

# 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\\_Robot\\_Dog\\_Kit\\_for\\_Raspberry\\_Pi/archive/master.zip](https://github.com/Freenove/Freenove_Robot_Dog_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

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- 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.

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## 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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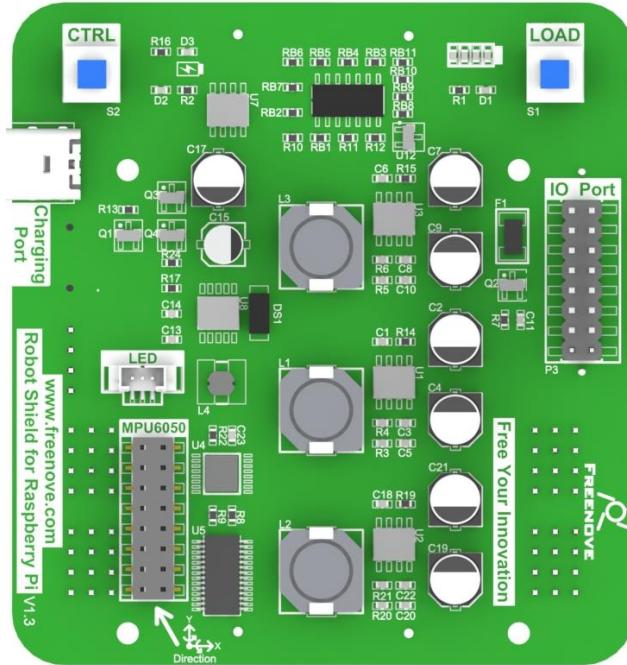
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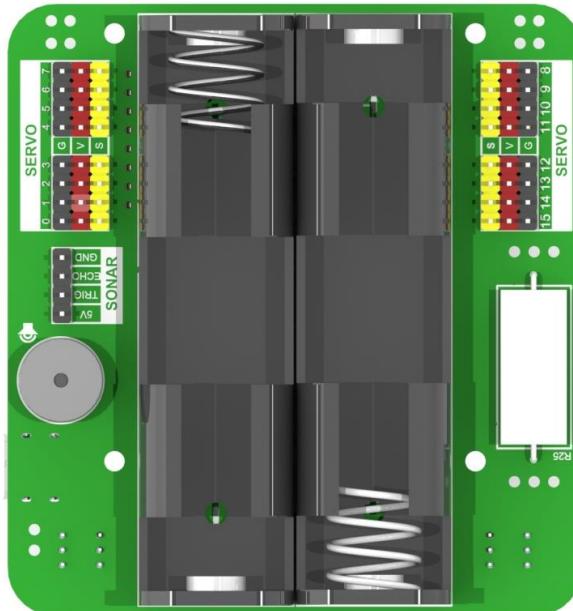
If you have any concerns, please feel free to contact us at [support@freenove.com](mailto:support@freenove.com)

## Robot Shield for Raspberry Pi

Top



Bottom



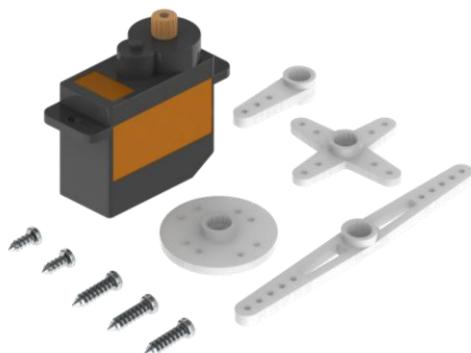
## Machinery Parts

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

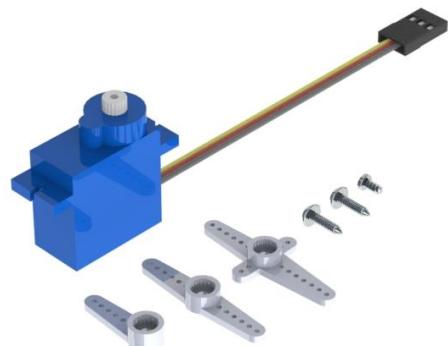
Note: You may receive M1.4\*4 or M1.4\*5. Both are suitable.

## Transmission Parts

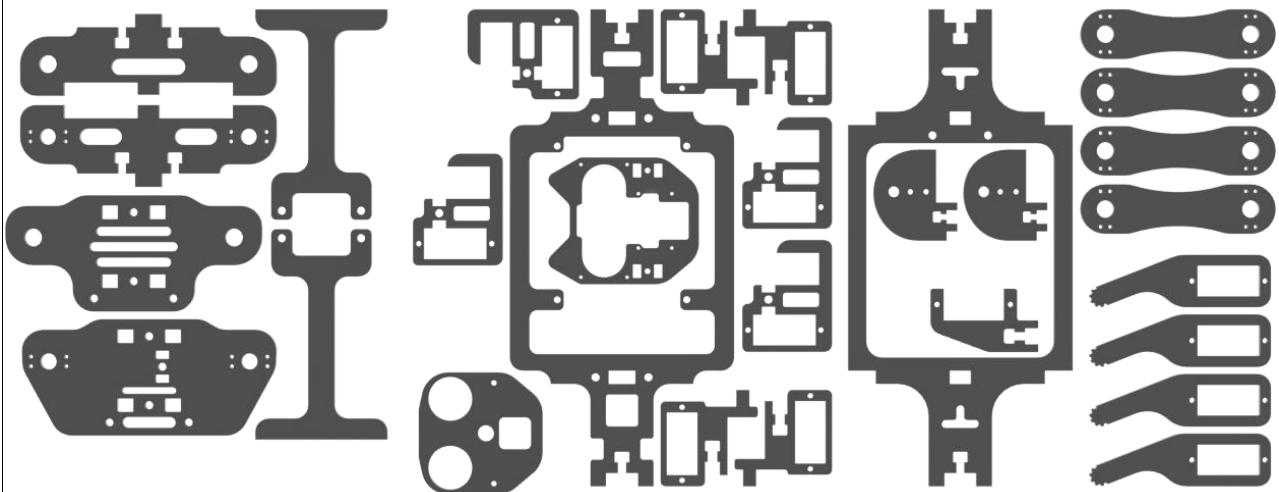
ES08MA II servo package x12



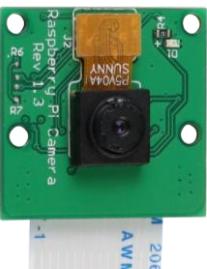
S90 servo package x1



## Acrylic Parts



## Electronic Parts and Tools

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

## Required but NOT Contained Parts

Two 18650 lithium batteries without protected board.

**The continuous discharge current >10A**

It is not easy to find proper batteries 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 Robot Dog Kit for Raspberry Pi. Following this tutorial, you can make a very cool robot dog with many functions.

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

If you encounter any problems, please feel free to contact us for quick and free technical support.

[support@freenove.com](mailto:support@freenove.com)

This book can help enthusiasts with little technical knowledge to make a robot dog. 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](http://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

## Introduction to Raspberry Pi

Raspberry Pi (or RPi, RPI, RasPi, which will be also referenced in this tutorial), a micro-computer with size of a card, quickly swept the world since it was launched. It is widely used in desktop workstation, media center, smart household, robots, and even the servers, etc. It can do almost everything, which continues to attract fans to explore it. Raspberry Pi is 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 run 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, at this writing, Raspberry Pi has advanced to its fourth generation product offering. Version changes are accompanied by increases in upgrades in hardware and capabilities.

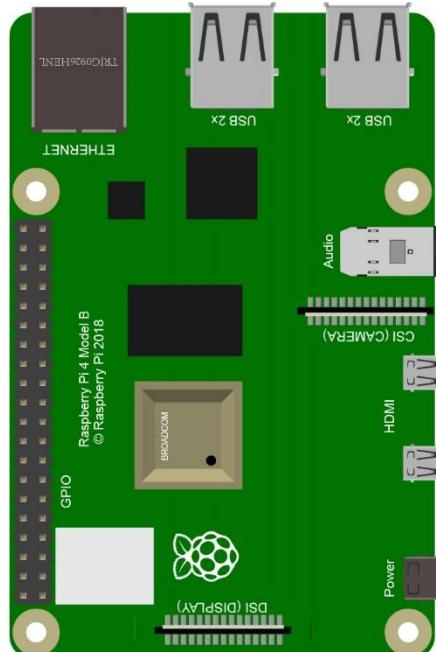
The A type and B type versions of the first generation products have been discontinued due to various reasons. What is most important is that other popular and currently available versions are consistent in the order and number of pins and their assigned designation of function, making compatibility of peripheral devices greatly enhanced between 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+:



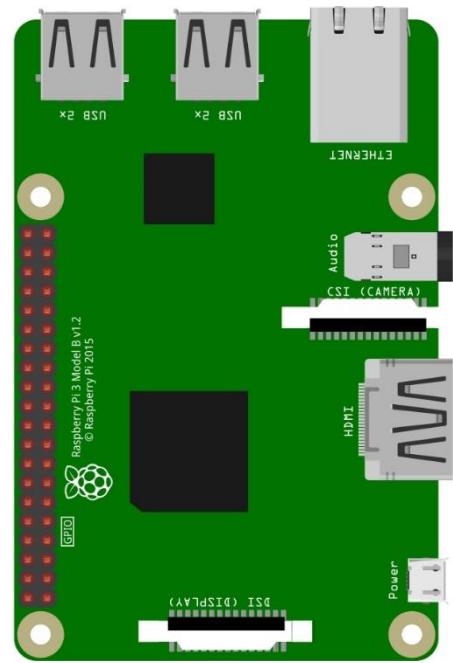
Model diagram of Raspberry Pi 3 Model B+:



Practicality picture of Raspberry Pi 3 Model B:



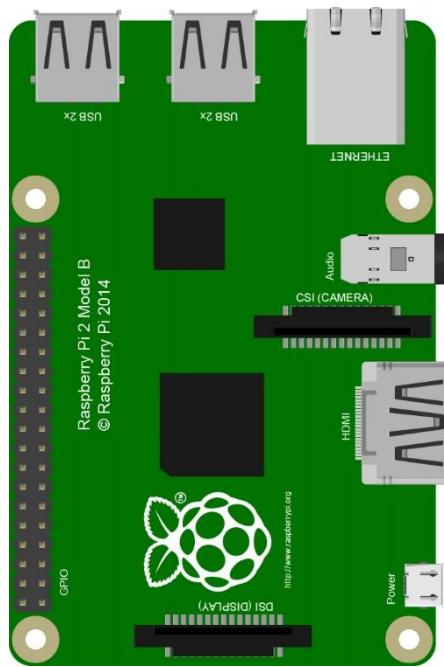
Model diagram of Raspberry Pi 3 Model B:



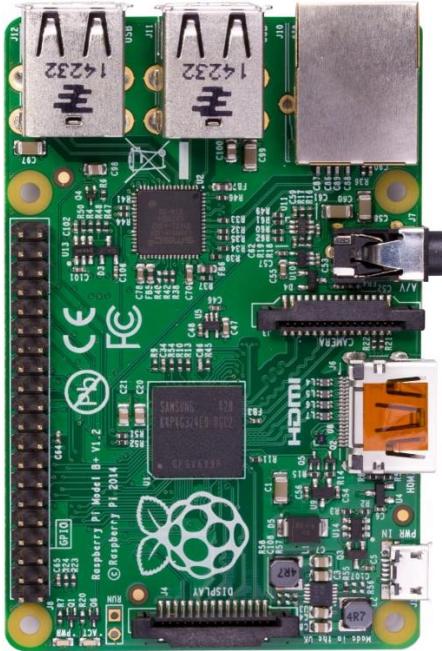
Practicality picture of Raspberry Pi 2 Model B:



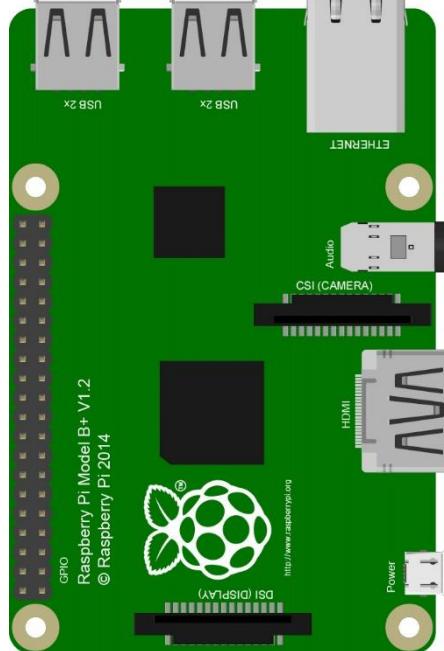
Model diagram of Raspberry Pi 2 Model B:



Practicality picture of Raspberry Pi 1 Model B+:



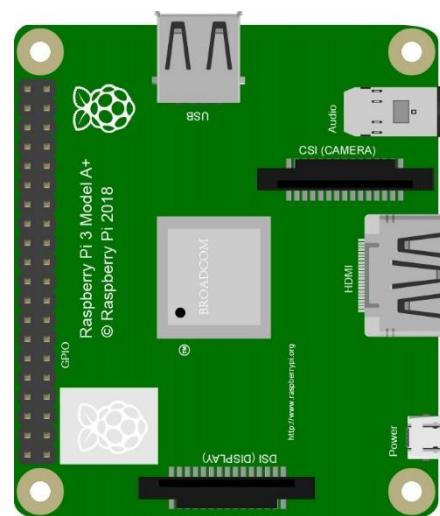
Model diagram of Raspberry Pi 1 Model B+:



Practicality picture of Raspberry Pi 3 Model A+:



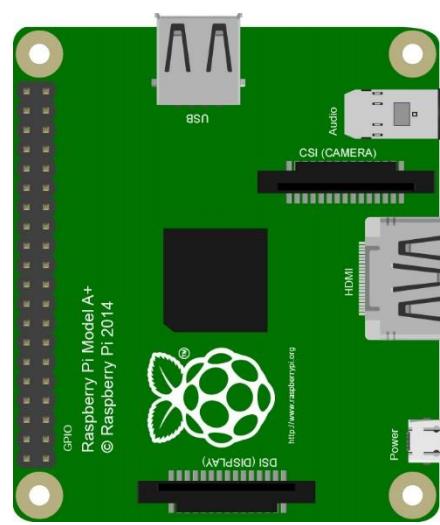
Model diagram of Raspberry Pi 3 Model A+:



Practicality picture of Raspberry Pi 1 Model A+:



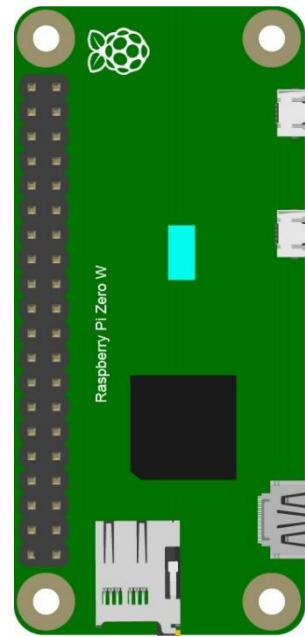
Model diagram of Raspberry Pi 1 Model A+:



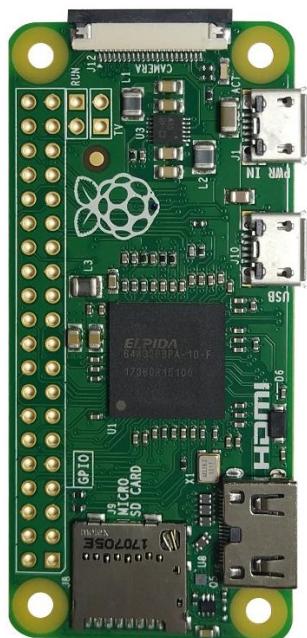
Practicality picture of Raspberry Pi Zero W:



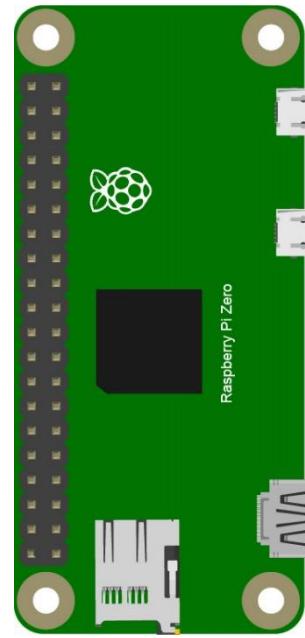
Model diagram of Raspberry Pi Zero W:



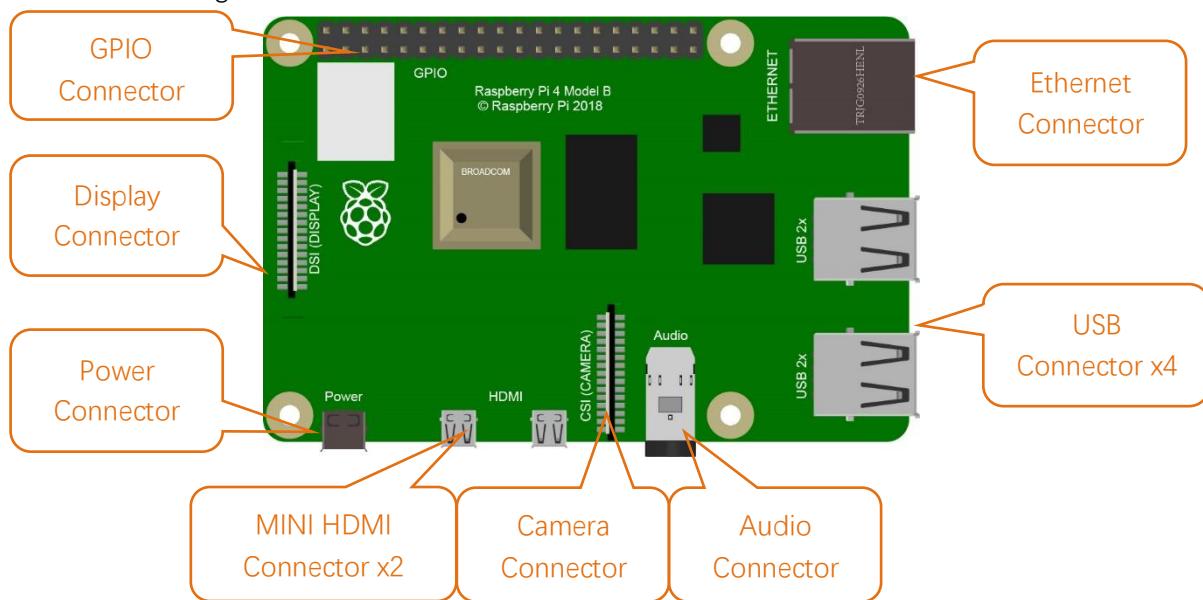
Practicality picture of Raspberry Pi Zero:



