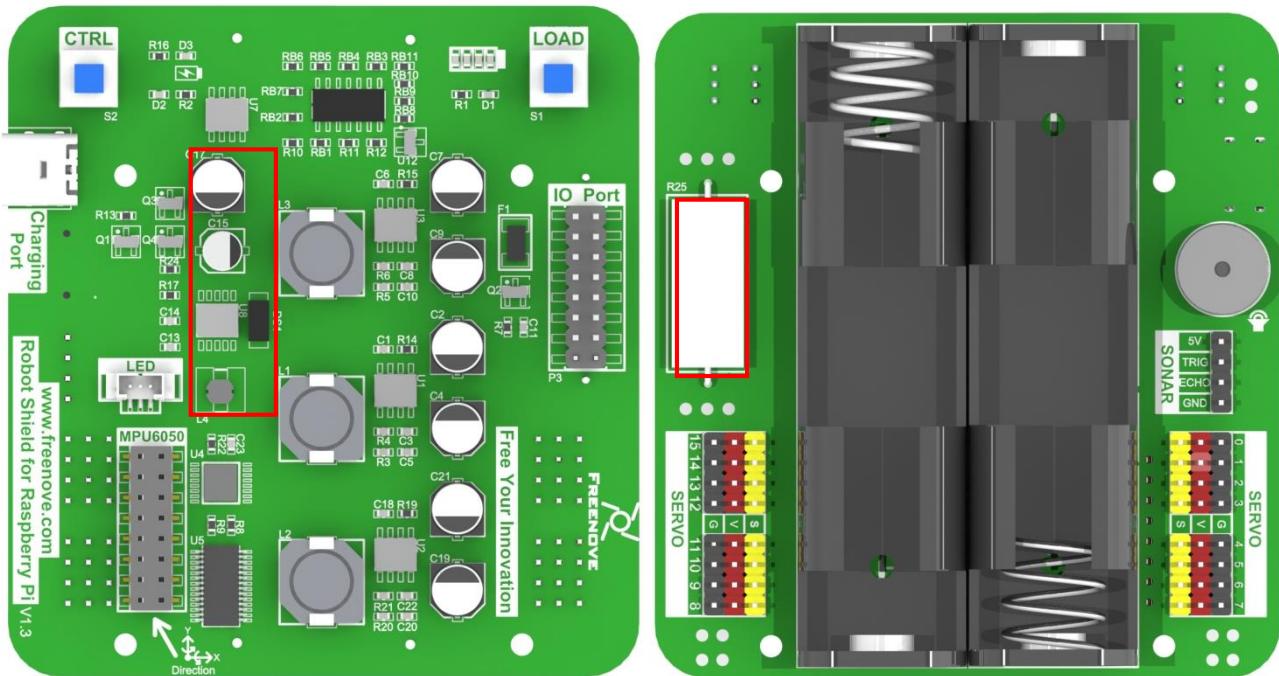
- 1 The control board has a complete battery charging protection function and uses a complete CC/CV charging mode. Two 18650 batteries can be charged through the TYPE-C port, but **not a single battery**.
- 2 When voltage of the two batteries is less than 2V, they are charged with 50mA. When voltage of two batteries is greater than 2V and less than 5.6V, they are charged with 100mA. When voltage of two batteries is larger than 5.6V, they are charged with 1A.
- 3 When the batteries are nearly full, they will be charged at constant voltage mode. At this time, the current will be small and the charging will be slow.
- 4 When voltage of each battery is greater than 3.6V and the sum voltage of the two batteries is greater than 7.2V, and the voltage drop is greater than 0.06V, the balanced charging function will be activated, and the maximum balanced current is about 370mA. If it is detected that the voltage difference between the two batteries is greater than 0.5V, it is judged that the batteries are damaged and the battery charging will stop.

How to use the charging function

- 1 To use the charging function, first **turn off the two switches S1 and S2** (D1, D2 and the power indicator are all off).
- 2 Insert the TYPE-C data cable into the TYPE-C port. Please use an adapter of 5V 2A or more. If there is no battery in the battery box, and the D3 charging indicator will blink continuously. Put **two batteries** into the battery holder (single one doesn't work). If they are already there, just continue reading. The D3 indicator will stop blinking and stay on (charging), and will turn off when the batteries are fully charged.
- 3 When there are no power indicator leds on when using, it is time to charge. Because when the voltage of two batteries are less than 5.6V. The charge current is very small. Therefore, we recommend to charging the battery beyond 3V.
- 4 It will take too long to get the batteries full charged with D3 off. You can turn on S2 (no need to disconnect charge cable) to check the power indicator after charge some hours. If there are less than 3 LED on, you can turn off S2. The charging will continue.
- 5 If the battery contact is abnormal, the output is short-circuited, the charging time is over, or the battery temperature is abnormal, the D3 indicator will flash and charging will stop.

Note:

In the process of charging with 1A current, the two positions of the shield will be hot, which is normal to use. Please avoid touching them with your hands.



Chapter 1 Install Python Libraries (Necessary)

If there are any concerns, please feel free to contact us at support@freenove.com

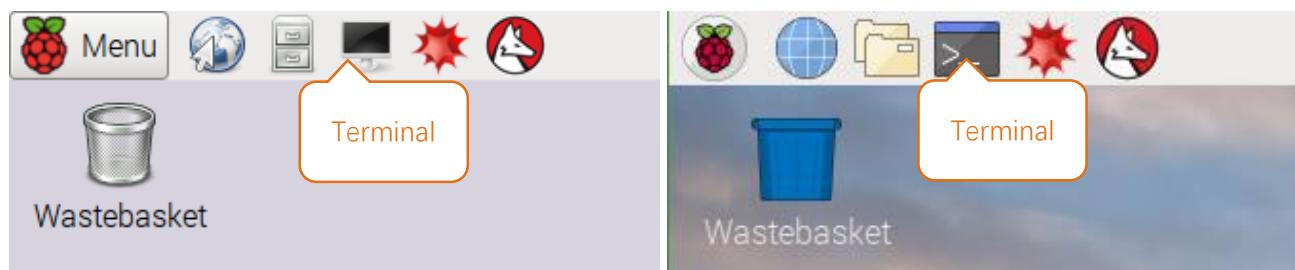
In this chapter, we will do some necessary preparations, start the Raspberry Pi and install some necessary python libraries. The next chapter will assemble the robot dog.

Note: The library installation needs a lot of time. You can use the power cable to power the Raspberry Pi (no battery power required).

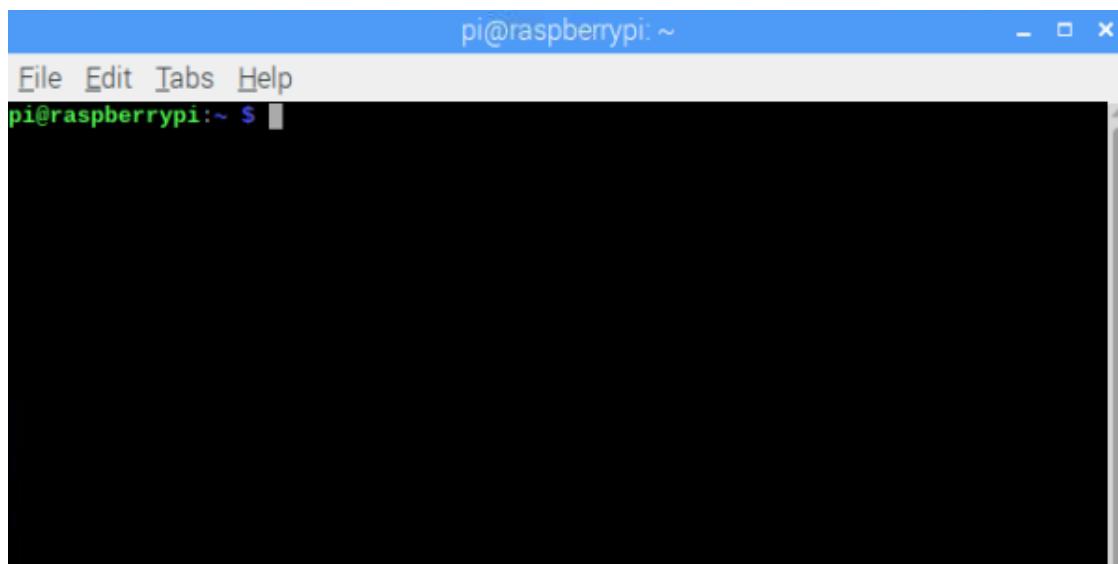
It is recommended to use [VNC Viewer](#) to build this robot when you use [Remote Desktop](#) to login RPi or there will be errors.

Step 1 Obtain the Code

Start the Raspberry Pi and open the terminal. You can click the terminal as shown below, or press "CTAL+ALT+T" on the desktop.



The terminal is shown below:



Type following command to get robot dog code and place it in user directory "Pi".

Please execute commands below one by one in turn.

```
cd ~
```

```
git clone https://github.com/Freenove/Freenove_Robot_Dog_Kit_for_Raspberry_Pi
```

```
pi@raspberrypi:~ $ cd ~  
pi@raspberrypi:~ $ git clone https://github.com/Freenove/Freenove_Robot_Dog_Kit_for_Raspberry_Pi
```

Downloading need much time. Please wait with patience.

You can also find and download the code by visiting our official website (<http://www.freenove.com>) or our GitHub repository (<https://github.com/freenove>).

Please note that all code for this robot dog is written with **Python3**. If executed under python 2, there will be error messages.

Set Python3 as default python

First, execute python to check default python on your raspberry Pi. Press Ctrl-Z to exit.

```
pi@raspberrypi:~ $ python
```

If it is python3, you can skip this section.

If it is python2, you need execute following commands to set default python to python3.

1. Enter directory /usr/bin

```
cd /usr/bin
```

2. Delete the old python link.

```
sudo rm python
```

3. Create new python links to python.

```
sudo ln -s python3 python
```

4. Check python. Press Ctrl-Z to exit.

```
python
```

```
pi@raspberrypi:~ $ cd /usr/bin  
pi@raspberrypi:/usr/bin $ sudo rm python  
pi@raspberrypi:/usr/bin $ sudo ln -s python3 python  
pi@raspberrypi:/usr/bin $ python  
Python 3.7.3 (default, Apr  3 2019, 05:39:12)  
[GCC 8.2.0] on linux  
Type "help", "copyright", "credits" or "license" for more information.  
>>>
```

If you want to set python2 as default python in **other projects**.

Just repeat command above and change python3 to python2.

```
pi@raspberrypi:~ $ cd /usr/bin  
pi@raspberrypi:/usr/bin $ sudo rm python  
pi@raspberrypi:/usr/bin $ sudo ln -s python2 python  
pi@raspberrypi:/usr/bin $ python  
Python 2.7.16 (default, Apr  6 2019, 01:42:57)  
[GCC 8.2.0] on linux2  
Type "help", "copyright", "credits" or "license" for more information.  
>>> █
```

Shortcut Key

Now, we will introduce several shortcuts that are very **useful** and **commonly used** in terminal.

1. **up and down arrow keys**. History commands can be quickly brought back by using up and down arrow keys, which are very useful when you need to reuse certain commands.

When you need to type command, pressing “↑” will bring back the previous command, and pressing “↓” will bring back the latter command.

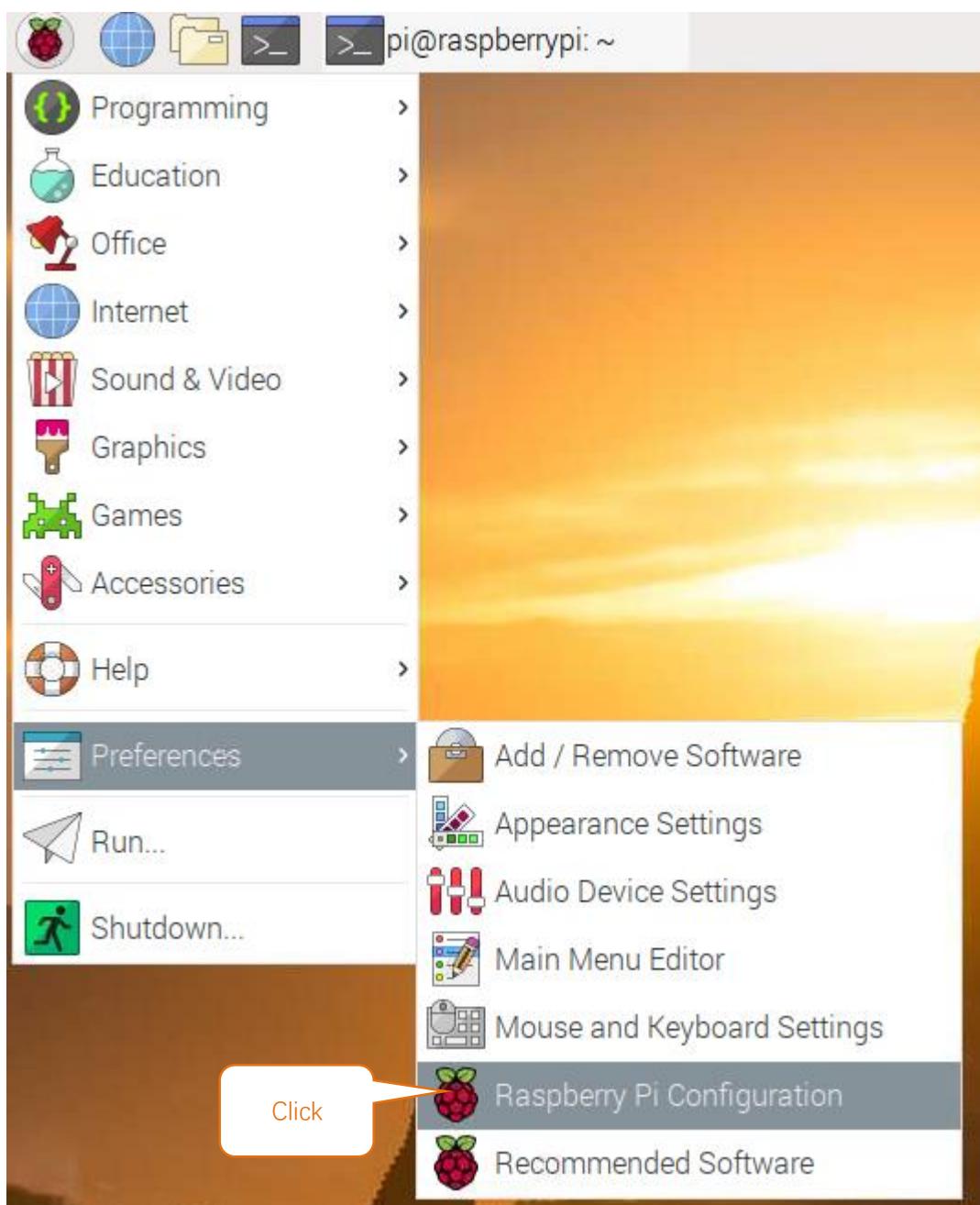
2. **Tab key**. The Tab key can automatically complete the command/path you want to type. When there are multiple commands/paths conforming to the already typed letter, pressing Tab key once won't have any result. And pressing Tab key again will list all the eligible options. This command/path will be directly completed when there is only one eligible option.

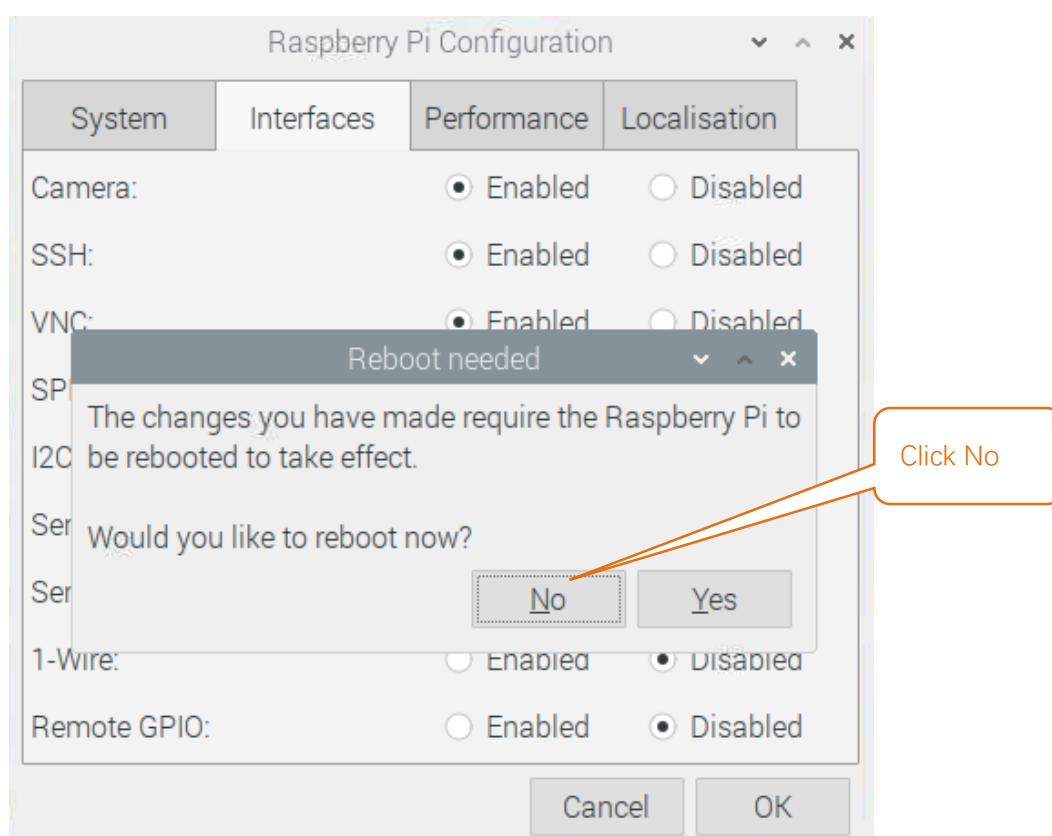
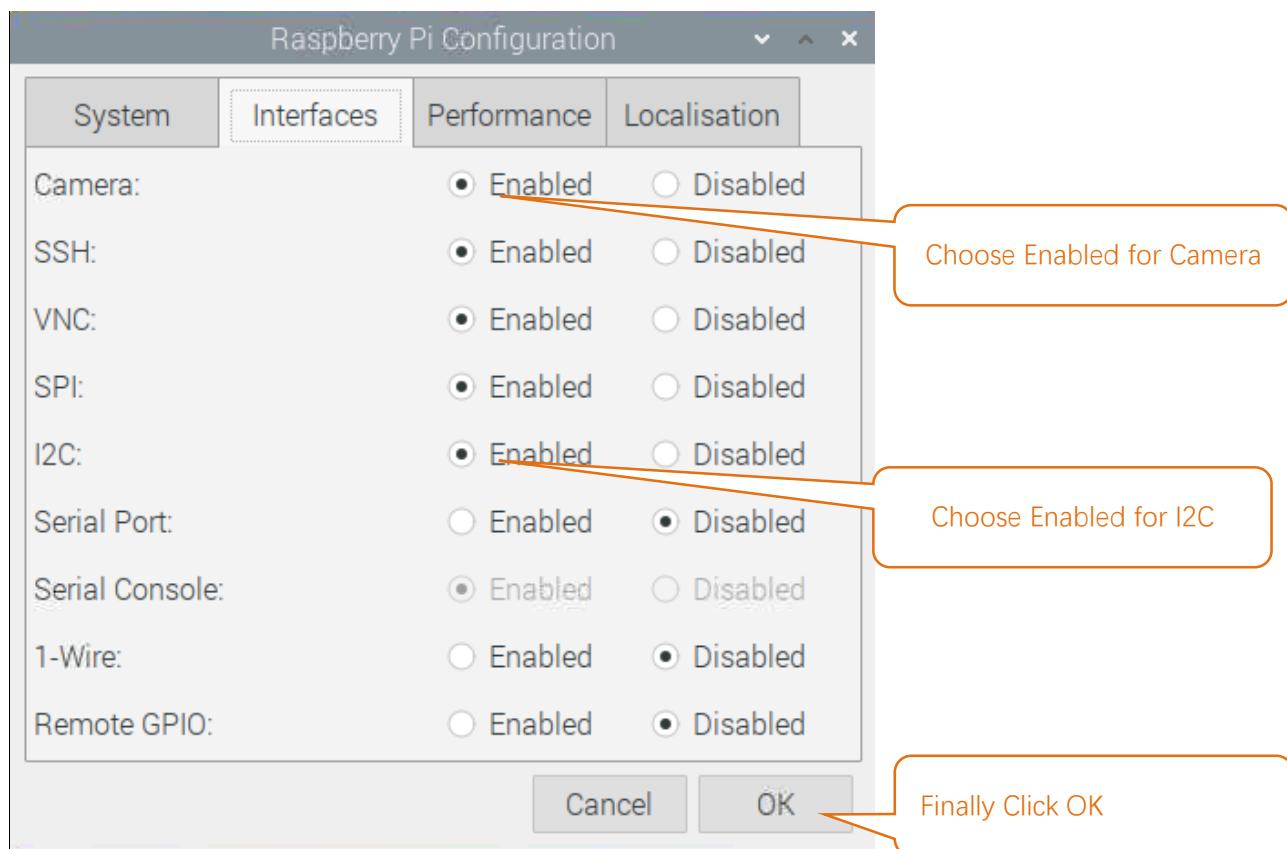
As shown below, under the ‘~’directory, enter the Documents directory with the “cd” command. After typing “cd D”, press Tab key, then there is no response. Press Tab key again, then all the files/folders that begin with “D” is listed. Continue to type the character “oc”, then press the Tab key, and then “Documents” is completed automatically.

```
pi@raspberrypi:~ $ cd D  
Desktop/  Documents/ Downloads/  
pi@raspberrypi:~ $ cd Doc█
```

```
pi@raspberrypi:~ $ cd D  
Desktop/  Documents/ Downloads/  
pi@raspberrypi:~ $ cd Documents/
```

Step 2 Enable I2C and Camera

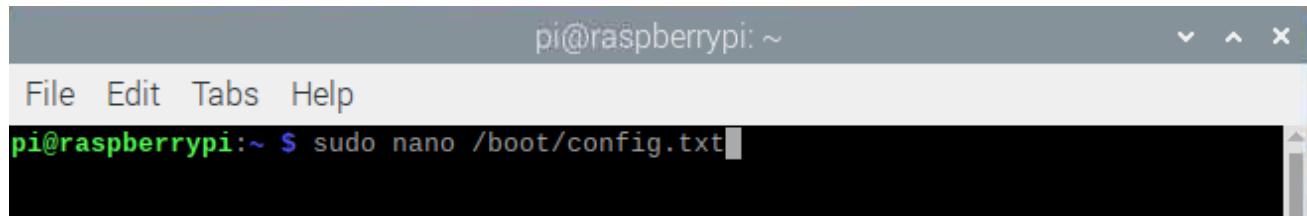




Set I2C Baud Rate

Open the terminal and enter following command.

```
sudo nano /boot/config.txt
```



The default I2C Baud Rate is 100000. Now we change it to 400000. Because this can speed up the response speed of the servos to make robot dog walk faster. If the baud rate is 100,000, the robot walks slowly.

Scroll the middle of the mouse to find **dtparam=i2c_arm=on**, and add "**i2c_arm_baudrate=400000**".

```
pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 3.2          /boot/config.txt

# uncomment to force a HDMI mode rather than DVI. This can make audio work in
# DMT (computer monitor) modes
#hdmi_drive=2

# uncomment to increase signal to HDMI, if you have interference, blanking, or
# no display
#config_hdmi_boost=4

# uncomment for composite PAL
#sdtv_mode=2

#uncomment to overclock the arm. 700 MHz is the default.
#arm_freq=800

# Uncomment some or all of these to enable the optional hardware interfaces
dtparam=i2c_arm=on,i2c_arm_baudrate=400000
#dtparam=i2s=on
#dtparam=spi=on
[ Wrote 67 lines ]
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos
^X Exit      ^R Read File ^V Replace   ^U Uncut Text ^T To Spell ^_ Go To Line
```

Press "CTRL"+"O" and then "Enter" to save the modified content. Then press "CTRL"+"X" to exit editing.

After the modification is completed, reboot Raspberry Pi to make the change work. You can also reboot the Raspberry Pi after completing the step 3 below.

Step 3 Run the Installation Program

All the commands are based on python3. If the default python is python2, please refer to the [Step1](#) to set python3 to default python.

1. Execute following commands to enter directory of "setup.py".

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code
```

2. Run setup.py

```
sudo python setup.py
```

This program will automatically install the pca9685, rpi_ws281x, PyQt5 library, etc. Please **reboot** the Raspberry Pi after the installation is completes, as shown below.

```
Now the installation is successful.
```

```
Please restart raspberry pi
```

If the installation fails, please rerun setup.py. After the installation is complete, restart the Raspberry Pi. Most installation failures are caused by network reasons.