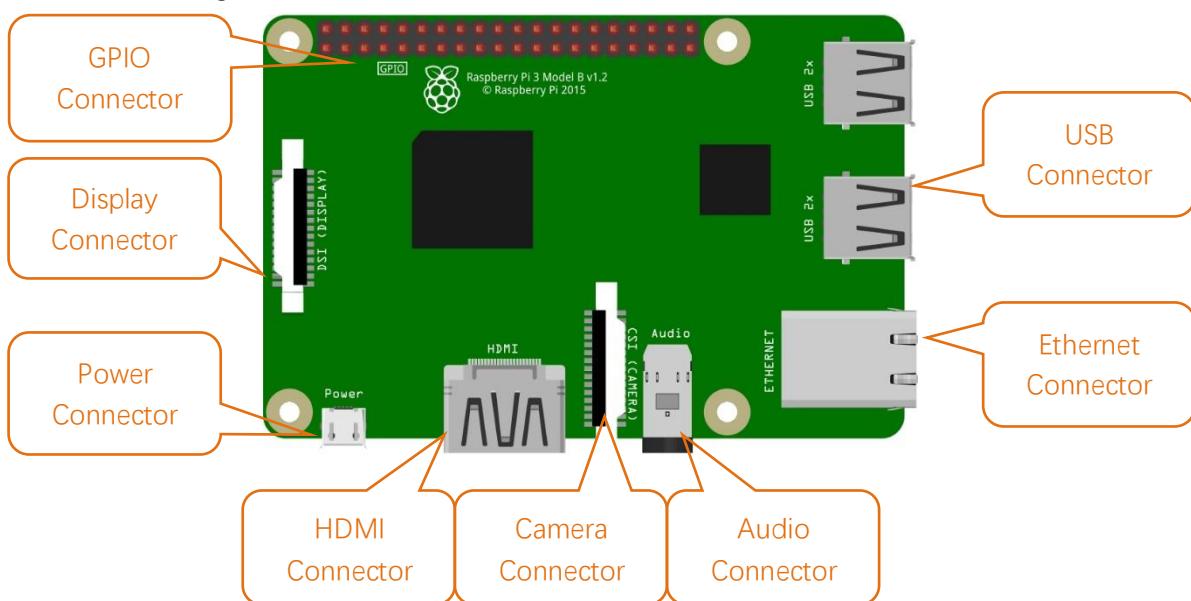
Model diagram of Raspberry Pi Zero:



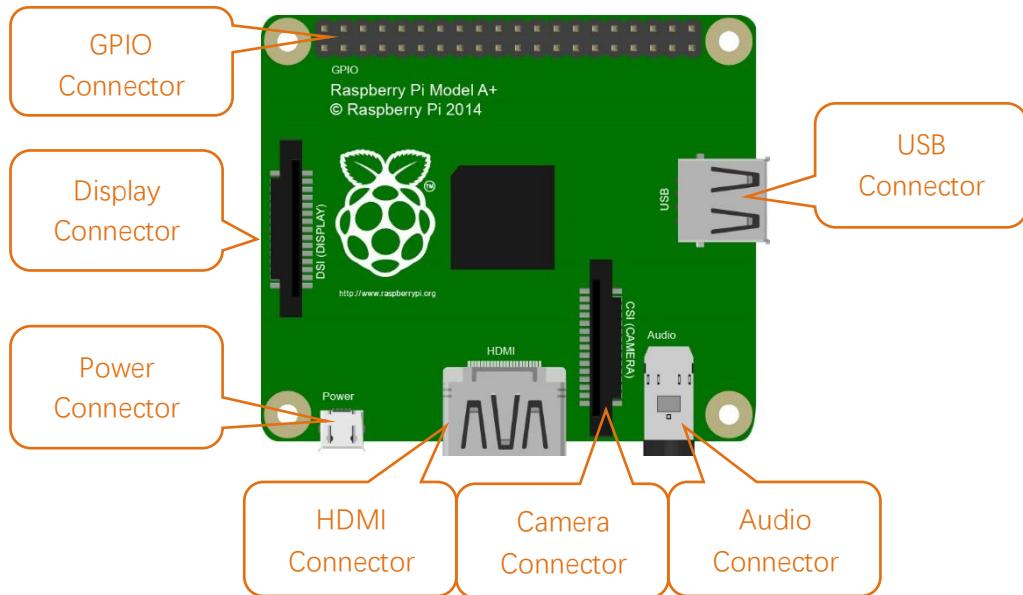
Hardware interface diagram of RPi 4B is shown below:



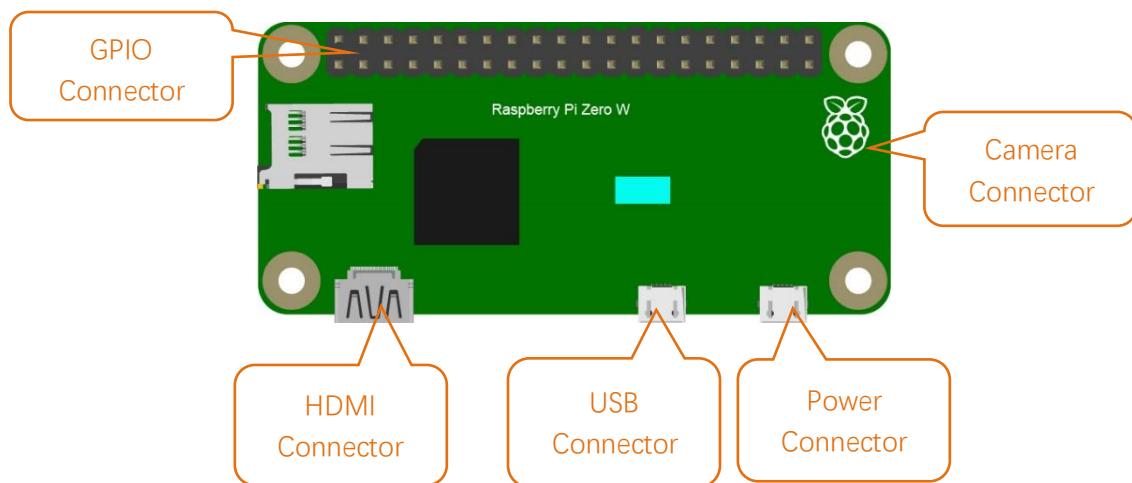
Hardware interface diagram of RPi 3B+/3B/2B/1B+ are shown below:



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



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



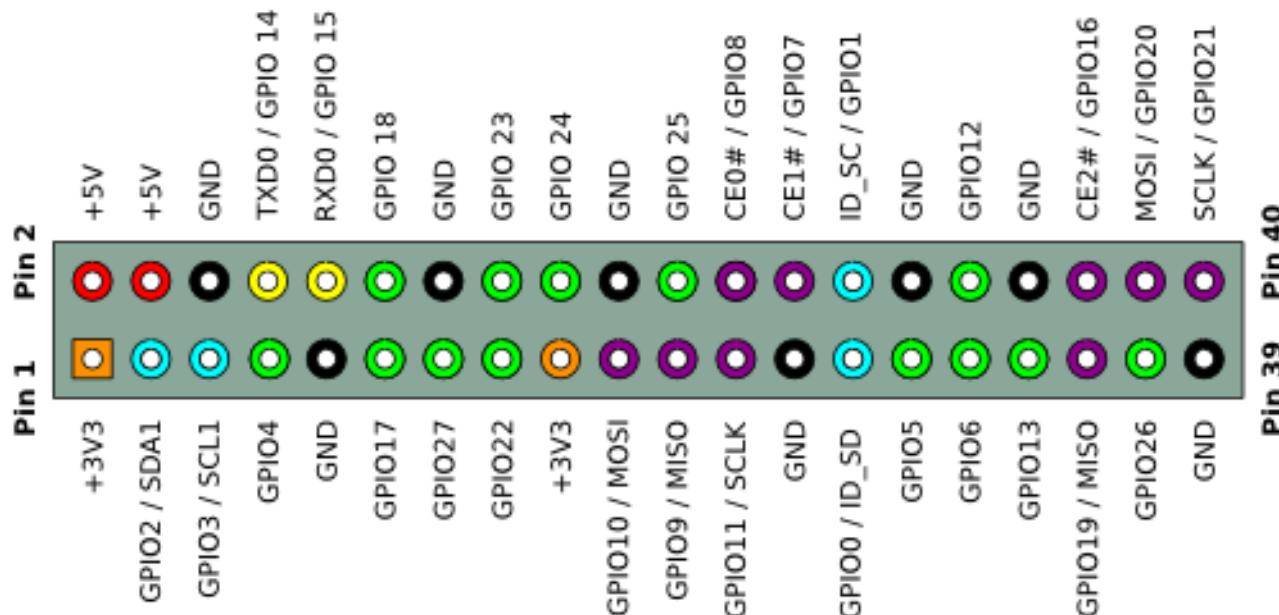
## GPIO

GPIO: General purpose input/output. We will introduce the specific feature of the pins on the Raspberry Pi and how you can utilize them in all sorts of ways in your projects. Most RPi Module pins can be used as either an input or output, depending on your program and its functions. When programming the GPIO pins, there are 3 different ways to reference them: GPIO numbering, physical numbering, WiringPi GPIO Numbering.

### BCM GPIO Numbering

The Raspberry Pi CPU uses Broadcom (BCM) processing chips BCM2835, BCM2836 or BCM2837. GPIO pin numbers are assigned by the processing chip manufacturer and are how the computer recognizes each pin. The pin numbers themselves do not make sense or have meaning as they are only a form of identification. Since their numeric values and physical locations have no specific order, there is no way to remember them, so you will need to have 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 two types of GPIO serial numbers, RPi GPIO serial number of the WiringPi are numbered according to the BCM chip use in RPi.

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/> )

Need support? ✉ support@freenove.com

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

```
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	ALTO	1	3	4		5V				
3	9	SCL.1	ALTO	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	ALTO	0	19	20		0v				
9	13	MISO	ALTO	0	21	22	0	IN	GPIO. 6	6	25	
11	14	SCLK	ALTO	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

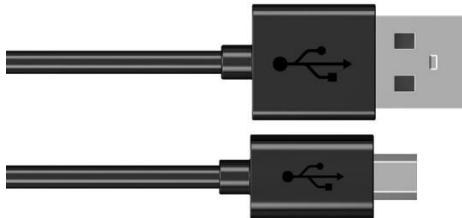
Raspberry Pi 4B / 3B+ / 3B / 3A+ (Recommended)



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 <a href="https://www.amazon.com/dp/B076Q595HJ/">https://www.amazon.com/dp/B076Q595HJ/</a>
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 requirements of various versions of Raspberry Pi are 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 an Ethernet network cable used to connect it to a WAN (Wide Area Network). All these components are necessary for any of your projects to work. Among them, the power supply of at least 5V/2.5A, because a lack of a sufficient power supply may lead to many functional issues and even damage your RPi, we STRONGLY RECOMMEND a 5V/2.5A power supply. We also recommend using a SD Micro Card with a capacity 16GB or more (which, functions as the RPi's "hard drive") and is used to store the operating system and necessary operational files.

In future projects, the components list with a RPi will contain 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: 1) Using a stand-alone monitor. 2) Using a remote desktop computer monitor “sharing” the PC monitor with your RPi.

### Required Accessories for Monitor

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

1. A Display with HDMI interface
2. A Mouse and a Keyboard with an USB interface

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

1. A Mini-HDMI to HDMI Adapter and Cable.
2. A Micro-USB to USB-A Adapter and Cable (Micro USB OTG Cable).
3. A USB HUB.
4. USB to Ethernet Interface or USB Wi-Fi receiver.

For different Raspberry Pi, the optional items are slightly different. But they all aim to convert the interfaces to Raspberry Pi standards.

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

### Required Accessories for Remote Desktop

If you do not have an independent monitor, or if you want to use a remote desktop, first you need to login to Raspberry Pi through SSH, then open the VNC or RDP service. This requires the following accessories.

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

## Raspberry Pi OS

### Official Method (Recommended)

You can follow the official method to install the system for raspberry pi via visiting link below:

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

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

### Download system manually (Optional)

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

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

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.

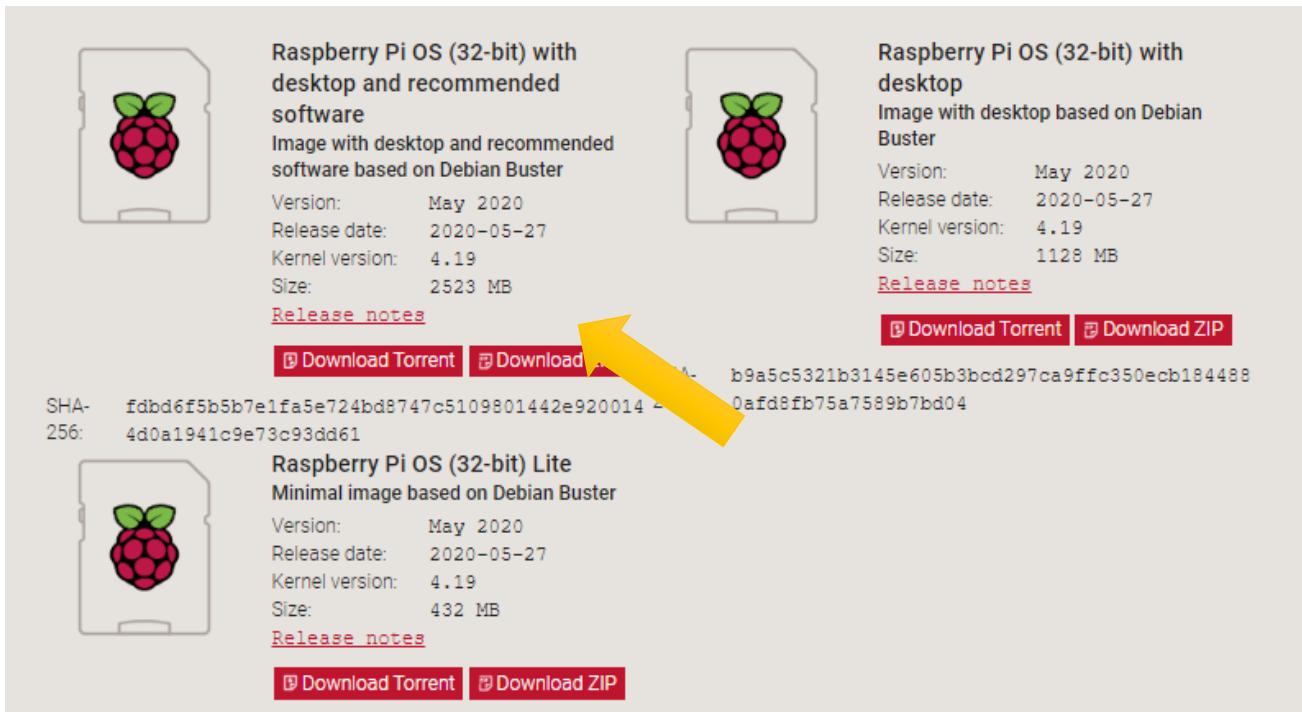
Use **Raspberry Pi Imager** for an easy way to install Raspberry Pi OS and other operating systems to an SD card ready to use with your Raspberry Pi:

- [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.



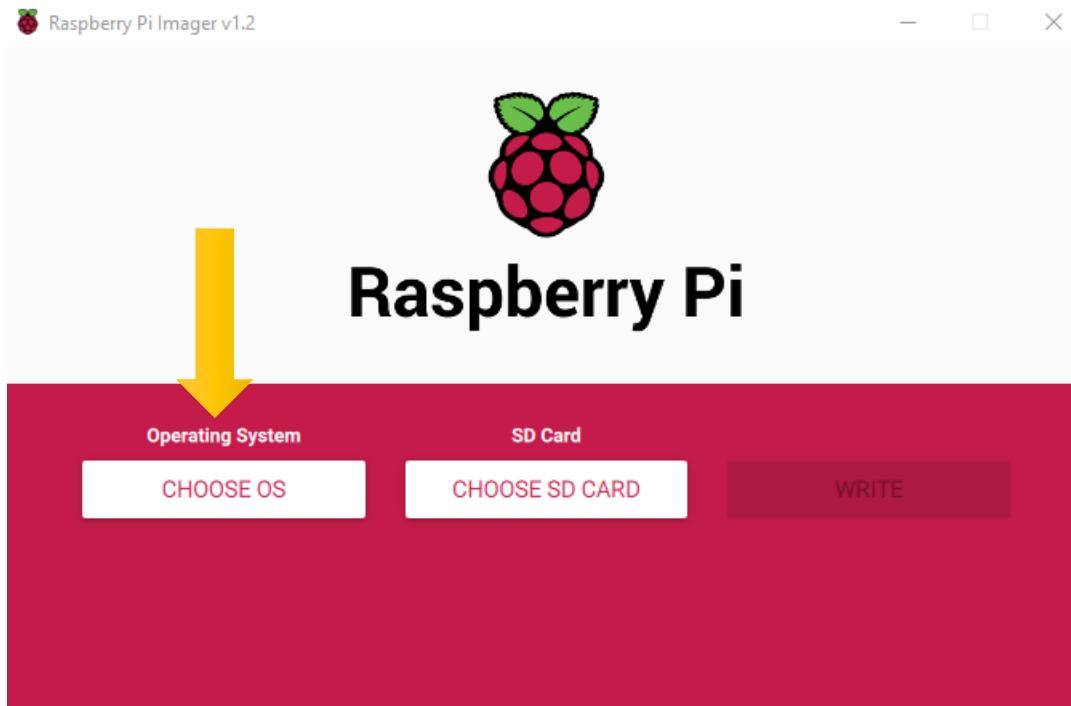
<https://www.raspberrypi.org/downloads/>

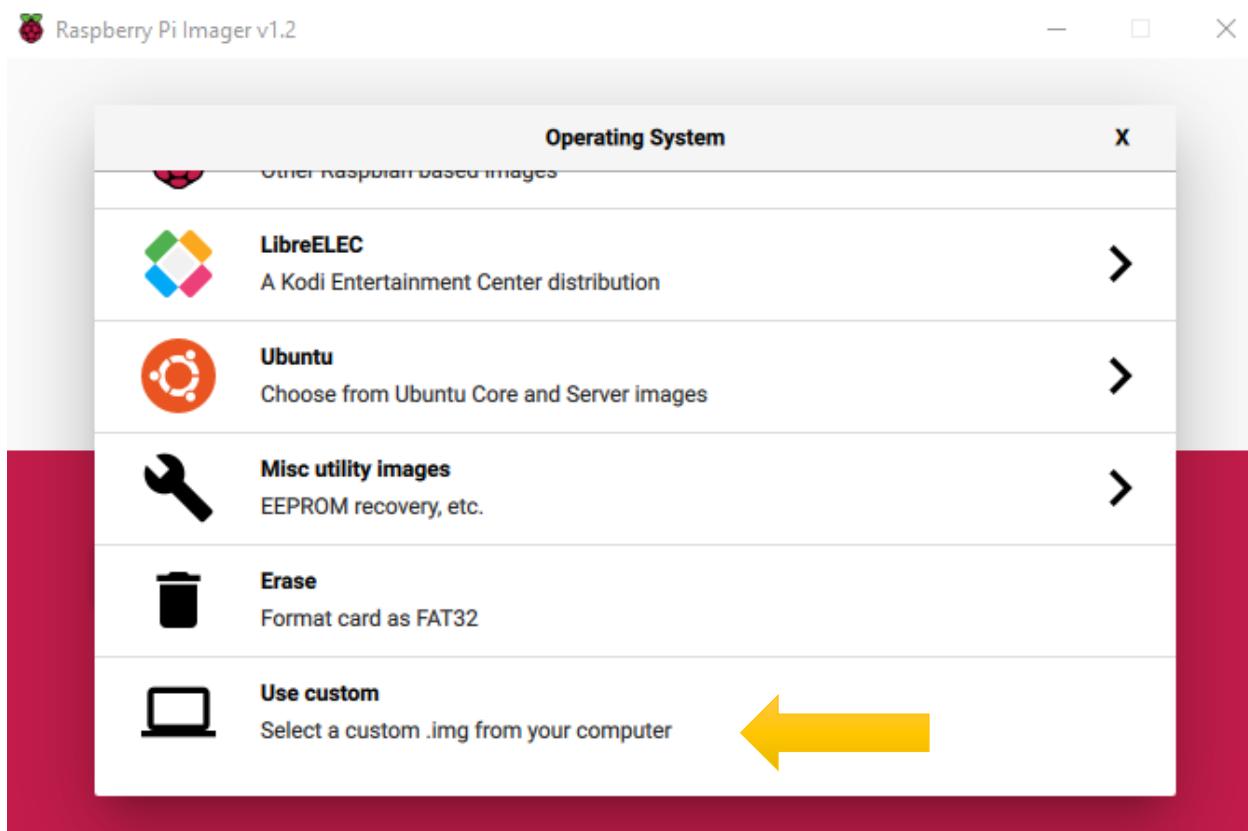


And then the zip file is downloaded.

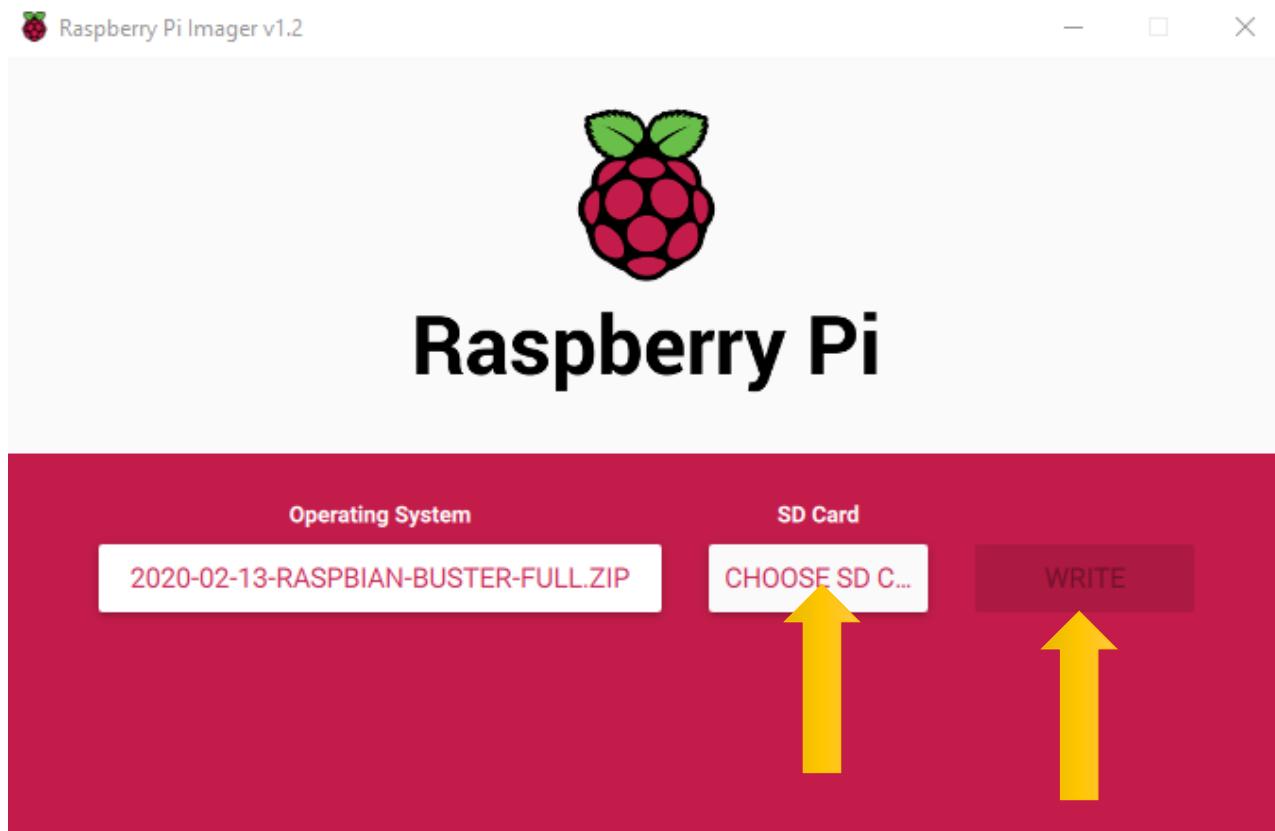
### Write System to Micro SD Card

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





Choose the SD card. Then click "WRITE".



### Start Raspberry Pi

If you don't have a spare monitor, please skip to next section.

If you have a spare monitor, please follow the steps in this section.

After the system is written successfully, take out Micro SD Card and put it into the SD card slot of RPi. Then connect your RPi to send video through the HDMI port, attach your mouse and keyboard through the USB ports, attach a network cable to the network card port and finally, connect your power supply (making sure that it meets the specifications required by your RPi Module Version). Your RPi should start (power up). Later, after setup, you will need to enter your user name and password to login. The default user name: pi; password: raspberry. After login, you should see the following screen.



Congratulations! You have successfully installed the RASPBERRY PI OS operating system on your RPi. Then you can connect WiFi on the right corner.

Now you can skip 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

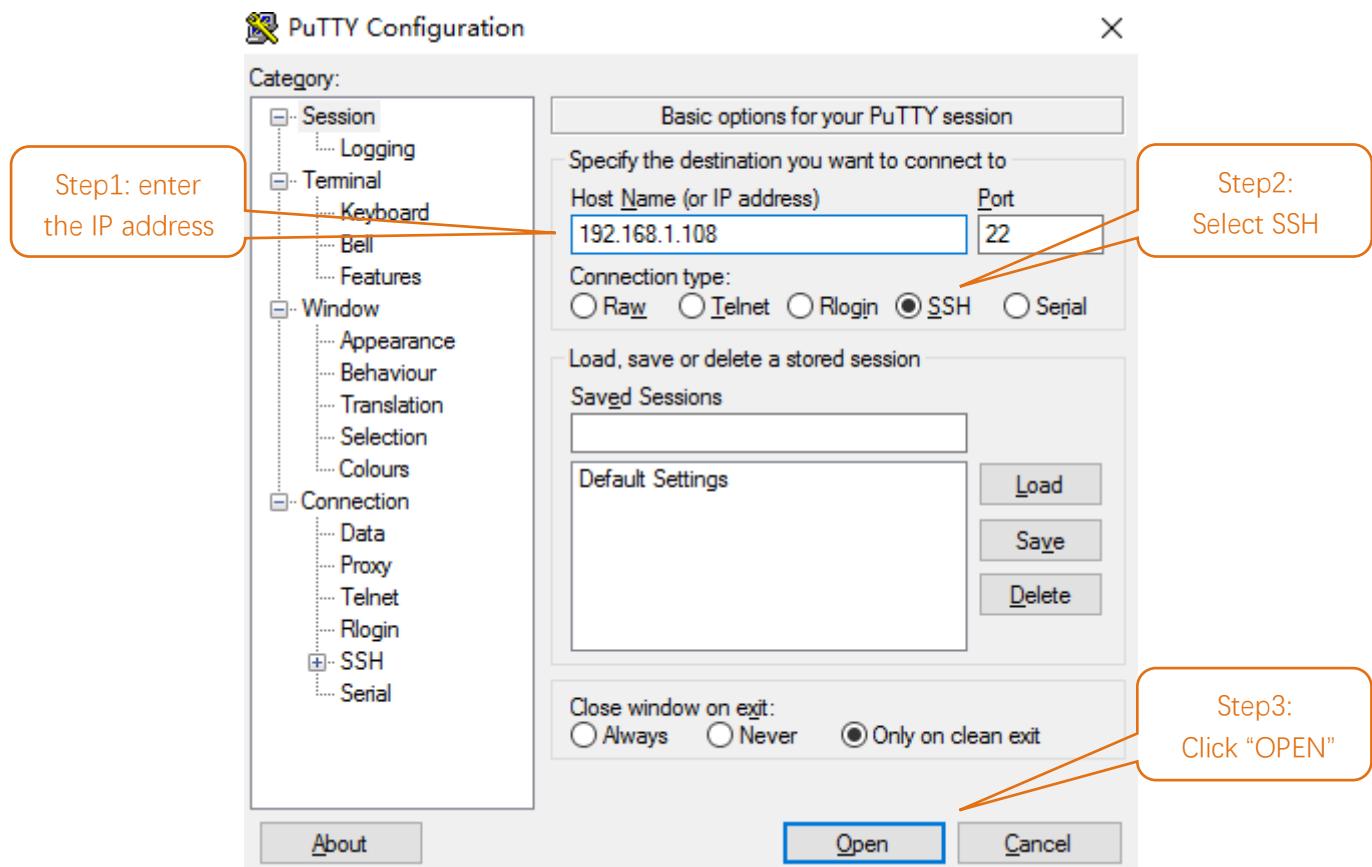
The windows built-in application remote desktop corresponds to the Raspberry Pi xrdp service.

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 same router with your PC. Then put the system Micro SD Card prepared before into the slot of the RPi and turn on the power supply. Enter router client to inquiry IP address named “raspberry pi”. For example, my RPi IP address 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".

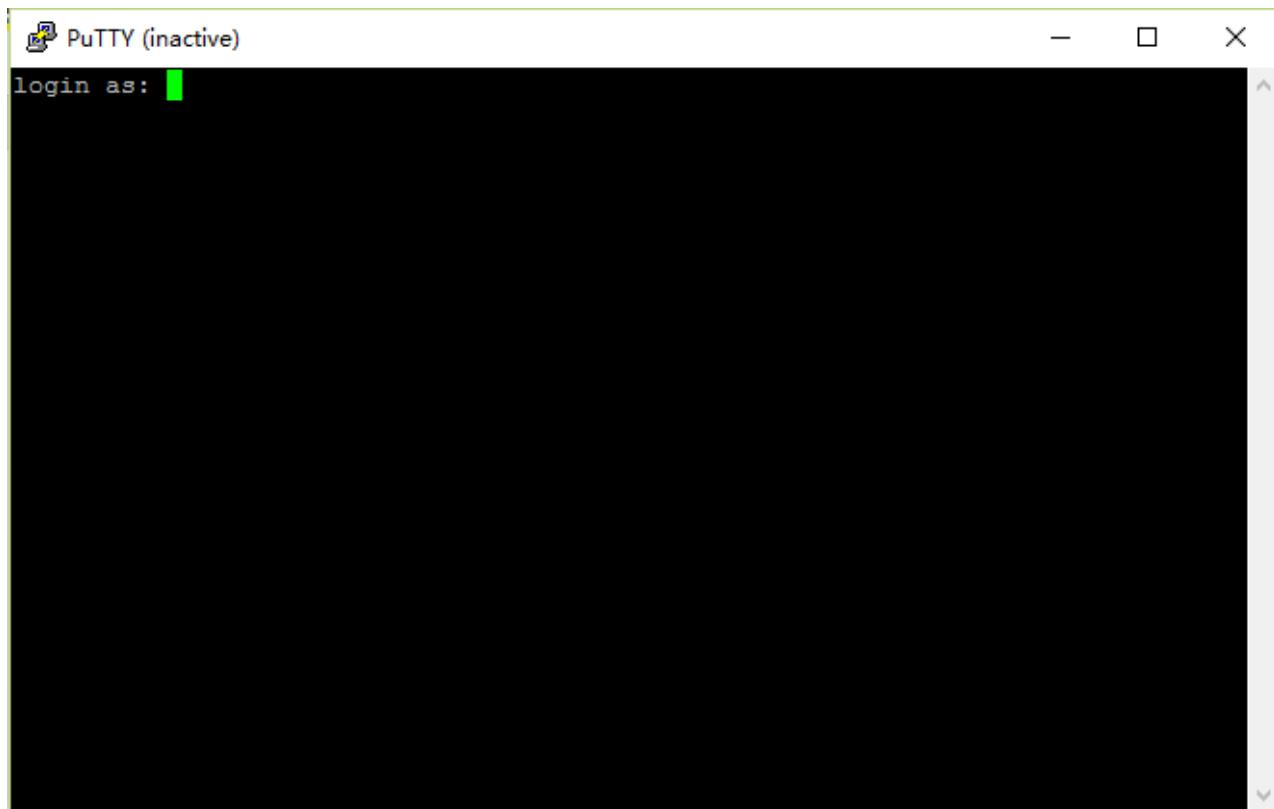
PuTTY Security Alert



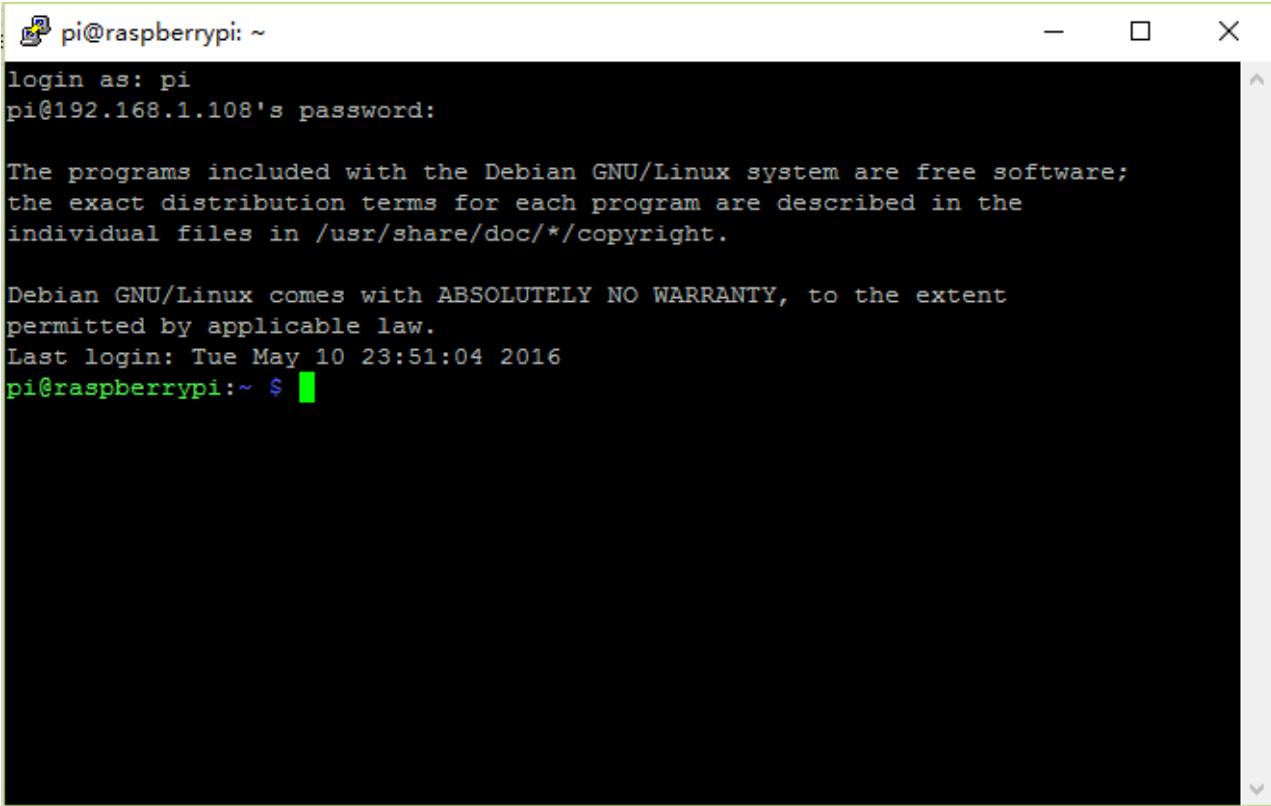
#### WARNING - POTENTIAL SECURITY BREACH!

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.