```
sudo python setup.py
```

Chapter 2 Assemble Robot

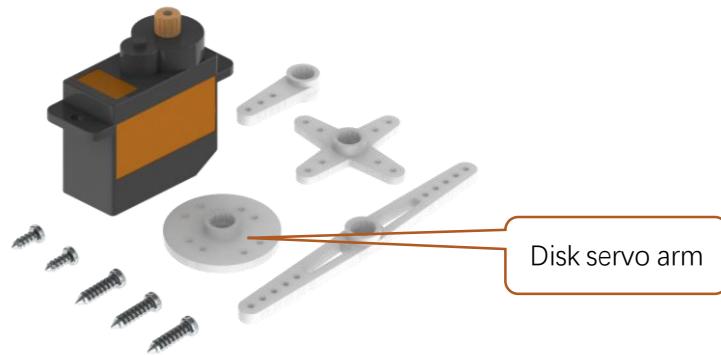
If there are any concerns, please feel free to contact us at support@freenove.com

It is recommended to assemble and use the robot dog according to the tutorial. Otherwise, there may be installation errors, device damage, etc.

Don't driver the screws too tight in the assembly.

Step 1 Install Disk Servo Arms

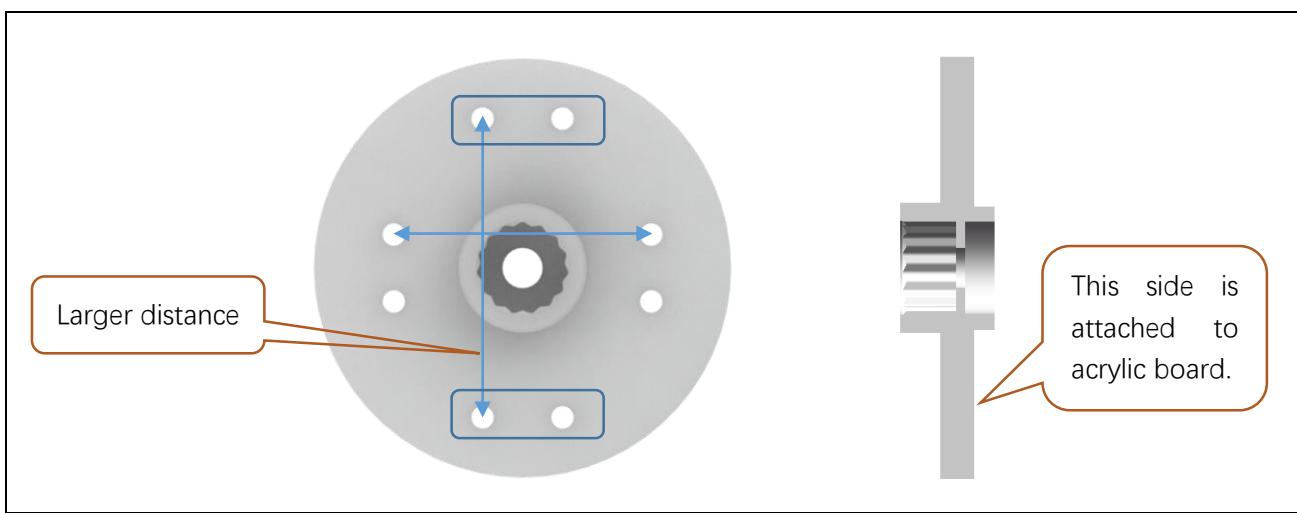
Take out 12 disk servo arms from the servo package.



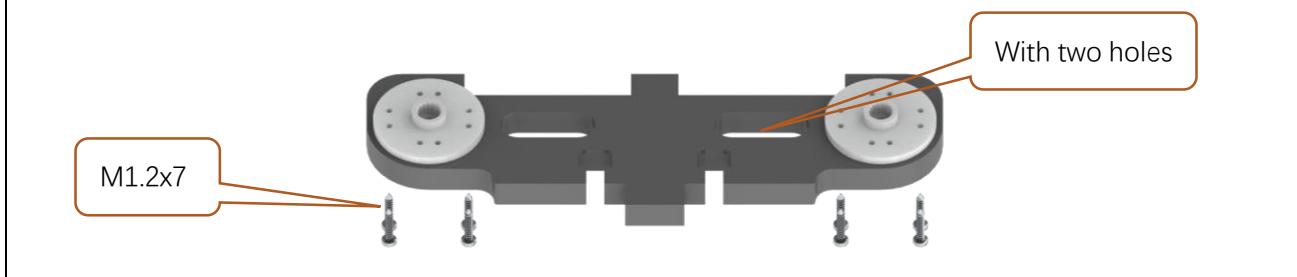
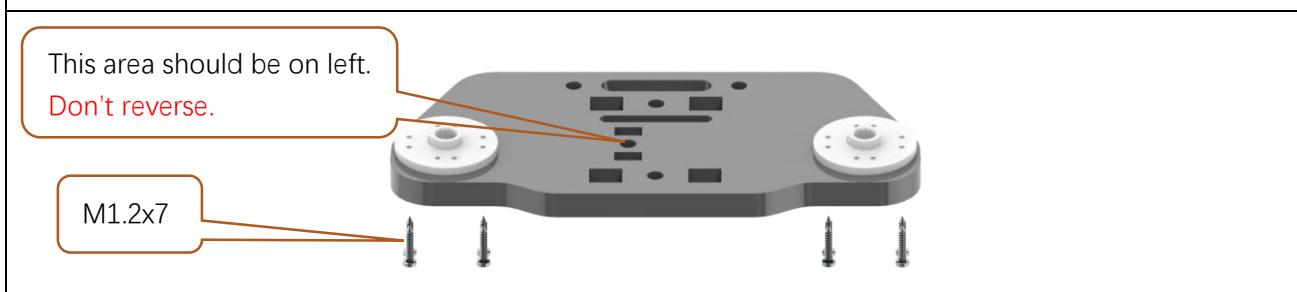
The distance between two holes are different.

Please use the holes with **larger distance** between them.

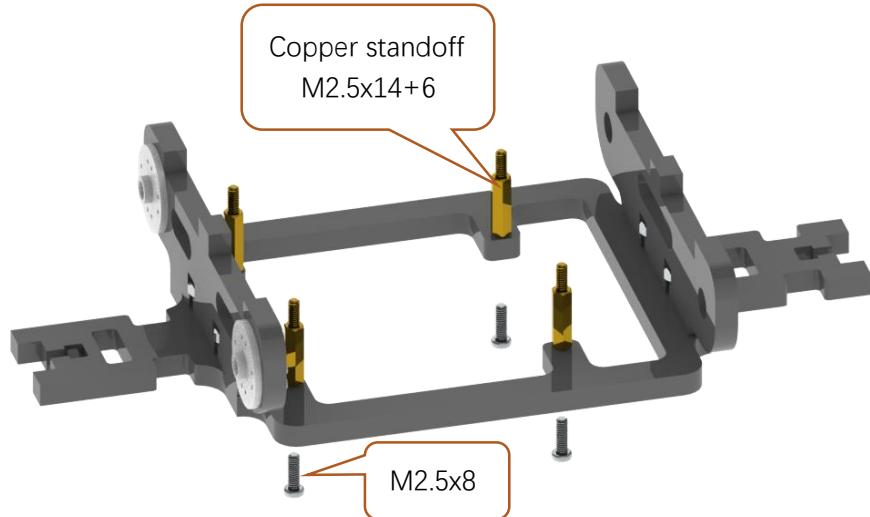
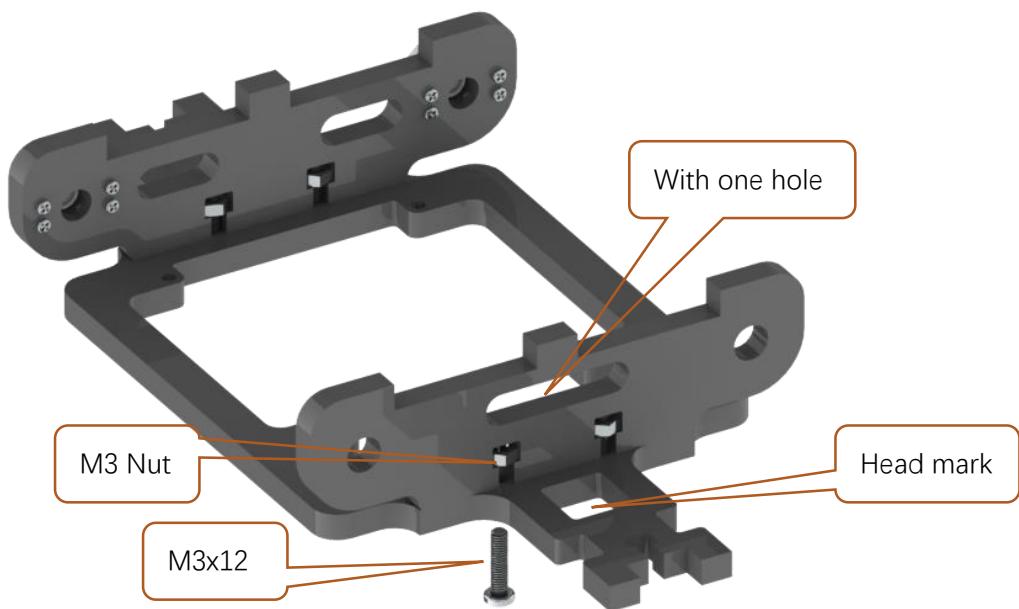
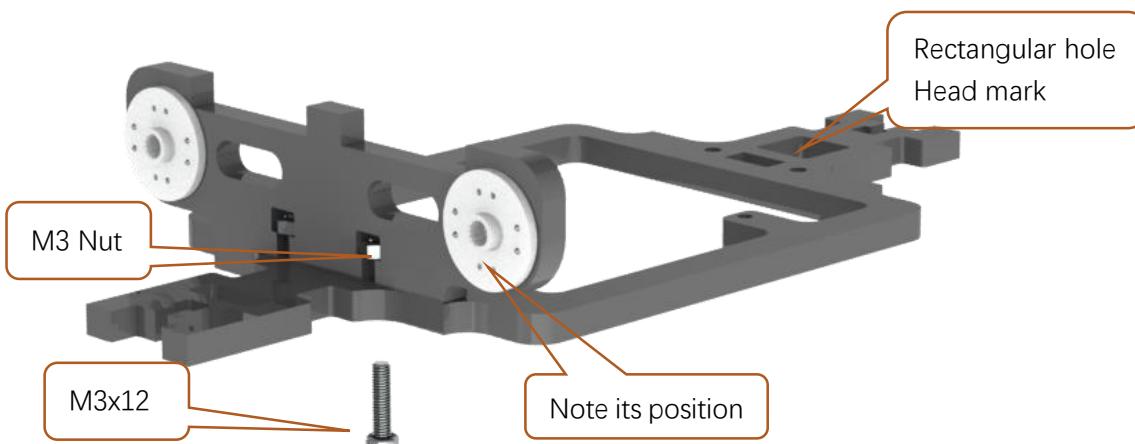




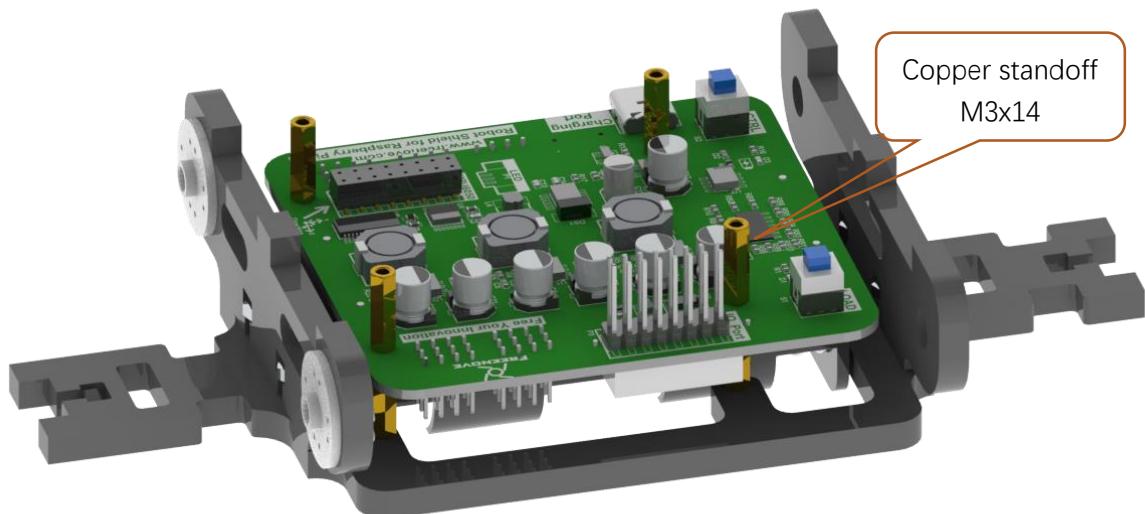
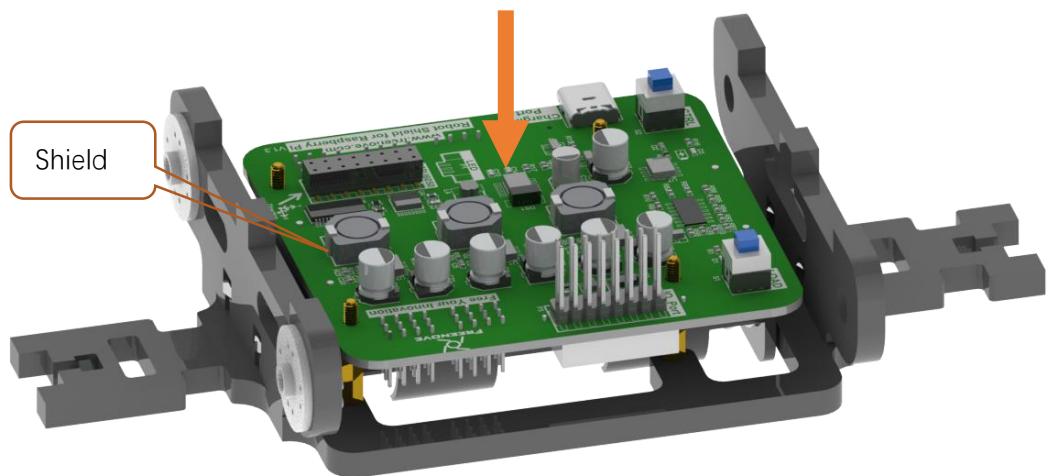
Get following 4 parts.



Step 2 Install Body Bracket

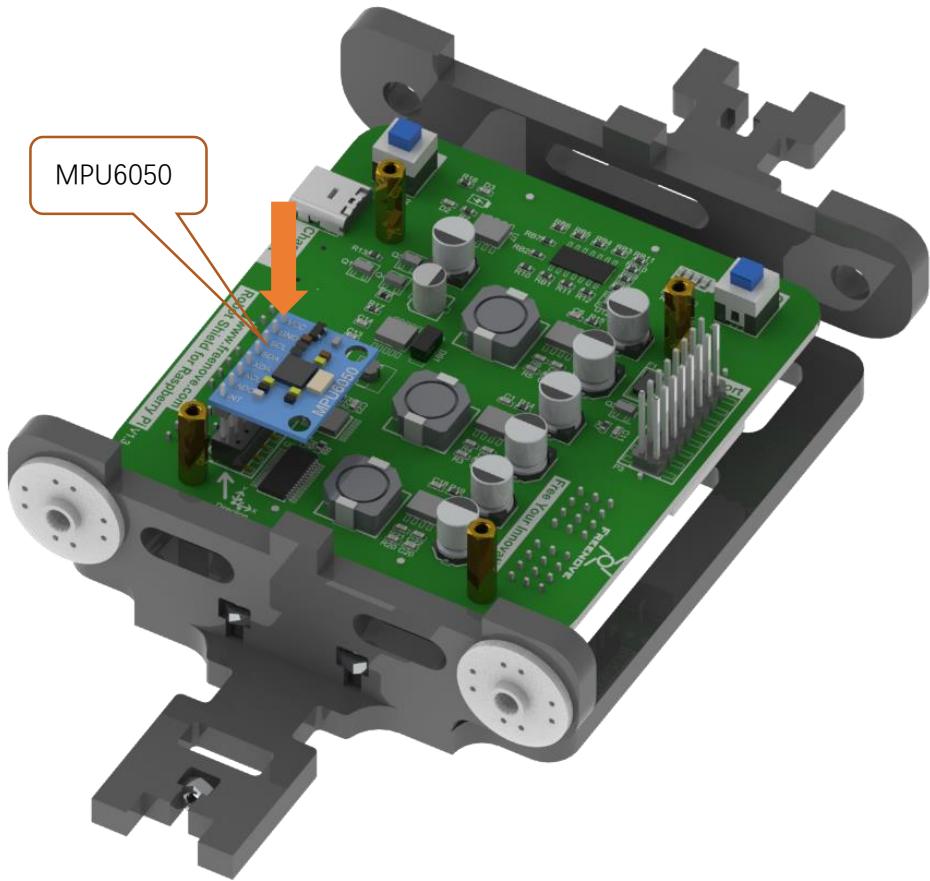


Step 3 Install Shield

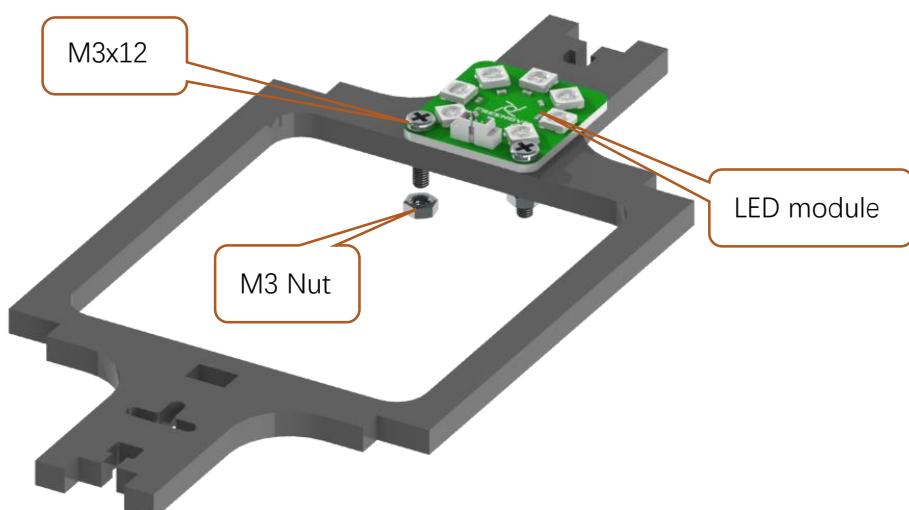


Step 4 Install MPU6050

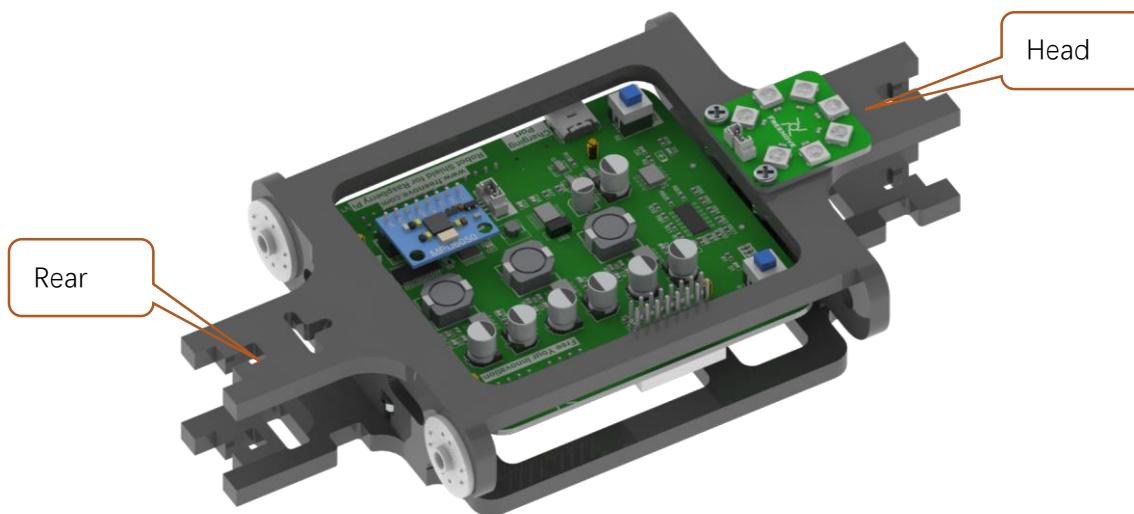
Note: There are two rows of row headers, fit MPU6050 to the Row toward outside.



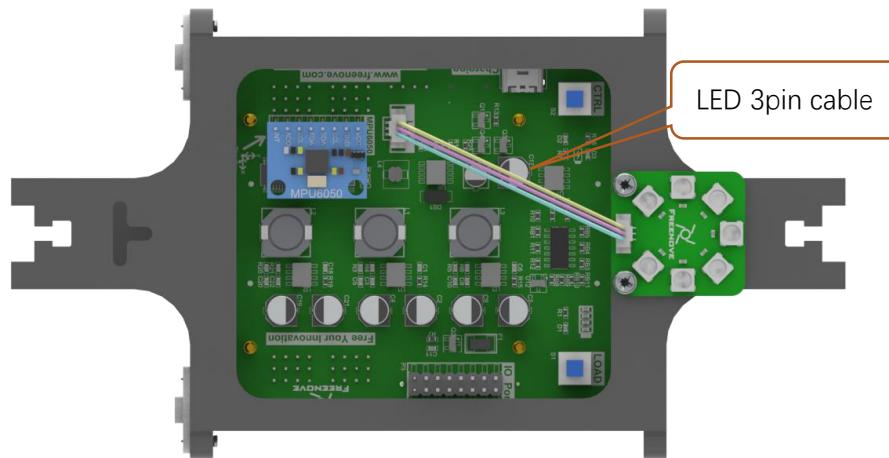
Step 5 Install LED module



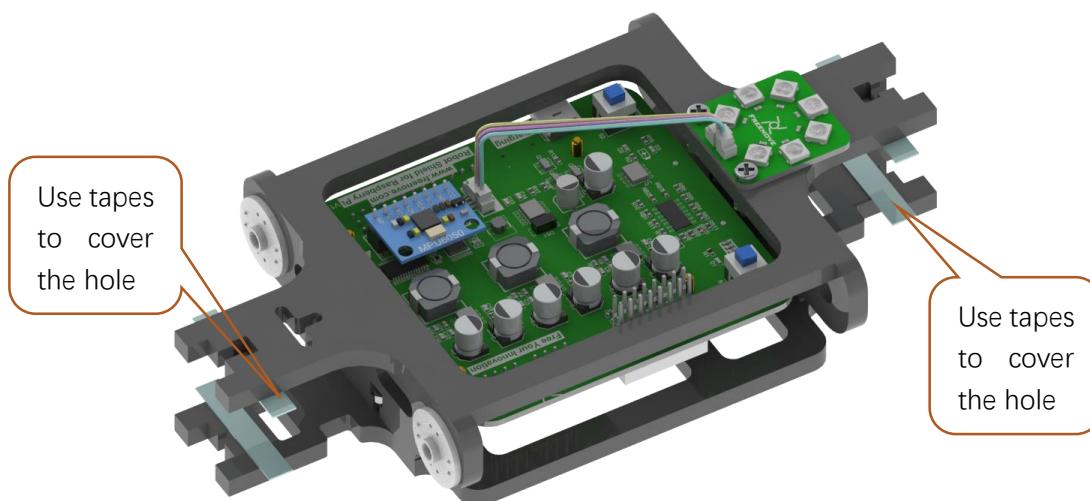
Put the top board on the body part.



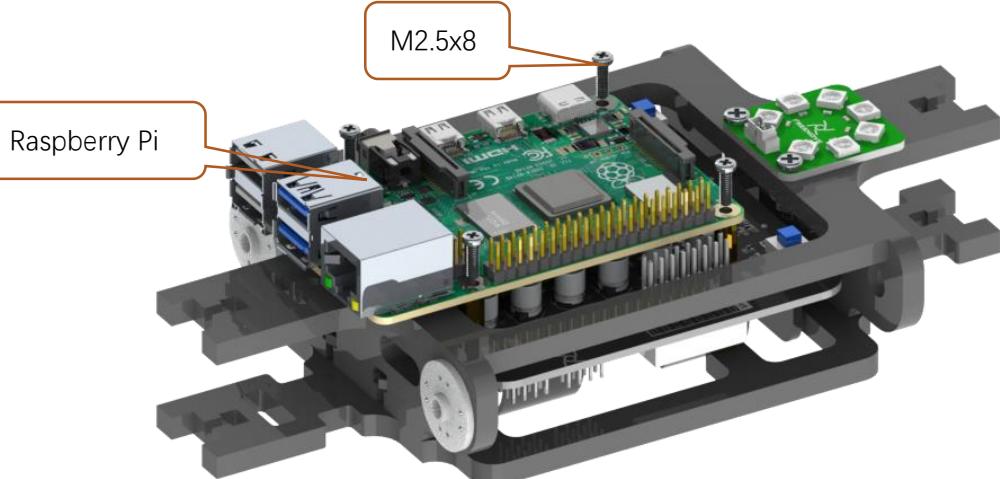
Connect shield with LED module with shield.



This step will be very helpful for later assembly.

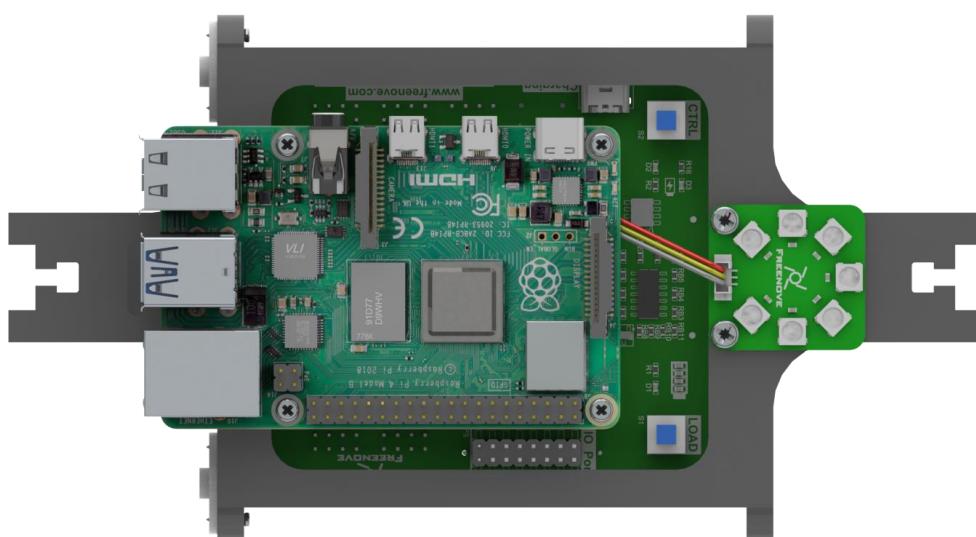
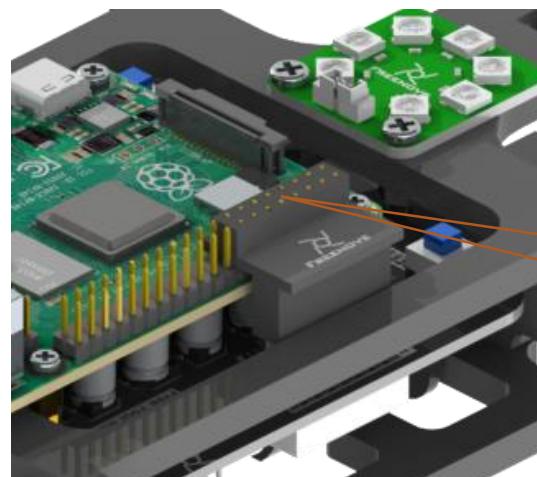
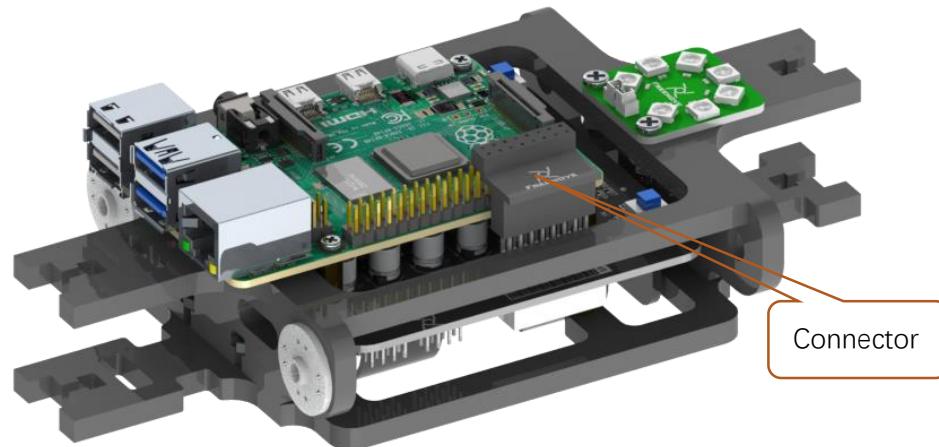


Step 6 Install Raspberry Pi



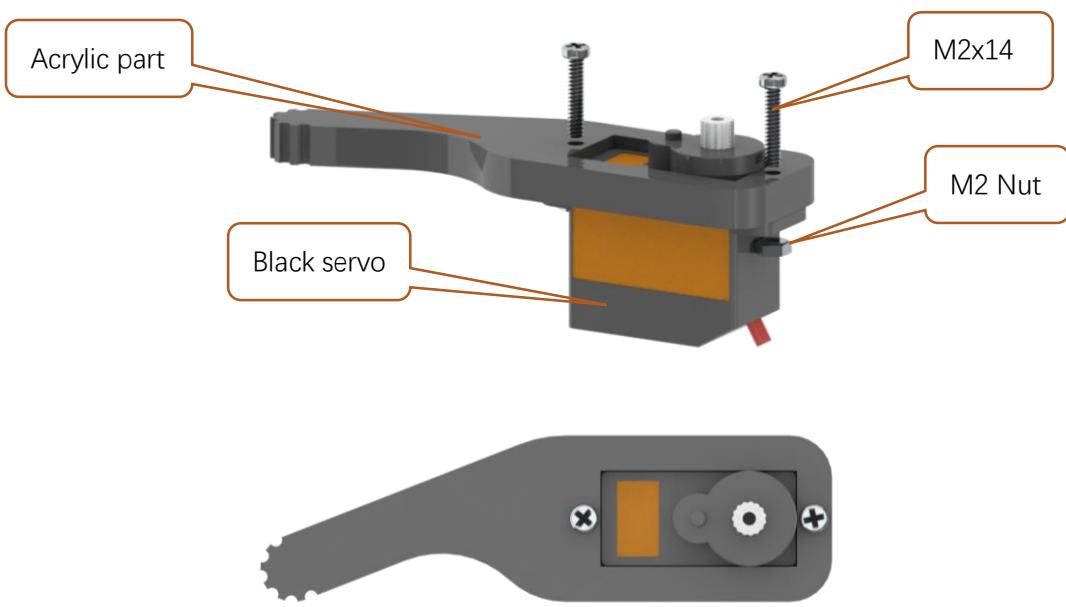
Step 7 Install Connector

Install connector to connect Raspberry Pi and shield.

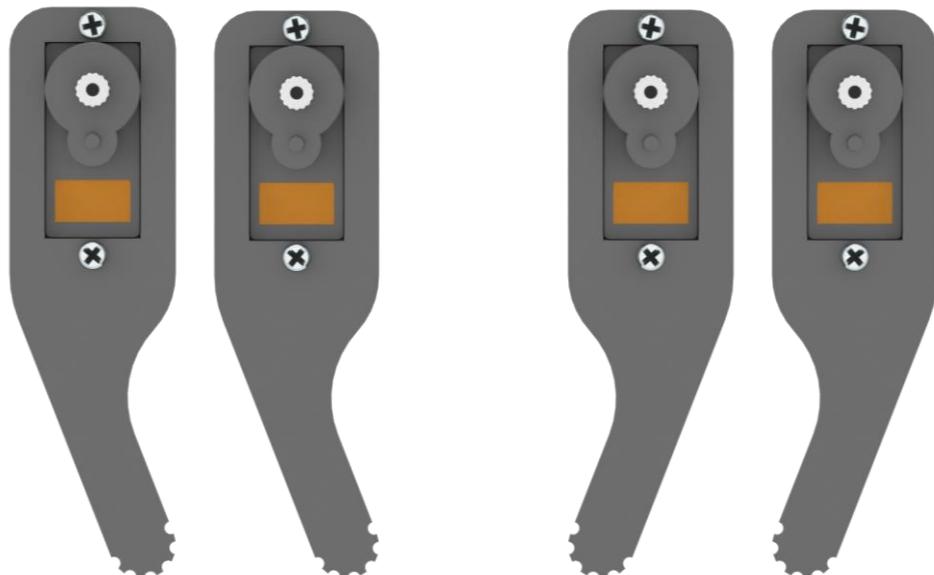


Now we have assembled the core body part. We will assemble leg parts later.

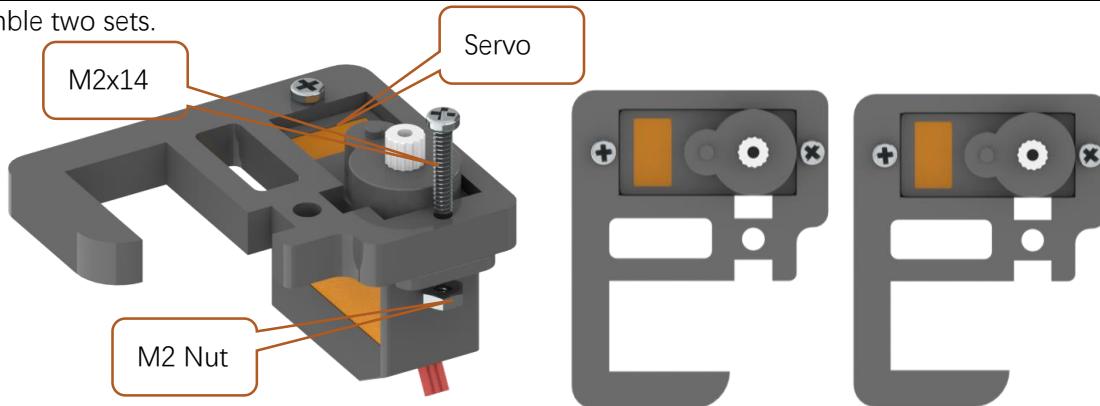
Step 8 Install Servo to Acrylic Board



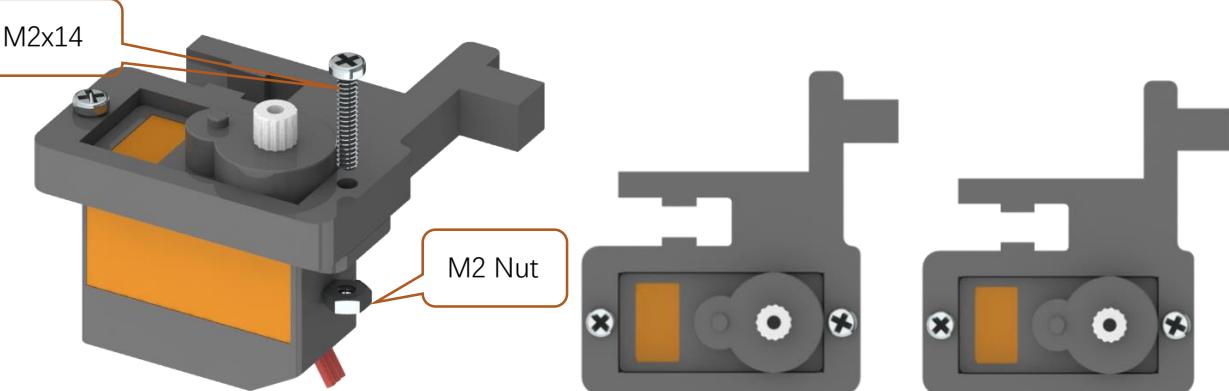
Note: There are four parts. They are different .



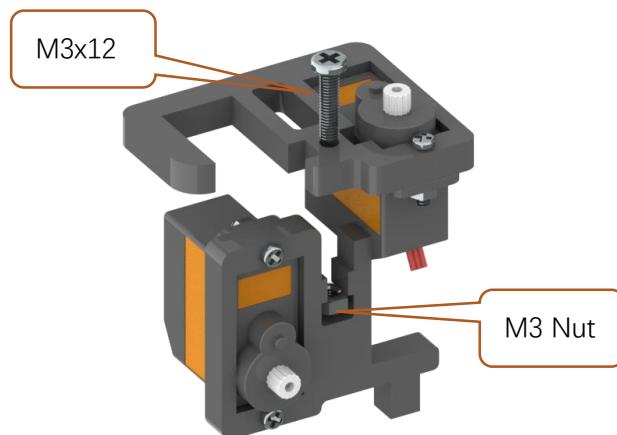
Assemble two sets.



Assemble two sets.



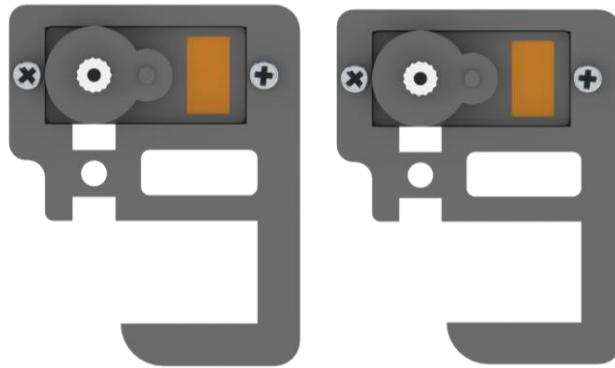
Assemble parts above.



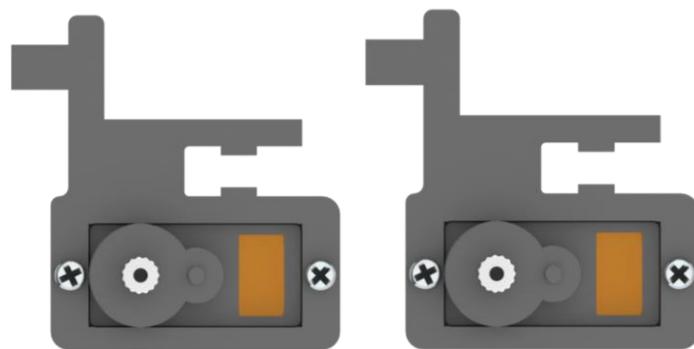
Now you get two sets joint parts.



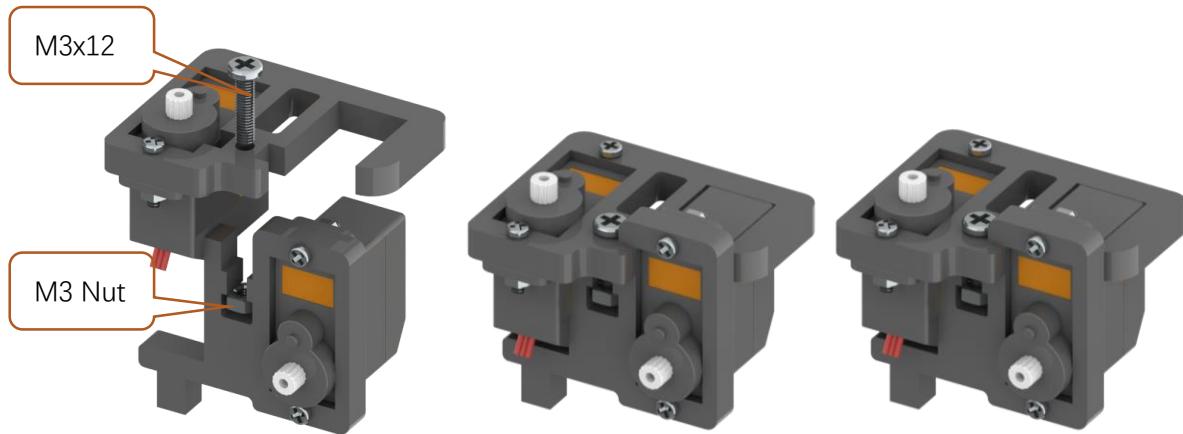
Assemble another two parts. **Note: they are different from parts above.**



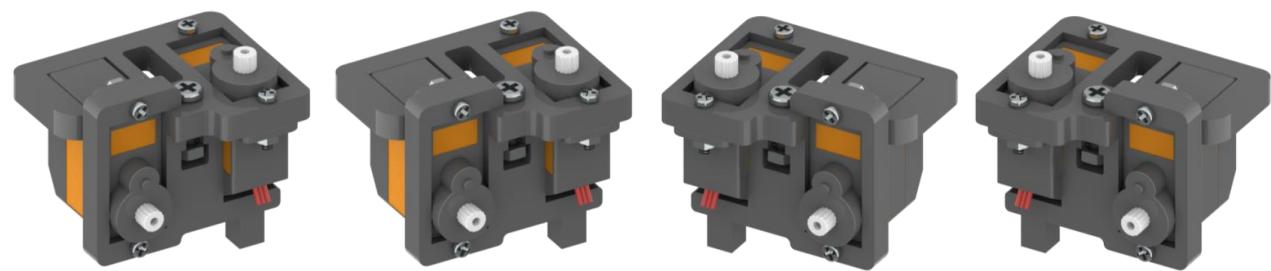
Assemble another two parts. **Note: they are different from parts above.**



Assemble them.

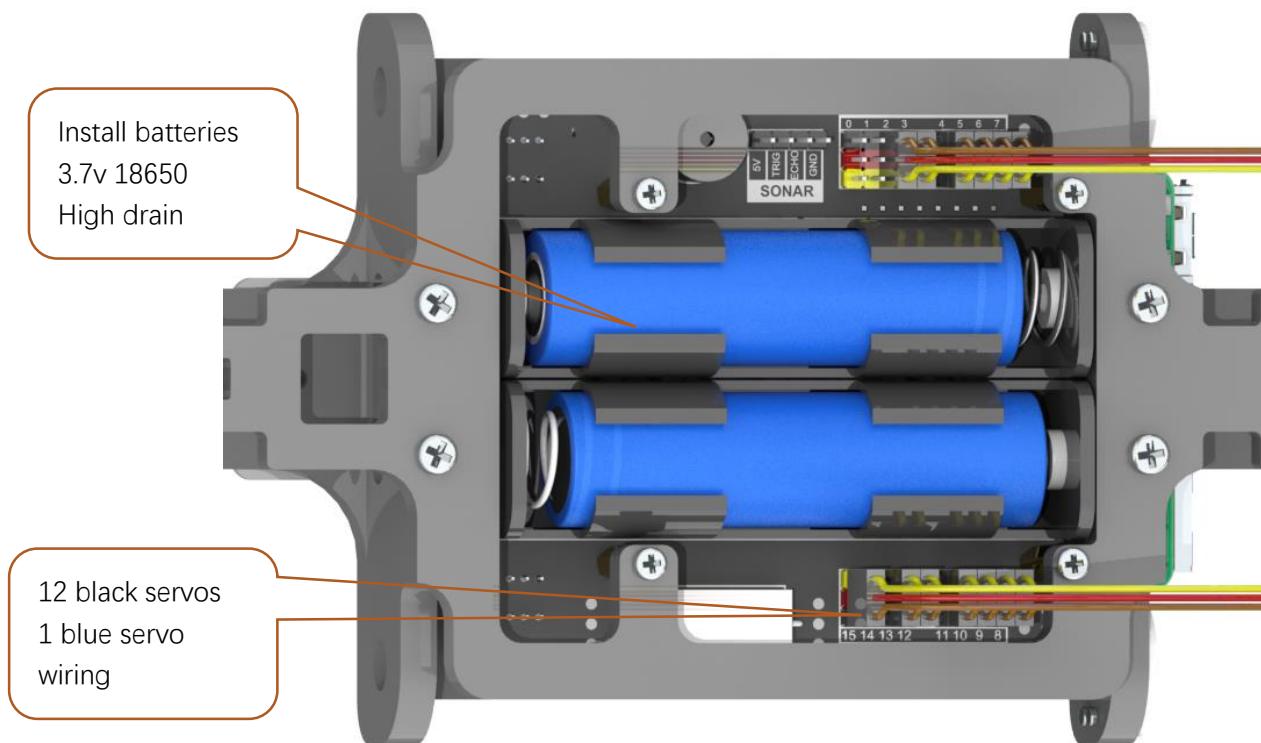


Now you will get four parts like below. **Note, they are different.**

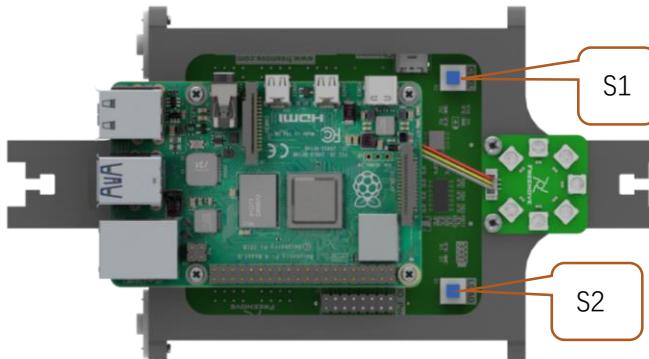


Step 9 Run Servo Program (Necessary)

Connect **All** 12 **black** servos and 1 **blue** servo to servo port **Randomly**. And install **batteries**.



You can still use cable to power Raspberry Pi with switches on. If you disconnect cable, the batteries will power Raspberry Pi. Press **S1** and **S2**. There will be two indicators on.



Turn on the Raspberry Pi. Make sure all three steps in Chapter 1 have been performed correctly. Otherwise, please perform the steps in Chapter 1 first.

- Type command below to enter servo code folder "Server".

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

- Run Servo.py

```
sudo python Servo.py
```

Then all servos will rotate to 90°. It is a necessary initialization.

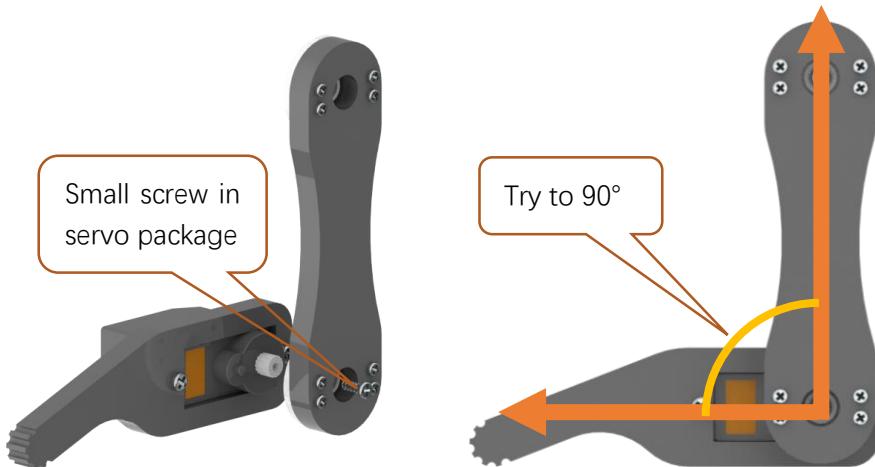
Next we will connect the servos to disk arm.

Keep the power on and all servo connected. Don't disconnect servo.

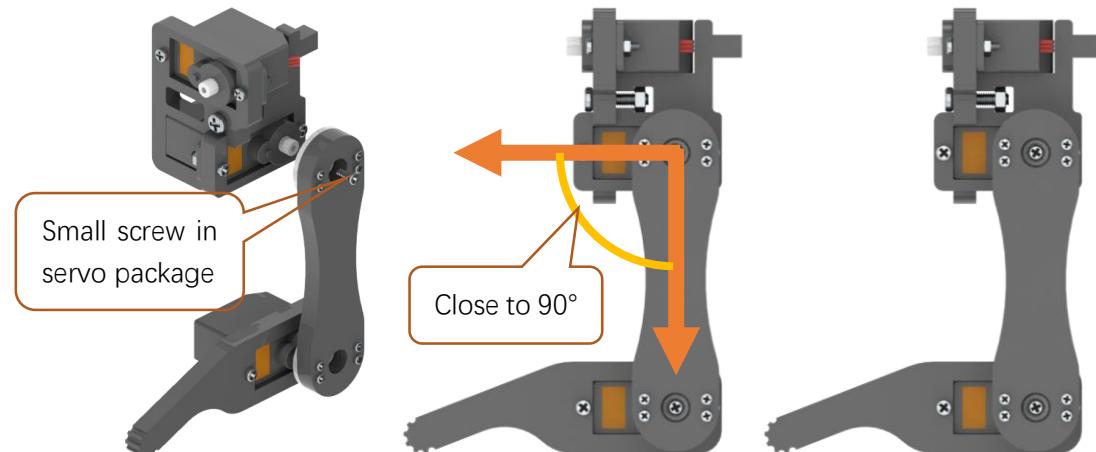
Step 10 Assemble Leg to Body

Keep the power on and all servo connected to shield. Don't disconnect wiring. We need keep the servo under 90° when connected to arm. (servo wires are not show later.)

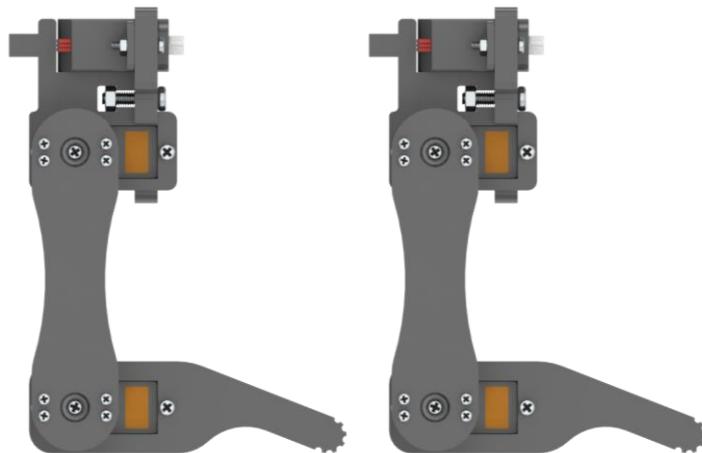
Try to install them colesed to 90°. The angles are reasonable within 65~115.



Assemble legs of one side. Try to install them 90°. The angles are reasonable within 65~115.

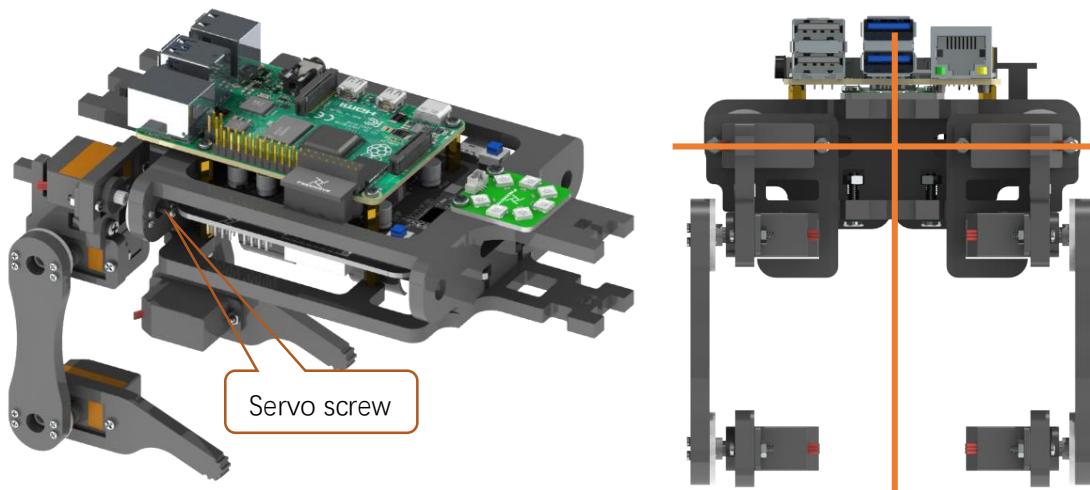


Assemble legs of another side.

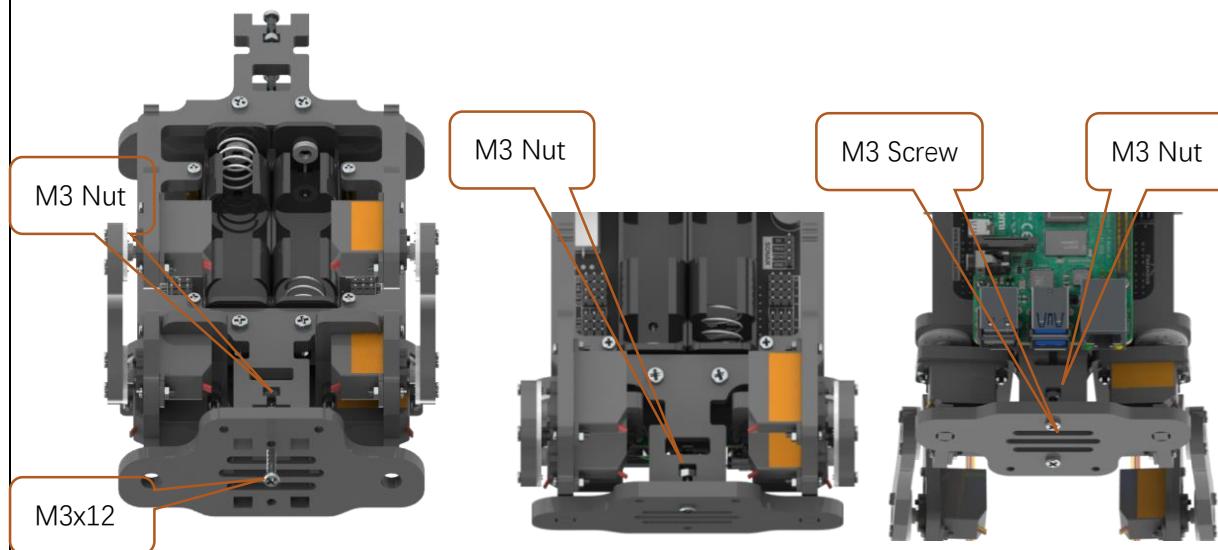


Keep the power on and all servo connected to shield. Don't disconnect wiring.

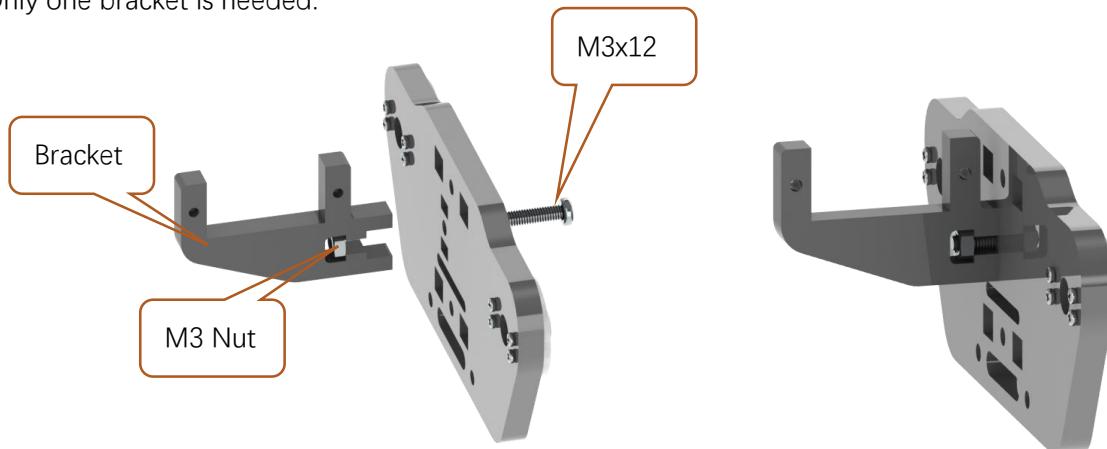
Select two legs of **different sides** as rear legs. And install them as below. Then install the servo screws.



In this step, if you did not cover tape to the holes, you can turn off **Load S1** to stall the screw. After the screw is installed, turn on the **Load S1**.

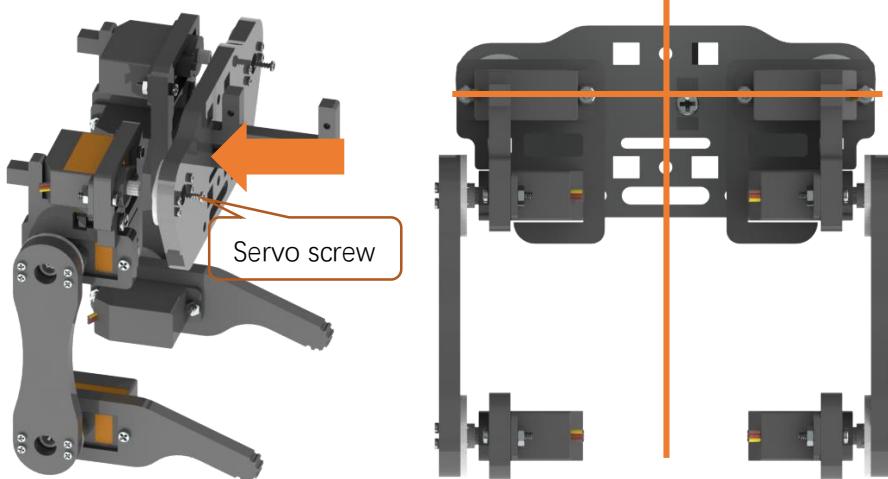


Only one bracket is needed.

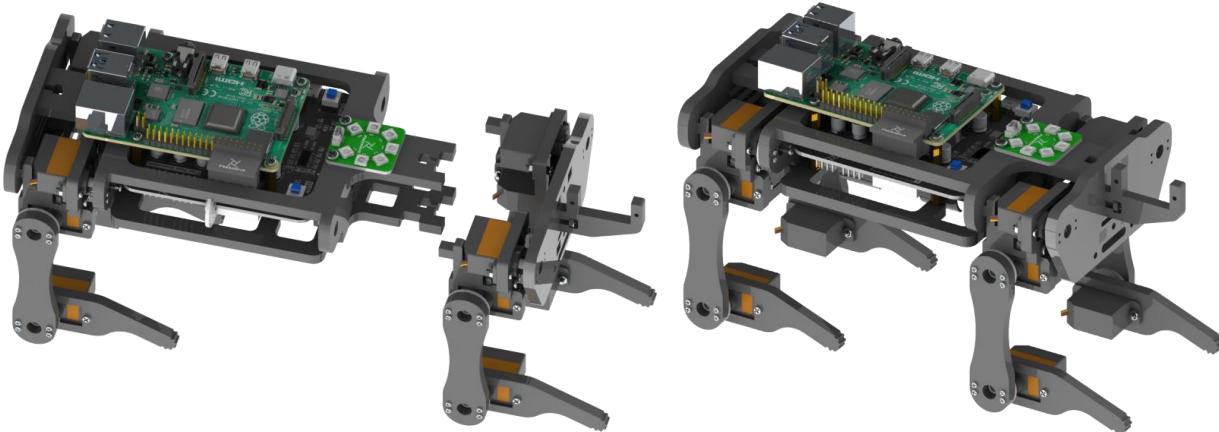


Keep the power on and all servo connected to shield. Don't disconnect wiring.

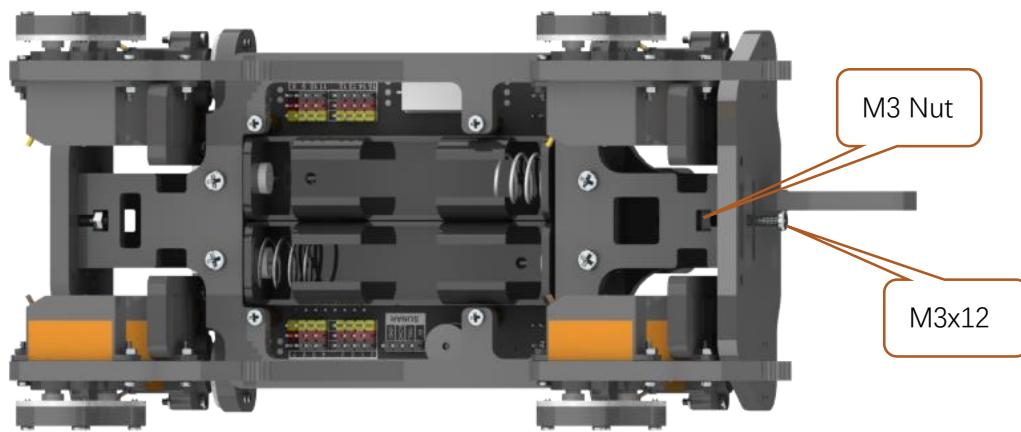
Assemble front legs and install the servo screw.

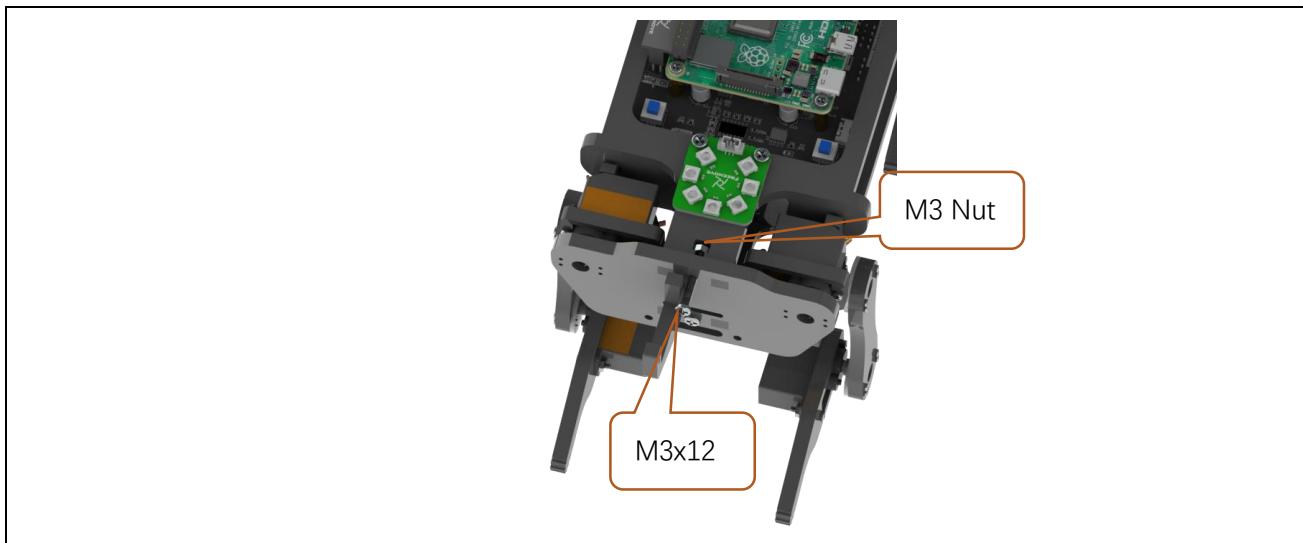


Assemble them.

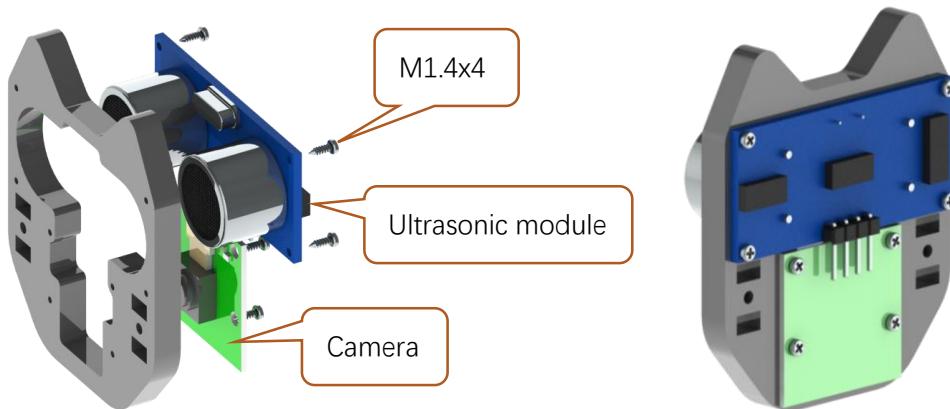


In this step, if you did not cover tape to the holes, you can turn off **Load S1** to stall the screw. After the screw is installed, turn on the **Load S1**.

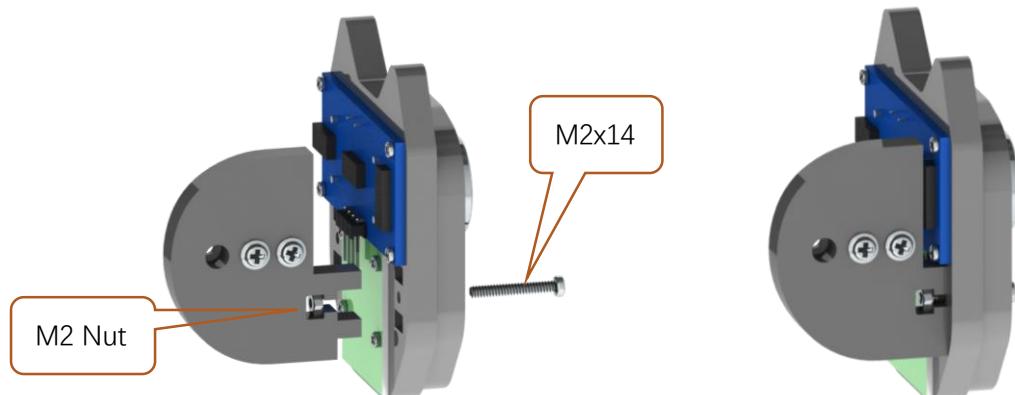
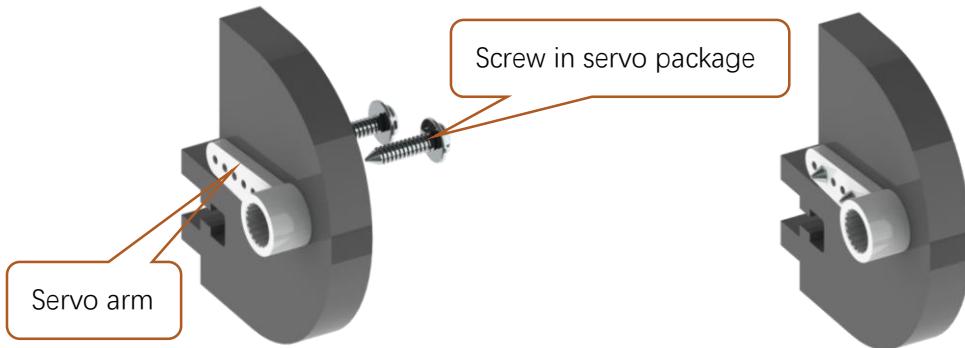




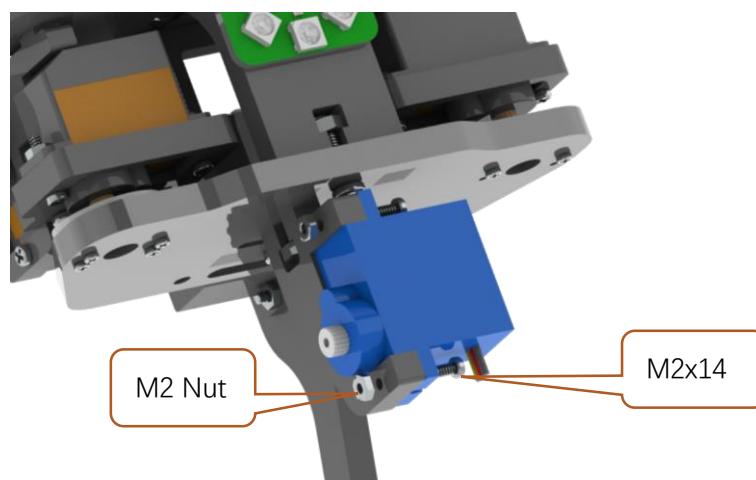
Step 11 Assemble Head



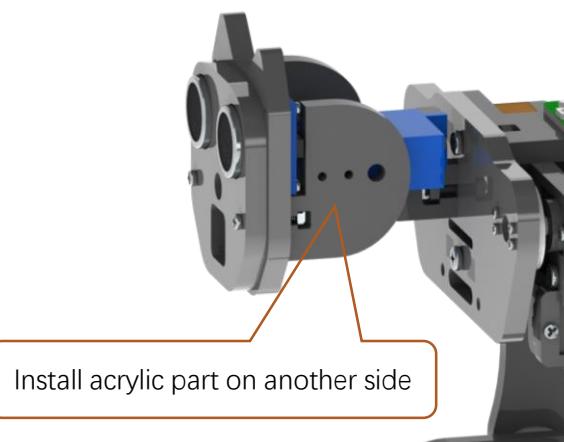
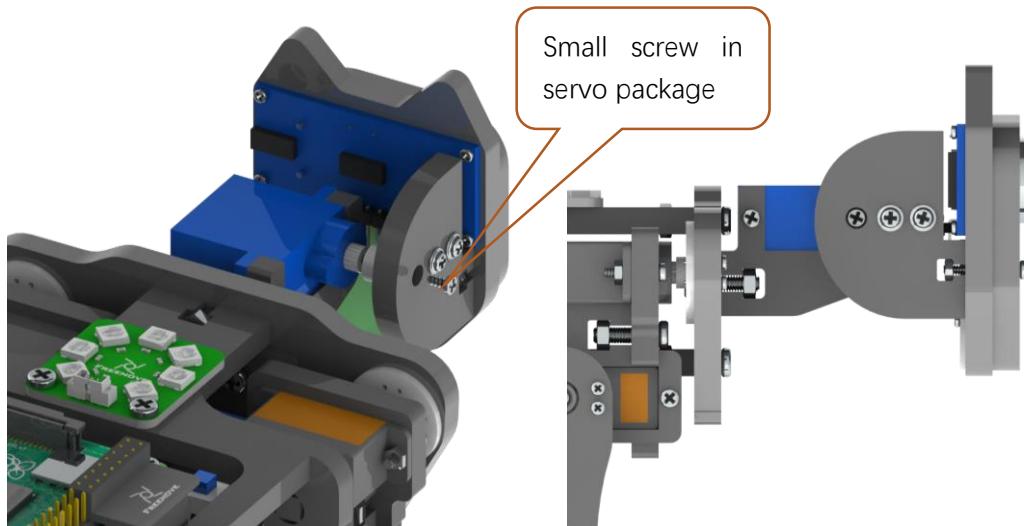
The servo arm and screw are included in the blue servo package.



Step 12 Assemble Head to Body



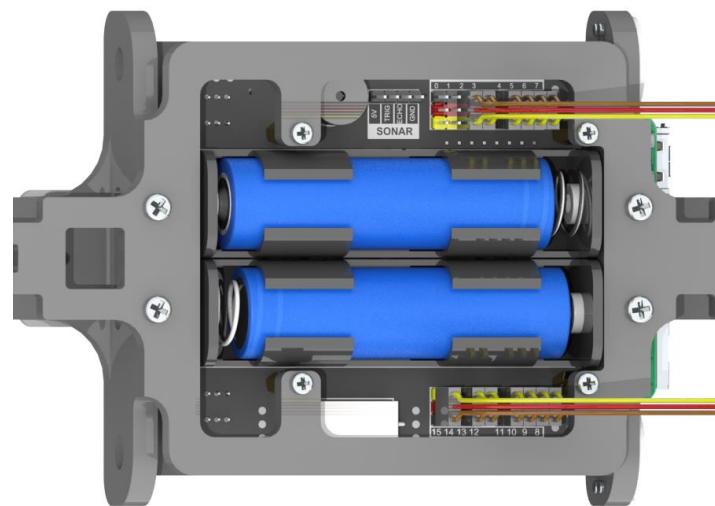
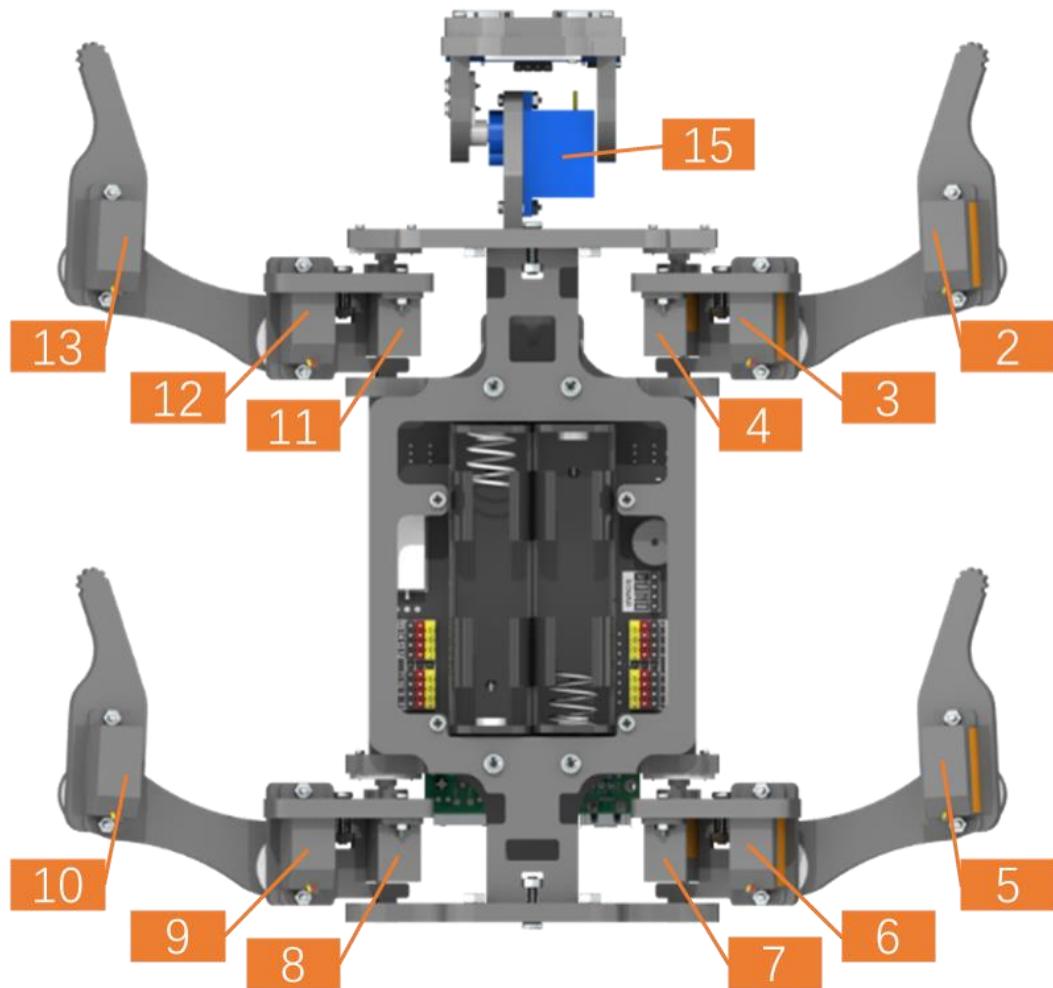
Keep the power on and servo connected when install arm to servo.



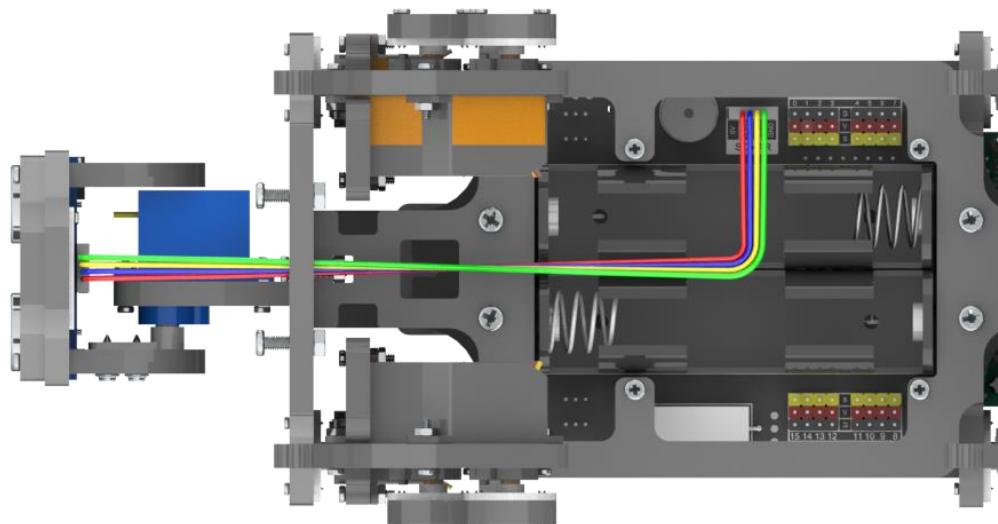
We will complete wiring in next section. Shut down the Raspberry Pi first. Don't turn on Raspberry Pi until chapter 3.

Step 13 Wiring

Connect servo according to the numbers. **Note servo port 0, 1, 14 have no servo.** They are spare.

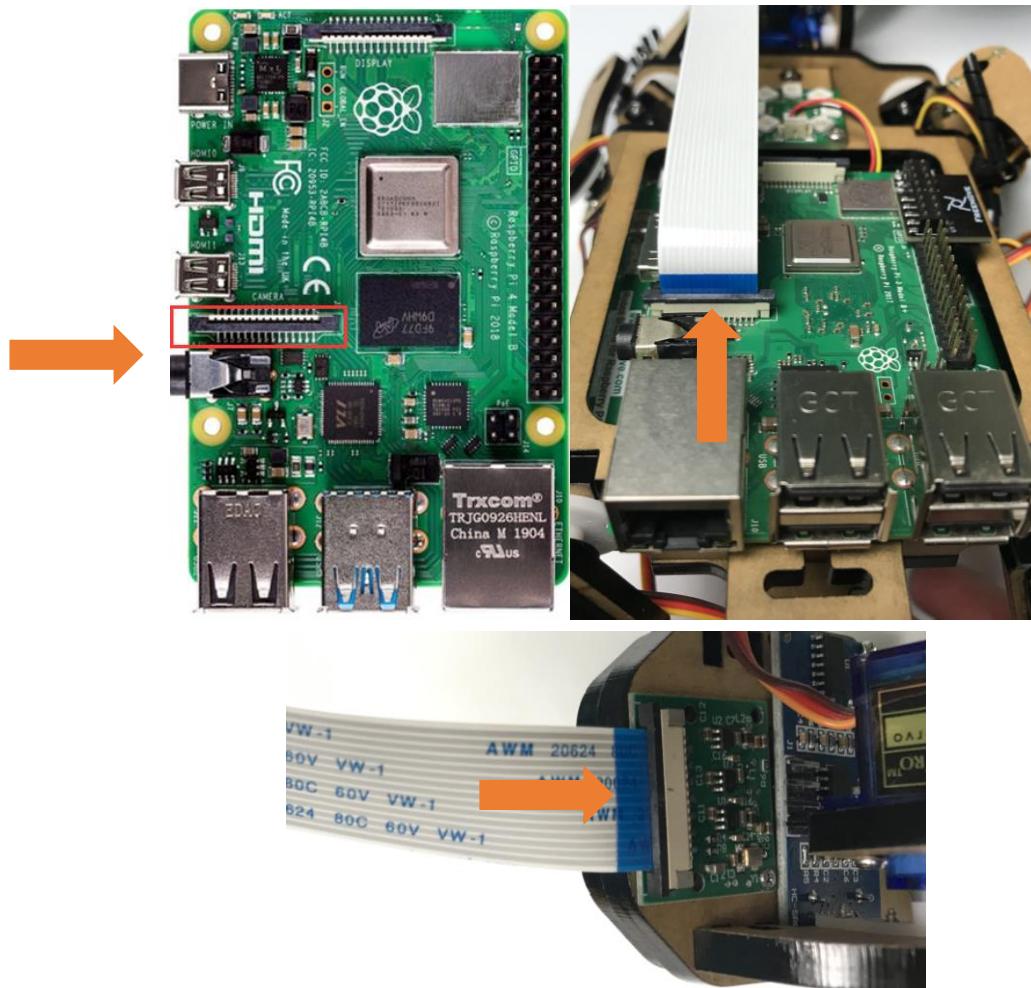


Ultrasonic module wiring (Note: **Do not connect wrongly. If you connect 5V to GND, this may damage the ultrasonic module**)

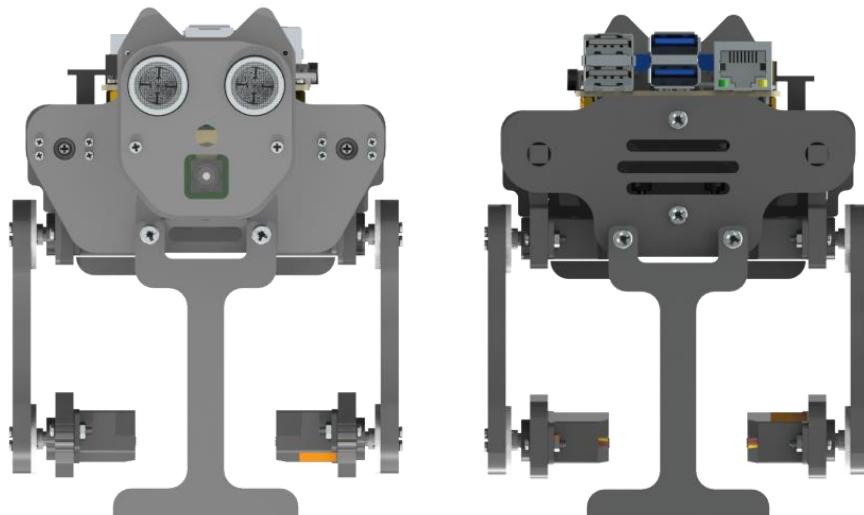
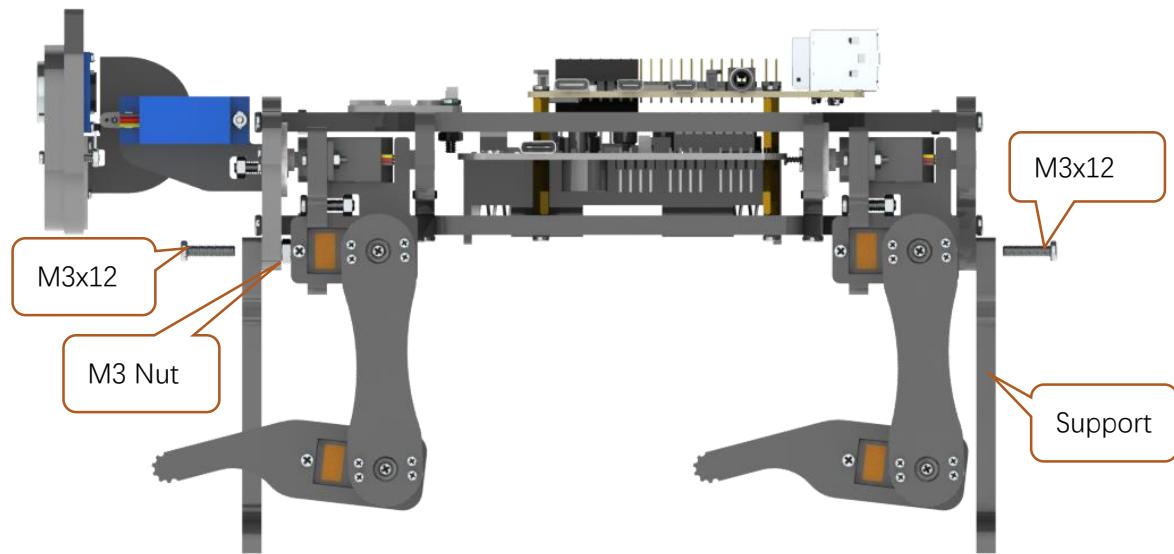


Pay attention to the **blue** side of camera cable.

(Note: plugging and unplugging the cable requires the Raspberry Pi to be powered off, otherwise the camera module may be burned.)



Step 14 Install Calibration Support



Chapter 3 Module test (necessary)

If there are any concerns, please feel free to contact us at support@freenove.com

The robot dog has been assembled in the previous chapter. This chapter will test each module of the robot dog. It is a necessary check for later control.

Before starting, please install the battery for the robot dog and **turn on the S1 and S2 switches**. Place the robot dog with the calibration supports on a horizontal table to ensure that the wiring of each servo is correct.

It is recommended to use [VNC Viewer](#) to build this robot when you use remote mode to login RPi, or there will be errors. Some remote way doesn't support GUI.

Servo

Execute following command to check i2c address.