```
pi@raspberrypi: ~
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.

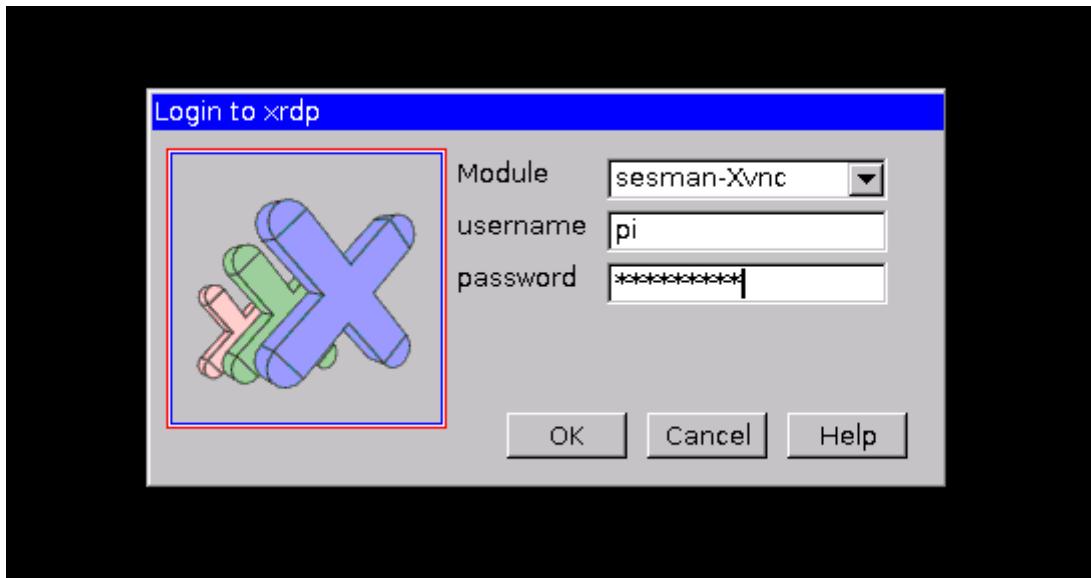


### Login to Windows remote desktop

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".

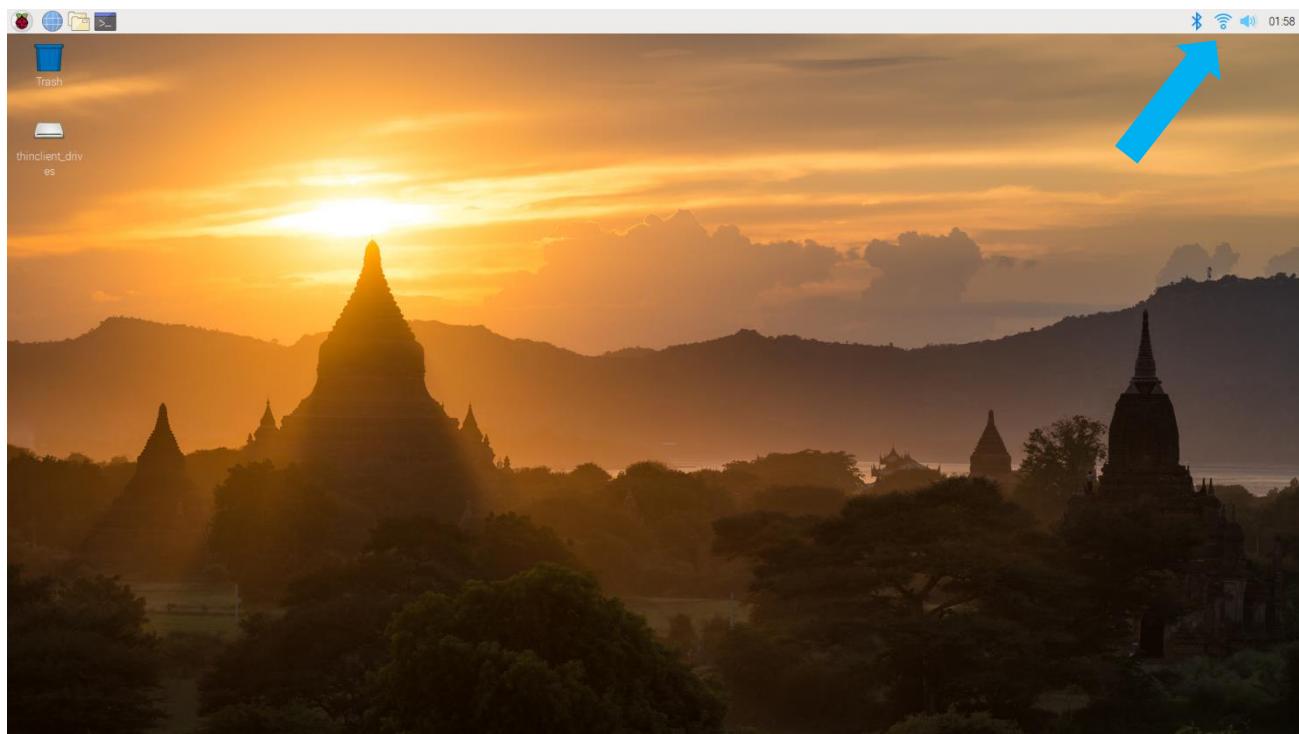


Later, you can enter the RPi desktop system.



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 operation. Raspberry Pi of other models can use wireless remote desktop through accessing an external USB wireless card.



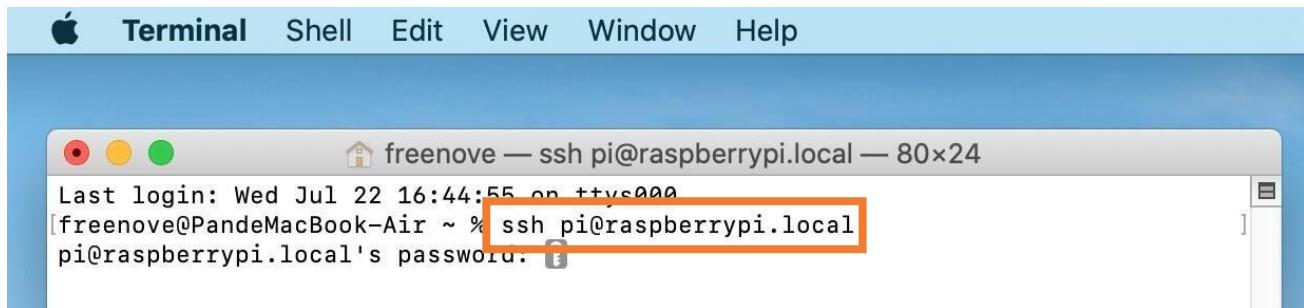
## MAC OS Remote Desktop

Connect your pi to the router via a network cable.

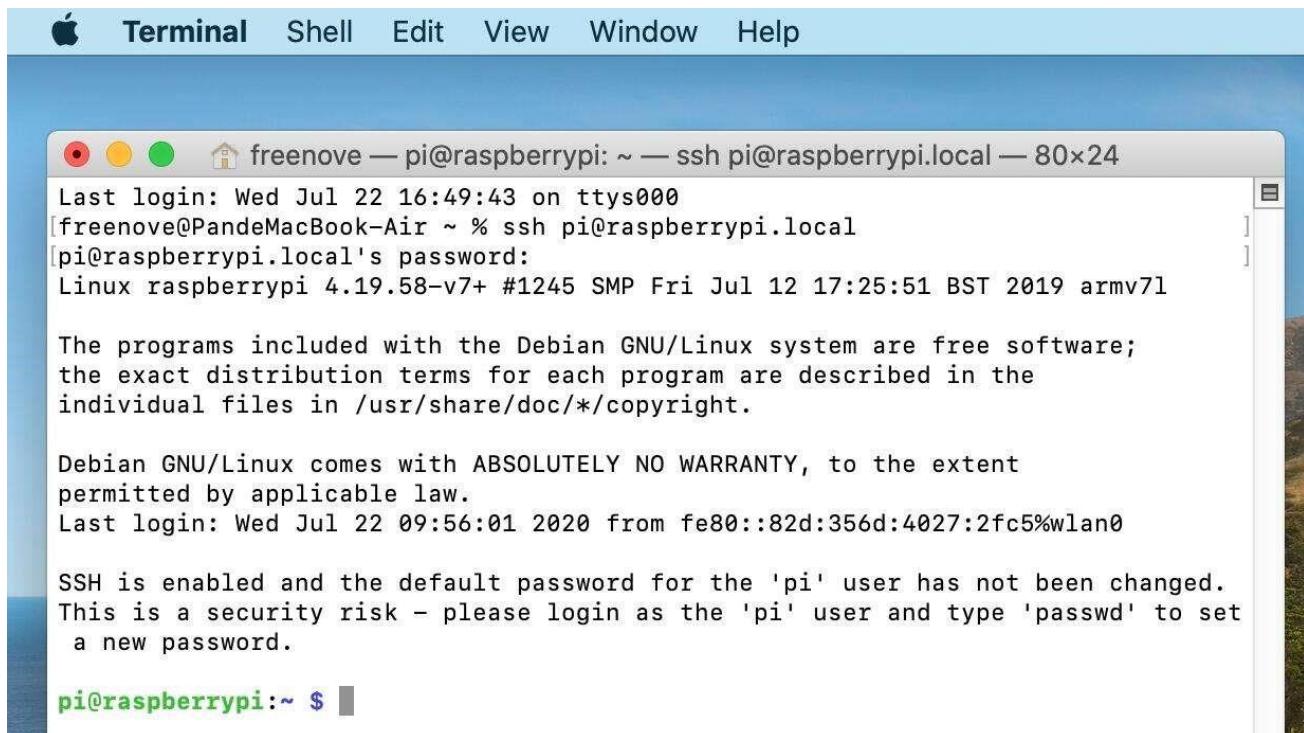
Open the terminal and type following command.

```
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 address 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 with the title bar "Terminal" and menu items "Shell", "Edit", "View", "Window", "Help". The main pane displays the following text:

```
freenove — pi@raspberrypi: ~ — ssh pi@192.168.1.131 — 81x44
[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 window, a separate window titled "Raspberry Pi Software Configuration Tool (raspi-config)" is displayed. It lists the following options:

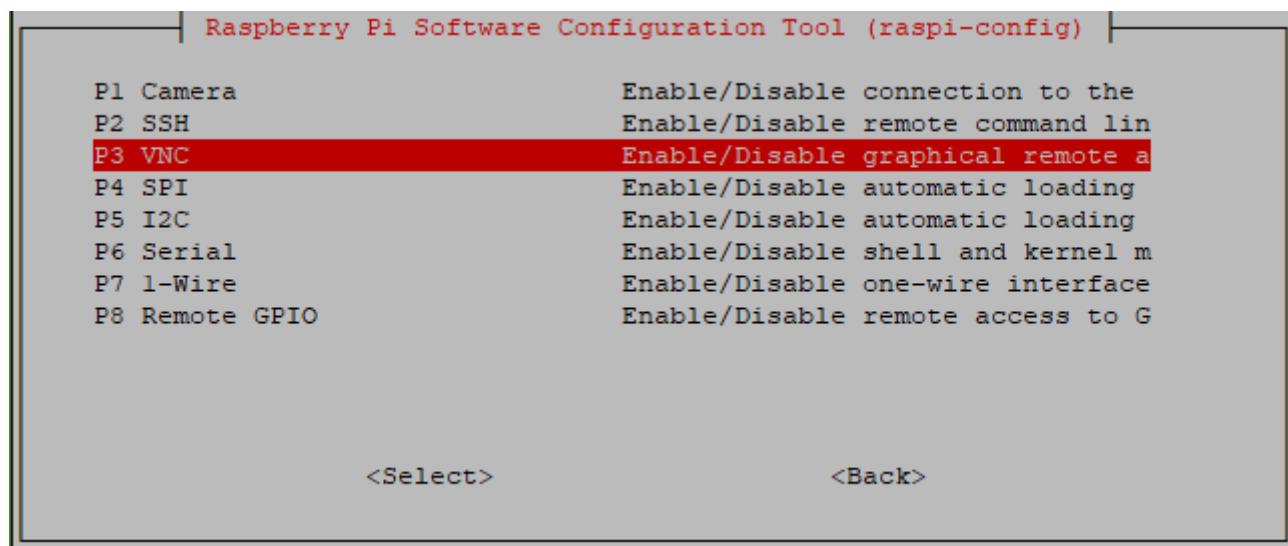
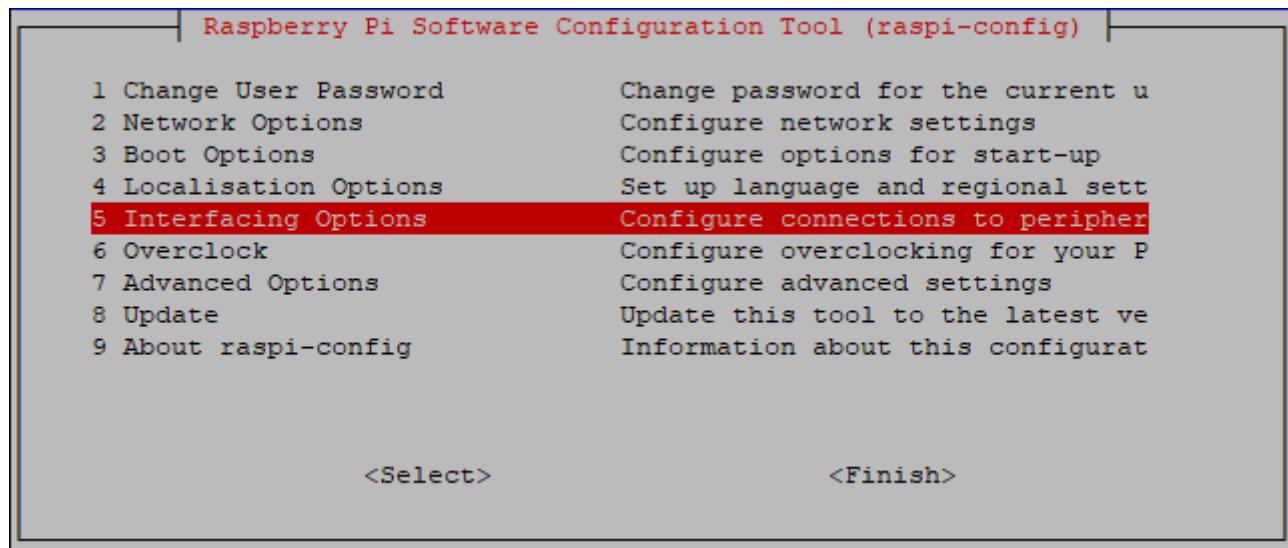
1 Change User Password	Change password for the current user
2 Network Options	Configure network settings
3 Boot Options	Configure options for start-up
4 Localisation Options	Set up language and regional settings to match your
5 Interfacing Options	Configure connections to peripherals
6 Overclock	Configure 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 configuration 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 to be restarted, and choose ok. Then open VNC interface.

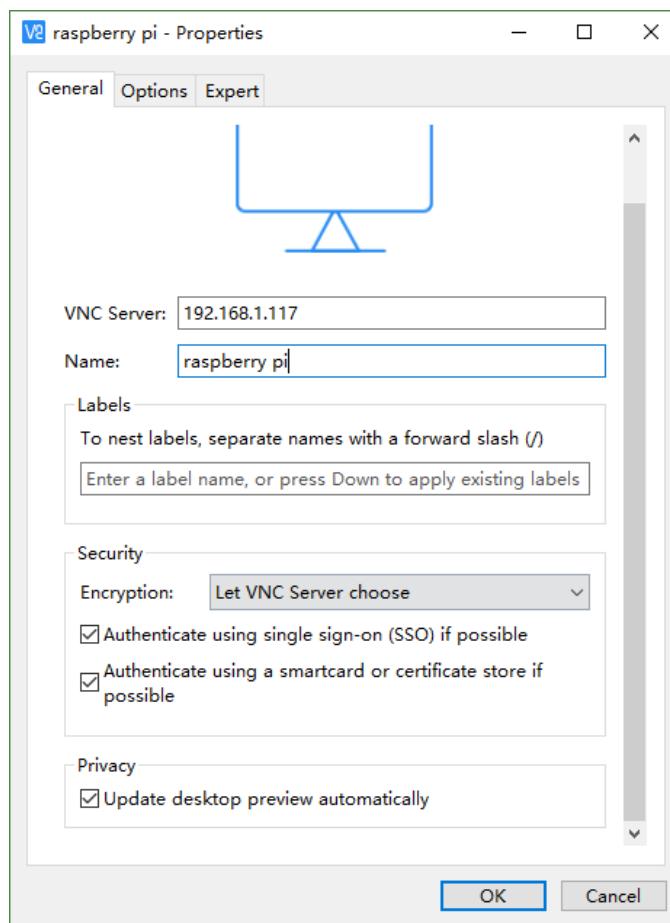
```
sudo raspi-config
```



Then download and install VNC Viewer according to your computer system by clicking 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.

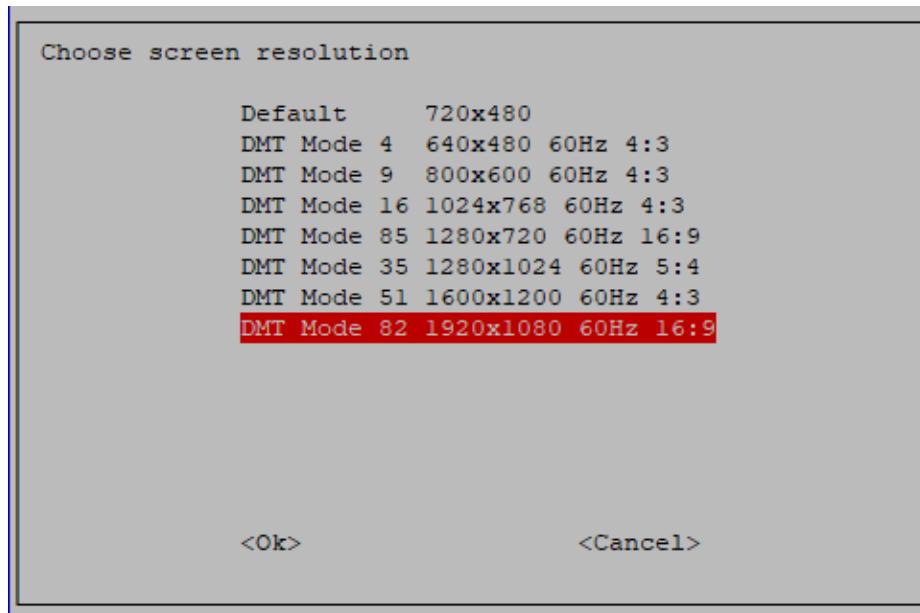


Here, you have logged in to Raspberry Pi successfully by using VNC Viewer

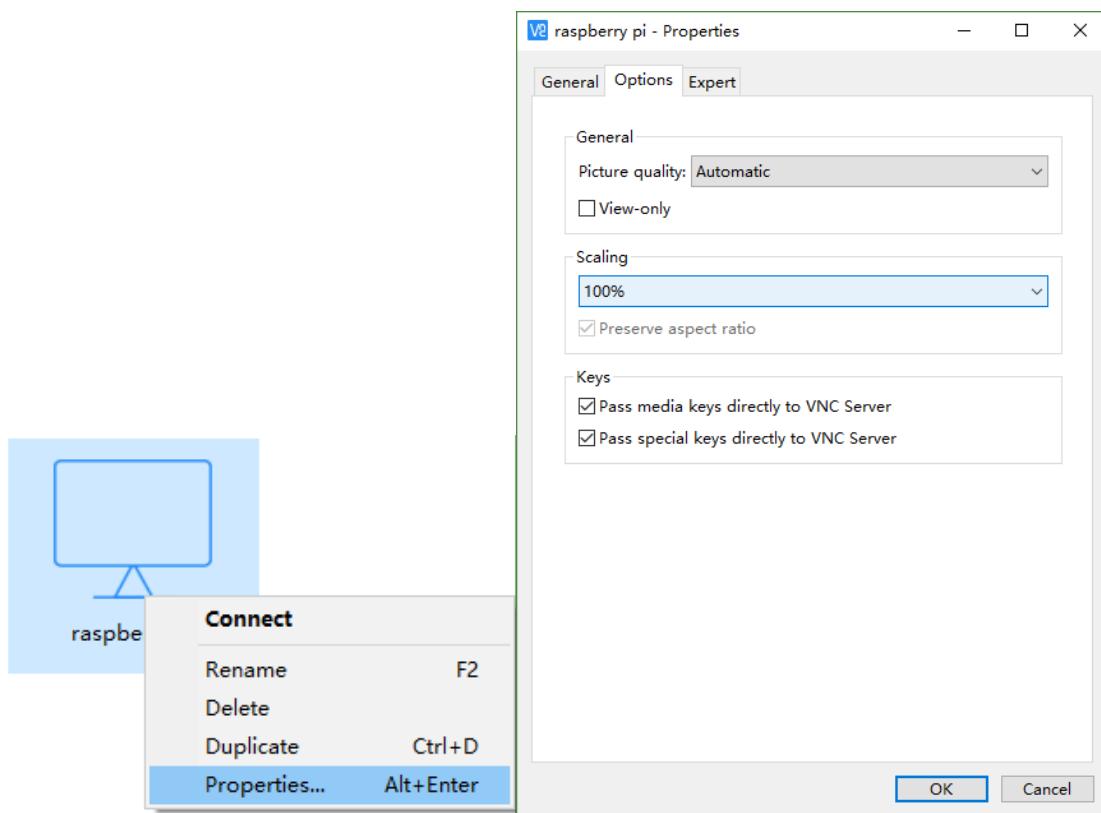
If the resolution ratio is not great or there is just a **little window**, you can set a proper resolution ratio via steps below.

```
sudo raspi-config
```

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

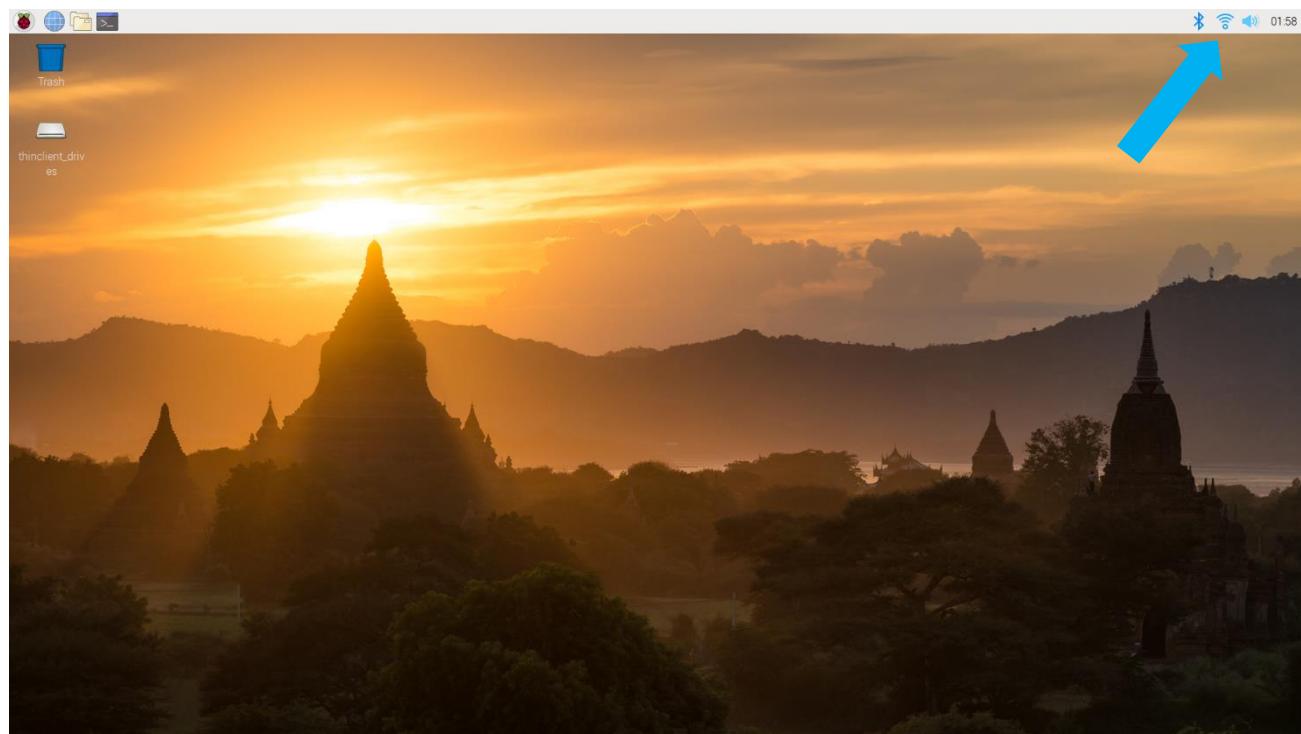


In addition, your VNC Viewer window may zoom your Raspberry Pi desktop. You can change it. On your VNC View control panel, click right key. And select Properties -> Options label -> Scaling. Then set proper scaling.



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

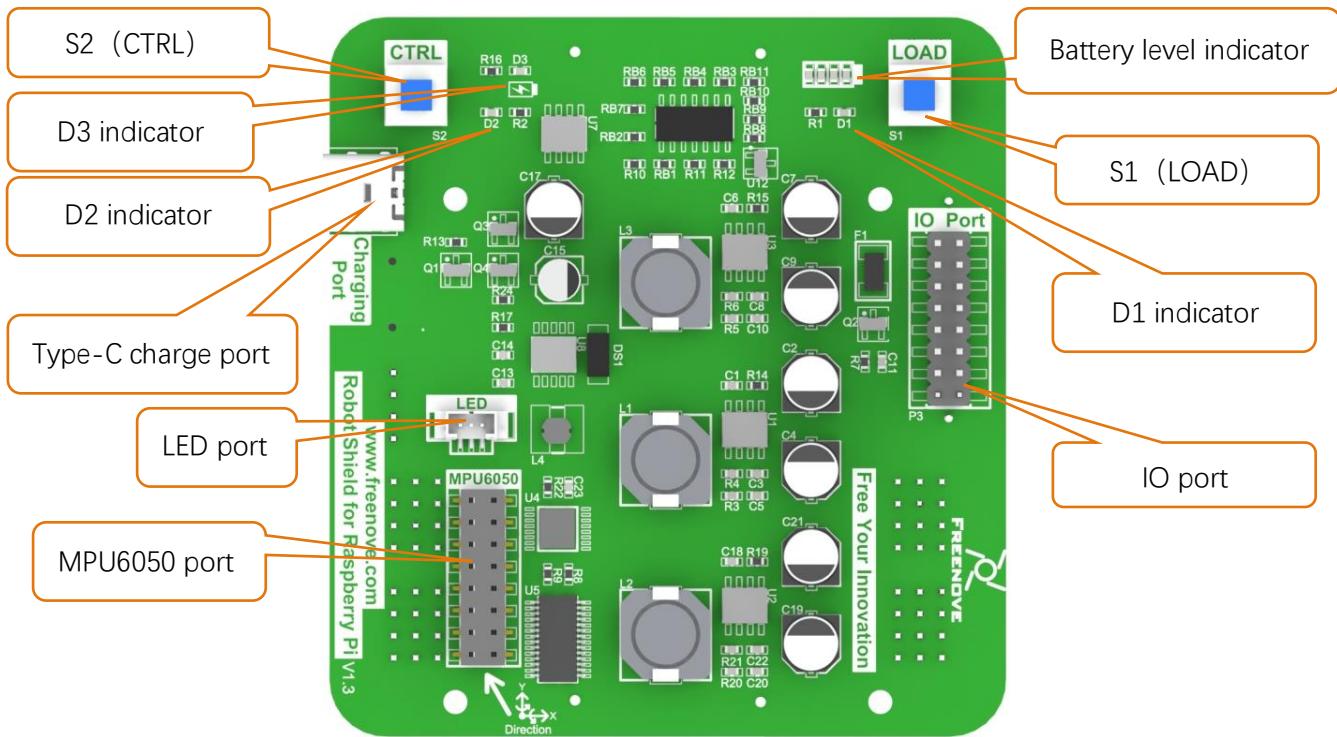
Raspberry Pi 4B/3B+/3B integrates a Wi-Fi adaptor. If you did not connect Pi to WiFi. You can connect it to wirelessly control the robot.

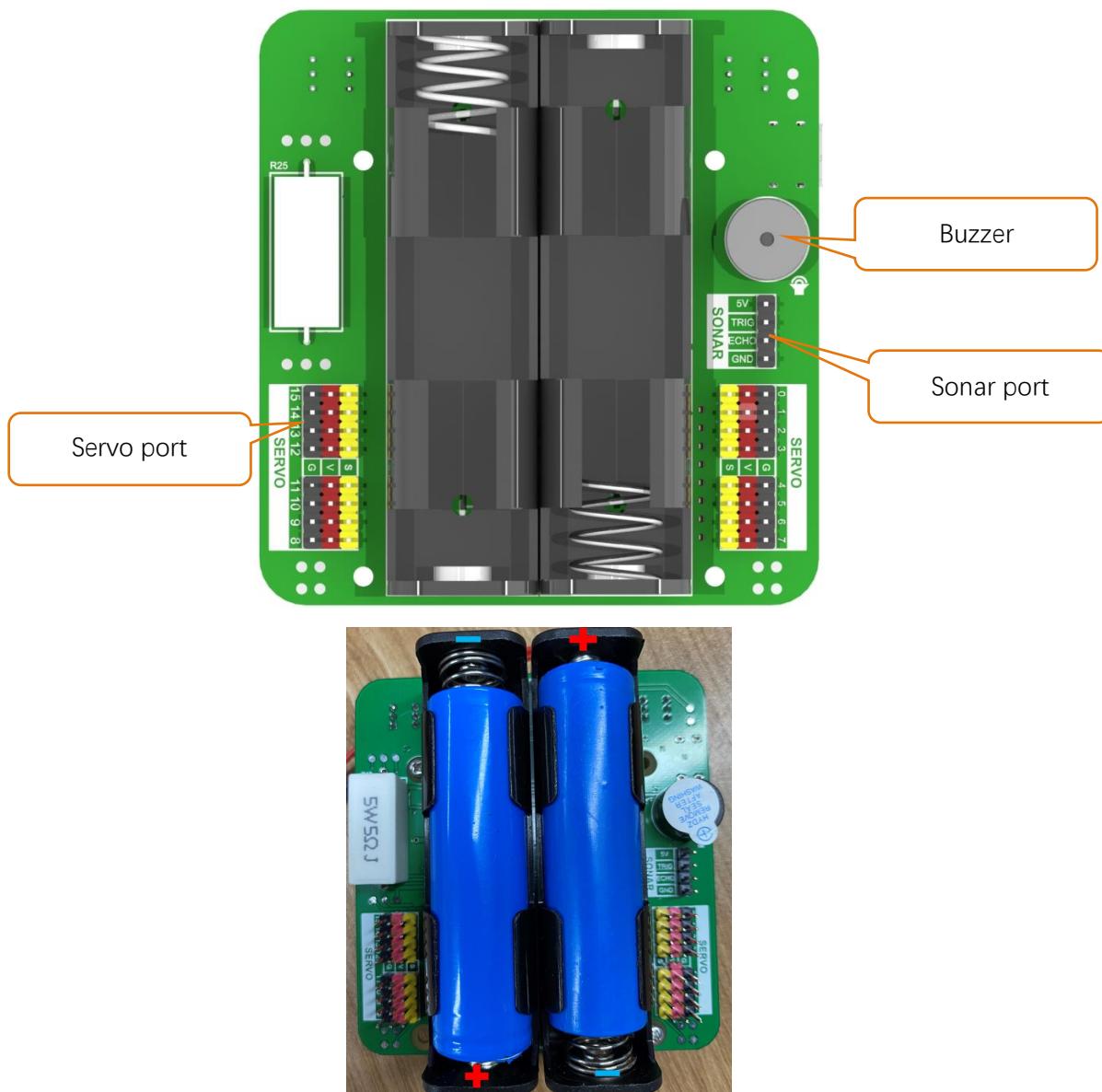


## Robot Shield for Raspberry Pi

### 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 requires 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 get dimmer gradually until it's 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 (Important 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 the voltage of each battery is greater than 3.6V and the sum of the voltages 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 the voltage difference between the two batteries is detected to be greater than 0.5V, the battery will be determined to be damaged and the charging will stop.

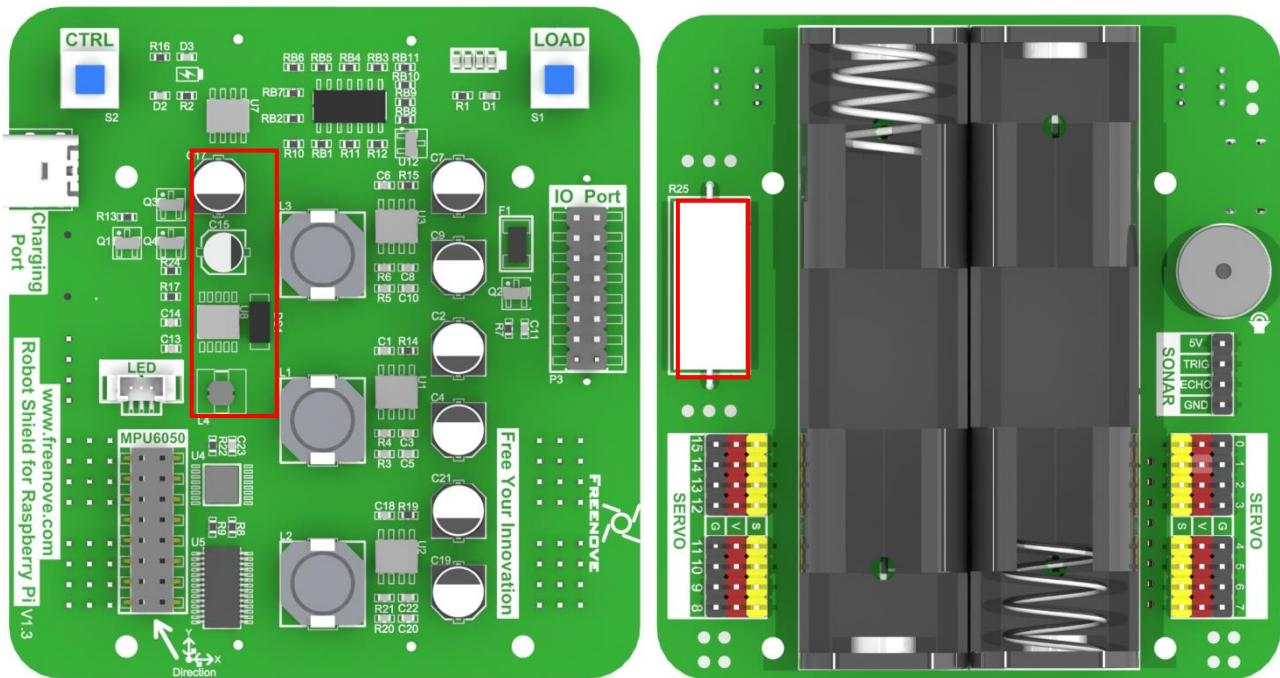
### How to use the charging function

- 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 above. If there is no battery in the battery holder, 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 it 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 is 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 charging for some hours. If there are less than 3 LEDs on, you can turn off S2. The charging will continue.
- 5 If the battery contact is abnormal, the output is short-circuited and the charging stops, or if the battery temperature is abnormal, the D3 indicator will flash and charging will stop.
- 6 If D3 keeps blinking, please use another adapter(5V2A) to try again, and check whether the batteries are contacted well with battery holder.