```
i2cdetect -y 1
```

As shown in the figure below, the addresses 0x40, 0X48, and 0X68 correspond to the PCA9685 chip, ADS7830 chip, and MPU6050 module, respectively.

```
pi@raspberrypi:~ $ i2cdetect -y 1
      0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00: --
10: --
20: --
30: --
40: 40 -- -- -- -- 48 -- -- -- -- --
50: --
60: -- -- -- -- -- 68 -- -- -- -- --
```

Run program

Enter following commands in the terminal to test servos.

If the terminal displays the directory as below (where test.py is located). You can **directly** execute the test.py command.

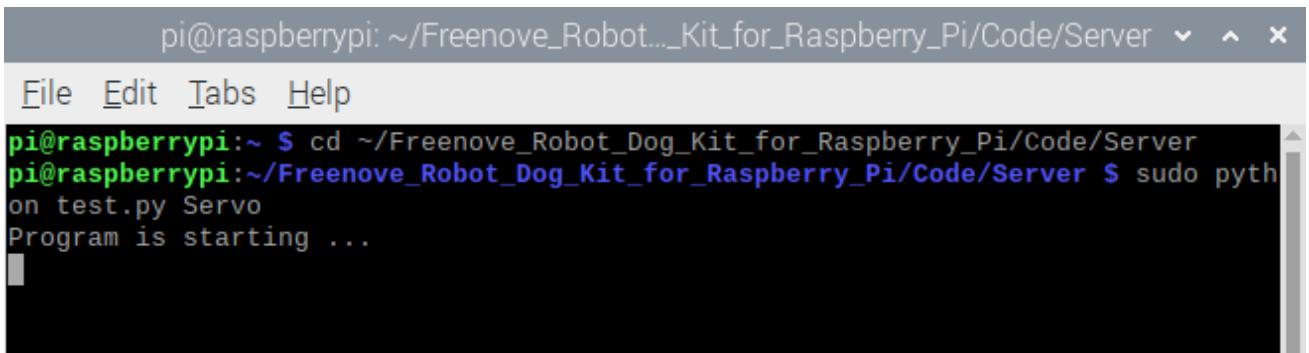
```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1. If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2. Execute test.py command:

```
sudo python test.py Servo
```



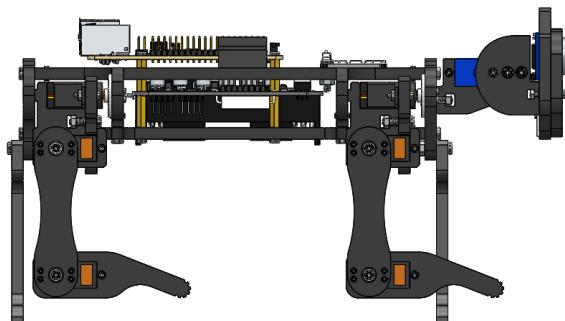
```
pi@raspberrypi: ~ /Freenove_Robot_Dog_Kit_for_Raspberry_Pi /Code /Server <-->
File Edit Tabs Help
pi@raspberrypi: ~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi /Code /Server
pi@raspberrypi: ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi /Code /Server $ sudo python
on test.py Servo
Program is starting ...
```

Result:

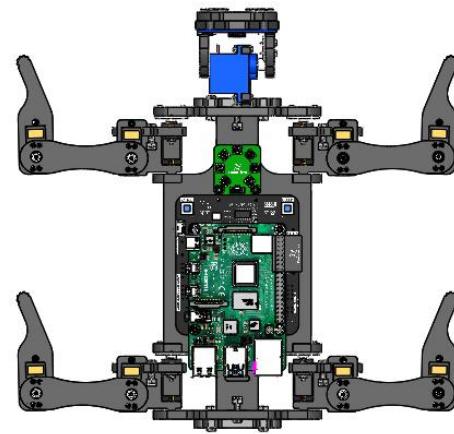
After assembly before in last chapter, the robot should be shown as picture A.

After servo test program is executed, the robot posture will change to A, B, C, D gradually, which indicates the servo channel works normally.

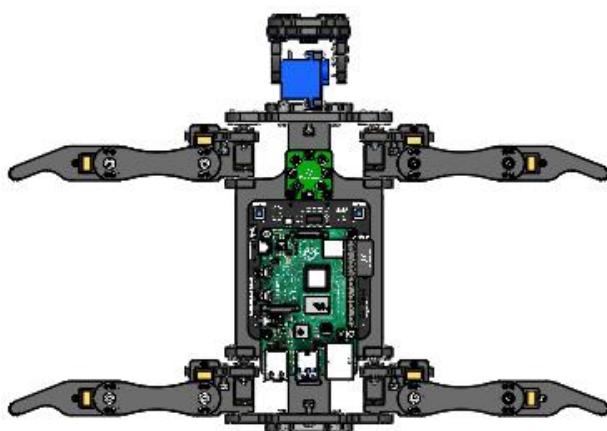
If the situation is not correct, check the servo [wiring](#).



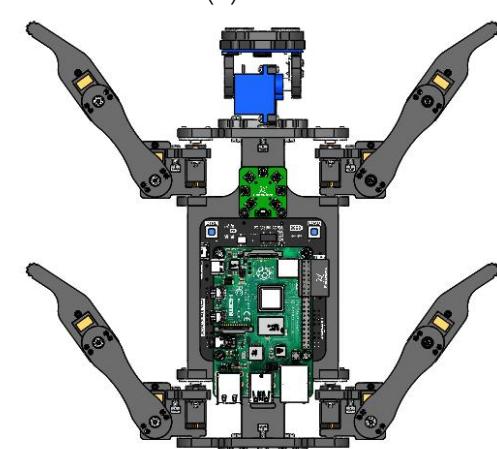
(A)



(B)



(C)



(D)

The code is as below:

```
1  from Servo import *
2  servo=Servo()
3  def test_Servo():
4      try:
5          for i in range(90):
6              servo.setServoAngle(4, 90-i)
7              servo.setServoAngle(7, 90-i)
8              servo.setServoAngle(8, 90+i)
9              servo.setServoAngle(11, 90+i)
10             time.sleep(0.01)
11         for i in range(90):
12             servo.setServoAngle(2, 90-i)
13             servo.setServoAngle(5, 90-i)
14             servo.setServoAngle(10, 90+i)
15             servo.setServoAngle(13, 90+i)
16             time.sleep(0.01)
17         for i in range(60):
18             servo.setServoAngle(3, 90-i)
19             servo.setServoAngle(6, 90-i)
20             servo.setServoAngle(9, 90+i)
21             servo.setServoAngle(12, 90+i)
22             time.sleep(0.01)
23         print ("\nEnd of program")
24     except KeyboardInterrupt:
25         print ("\nEnd of program")
```

Reference

setServoAngle(channel, angle)

This function has two parameters to control the Servo of the corresponding channel to the corresponding angle.

The first parameter indicates the servo channel

The second parameter is the rotation angle

Example:

setServoAngle (0,60) The Servo of channel 0 is turned to 60 degrees

setServoAngle (15,160) The Servo of channel 15 is turned to 160 degrees

ADC Module

Run program

Enter following commands to test ADC module.

If the terminal displays the directory as below (where test.py is located). You can **directly** execute second test.py command.