**Note:**

Need support? [✉ support@freenove.com](mailto:support@freenove.com)

In the process of charging with 1A current, the two positions of the shield (marked in the illustration) will be hot, which is normal. Please avoid touching them with your hands.





# Chapter 1 Install Python Libraries (Required)

If you have any concerns, please feel free to contact us at [support@freenove.com](mailto:support@freenove.com)

In this chapter, we will do some necessary foundational preparation work: Start your Raspberry Pi and install some necessary libraries. And in next chapter, we will assemble the robot dog.

**Note:**

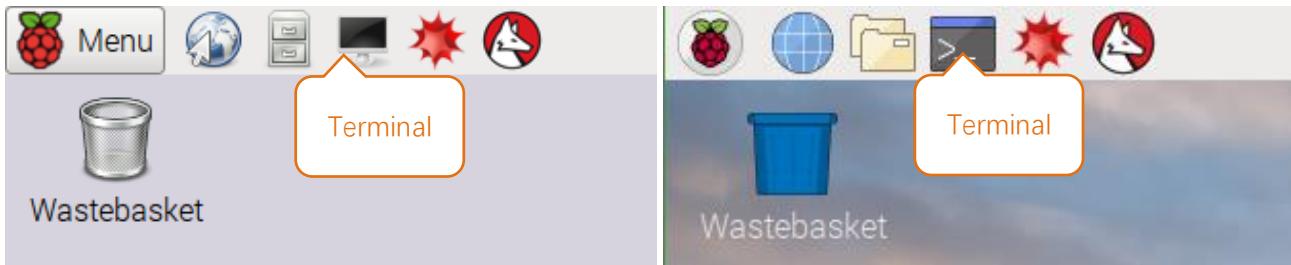
1, Please use Raspberry Pi OS with Desktop

2, The installation of libraries takes much time. You can power Raspberry Pi with a power supply Cable.

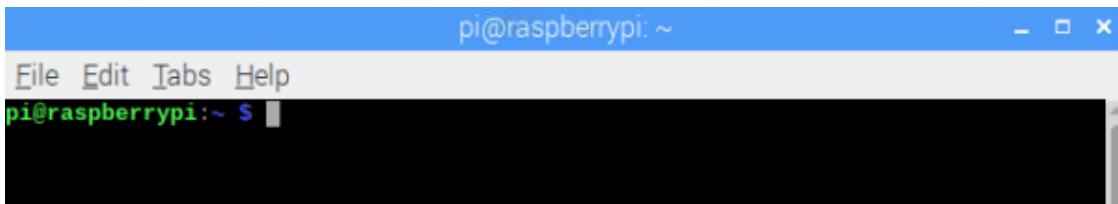
3, If you are using **remote desktop** to login Raspberry Pi, you need to use [VNC viewer](#).

## Step 1 Obtain the Code and Set python3 as default

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



The terminal is shown below:



You can view YouTube video as a reference.

<https://www.youtube.com/watch?v=Lq-OERj2WZM>

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 takes 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 codes for this robot dog is written with **Python3**. If executed under python 2, there will be error messages.

Need support? ✉ [support@freenove.com](mailto:support@freenove.com)

## Set Python3 as default python

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

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

If it is python3, you can skip this section.

If it is python2, you need to execute the 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 python3.

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

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

```
python --version
```

```
pi@raspberrypi:~ $ cd /usr/bin
pi@raspberrypi:/usr/bin $ sudo rm python
pi@raspberrypi:/usr/bin $ sudo ln -s python3 python
```

If you want to set python2 as default python in **other projects**, just repeat the above command 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
```

### 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 “↑” (the Up key) will go backwards through the command history and pressing “↓” (the Down Key) will go forwards through the command history.**

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 letters, pressing Tab key once won't have any result. And pressing Tab key again will list all the eligible options. However, when there is only one eligible option, the command/path will be completely typed as soon as you press the Tab key..

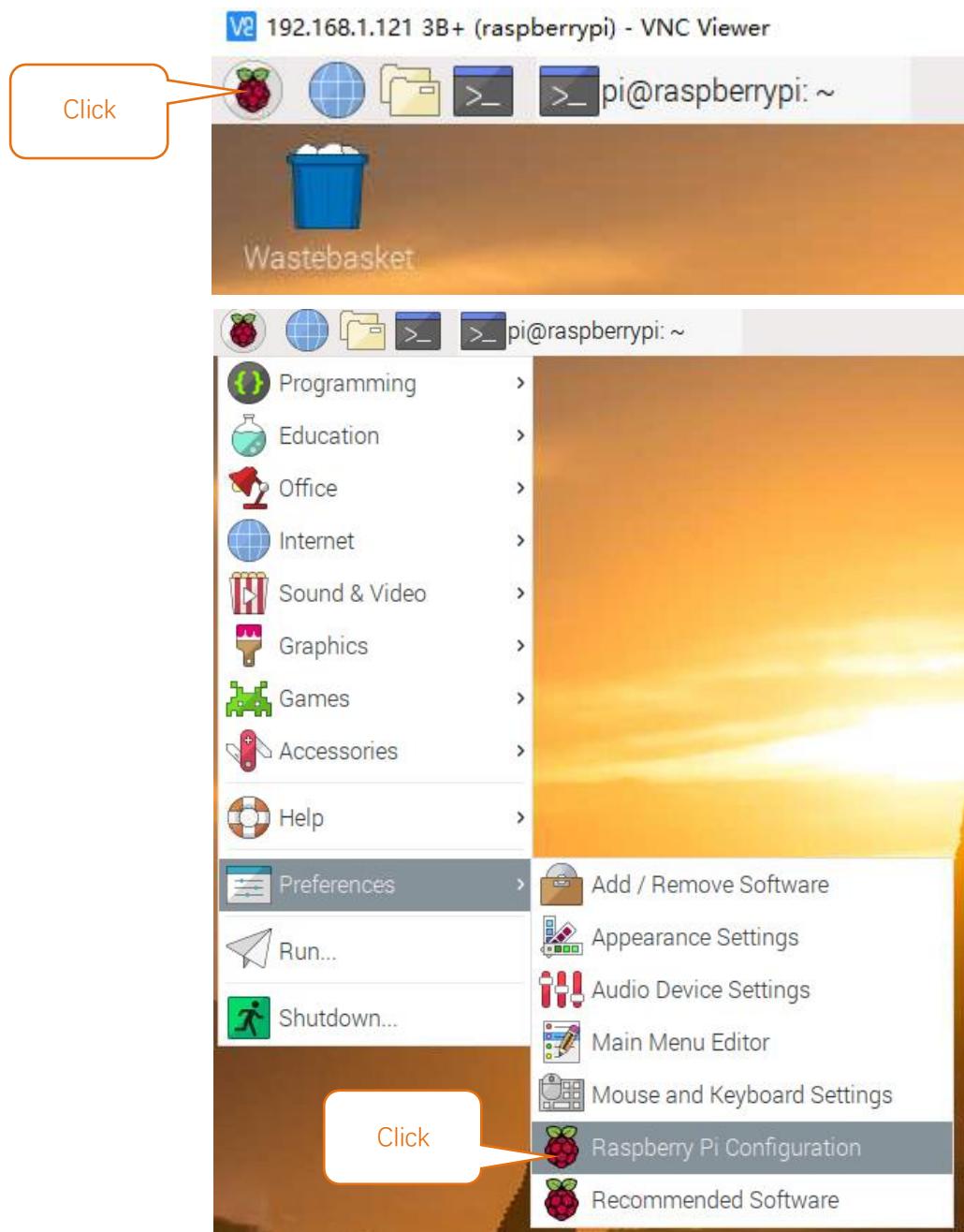
As shown below, under the ‘~’directory, enter the Documents directory with the “cd” command. After typing “cd D”, press Tab key, there is no response. Press Tab key again, all the files/folders that begin with “D” is listed. Continue to type the character “oc”, then press the Tab key, and then “Documents”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

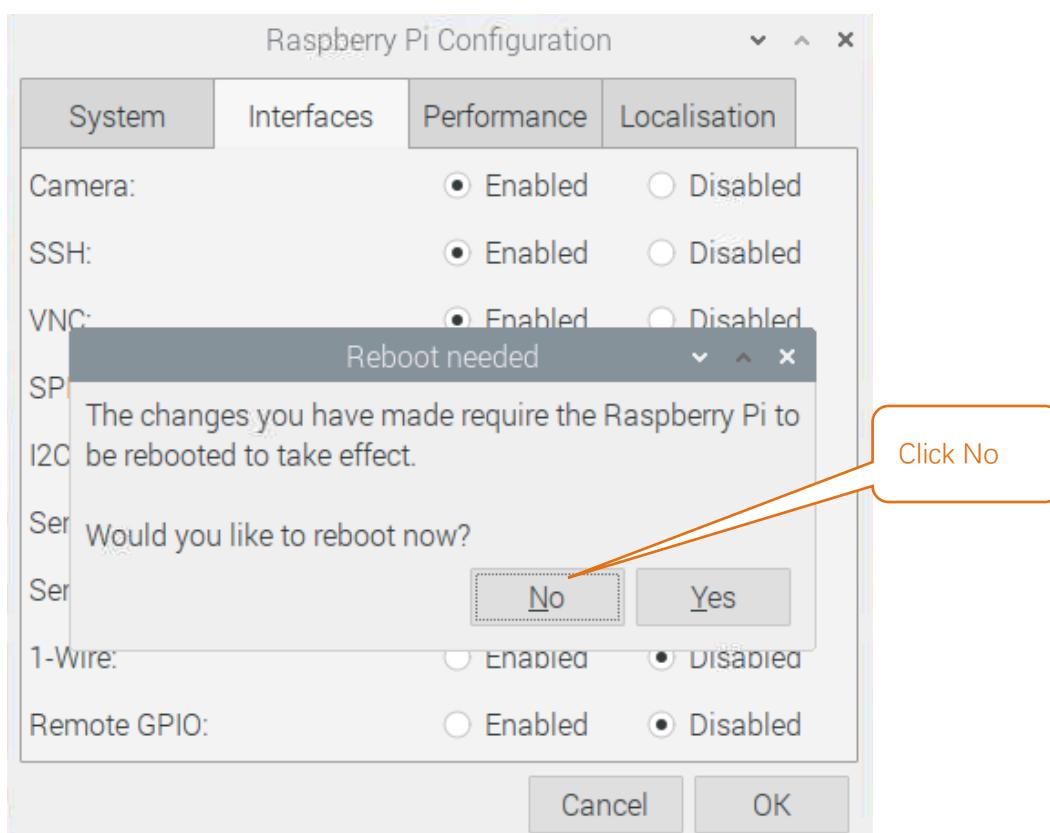
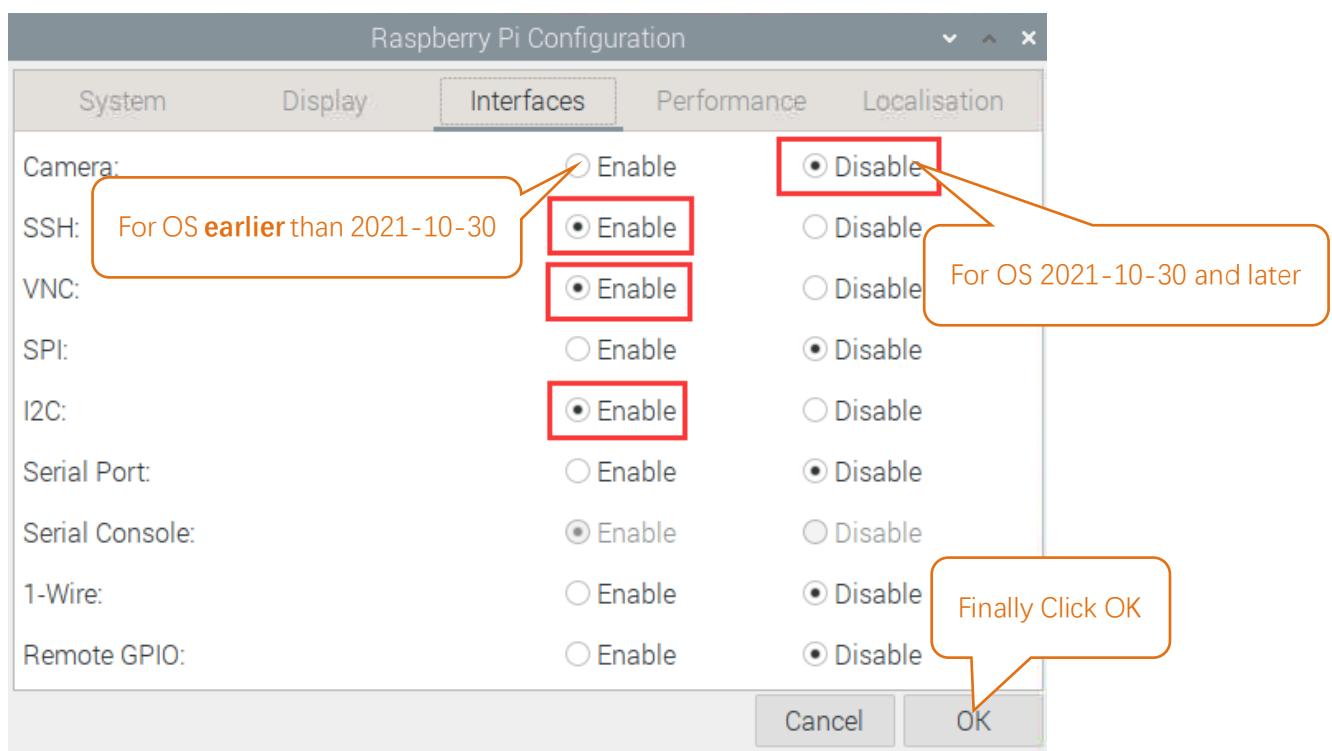
```
pi@raspberrypi:~ $ cd D
Desktop/  Documents/ Downloads/
pi@raspberrypi:~ $ cd Doc
```

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

## Step 2 Configuration

### Enable i2c

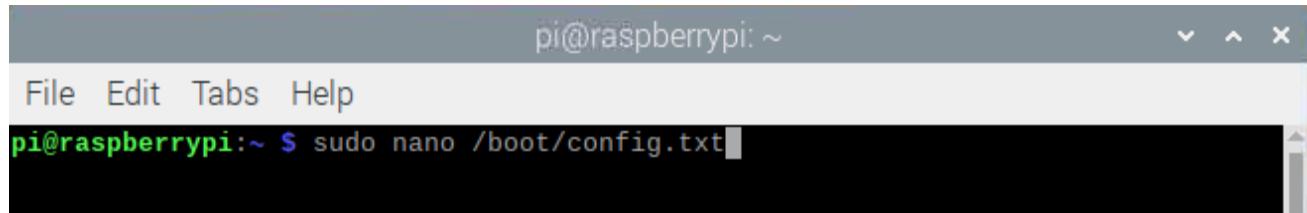




## Set I2C Baud Rate

Open the terminal and enter the 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.

Scrolling 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
```

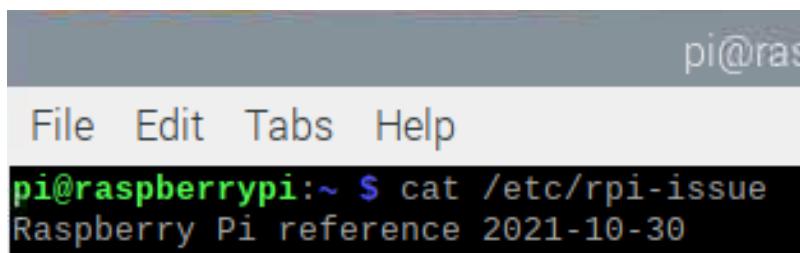
Press "CTRL"+"O" and then "Enter" to save the modified content. Then press "CTRL"+"X" to exit editing.

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.

Patch for OS 2021-10-30 and Later.

```
cat /etc/rpi-issue
```

If the result is 2021-10-30, execute following step.



```
pi@raspberrypi:~ $ cat /etc/rpi-issue
Raspberry Pi reference 2021-10-30
```

If the result is earlier than 2021-10-30, skip this section.

Open the terminal and enter the following command.

1. Execute following commands to enter directory of "Patch".

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

2. Run

```
sudo sh ./patch_for_bullseye.sh
```



```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Patch
File Edit Tabs Help
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Patch
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Patch $ sudo sh ./patched_for_bullseye.sh
patched complete! Please reboot the system!
```

If there is "patched complete!", just ignore "/opt/vc/lib/libmmal.so doesn't exist" and move on.

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

1 Add # before `camera_auto_detect=1` → `# camera_auto_detect=1`

2 Add `f` in `dtoverlay=vc4-kms-v3d` → `dtoverlay=vc4-fkms-v3d`

3 Add following in the end.

```
start_x=1
```

```
gpu_mem=128
```

```
hdmi_force_hotplug=1
```

```
hdmi_ignore_edid=0xa5000080
```

```
hdmi_group=2
```

```
hdmi_mode=82
```

Finally press **Ctrl+O**, Enter, then **Ctrl+X**.

File Edit Tabs Help	File Edit Tabs Help
<pre> GNU nano 5.4 #dtoverlay= gpio-ir,gpio_pin=17 #dtoverlay= gpio-ir-tx,gpio_pin=18  # Additional overlays and parameters  # Enable audio (loads snd_bcm2835) dtparam=audio=on  # Automatically load overlays for de camera_auto_detect=1  # Automatically load overlays for de display_auto_detect=1  # Enable DRM VC4 V3D driver dtoverlay=vc4-kms-v3d max_framebuffers=2  # Disable compensation for displays </pre>	<pre> GNU nano 5.4 #dtoverlay= gpio-ir,gpio_pin=17 #dtoverlay= gpio-ir-tx,gpio_pin=18  # Additional overlays and parameters  # Enable audio (loads snd_bcm2835) dtparam=audio=on  # Automatically load overlays for de <del>camera_auto_detect=1</del>  # Automatically load overlays for de display_auto_detect=1  # Enable DRM VC4 V3D driver dtoverlay=vc4-fkms-v3d max_framebuffers=2  # Disable compensation for displays </pre>
<pre> [cm4] # Enable host mode on the 2711 built-in # This line should be removed if the le # (e.g. for USB device mode) or if USB otg_mode=1  [all]  [pi4] # Run as fast as firmware / board allow arm_boost=1  [all] </pre>	<pre> [cm4] # Enable host mode on the 2711 built-in # This line should be removed if the le # (e.g. for USB device mode) or if USB otg_mode=1  [all]  [pi4] # Run as fast as firmware / board allow arm_boost=1  [all] start_x=1 gpu_mem=128 </pre>
$\wedge G$ Help $\wedge O$ Write Out $\wedge W$ Where Is $\wedge X$ Exit $\wedge R$ Read File $\wedge \backslash$ Replace	$\wedge G$ Help $\wedge O$ Write Out $\wedge W$ Where Is $\wedge X$ Exit $\wedge R$ Read File $\wedge \backslash$ Replace

Before                          After

## Additional supplement

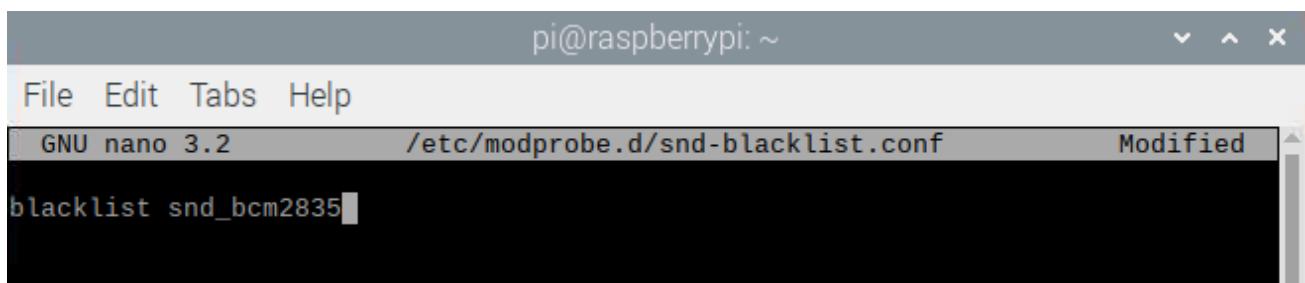
Raspberry Pi, other than 4B and 400, needs to disable the audio module, otherwise the LED will not work properly.

1. Create a new snd-blacklist.conf and open it for editing

```
sudo nano /etc/modprobe.d/snd-blacklist.conf
```

Add following content: After adding the contents, you need to press Ctrl+O, Enter, Ctrl+Z.

```
blacklist snd_bcm2835
```



```
pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 3.2          /etc/modprobe.d/snd-blacklist.conf      Modified
blacklist snd_bcm2835
```

2. We also need to edit config file.

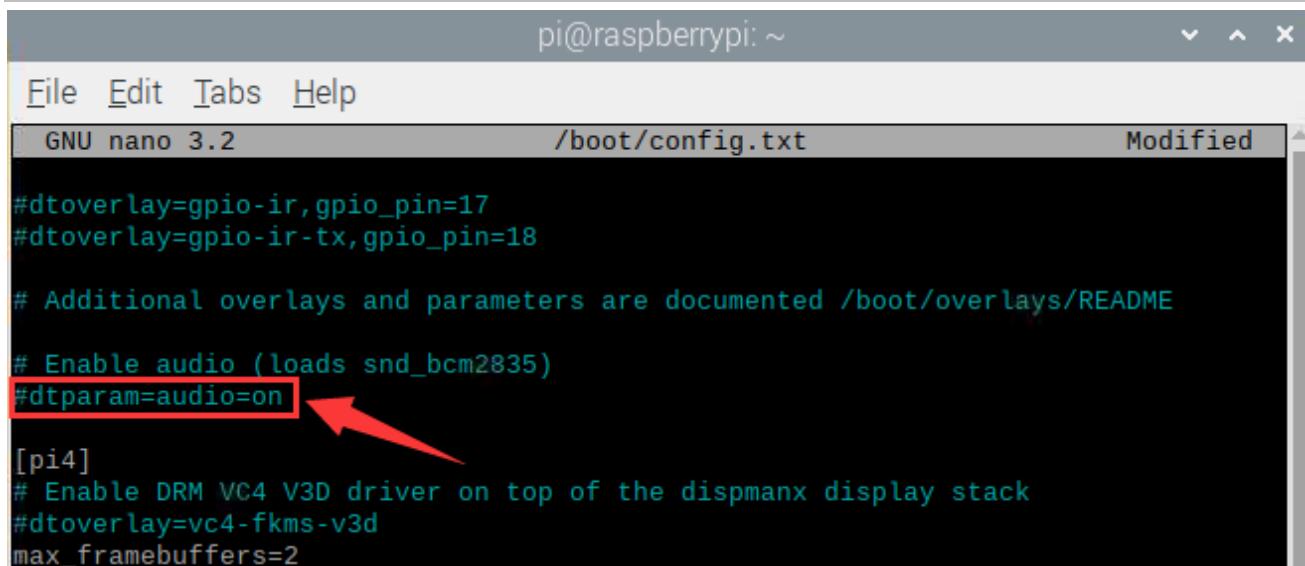
```
sudo nano /boot/config.txt
```

Find the contents of the following two lines (with Ctrl + W you can search):

```
# Enable audio (loads snd_bcm2835)
dtparam=audio=on
```

Add # to comment out the second line. Press Ctrl+O, Enter, Ctrl+Z.

```
# Enable audio (loads snd_bcm2835)
# dtparam=audio=on
```



```
pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 3.2          /boot/config.txt      Modified
#dtoverlay= gpio-ir,gpio_pin=17
#dtoverlay= gpio-ir-tx,gpio_pin=18

# Additional overlays and parameters are documented /boot/overlays/README

# Enable audio (loads snd_bcm2835)
#dtparam=audio=on [red box and arrow here]

[pi4]
# Enable DRM VC4 V3D driver on top of the dispmanx display stack
#dtoverlay=vc4-fkms-v3d
max_framebuffers=2
```

It will take effect after restarting, and you can restart after executing the next section.

If you want to restart the audio module, just restore the content modified in the above two steps.

## 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.

3. Execute following commands to enter directory of "build.sh".

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

4. Run build.sh

```
sh ./build.sh
```

```
Processing dependencies for rpi-ws281x==4.2.6
Finished processing dependencies for rpi-ws281x==4.2.6
The installation is complete!
```

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

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

4. 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 completed, as shown below.

```
Now the installation is successful.

Please restart raspberry pi
```

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

```
sudo python setup.py
```

# Chapter 2 Assemble Robot

If you have any concerns, please feel free to contact us at [support@freenove.com](mailto:support@freenove.com)

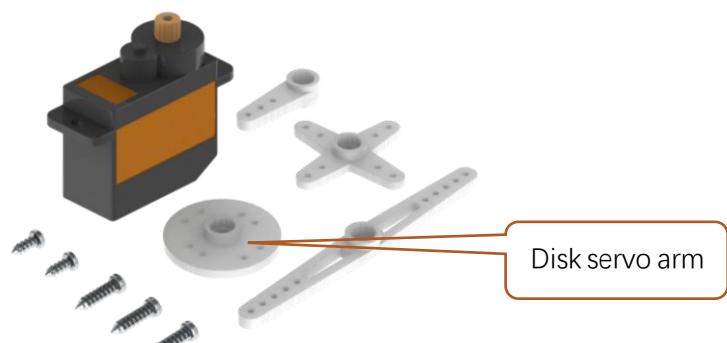
It is recommended to assemble and use the robot dog according to the tutorial. Otherwise, there may be installation errors, device damage, etc.

**Don't reverse batteries. Or the board will be damaged.**



## Step 1 Install Disk Servo Arms

Take out 12 disk servo arms from the servo packages.

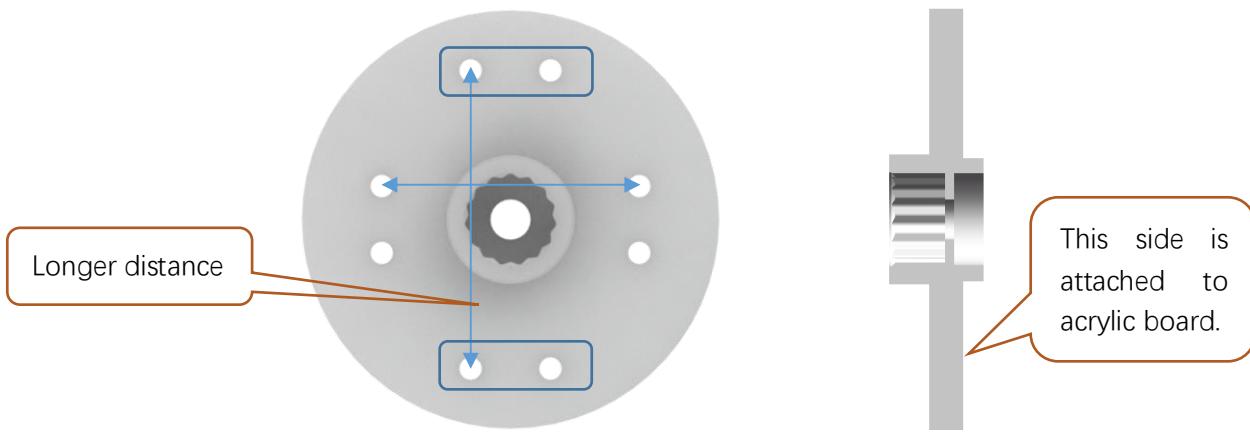


Need support? ✉ [support@freenove.com](mailto:support@freenove.com)

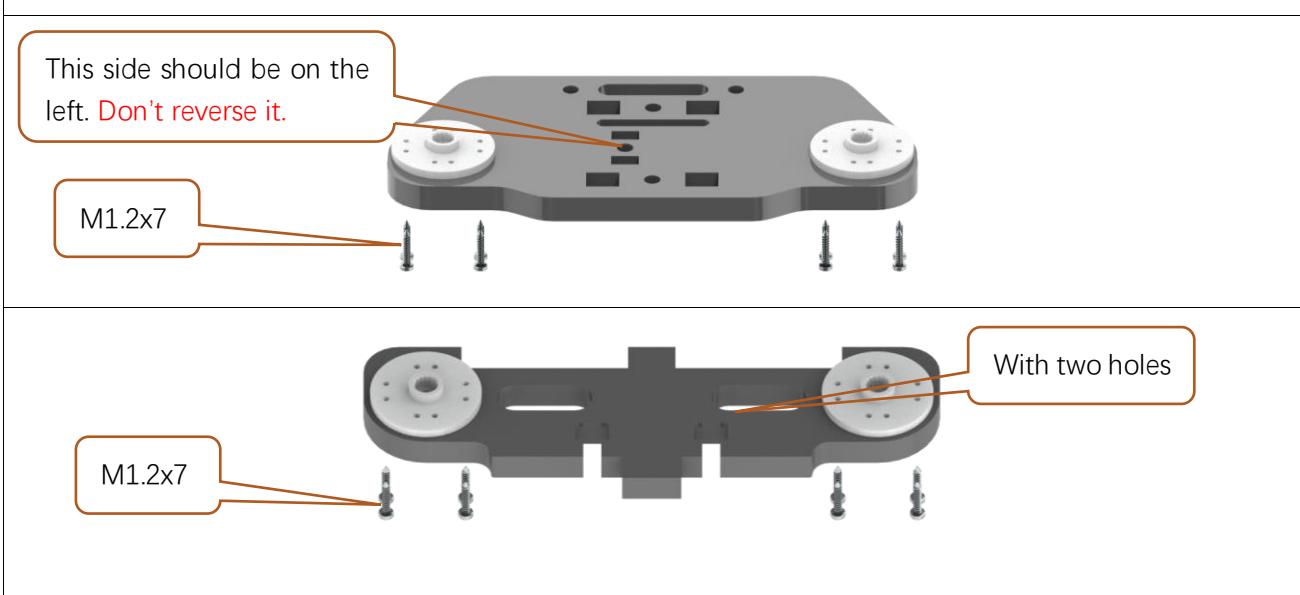
There are 4 pairs of opposite holes on the disk servo arm, and the distance between each pair is different. Please use the 2 pairs of holes with **longer distance**.



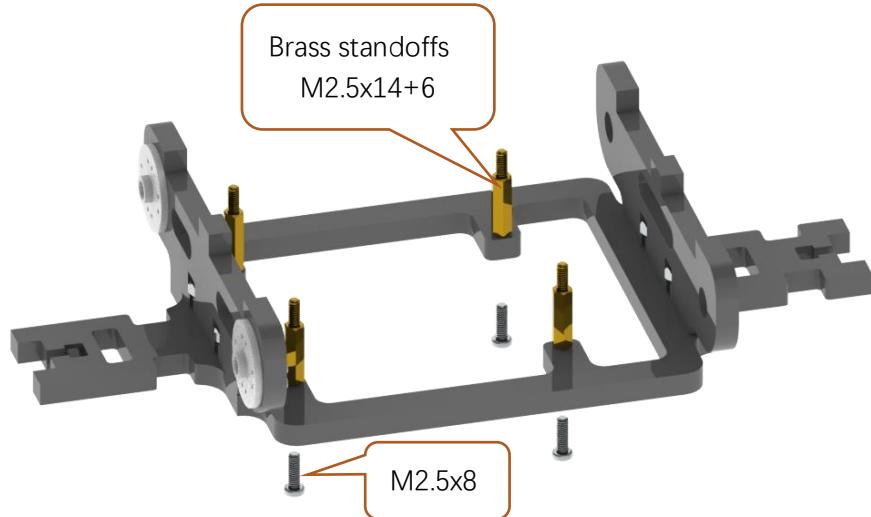
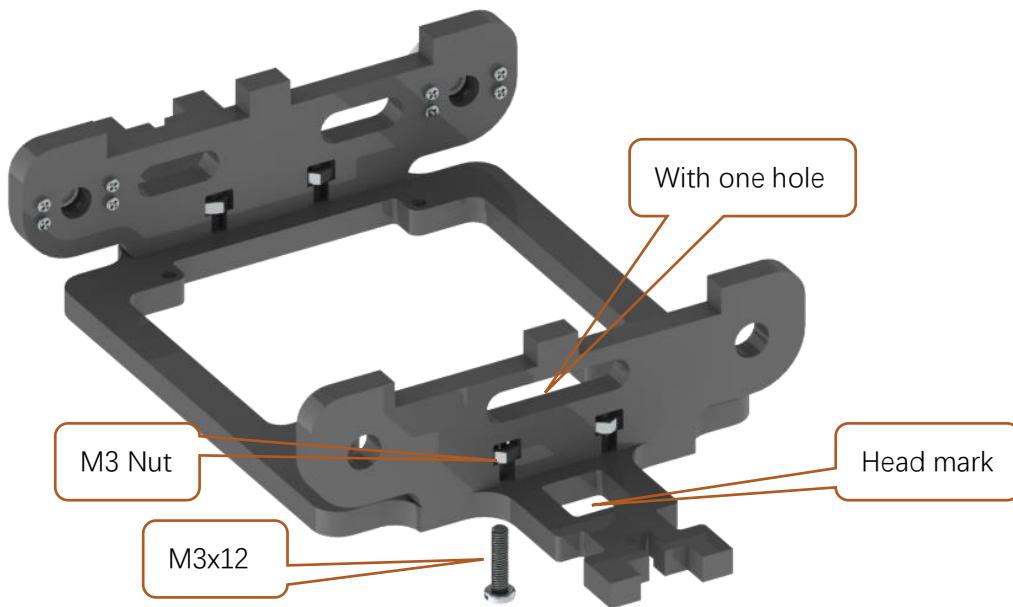
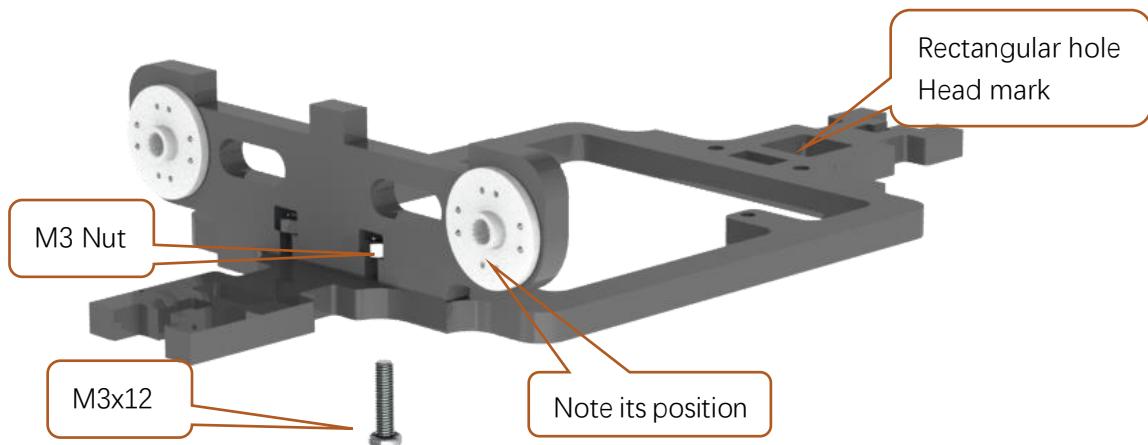
M1.2\*7 screws are contained in following plastic bag.