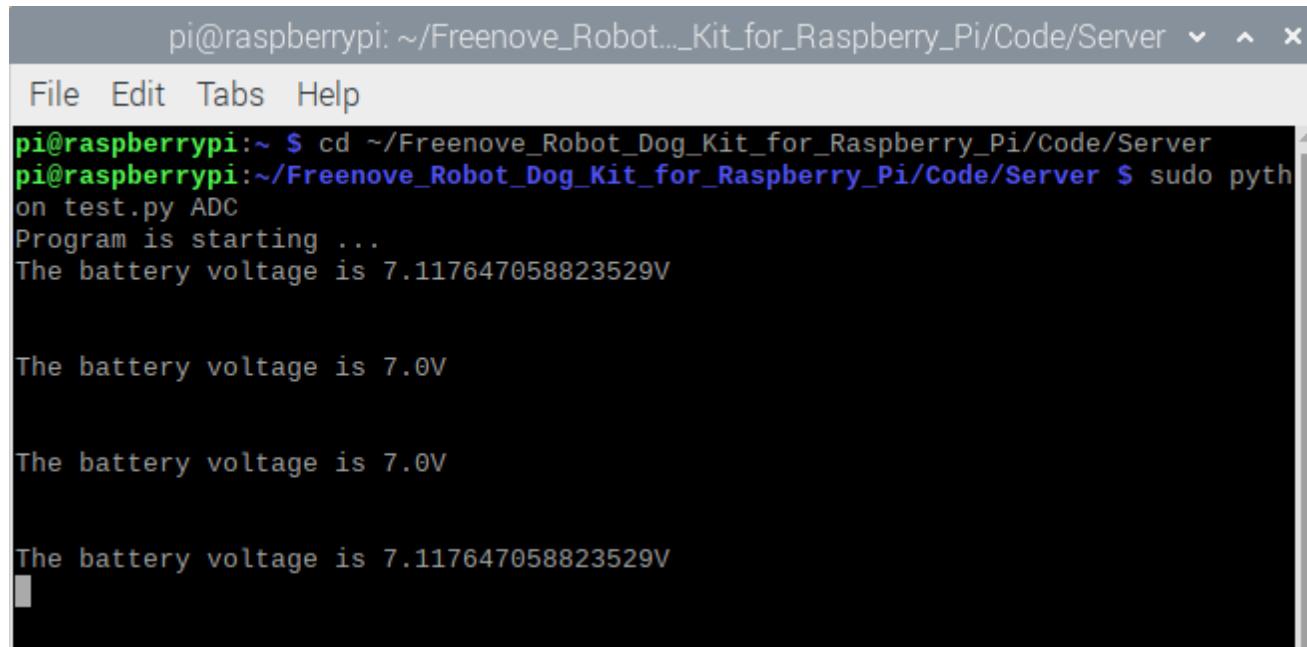
```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1.If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2.Execute test.py command:

```
sudo python test.py ADC
```



The screenshot shows a terminal window with a dark background and light-colored text. At the top, it says "pi@raspberrypi: ~ /Freenove_Robot..._Kit_for_Raspberry_Pi/Code/Server". Below that is a menu bar with "File", "Edit", "Tabs", and "Help". The main area of the terminal shows the following command-line session:

```
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server  
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo python test.py ADC  
Program is starting ...  
The battery voltage is 7.117647058823529V  
  
The battery voltage is 7.0V  
  
The battery voltage is 7.0V  
  
The battery voltage is 7.117647058823529V
```

Result:

Print batteries voltage value per second. You can press "Ctrl + C" to end the program.

The code is as below:

```
1 from ADS7830 import *
2 adc=ADS7830()
3 def test_Adc():
4     try:
5         while True:
6             Power=adc.readAdc(0)/255.0*5.0*3
7             print ("The battery voltage is "+str(Power)+"V")
8             time.sleep(1)
9             print ('\n')
10        except KeyboardInterrupt:
11            print ("\nEnd of program")
```

Reference

readAdc (channel)

This function has one parameter for reading the ADC value of the corresponding channel.

For example:

readAdc (0)

Read the ADC value of the batteries voltage. The returned number range is 0-255. Divide the obtained value by 255.0 and then multiply by the reference voltage of 5.0V, and then triple the value to get the batteries voltage.

Ultrasonic module

Run program

If the terminal displays the directory as below (where test.py is located). You can **directly** execute the test.py command.

```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1. If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2. Execute test.py command:

```
sudo python test.py Ultrasonic
```

```
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo python
test.py Ultrasonic
Program is starting ...
Obstacle distance is 40CM
Obstacle distance is 60CM
Obstacle distance is 63CM
Obstacle distance is 61CM
Obstacle distance is 3CM
Obstacle distance is 13CM
Obstacle distance is 14CM
Obstacle distance is 42CM
^C
End of program
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

Result:

Every 1s, the distance between the obstacle and the ultrasonic module will be printed in, and you can press "Ctrl + C" to end the program.

The code is as below:

```
1 from Ultrasonic import *
2 ultrasonic=Ultrasonic()
3 def test_Ultrasonic():
4     try:
5         while True:
6             data=ultrasonic.getDistance()    #Get the value
7             print ("Obstacle distance is "+str(data)+"CM")
8             time.sleep(1)
9         except KeyboardInterrupt:
10            print ("\nEnd of program")
```

Reference

`getDistance()`

This function is used to obtain the distance of ultrasonic module and front obstacle, with unit CM.

Led

There is a RGB LED module on the robot as below:



Run program

Enter the following commands to test LED.

If the terminal displays the directory as below (where test.py is located). You can **directly** execute the test.py command.

```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1.If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2.Execute test.py command:

```
sudo python test.py Led
```

```
pi@raspberrypi: ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server 
File Edit Tabs Help
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo python
test.py Led
Program is starting ...

Red wipe
Green wipe
Blue wipe
White wipe

End of program
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

Result:

The LED module will show red, green, blue and white in turn. Then all LED are turned off.

You can end the program ahead of time by pressing "ctrl+c".

If the LED color display order is not correct, open the "**Led.py**" file in the current directory and modify the value of the "self.ORDER" variable on line 16.

The code of test.py is as below:

```
1  from Led import *
2  led=Led()
3  def test_Led():
4      try:
5          #Red wipe
6          led.colorWipe(led.strip, Color(255, 0, 0))
7          time.sleep(1)
8          print ("\nRed wipe")
9
10         #Green wipe
11         led.colorWipe(led.strip, Color(0, 255, 0))
12         time.sleep(1)
13         print ("\nGreen wipe")
14
15         #Blue wipe
16         led.colorWipe(led.strip, Color(0, 0, 255))
17         time.sleep(1)
18         print ("\nBlue wipe")
19
20         #White wipe
21         led.colorWipe(led.strip, Color(255, 255, 255))
22         time.sleep(1)
23         print ("\nWhite wipe")
24
25         led.colorWipe(led.strip, Color(0, 0, 0))    #turn off the light
26         print ("\nEnd of program")
27     except KeyboardInterrupt:
28         led.colorWipe(led.strip, Color(0, 0, 0))    #turn off the light
29         print ("\nEnd of program")
```

Reference

colorWipe(strip, color, wait_ms)

This function erases the color of one pixel at a time, has three input parameters, strip represents the Neopixel object, color represents the color to be erased, and wait_ms represents the erasure interval. The default is 50ms. For example, colorWipe(strip, Color(255,0,0),20) means that the LED0 color is red first, wait for 20ms, and then the LED1 color is also red, so that all eight LEDs are lit and red.

Buzzer

Run the program

Enter following command in the terminal to test buzzer.

If the terminal displays the directory as below (where test.py is located). You can **directly** execute the test.py command.

```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1.If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2.Execute test.py command:

```
sudo python test.py Buzzer
```

The terminal window shows the following session:

```
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server  
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo python  
test.py Buzzer  
Program is starting ...  
1S  
2S  
3S  
End of program  
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

Result:

The buzzer will be turn on lasting for 3s. Then the program will automatically end or you can press "Ctrl + C" to end the program.

The code is as below:

```
1 from Buzzer import *
2 buzzer=Buzzer()
3 def test_Buzzer():
4     try:
5         buzzer.run('1')
6         time.sleep(1)
7         print ("1S")
8         time.sleep(1)
9         print ("2S")
10        time.sleep(1)
11        print ("3S")
12        buzzer.run('0')
13        print ("\nEnd of program")
14    except KeyboardInterrupt:
15        buzzer.run('0')
16        print ("\nEnd of program")
```

Reference

buzzer.run(cmd)

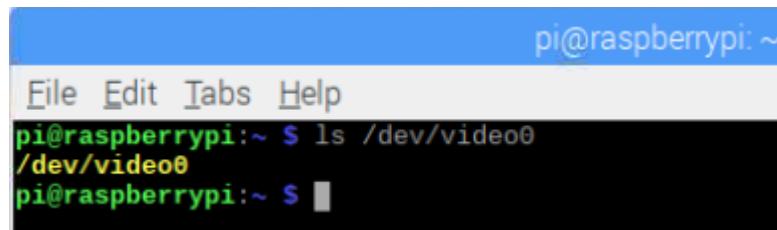
This function has one input parameter. If the input is '1', the buzzer will be turned on. If the input is '0', the buzzer will be turned off.

Camera

Enter following command to check if the camera is connected successfully.

```
ls /dev/video0
```

Then the device node will be shown below:



A screenshot of a terminal window titled "pi@raspberrypi: ~". The window shows a menu bar with "File", "Edit", "Tabs", and "Help". Below the menu, the command "ls /dev/video0" is entered and its output is displayed: "/dev/video0". The prompt "pi@raspberrypi: ~ \$" is at the bottom.

If the result above does not appear, please check the camera [Wiring](#) and if the camera interface is [enabled](#).

(Note: plugging and unplugging the cable requires the Raspberry Pi to be powered off, otherwise the camera module may be burned.)

Run program

Enter following commands in the terminal to test camera.

If the terminal displays the directory as below (where test.py is located). You can **directly** execute the test.py command.

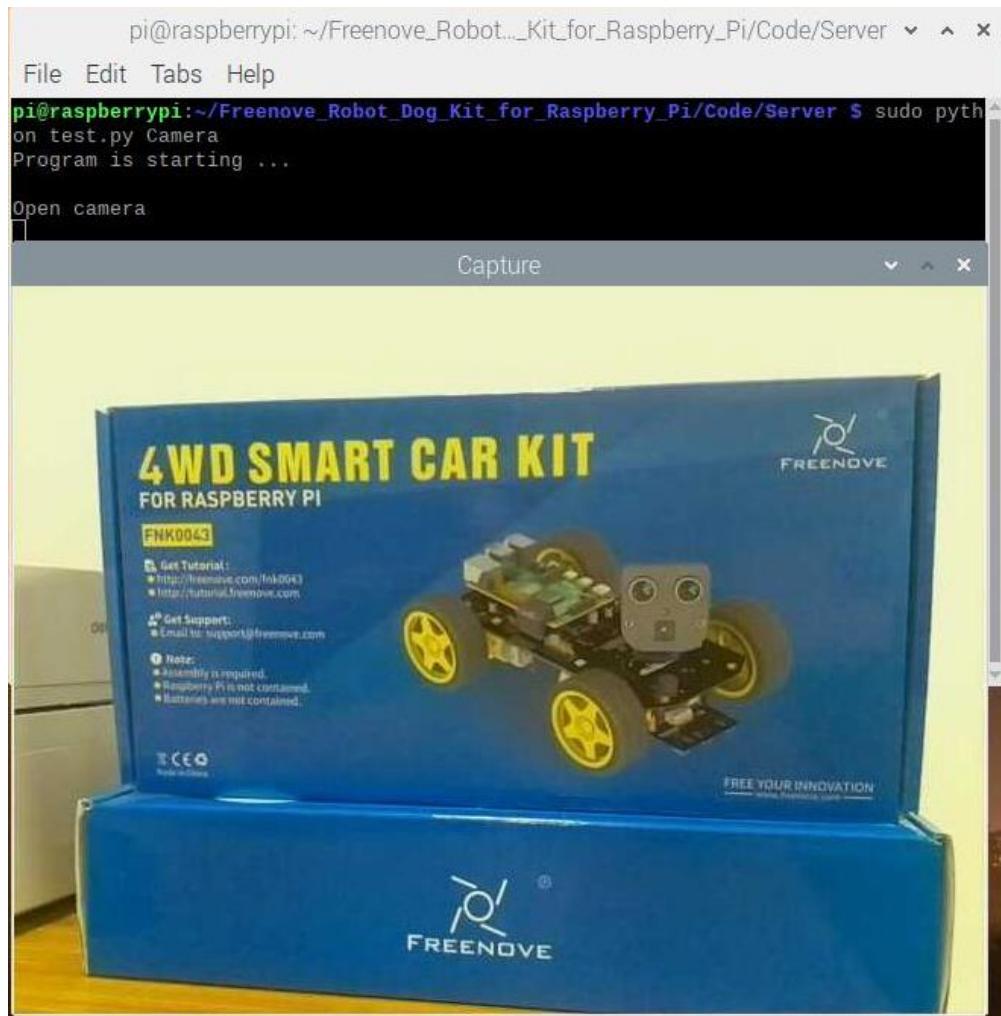
```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

1. If not, execute the cd command:

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2. Execute test.py command:

```
sudo python test.py Camera
```



Result:

A window will pop up and display the picture shot by the camera. Press "Ctrl + "C" in the **terminal** window to end the program. (Note: pressing "Ctrl + C" in the **camera** window doesn't work.)

The code is below:

```

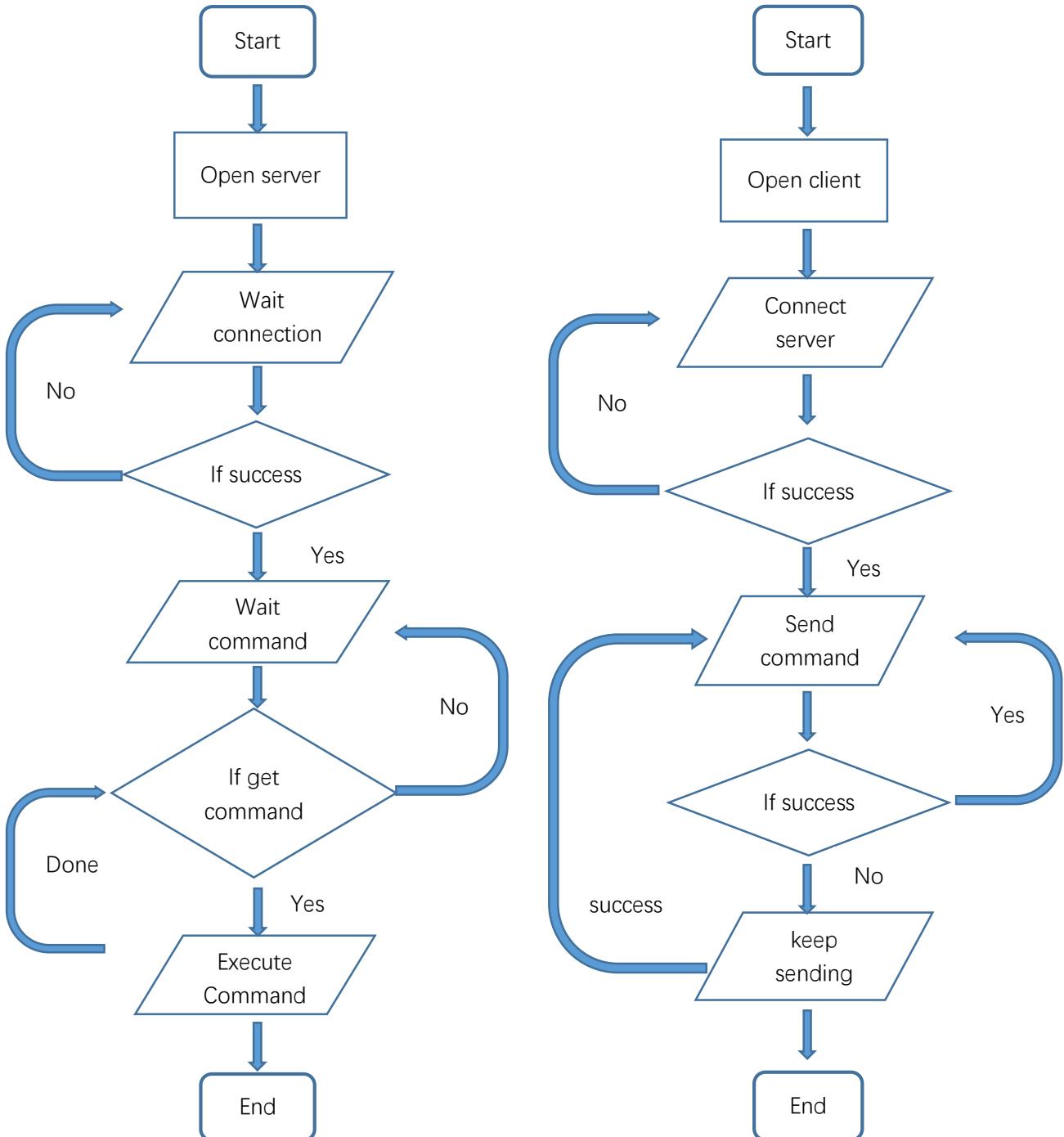
1 import cv2
2 def test_Camera():
3     try:
4         print ("\nOpen camera")
5         capturing_Flag = True
6         cap = cv2.VideoCapture(0)
7         while(capturing_Flag):
8             ret, frame = cap.read()
9             cv2.imshow("Capture", frame)
10            cv2.waitKey(5)
11            cv2.destroyAllWindows()
12        except KeyboardInterrupt:
13            print ("\nClose camera")
14            capturing_Flag = False

```

Chapter 4 Robot Dog

If there are any concerns, please feel free to contact us at support@freenove.com

This robot has rich functions, such as real-time video, LED, ultrasonic ranging. The server and client are established, based on Python3 and PyQt5. They communicate via TCP/IP protocol. The robot can be controlled remotely within a local area network.



Server

The server runs on the Raspberry Pi. It sends the camera data and ultrasonic module data to the client, and receive commands from client.

Part of server code is as below:

```
1  def get_interface_ip(self):
2      s = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
3      return socket.inet_ntoa(fcntl.ioctl(s.fileno(),
4                                         0x8915,
5                                         struct.pack('256s', b'wlan0')[:15])
6                                         )[20:24])
7
8  def turn_on_server(self):
9      #ip address
10     HOST=self.get_interface_ip()
11     #Port 8000 for video transmission
12     self.server_socket = socket.socket()
13     self.server_socket.setsockopt(socket.SOL_SOCKET,socket.SO_REUSEPORT,1)
14     self.server_socket.bind((HOST, 8000))
15     self.server_socket.listen(1)
16
17     #Port 5000 is used for instruction sending and receiving
18     self.server_socket1 = socket.socket()
19     self.server_socket1.setsockopt(socket.SOL_SOCKET,socket.SO_REUSEPORT,1)
20     self.server_socket1.bind((HOST, 5000))
21     self.server_socket1.listen(1)
22
23     print('Server address: '+HOST)
24
25  def turn_off_server(self):
26      try:
27          self.connection.close()
28          self.connection1.close()
29      except :
30          print ('\n'+ "No client connection")
```

Reference

For more code details, please open “Server.py” under Server folder to check.

`get_interface_ip()`

This function can get the IP address of WLAN0 of the Raspberry Pi.

`turn_on_server()`

This function is used to open TCP and wait for a client connection. The channel of port 5000 is mainly used to send and receive commands between the client and server. The channel of port 8000 is used to send video data to the client.

`turn_off_server()`

This function is used to close TCP.

`send_data()`

This function is used to send commands to the client.

`reset_serve()`

This function is used to close TCP and restart.

`transmission_video()`

This function is used to transmit video data to the client.

`receive_instruction()`

This function is used to receive commands from the client

Turn on Server

Enter following command in the terminal.

1. Use cd command to enter directory where main.py is located:

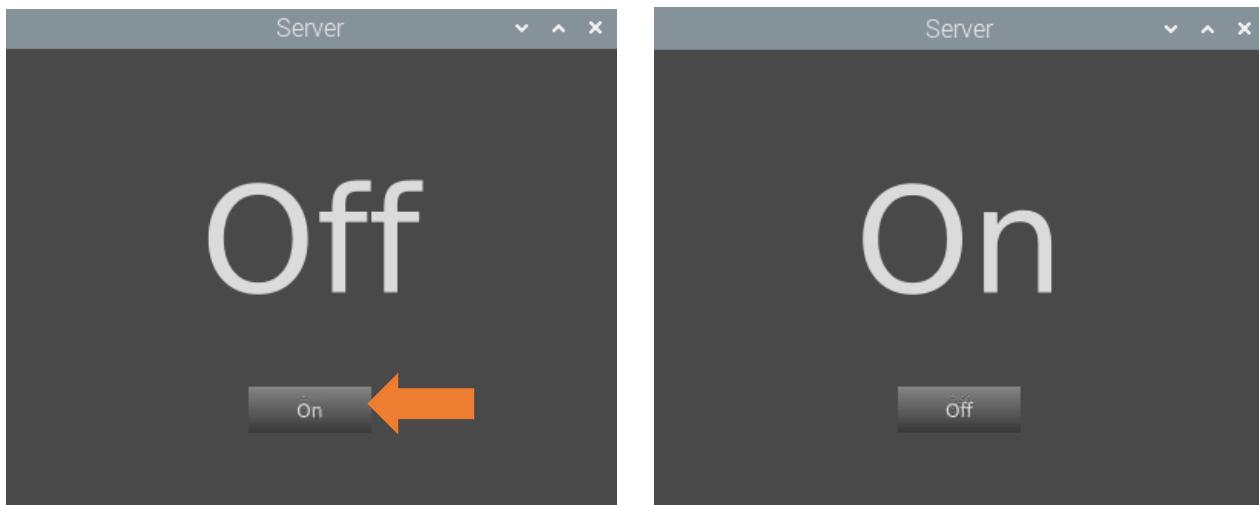
```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2. Run main.py:

```
sudo python main.py
```

The screenshot shows a terminal window with a dark background and light-colored text. At the top, it says "pi@raspberrypi: ~ /Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server". Below that is a menu bar with "File", "Edit", "Tabs", and "Help". The main area of the terminal shows the command being entered: "pi@raspberrypi:~ \$ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server" followed by "pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server \$ sudo python main.py". The cursor is visible at the end of the command line.

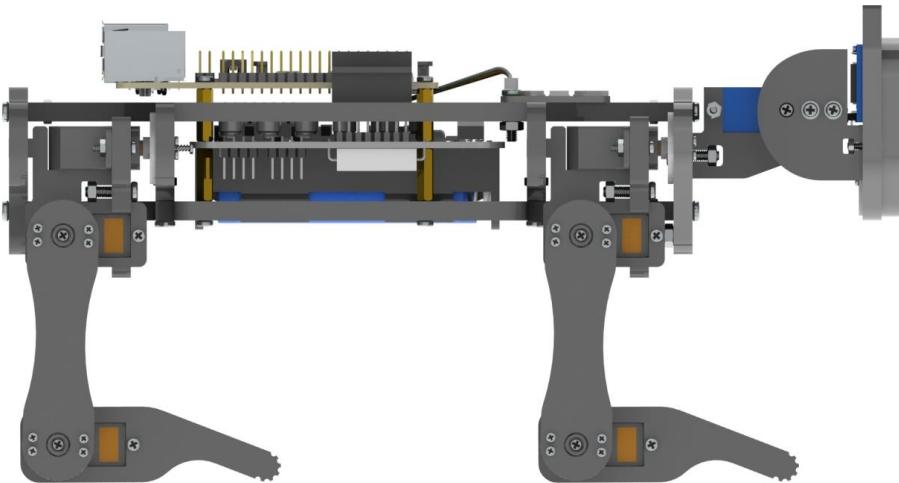
The interface is as below: Click “On” to open the server. The result is show as below:



You will see your server address (Raspberry Pi IP).

```
pi@raspberrypi:~/Desktop/20200327Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Se
rver $ sudo python main.py
libEGL warning: DRI2: failed to authenticate
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tmp/runtime-root'
Server address: 192.168.1.131
```

The robot will start from this posture. We define it as **Relax mode**. It will also be used later.



Client

The client can receive video data and commands from the server, and can send commands to the server. And it can run on different systems, such as windows, macOS and so on. However, you need to install related software and libraries when run it.

Part of client code is as below:

```
1  def turn_on_client(self, ip):
2      self.client_socket1 = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
3      self.client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
4      print (ip)
5  def turn_off_client(self):
6      try:
7          self.client_socket.shutdown(2)
8          self.client_socket1.shutdown(2)
9          self.client_socket.close()
10         self.client_socket1.close()
11     except Exception as e:
12         print(e)
13  def receiving_video(self, ip):
14      stream_bytes = b' '
15      try:
16          self.client_socket.connect((ip, 8000))
17          self.connection = self.client_socket.makefile('rb')
18      except:
19          #print ("command port connect failed")
20          pass
21      while True:
22          try:
23              stream_bytes= self.connection.read(4)
24              leng=struct.unpack('L', stream_bytes[:4])
25              jpg=self.connection.read(leng[0])
26              if self.is_valid_image_4_bytes(jpg):
27                  if self.video_flag:
28                      self.image = cv2.imdecode(np.frombuffer(jpg, dtype=np.uint8),
29                      cv2.IMREAD_COLOR)
30                      if self.ball_flag:
31                          self.Looking_for_the_ball()
32                          self.video_flag=False
33              except BaseException as e:
34                  print (e)
35                  break
```

Reference

For more code details, please open “Client.py” under Client folder to check.

`turn_on_client ()`

This function is used to connect client to the server.

`turn_off_client ()`

This function is used to disconnect from the server.

`receiving_video()`

This function is used to receive video data sent from the server.

`is_valid_image_4_bytes ()`

This function is used to check whether each frame of video data is complete.

`Looking_for_the_ball ()`

This function is used to find the small ball in the video image.

`send_data ()`

This function is used to send commands to the server.

`receive_data ()`

This function is used to receive commands from the server.

Run Client on Windows system

This section will be completed in your **computer with windows system, not Raspberry Pi**.

To run the client on a Windows system, you need to install some software and libraries, and it takes some time. At this time, it does not need to run a server and a Raspberry Pi. You can turn off the Raspberry Pi first. After the installation is complete, turn on the Raspberry Pi and the server.

Install python3

Download the installation file via below:

<https://www.python.org/downloads/windows/>

The screenshot shows the Python Downloads page for Windows. The header has three tabs: 'About', 'Downloads' (which is selected), and 'Documentation'. Below the header, a breadcrumb navigation shows 'Python >>> Downloads >>> Windows'. The main title 'Python Releases for Windows' is in large, bold, dark gray font. Below the title is a list of download options:

- [Latest Python 3 Release - Python 3.8.1](#)
- [Latest Python 2 Release - Python 2.7.17](#)

Click **Latest Python 3 Release** - Python 3.8.1 (as an example).

Version	Operating System	Description
Gzipped source tarball	Source release	
XZ compressed source tarball	Source release	
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later
Windows help file	Windows	
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64
Windows x86 embeddable zip file	Windows	
Windows x86 executable installer	Windows	
Windows x86 web-based installer	Windows	

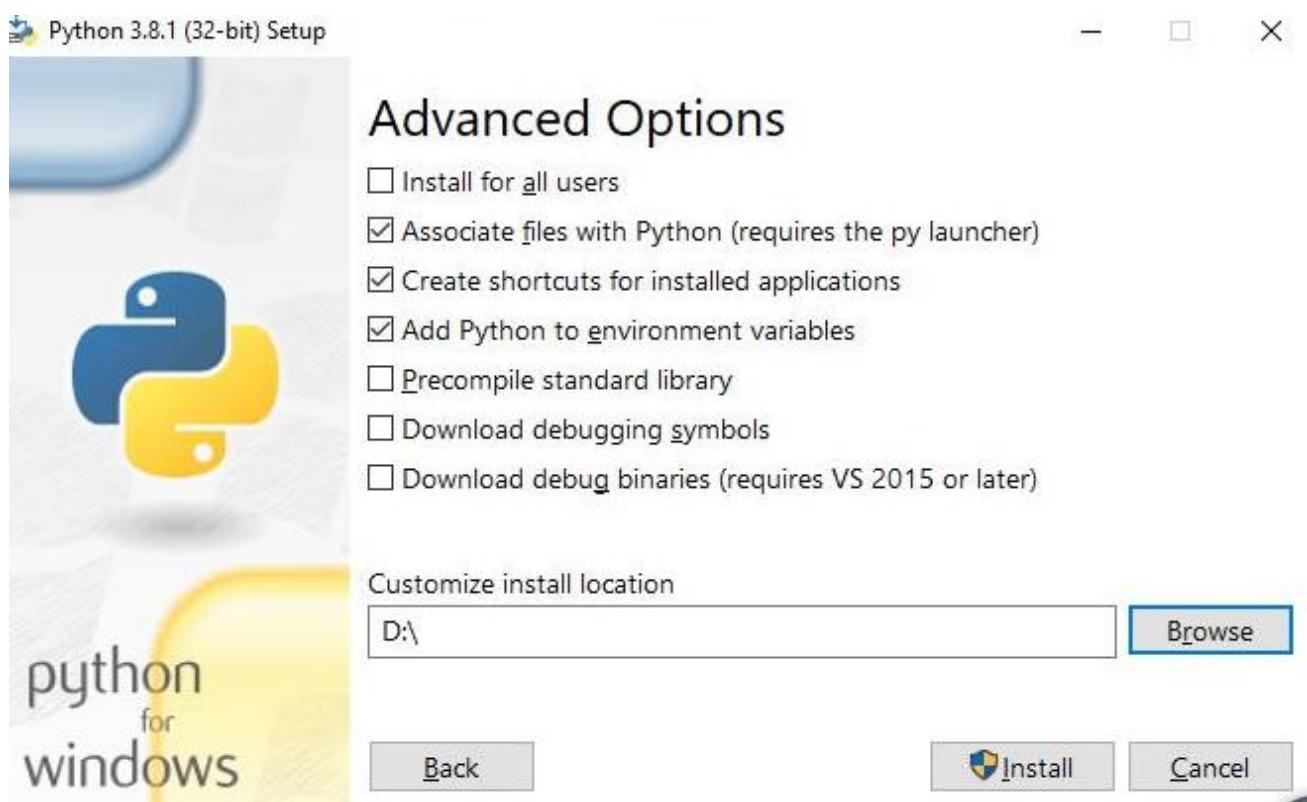
Choose "Windows x86-64 executable installer" to download and install.



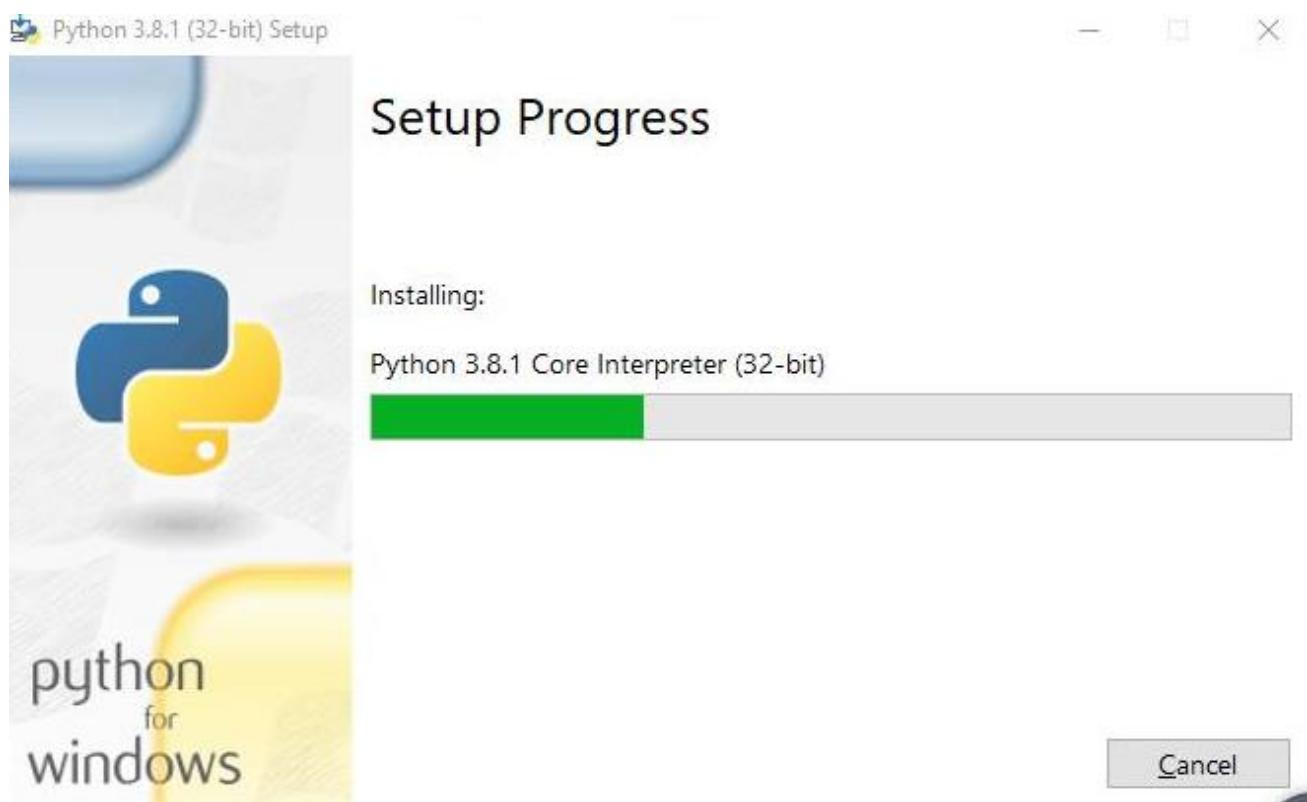
Select "Add Python 3.8 to PATH". And choose Customize installation.



Select all options and click Next.



Here python is installed into D disk as an example (You can choose your own installation path). Click Install.



Wait installation.



Installation is successful.

Install PyQt5, opencv, numpy and other libraries

If have not download the zip file, download it via below:

https://github.com/Freenove/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/archive/master.zip

Then unzip it and delete “-master” to rename it to “Freenove_Robot_Dog_Kit_for_Raspberry_Pi”.

Then put it into D disk for example.

You can also place it into other disks (like E), but the path in following command should be modified accordingly (replace D: by E:).

Press “win + R” and enter cmd, and click ok. Then enter following commands.

1.Enter D disk. If you put it into E, it should be E:

D:

2.Enter directory where setup_windows.py is located:

cd D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code

3.Run: setup_windows.py

Python setup_windows.py

```
C:\Users\Freenove>D:  
D:>cd D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code  
D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi>Python setup_windows.py
```

Or double-click "setup_windows.py" to execute the installation program, under following path:

Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code

Or use python3 to run "setup_windows.py".

Note: If your windows system defaults to python not python3 but python2, then change all "python" in "setup_windows.py" to "python3" and run the command "setup_windows.py" as shown below.

```
import os  
import sys  
import time  
flag=0x00  
for x in range(1,4):  
    if os.system("python -m pip install --upgrade pip") == 0:  
        flag=flag | 0x01  
        break  
for x in range(1,4):  
    if os.system("pip3 install PyQt5") == 0:  
        flag=flag | 0x02
```

Python3 setup_windows.py

Installation takes some time, please be patient. If all installation is successful, it will prompt "Press any key to continue..." and "All libraries installed successfully".

```
Package      Version
-----
click        7.1.1
numpy        1.18.2
opencv-python 4.2.0.32
Pillow       7.0.0
pip          20.0.2
PyQt5        5.13.2
PyQt5-sip    12.7.1
pyqt5-tools  5.13.2.1.6rc1
python-dotenv 0.12.0
setuptools   41.2.0
Press any key to continue . . .

All libraries installed successfully
```

If some libraries are not installed successfully, it will prompt "Some libraries have not been installed yet. Please run '**python setup_windows.py**' again". Then you need to execute the python3 setup_windows.py command again. Most installation failures are caused by a slow network. You can check the network before installing.

Open client

Press "win + R" and enter cmd, and click ok. Then enter following commands.

1.Enter D disk. If you put it into E, it should be E:

D:

2.Enter directory where Main.py is located:

```
cd D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code\Client
```

3.Run Main.py:

```
Python Main.py
```

```
C:\Users\Freenove>D:
```

```
D:>cd D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code\Client
```

```
D:\Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code\Client>Python Main.py
```

Or double-click "Main.py". under following path:

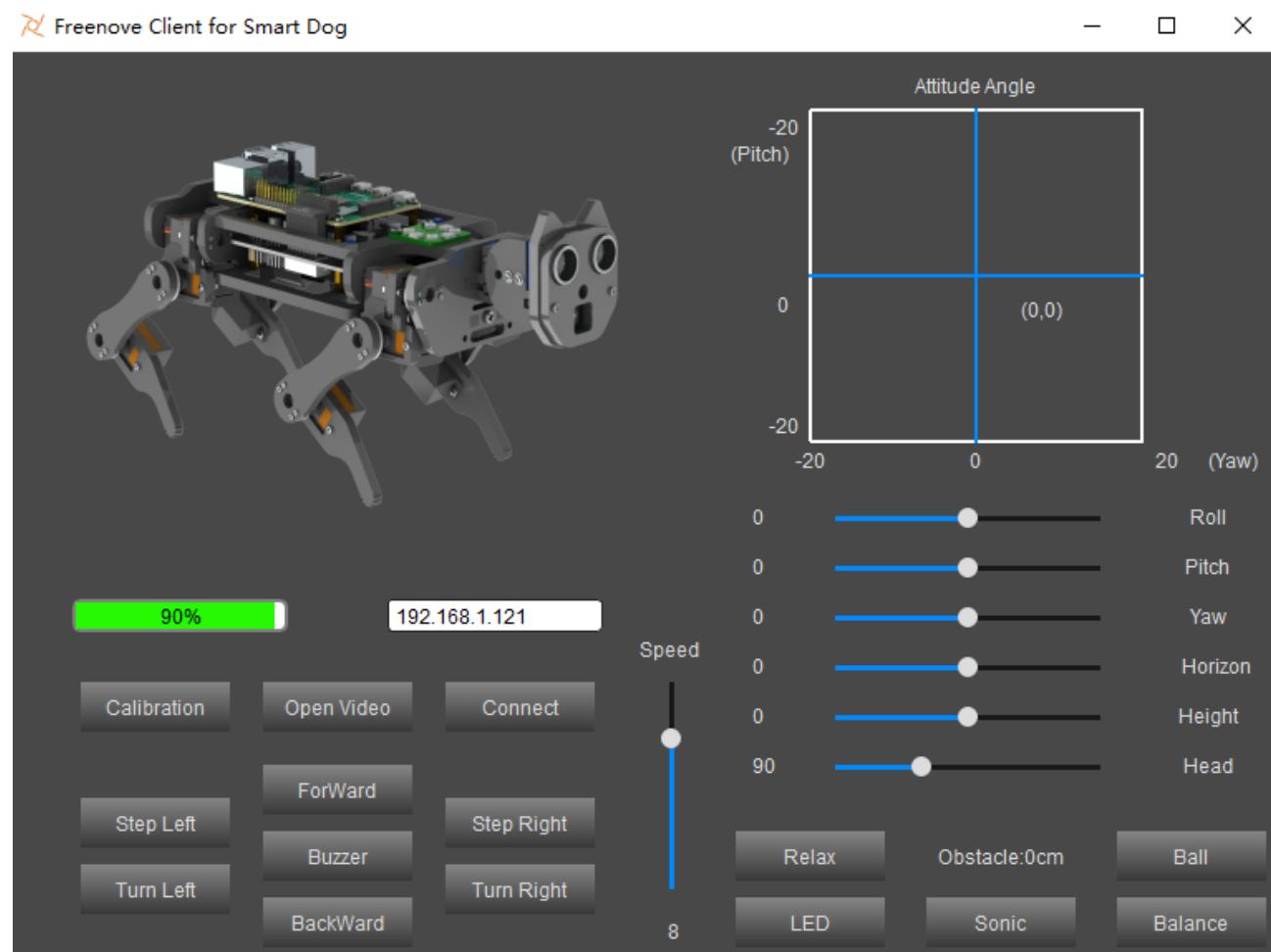
Freenove_Robot_Dog_Kit_for_Raspberry_Pi\Code\Client

Or use python3 to run "Main.py".

Note: If default python in your windows system is not python3, then change the command to run Main.py as shown below.

Python3 Main.py

The client interface is shown as below:



After the client is successfully opened,

- 1, You need to open the Raspberry Pi and [Turn on the server](#),
- 2, Enter the Raspberry Pi's IP address in the white IP edit box,
- 3, Click "**Connect**" to connect client to the Raspberry Pi.

After the connection is successful, you need to calibrate the robot in [Calibration](#) section. After the calibration is completed, the robot dog can be controlled to move.

Note: when Raspberry Pi is shut down, server will be closed. You need open server again the next time.

Run Client on macOS system

Here take MacOS 10.13 as an example. To run the client on MacOS, you need to install some software and libraries. At this time, it does not need to run a server and use a Raspberry Pi. You can turn off the Raspberry Pi first. After the installation is complete, turn on the Raspberry Pi and run the server. MacOS 10.13 comes with python2, but no python3. The programs of this robot can only run on python3.

Install python3

Download installer, link <https://www.python.org/downloads/>

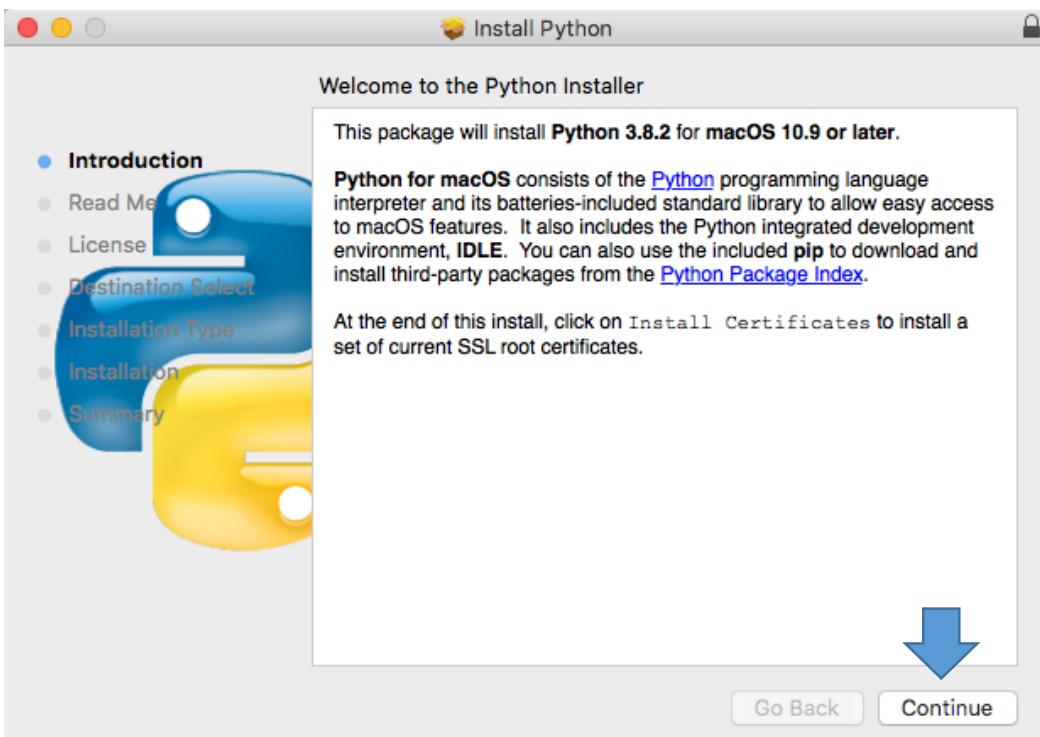
Release version	Release date	
Python 3.8.2	Feb. 24, 2020	 Download
Python 3.8.1	Dec. 18, 2019	 Download
Python 3.7.6	Dec. 18, 2019	 Download
Python 3.6.10	Dec. 18, 2019	 Download
Python 3.5.9	Nov. 2, 2019	 Download
Python 3.5.8	Oct. 29, 2019	 Download

Click Python 3.8.2.

Version	Operating System	Description
Gzipped source tarball	Source release	
XZ compressed source tarball	Source release	
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later
Windows help file	Windows	
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64
Windows x86 embeddable zip file	Windows	
Windows x86 executable installer	Windows	
Windows x86 web-based installer	Windows	

On the bottom of the page, click macOS 64-bit installer to download installer.

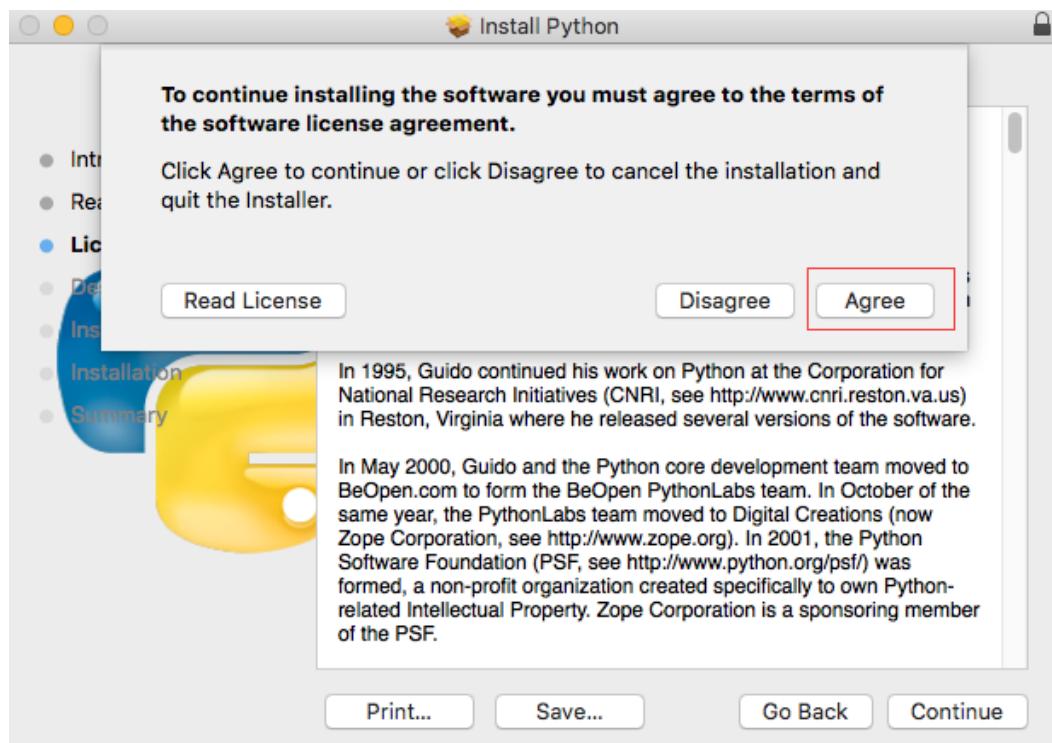
Then install python.



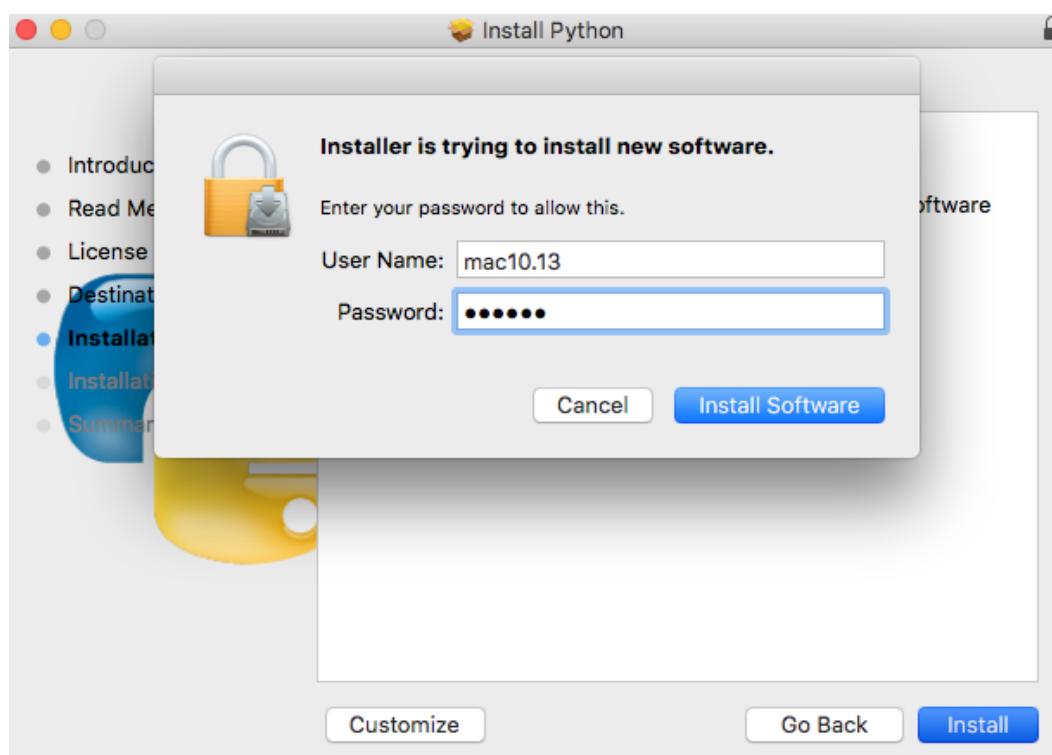
Click Continue.



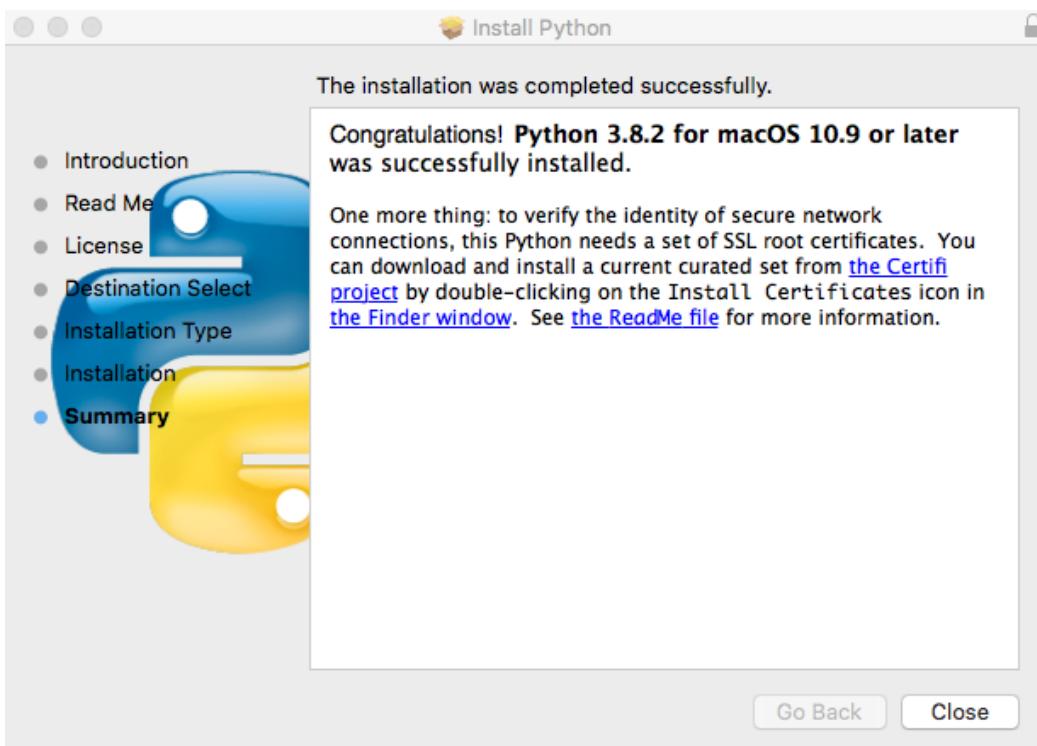
Click Continue.



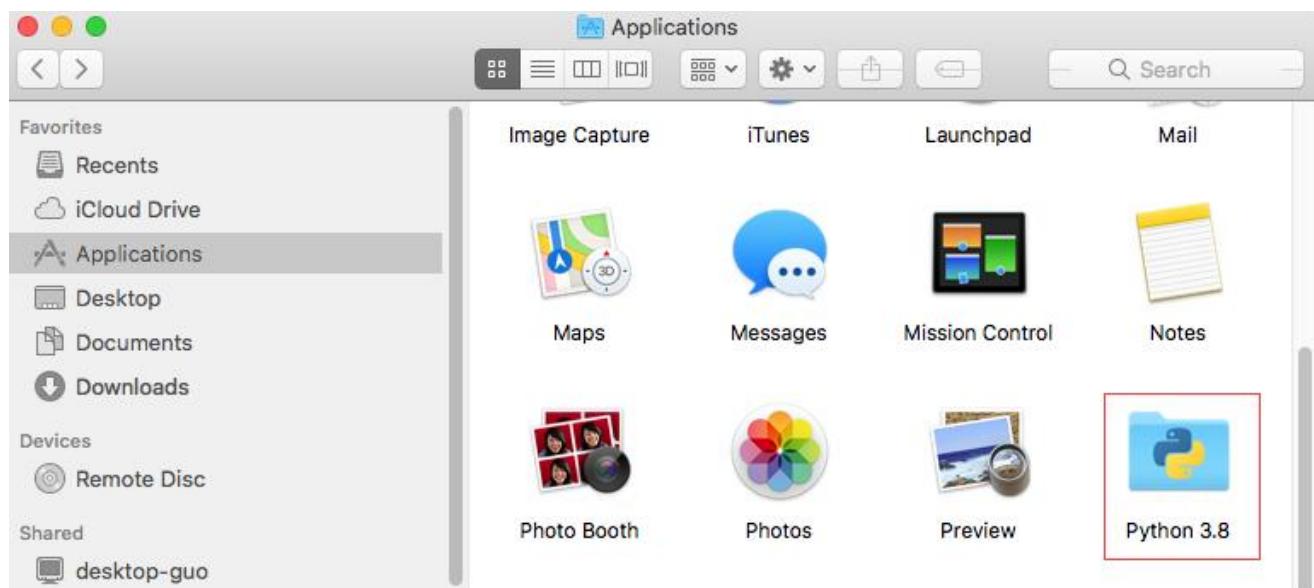
Click Agree.



Click Install. If your computer has a password, enter the password and click Install Software.



Now the installation is completed successfully.



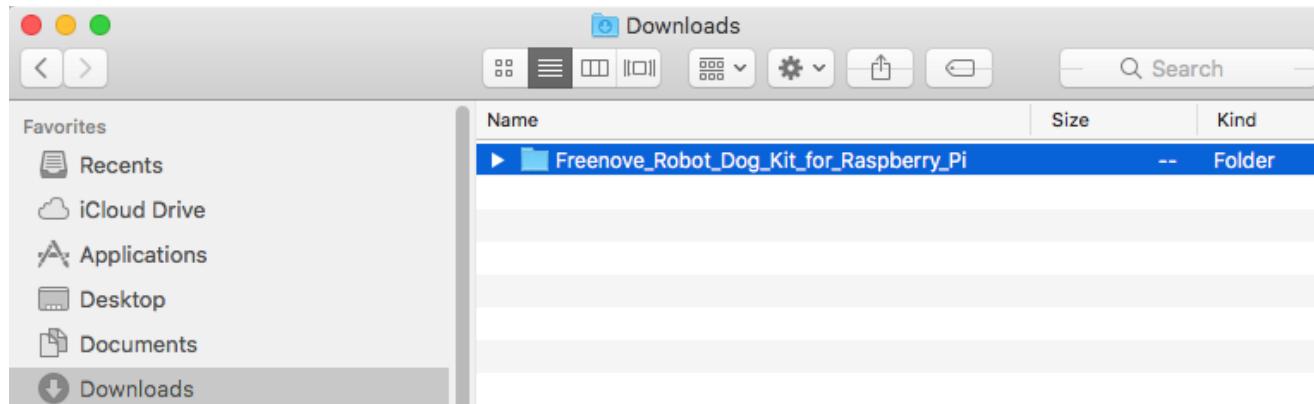
You can find in Applications.

Install PyQt5、opencv、numpy and other libraries

If there is no robot dog code in your macOS, you can download it via link below:

https://github.com/Freenove/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/archive/master.zip

After downloaded successfully, you can find it under “Downloads”.



Open “Terminal”.



Type following command in Terminal.

1. Enter “Downloads” where the code is located. If your path is different, please modify the command.

```
cd Downloads
```

2. Enter directory where setup_macos.py is located:

```
cd Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/
```

3. Run setup_macos.py:

```
python3 setup_macos.py
```

Installation need some time, please wait patiently.

Package	Version
<hr/>	
numpy	1.18.1
opencv-python-headless	4.2.0.32
Pillow	7.0.0
pip	20.0.2
PyQt5	5.14.1
PyQt5-sip	12.7.1
setuptools	41.2.0

```
All libraries installed successfully
mac13deMac:Code mac10.13$
```

If some libraries are not installed successfully, it will prompt "Some libraries have not been installed yet. Please run 'python3 setup_windows.py' again". Then you need to execute the python3 setup_windows.py command again. Most installation failures are caused by a slow network. You can check the network before installing.

Open client

After installation is complete in previous step, now it is in the directory where setup_macos.py is located.

```
Package           Version
-----
numpy            1.18.1
opencv-python-headless 4.2.0.32
Pillow           7.0.0
pip              20.0.2
PyQt5            5.14.1
PyQt5-sip        12.7.1
setuptools       41.2.0
```

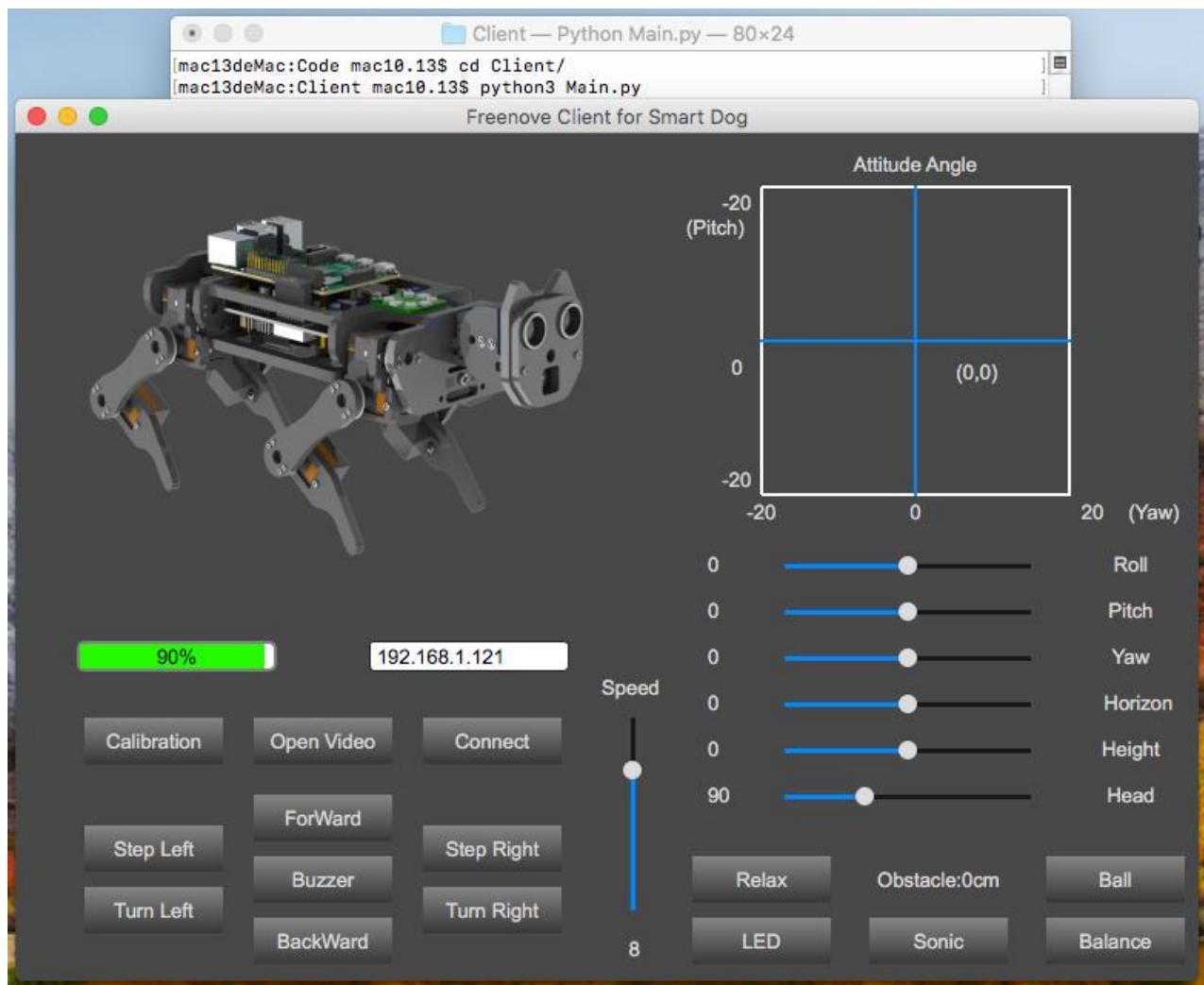
```
All libraries installed successfully
mac13deMac:Code mac10.13$
```

1. Type following command to enter where the program is located.

```
cd Client/
```

2. Type following command to run the program.

```
python3 Main.py
```



After the client is successfully opened,

- 1, You need to open the Raspberry Pi and [Turn on the server](#),
- 2, Enter the Raspberry Pi's IP address in the white IP edit box,
- 3, Click "Connect" to connect client to the Raspberry Pi.

Then you need calibrate the robot in the [Calibration](#) section. After the calibration is completed, then robot dog can be controlled to move.

Note: when Raspberry Pi is shut down, server will be closed. You need open server again the next time.

Run client on Raspberry Pi(Linux) system

Open client

Enter the following commands at the terminal.

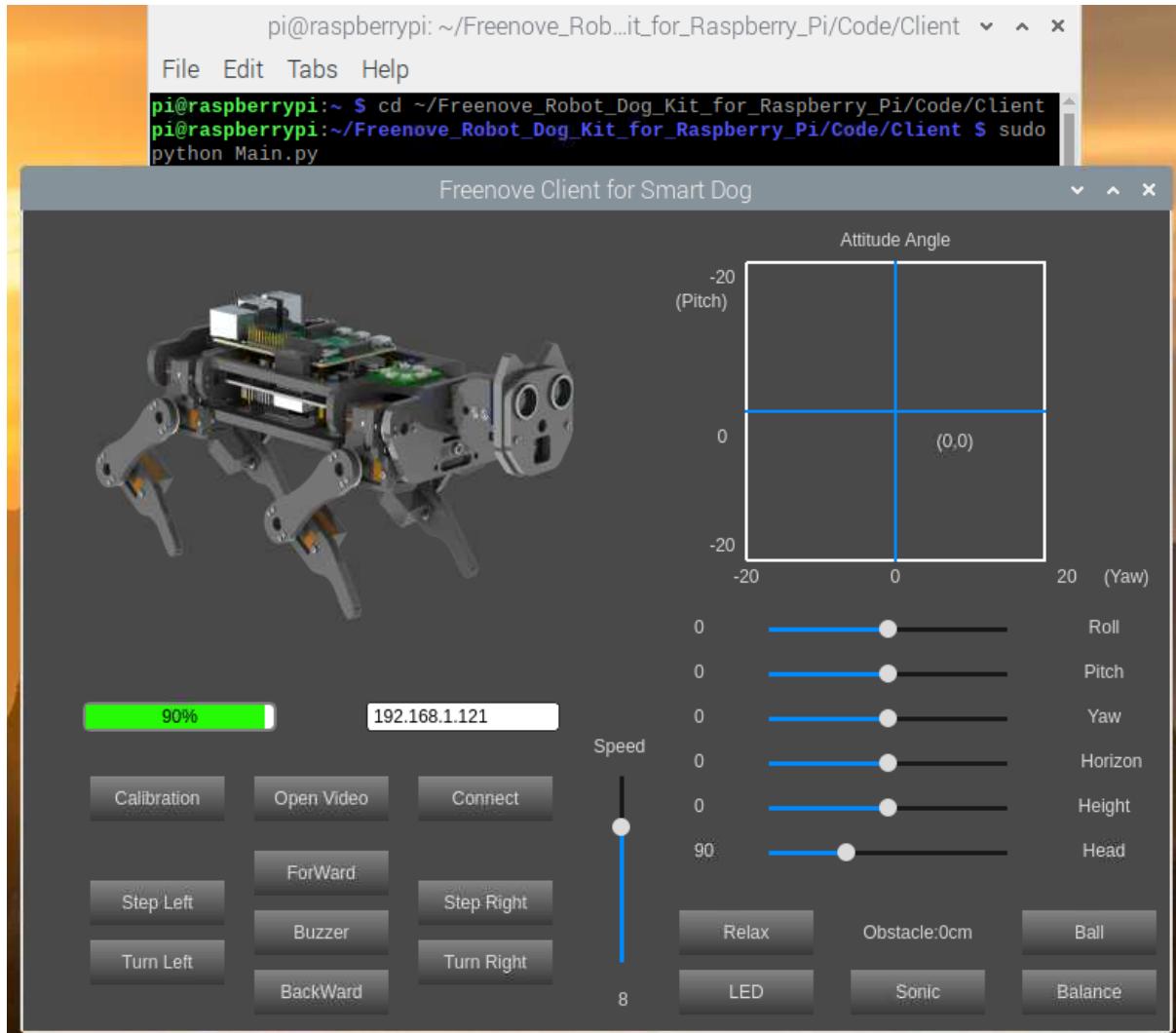
1. Use the cd command to go to the directory where Main.py is located.

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Client
```

2. Run Main.py:

```
sudo python Main.py
```

The interface is shown below. The face recognition cannot work well because it need more computing power than Raspberry Pi have.



After the client is successfully opened,

1. You need to open the Raspberry Pi and [Turn on the server](#),
2. Enter the Raspberry Pi's IP address in the white IP edit box,
3. Click "Connect" to connect client to the Raspberry Pi.

After the connection is successful, you need to calibrate the four legs of the robot dog in [Calibration](#) section.

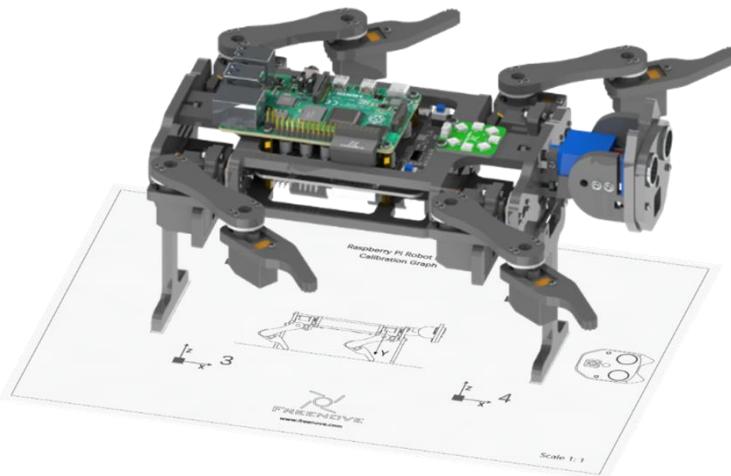
After the calibration is completed, then robot dog can be controlled to move.

Note: when Raspberry Pi is shut down, server will be closed. You need open server again the next time.

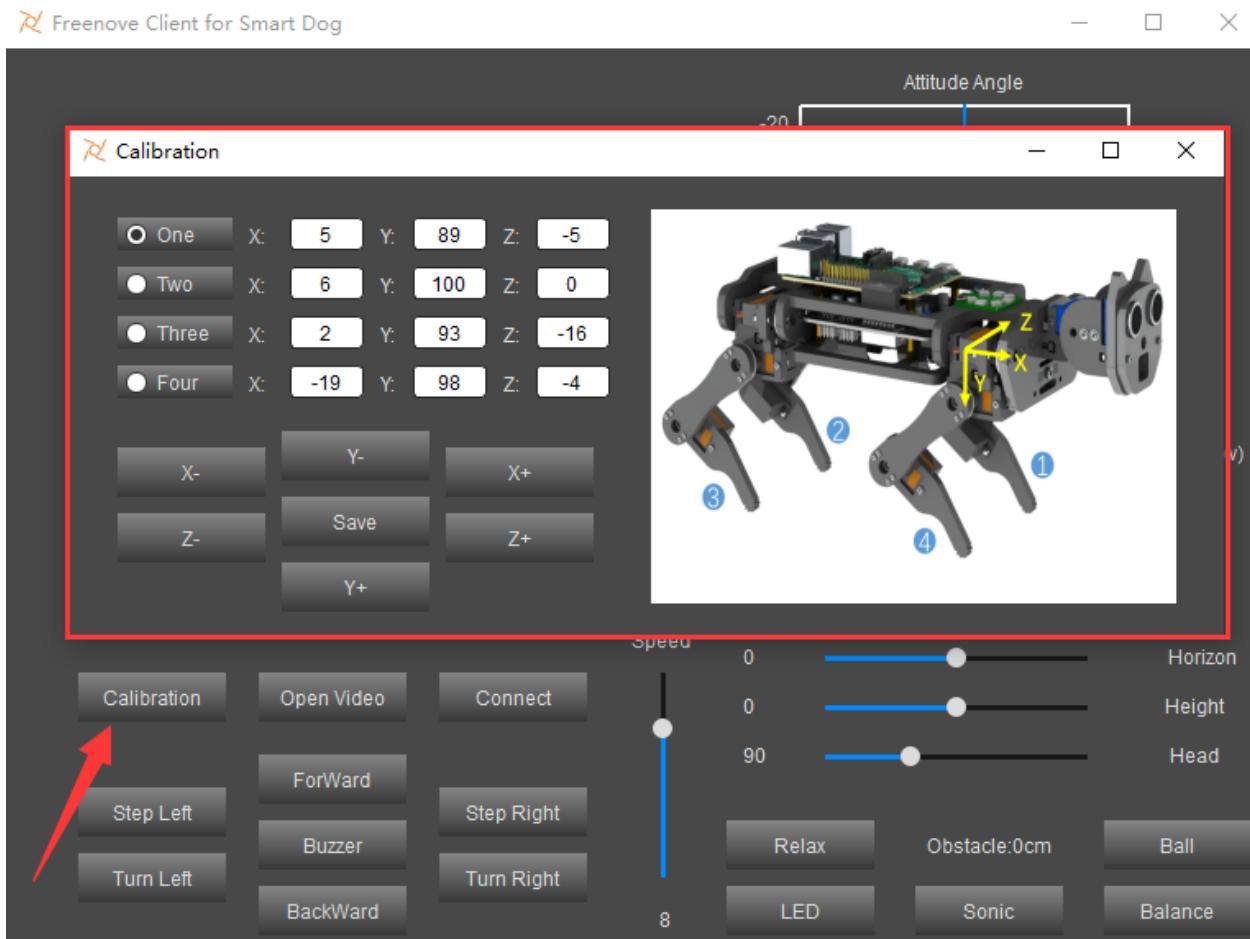
Calibration

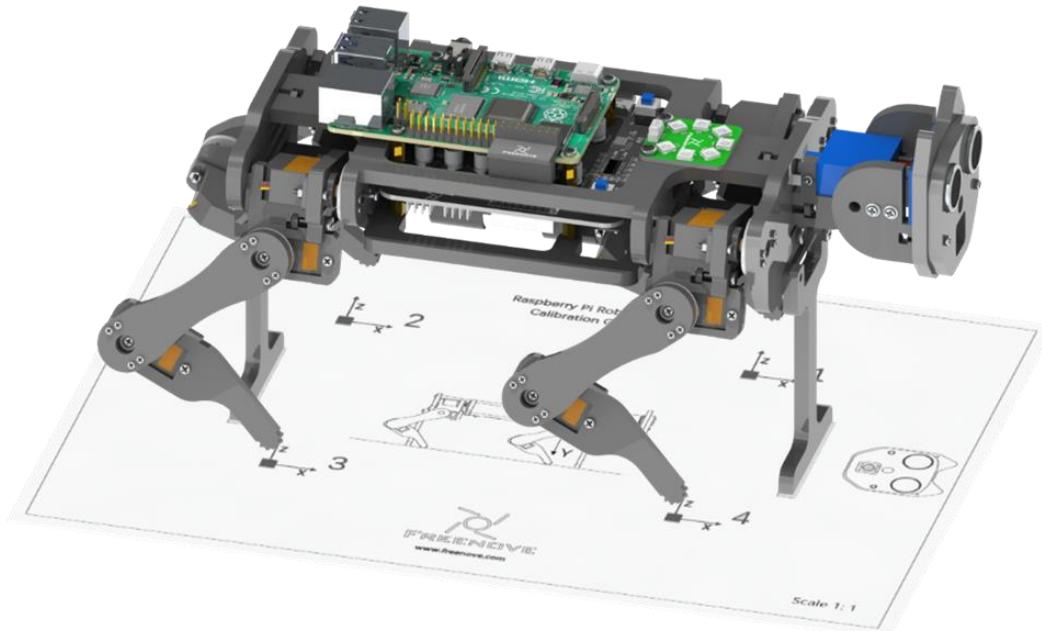
Calibrate the robot.

1. Lay the calibration paper on a level hard table.
2. Install the calibration supports on the robot dog and place it on the corresponding position on the calibration paper.

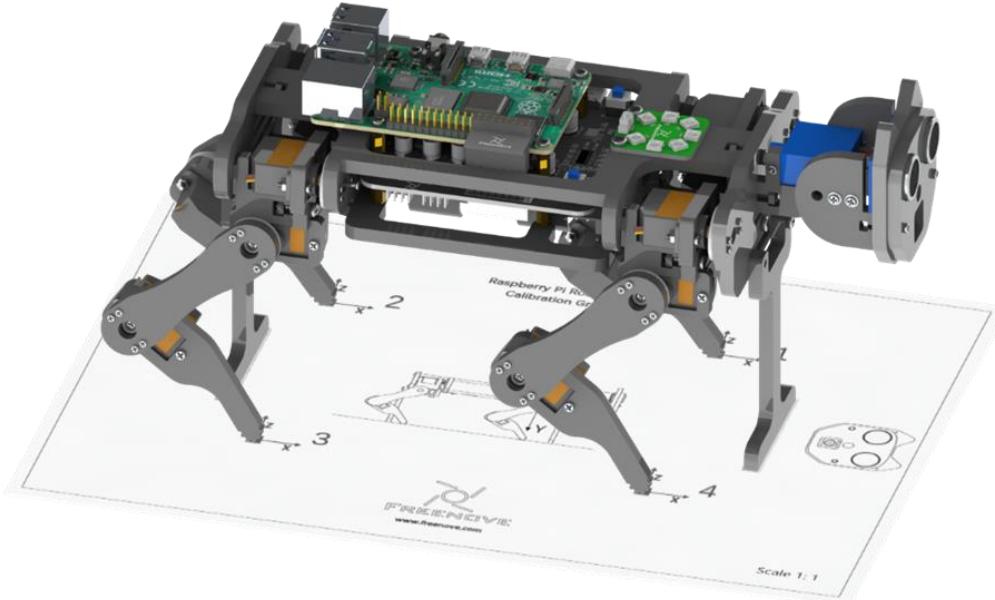


3. Connect client with server successfully, click the "Calibration" button on the client, then a calibration window pops up. And the robot leg will active to following position.





4. Calibrate the four legs to make 4 foot points fall to the corresponding positions. Feel the contact force with the ground during calibration. The later control depends on this step.



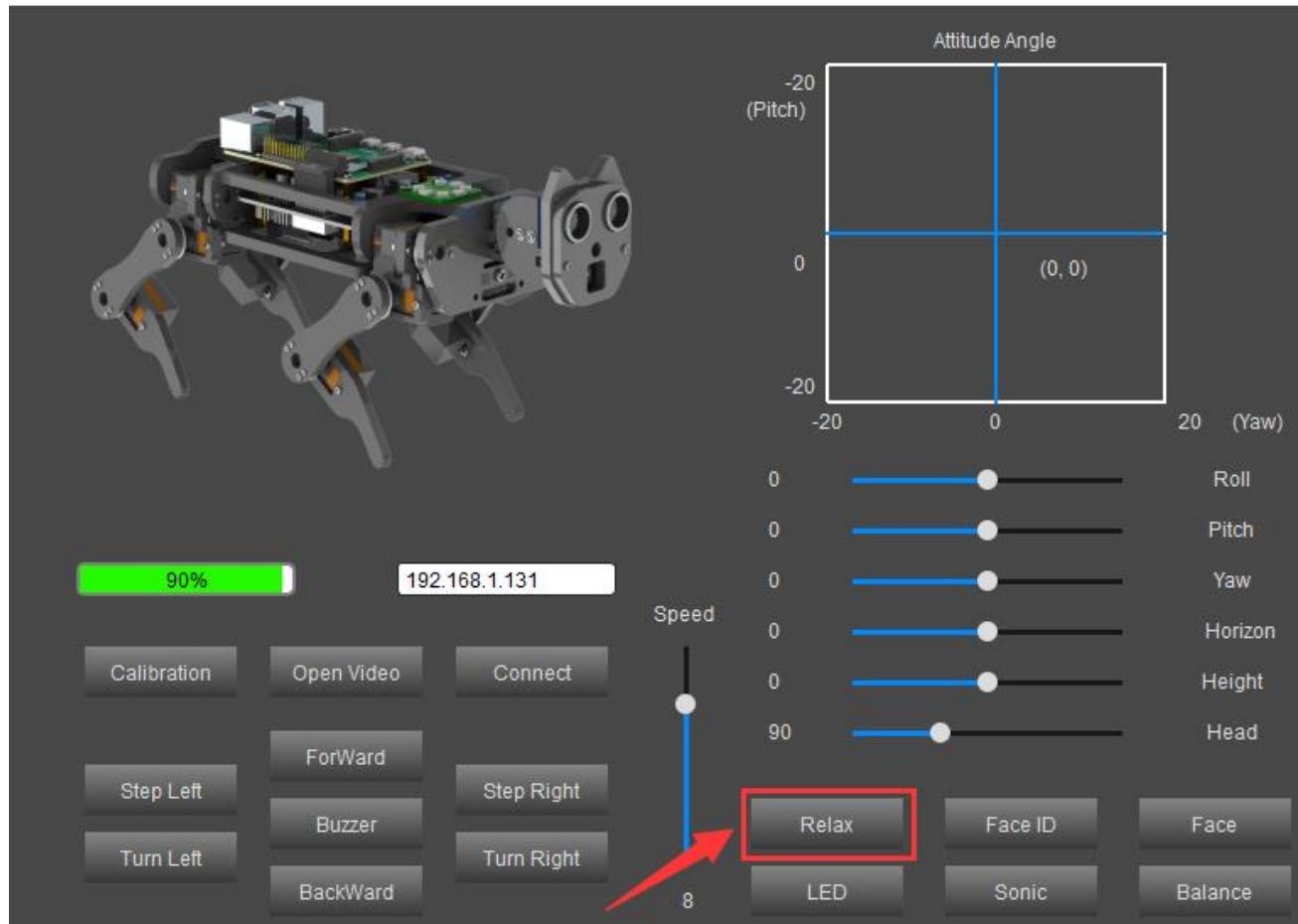
5. After all 4 points have reached the designated position, click "Save" to save. Now calibration is completed.

NOTE:

1. It is best to let the robot dog walk on a **flat hard** floor. The robot dog may not walk well on other roads.
2. **There is a offset when control the robot dog to walk straightly, which is normal.** It is caused by the installation error and the error of the servo itself. As a result, the left and right legs cannot be completely symmetrical, and may differ by 1mm or 2mm. As the walking distance accumulates, this error is constantly superimposed. Then there will be large offset from the original position.
3. If the calibration is not good enough, it will affect walking. You can **recalibrate** the robot with same steps.

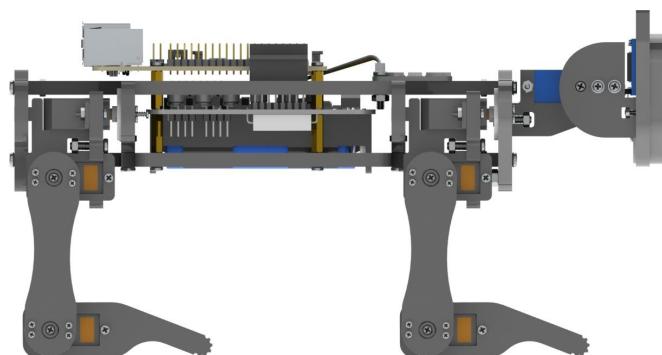
Control

After calibration is successfully, you can control the robot dog to move.

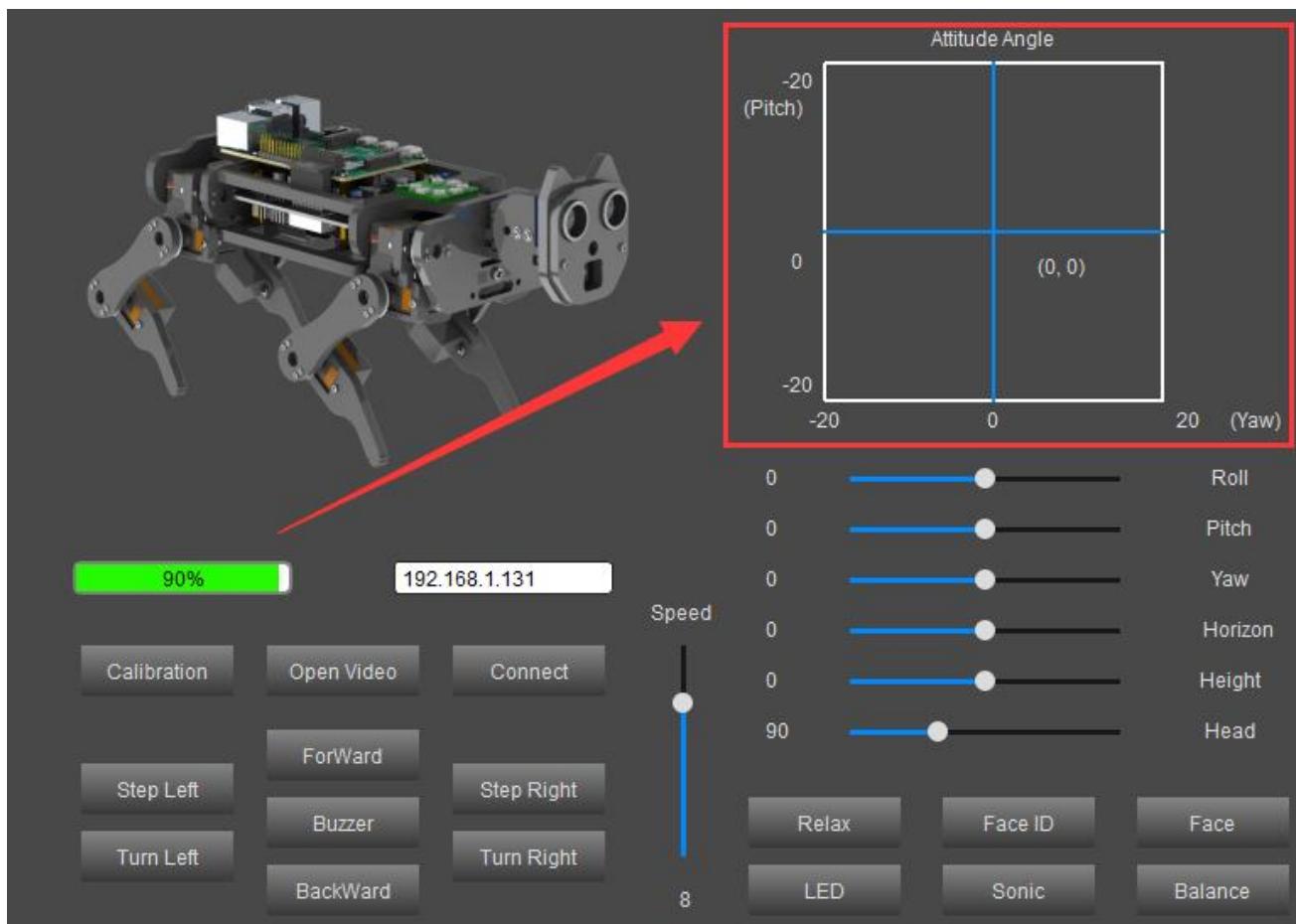


Relax mode.

- When the robot dog moves for 3 minutes in total, it will feel tired (the servo will get hot). In order to protect the servo, the robot will get into relax mode for 1 minute. **During this time, it won't respond to motion command.** You can still use the functions of LED, buzzer, real-time video and so on.
- When the robot dog moves for <3 minutes and then the robot rest for 1 minute. The timer will start from 0. Then the robot can moves for 3 minutes again.
- If the robot isn't tired and is standing, when the robot don't receive motion command for 10s, it will get into relax mode. In this situation, it will responds to any commands.



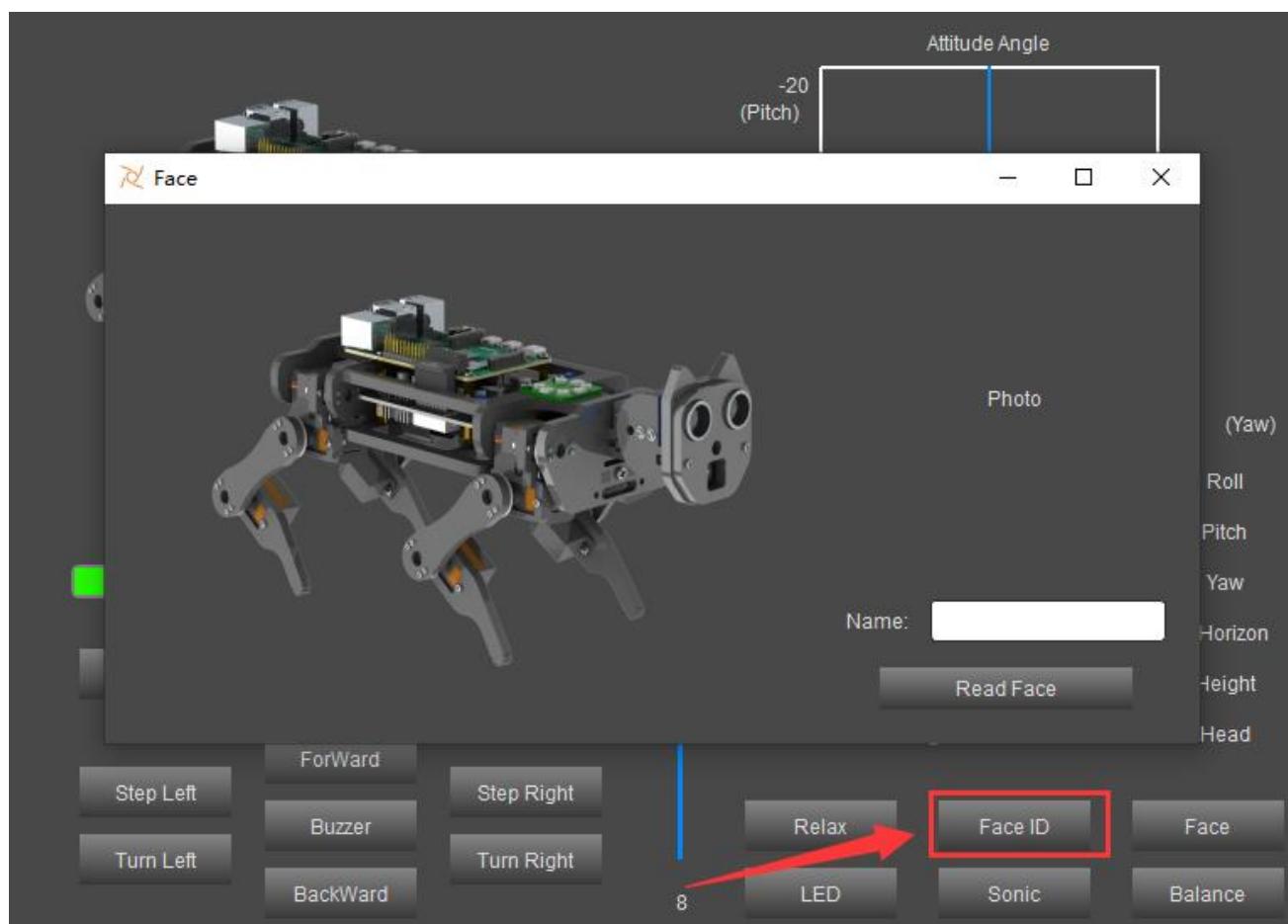
You can click and drag the cross cursor in the coordinate system to adjust the yaw and pitch angle of body.



The following is the corresponding operation of the buttons and keyboards.

Button on Client	Key	Action
ForWard	W	Move
BackWard	S	Back off
Turn Left	A	Turn left
Turn Right	D	Turn right
Step Left	Q	Step Left
Step Right	E	Step Right
Connect/ Disconnect	C	On/Off Connection
Open Video/ Close Video	V	On/Off Video
Calibration	M	Open calibration interface
Buzzer/Noise	Space	On/Off Buzzer
Relax	R	Relax station
LED	L	Open LED control interface
Sonic	U	Measure and display distance from obstacle
Balance	B	Open/Close balance mode
Face/Ball/Close	F	Face recognition and ball tracking
Face ID		Input images of human faces

Input images of human faces and recognize them.



1. Click "Face ID".
2. Enter name in the box of the pop-up window.
3. Click "Read Face".
4. A picture is taken and recorded every two seconds, and a total of 30 images will be taken. **Try to show faces at different distances and angles during the shooting process.** (When the face is not recognized, the picture will not be recorded until the face is recognized again.)
5. **After the 30 images are recorded, you can close the window** and click "Face" on the Right to identify the face.

Note: Do NOT use different names when re-entering images of the same person to avoid client working abnormally.

The function of SliderBar is below:

SliderBar	Function
Head	Adjust head angle.
Height	Control body height.
Horizon	Make body move forward or back.
Yaw	Adjust Yaw angle of body
Pitch	Adjust Pitch angle of body
Roll	Adjust Roll angle of body

Note:

If the robot work abnormally, please check following contents.

1. Check the battery level. Low battery level will make the server shut down.
2. Check if the wireless connection is disconnected.
3. Check if the Raspberry Pi is stuck.
4. If all three points above work well, please restart server and client. If there still is any abnormality, please contact us by email (support@freenove.com). We will help you.

Free your innovation

If you have any concerns, please feel free to contact us via support@freenove.com

If you want to write your own program to control the robot dog, you can follow this chapter to learn.

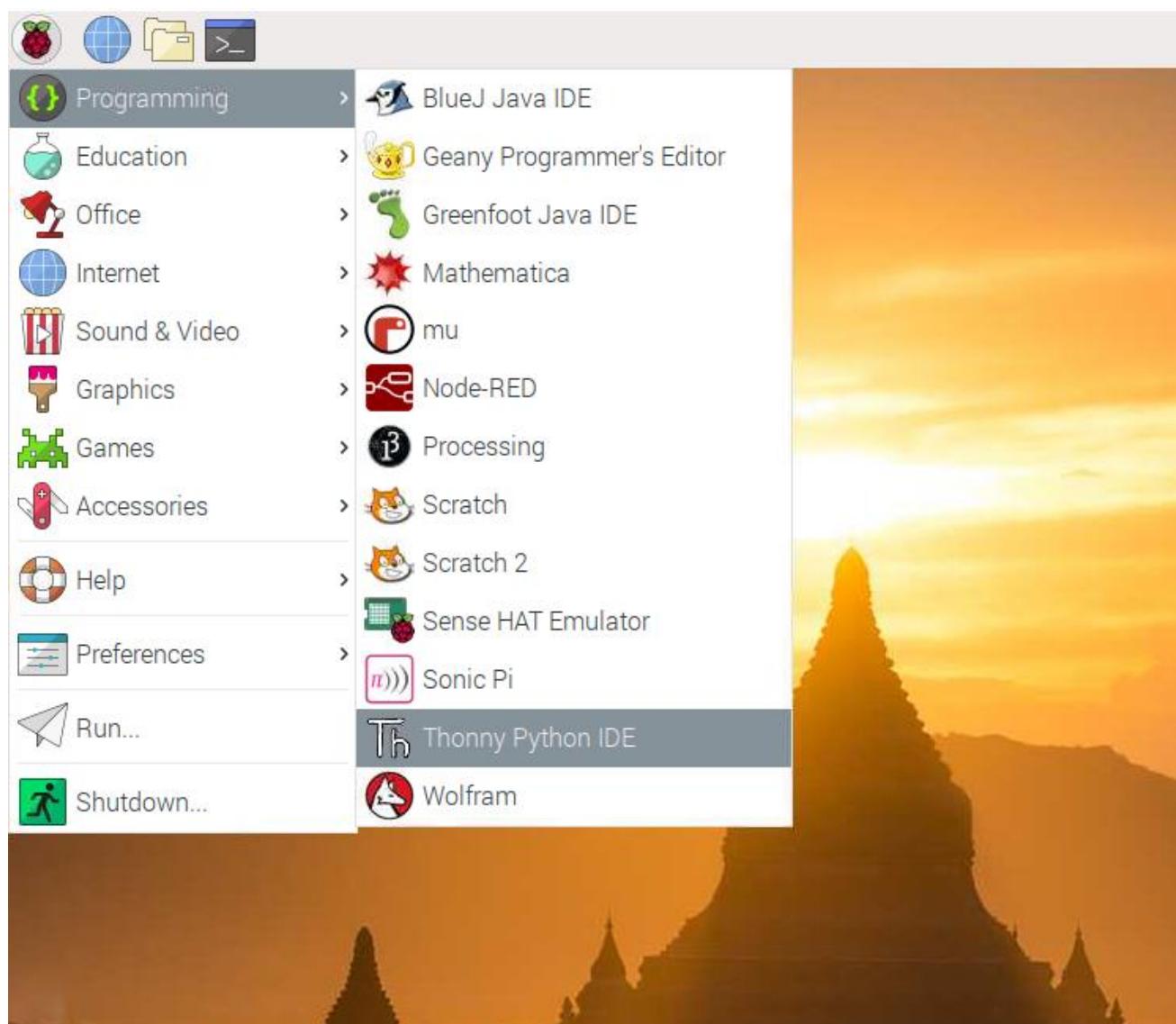
The robot dog program is based on python3. If your python is python2 by default, please change to python3.

If you have never learned python before, you can learn some basics through the following links:

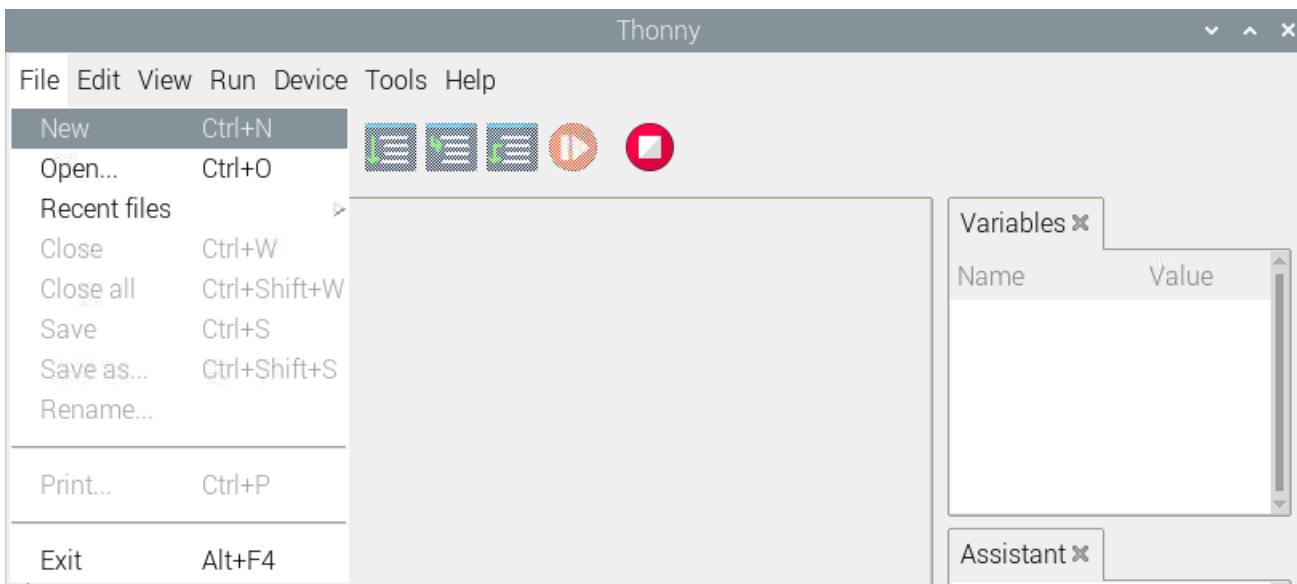
<https://python.swaroopch.com/basics.html>

Program

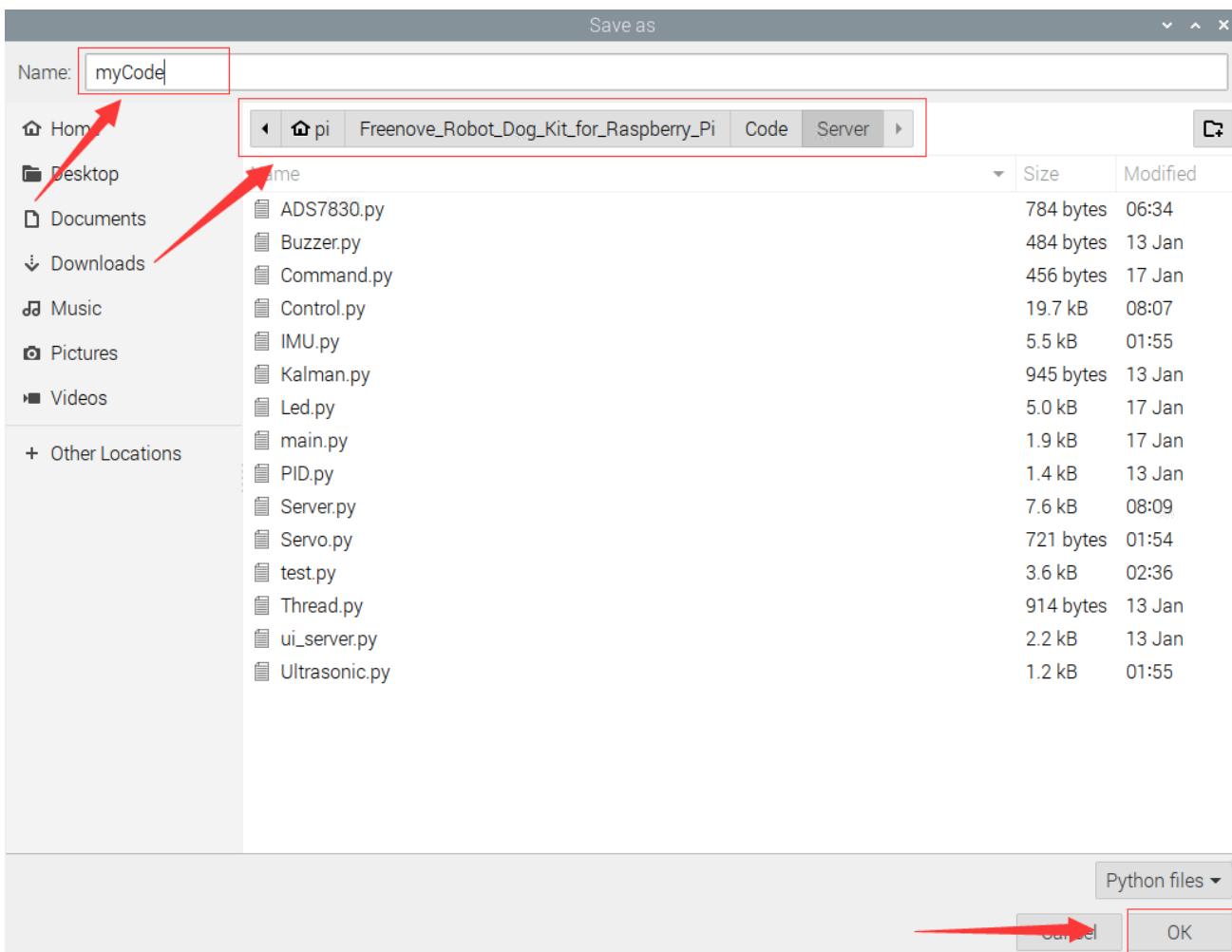
First, open Thonny Python IDE which is easy to use for beginners.



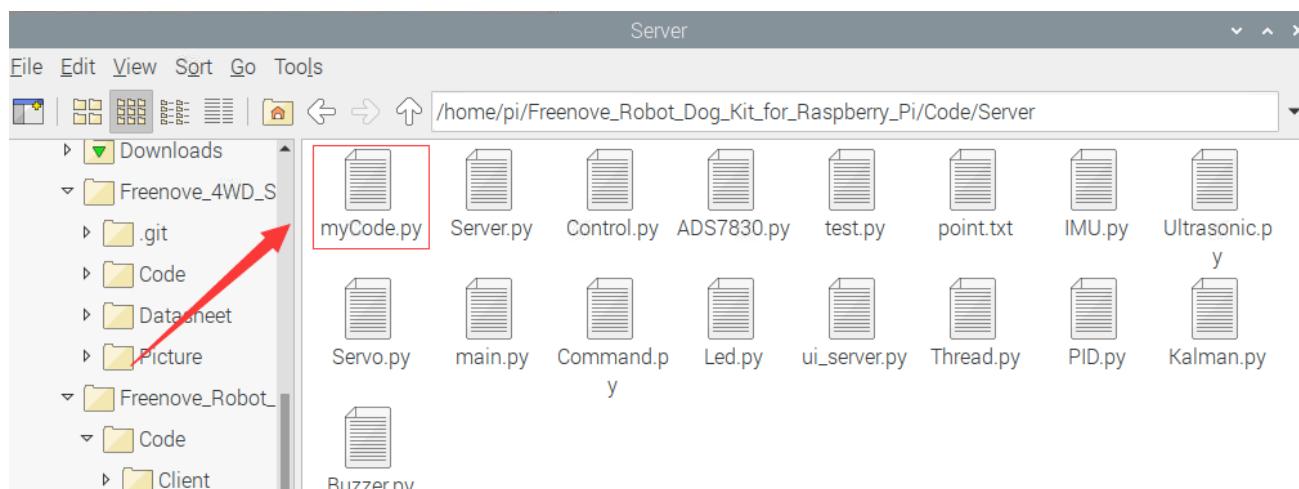
Create a new file.



Name it with myCode as an example and save it under Server folder of robot code folder.



Open the Server folder of the robot dog code and you can see that the file you created.



Write the code in myCode.py like below and click save after finished, as shown below.

The screenshot shows the Thonny Python IDE interface. The title bar says 'Thonny - /home/pi/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server/myCode.py @ 3'. The menu bar includes File, Edit, View, Run, Device, Tools, and Help. The toolbar has icons for new file, open file, save file (highlighted with a red arrow), run, and stop. The code editor window shows the following Python script:

```

1 #Import everything in the control module,
2 #including functions, classes, variables, and more.
3
4 from Control import *
5
6 #Creating object 'control' of 'Control' class.
7 control=Control()
8
9 #Using the forward function, let the robot dog move forward five steps and keep standing.
10 for i in range(5):
11     control.forward()
12 control.stop()
13
14 #Turn the robot dog's body 10 degrees to the right
15 for i in range(10):
16     control.attitude(0,0,i)
17     time.sleep(0.1)
18
19 #Turn the robot dog's body 20 degrees to the left
20 for i in range(10,-10,-1):
21     control.attitude(0,0,i)
22     time.sleep(0.1)
23
24 #Straighten the robot dog's body
25 for i in range(-10,0,1):
26     control.attitude(0,0,i)
27     time.sleep(0.1)
28
29 #Using the forward function, let the robot dog move forward five steps and keep standing.
30 for i in range(5):
31     control.forward()
32 control.stop()

```

Below the code editor is a 'Shell' tab with the text: 'Python 3.7.3 (/usr/bin/python3)' and '>>>'. A red arrow points to the 'Save' button in the toolbar.

Type the following command to enter the directory where myCode.py is located.

```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

Run myCode.py

```
sudo python myCode.py
```

```
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo
python myCode.py
```

You can see that your robot dog moves forward 5 steps, then twists body 10 degrees to the right, then 20 degrees to the left, then returns to the original attitude and move forward 5 steps and then stops.

Related py files

Some important functions included in the py files are listed below. If you want to see more detailed code content, please open the corresponding py file to check directly.

ADS7830.py

Function	Description
power(channel)	Enter 0 to return the battery voltage value.

Buzzer.py

Function	Description
run(command)	Enter 0, then the buzzer will not sound. Enter 1, the buzzer will sound.

Contorl.py

Function	Description
coordinateToAngle(x,y,z)	Enter the foot coordinate then return servo angle of each joint in one leg.
angleToCoordinate(a,b,c)	Enter the leg joint angle then return the foot coordinate.
Condition()	Execute corresponding action commands
map()	Mapping a value from one range to another
backWard()	Move backward one step
forward()	Move forward one step
turnLeft()	Turn left one step
turnRight()	Turn right one step
stop()	Stop.
setpLeft()	Move to left one step
setpRight()	Move to right one step
upAndDown()	Adjust height of body
beforeAndAfter()	Make body move forward or backward
attitude(r,p,y)	Set roll, pitch, and yaw angle of the robot.

IMU.py

Function	Description
imuUpdate()	Update the current roll, pitch, and yaw angle of the robot.

Led.py

Function	Description
ledIndex(Index, R, G, B)	Turn on one LED and set color.
wheel(pos)	Create different RGB values.
LED_TYPR(order,R_G_B)	Change the order in which the LED color data is transmitted. When the value of the order parameter is "RGB", the order of data transmission should be: R-G-B; when the value of the order parameter is "GBR", and the order of data transmission should be: G-B-R
theaterChaseRainbow(strip, wait_ms)	The function is used to make 7 Leds show one color at the same time, and change various colors to blink. The blinking interval is wait_ms, and the default value is 50ms
rainbow(strip, wait_ms)	This function achieves the effect of rainbow breathing. It makes 8 Leds display same color at the same time, and then change all various colors like breathing. The interval is wait_ms. The default value is 20ms.
rainbowCycle(strip, wait_ms)	This function also achieves the effect of rainbow breathing. but unlike rainbow(), it makes eight Leds to display different colors at the same time, and then change various color separately. The interval is wait_ms. The default value is 20ms

Servo.py

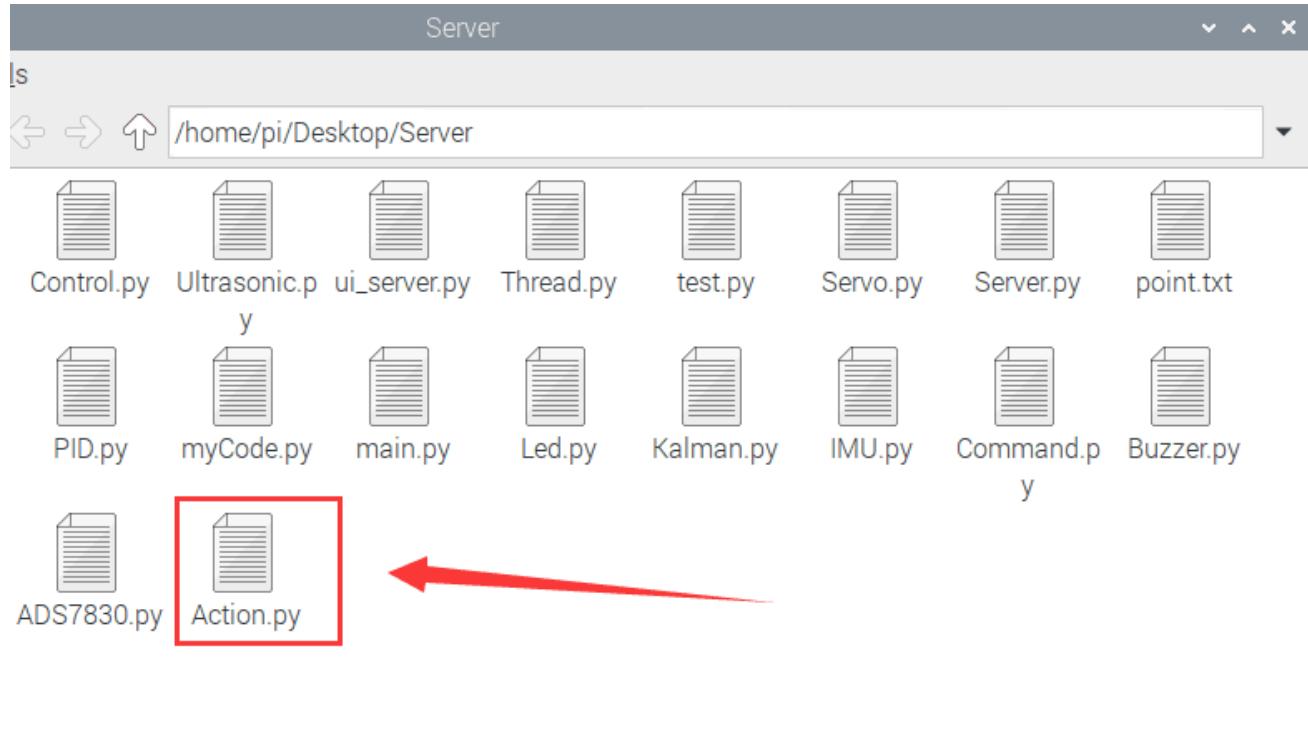
Function	Description
setServoAngle(channel, angle)	Turn the servo of the specified channel to specified angle.

Ultrasonic.py

Function	Description
getDistance()	Obtain the distance between the obstacle in front and the ultrasound.

Custom Action

We have also customized some specific actions, such as push-up, greeting, etc. You can run "Action.py" to play.



Android and iOS app

You can download and install the Freenove **Android app** from below:

On Google play:

<https://play.google.com/store/apps/details?id=com.freenove.suhayl.Freenove>

On GitHub:

https://github.com/Freenove/Freenove_App_for_Android

In this GitHub repository, you can find the App instruction (Tutorial.pdf).

You can download and install the Freenove **iOS app** by searching **freenove** in app store.



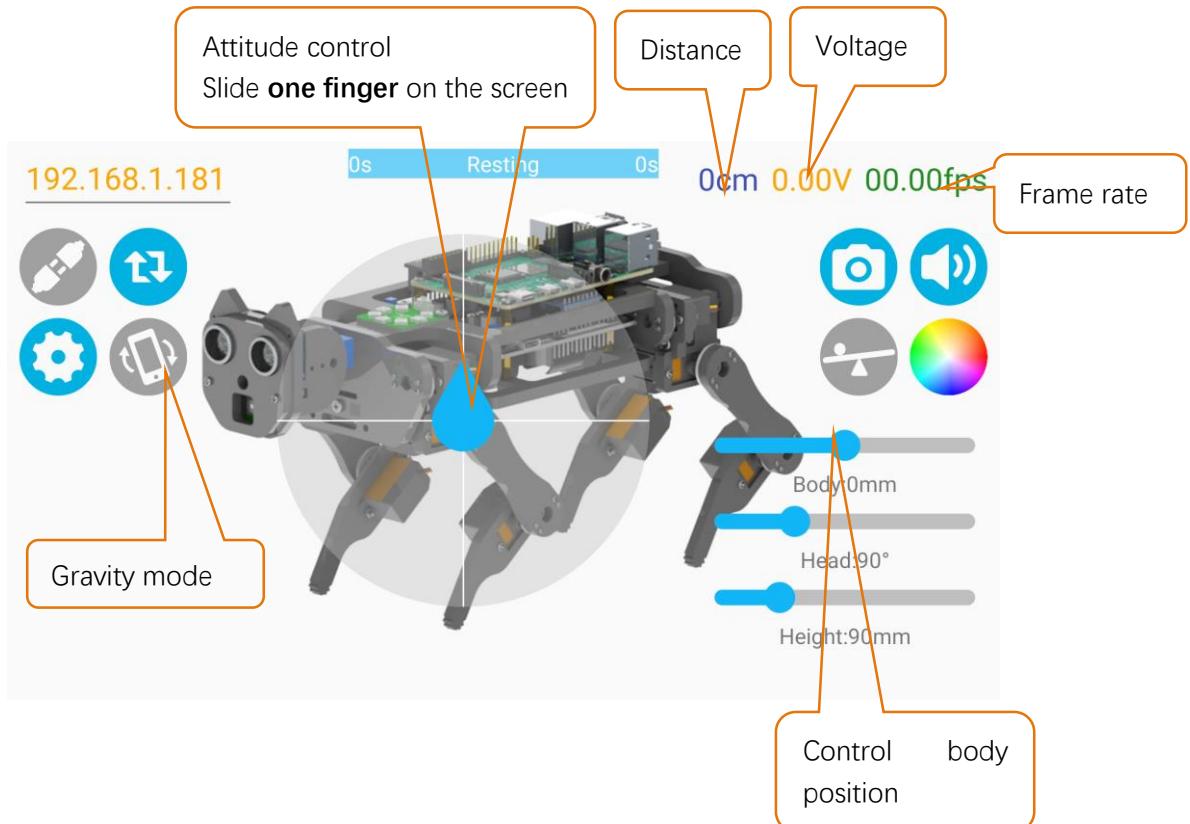
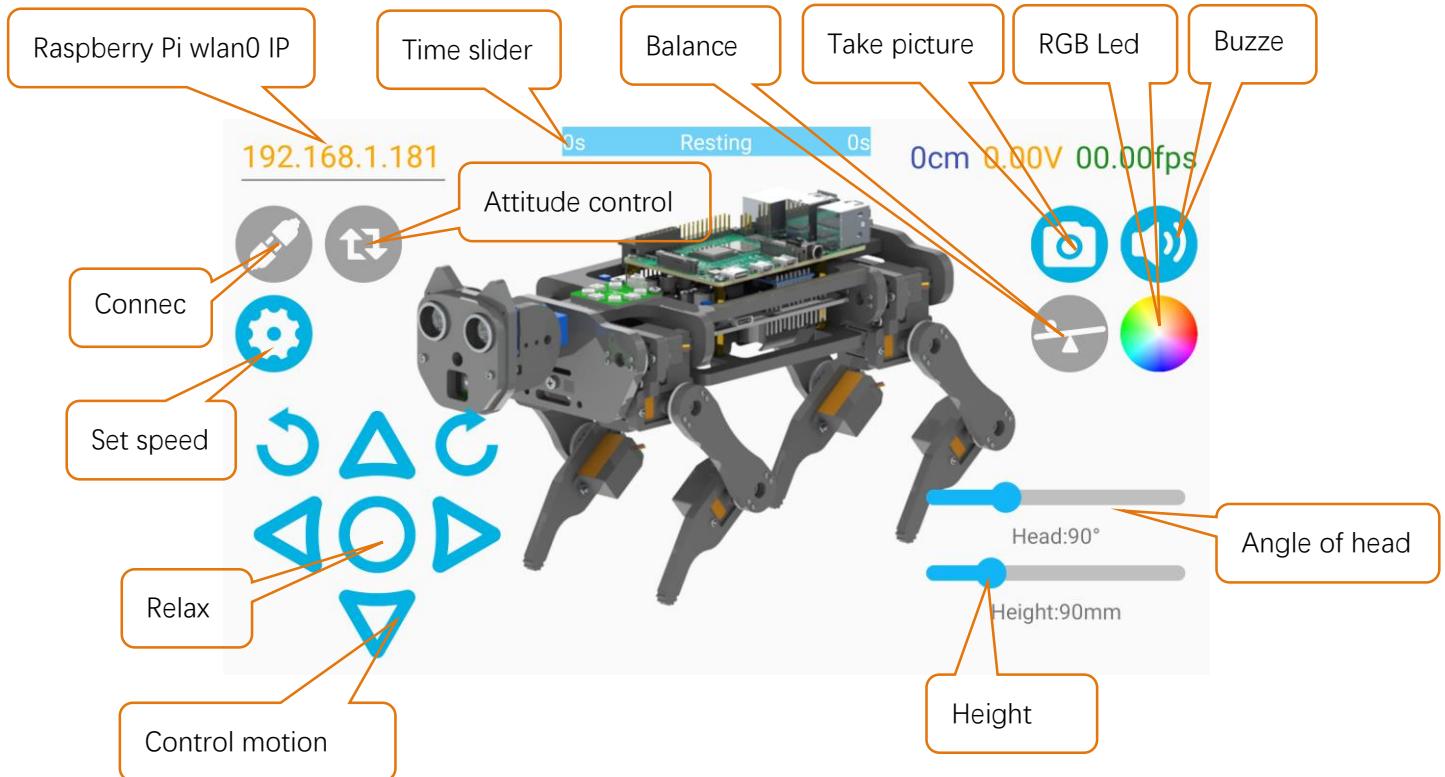
Relax mode.

- When the robot dog moves for 3 minutes in total, it will feel tired (the servo will get hot). In order to protect the servo, the robot will get into relax mode for 1 minute. **During this time, it won't respond to motion command.** You can still use the functions of LED, buzzer, real-time video and so on.
- When the robot dog moves for <3 minutes and then the robot rest for 1 minute. The timer will start from 0. Then the robot can move for 3 minutes again.
- If the robot isn't tired and is standing, when the robot don't receive motion command for 10s, it will get into relax mode. In this situation, it will respond to any commands.

Following are the features of his app.

First, you need turn on the [Server](#). Then enter your raspberry pi IP address and click connect icon.

On the top of the interface, there is a timer slider to indicate the time for moving or resting.



What's next?

Thanks for your reading.

This book is all over here. If you find any mistakes, missions or you have other ideas and questions about contents of this book or the kit and ect., please feel free to contact us at support@freenove.com and we will check and correct it as soon as possible.

After completing the contents in this book, you can try to reform this smart car, such as purchasing and installing other Freenove electronic modules, or improving the code to achieve different functions. We will also try our best to add more functions and update the code on our GitHub (<https://github.com/freenove>).

If you want to learn more about Arduino, Raspberry Pi, smart cars, robots and other interesting products in science and technology, please continue to focus on our website (www.freenove.com). We will continue to launch cost-effective, innovative and exciting products.

Thank you again for choosing Freenove products.