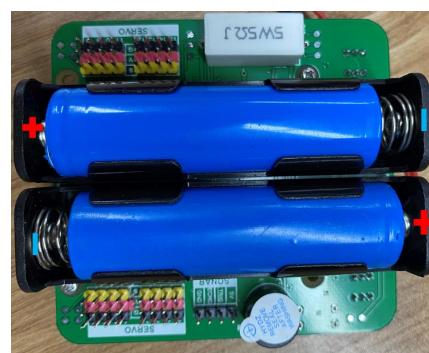
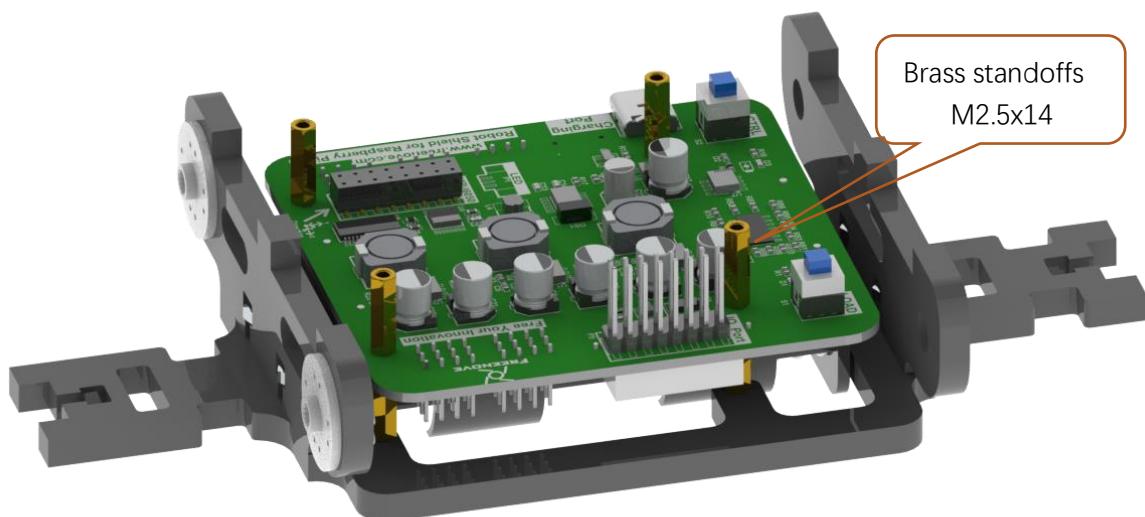
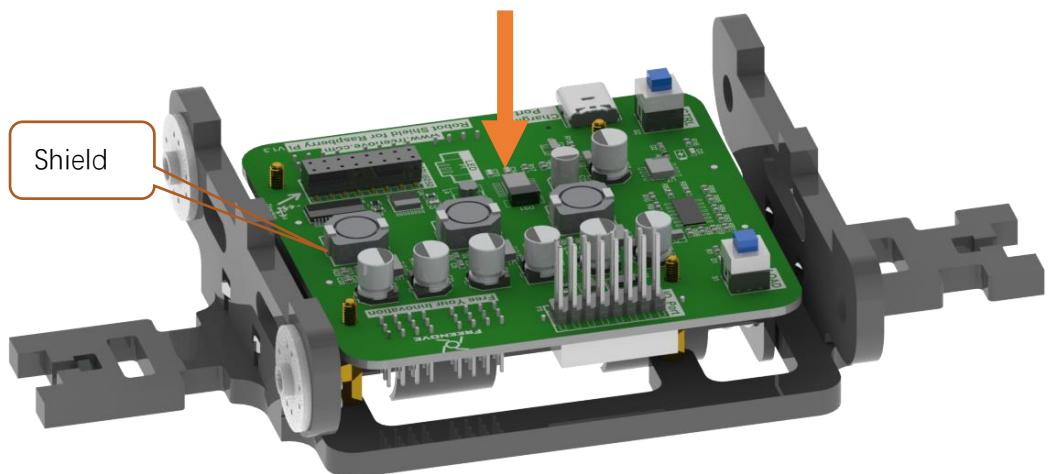
Get following 4 parts.



## Step 2 Install Body Bracket

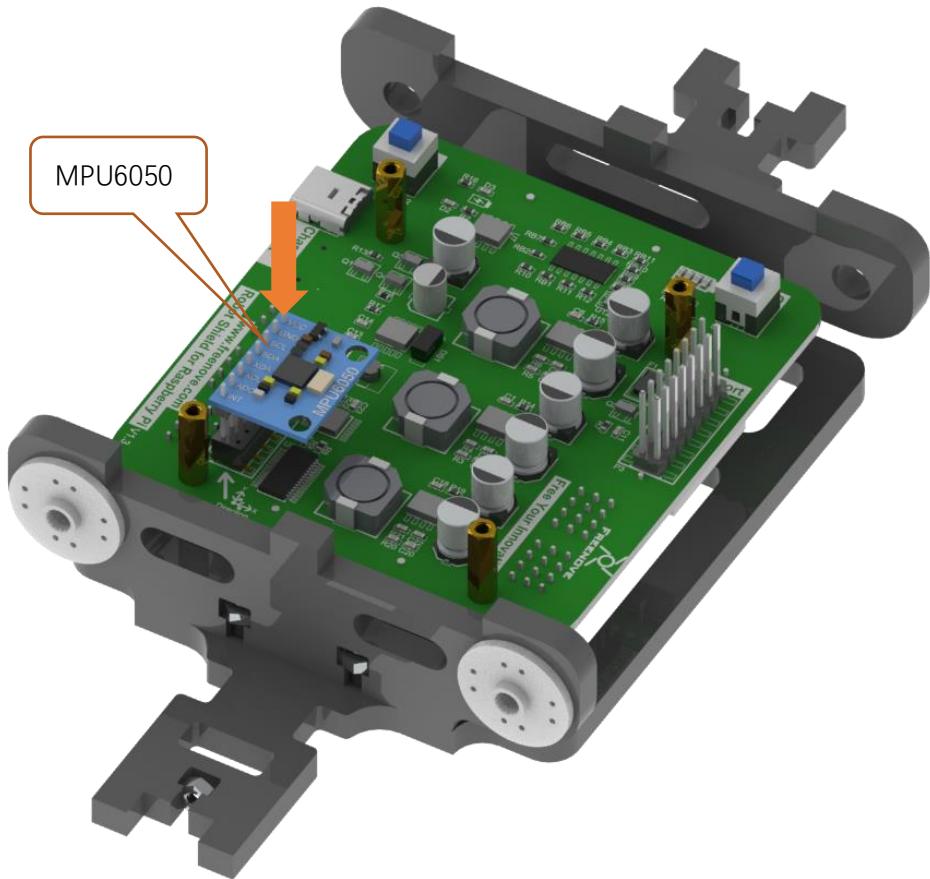


## Step 3 Install Shield

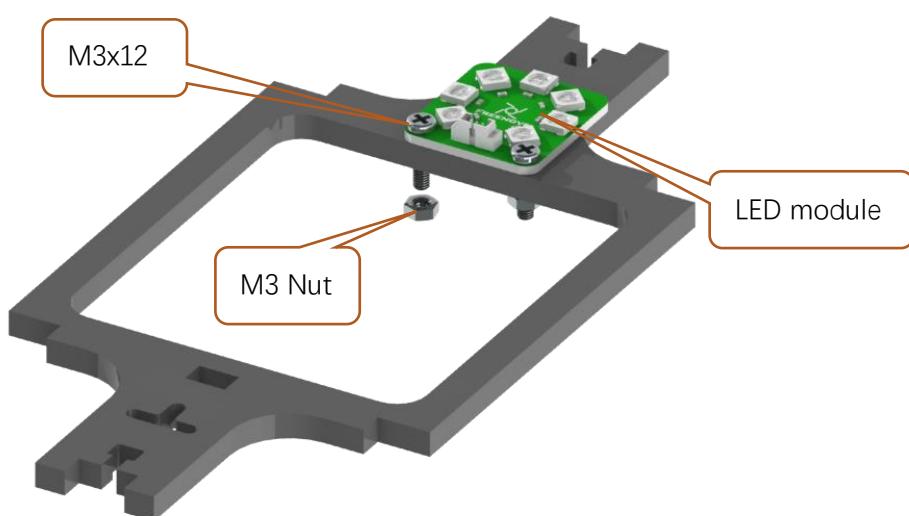


## Step 4 Install MPU6050

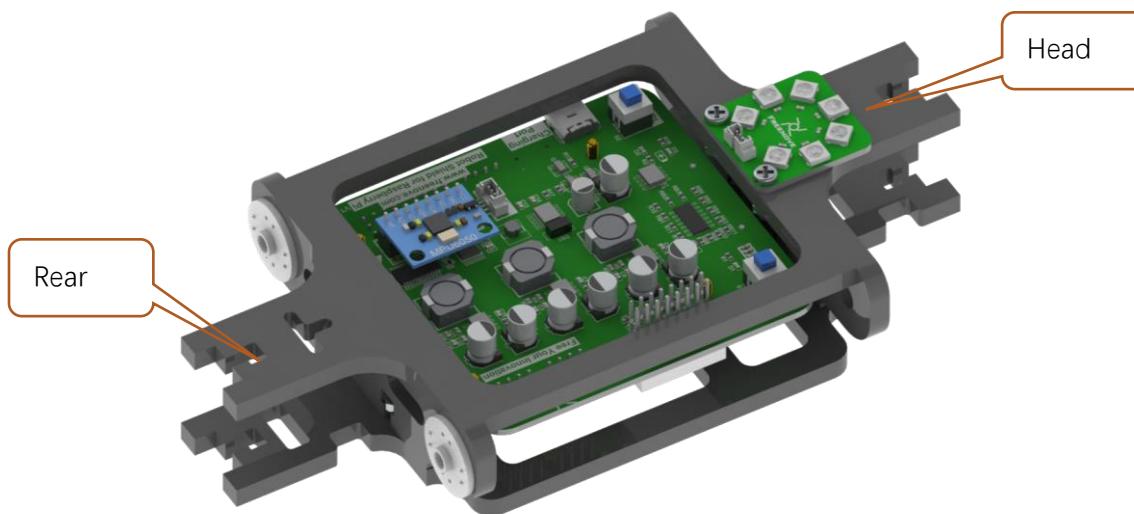
Note: There are two rows of headers. Plug the MPU6050 into the outer Row.



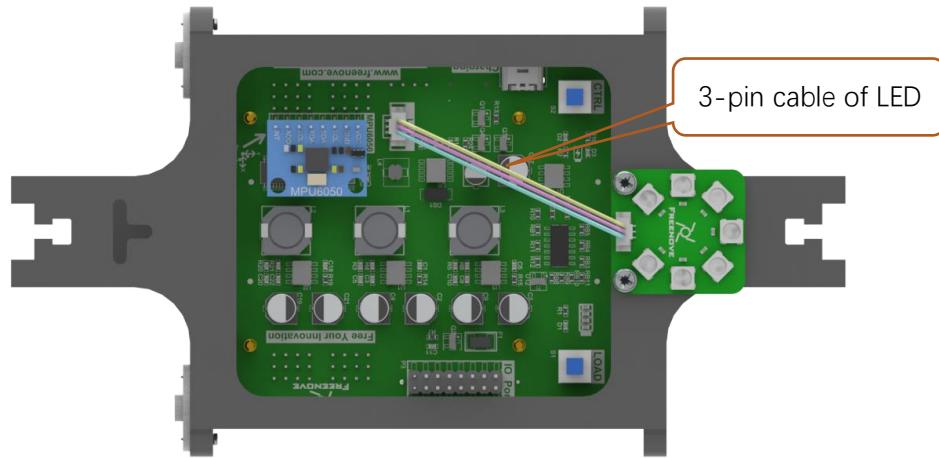
## Step 5 Install LED module



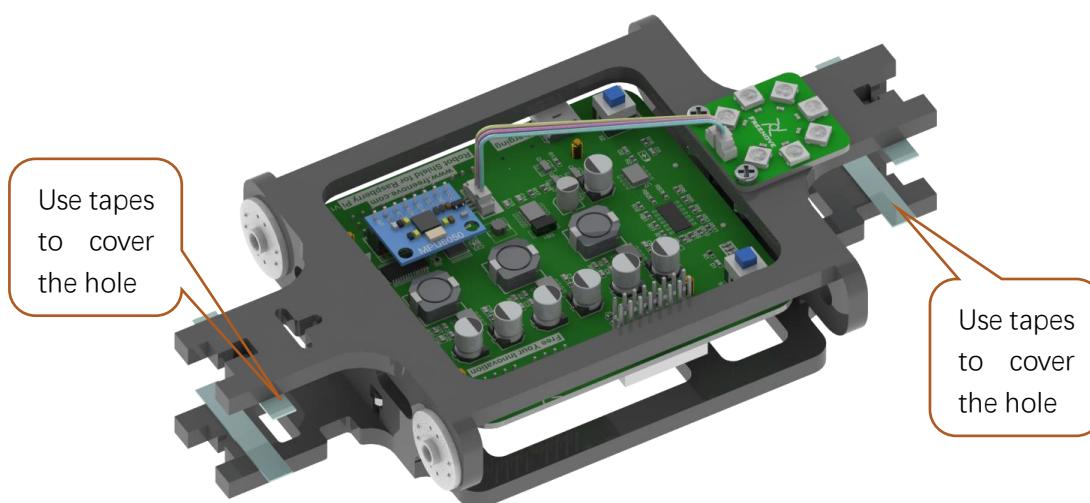
Install the top bracket.



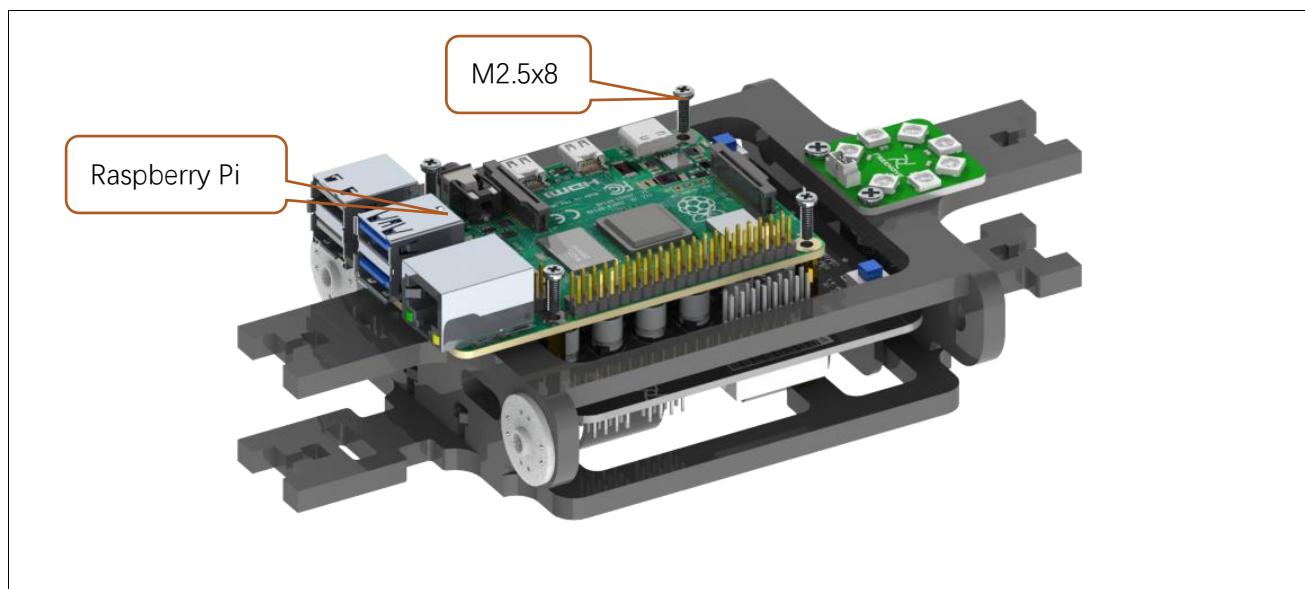
Connect shield with LED module.



This step will be very helpful for later assembly.

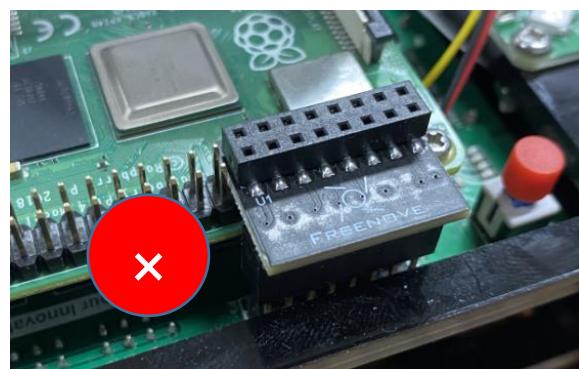
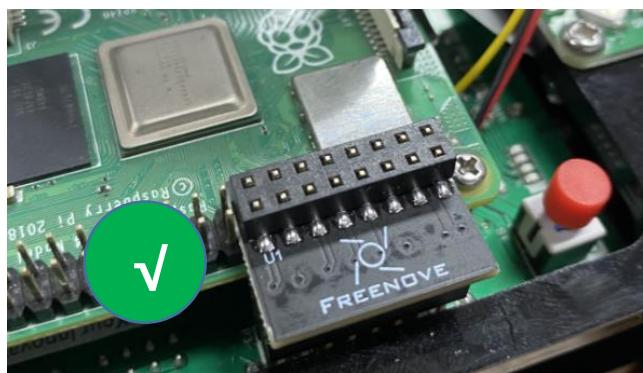
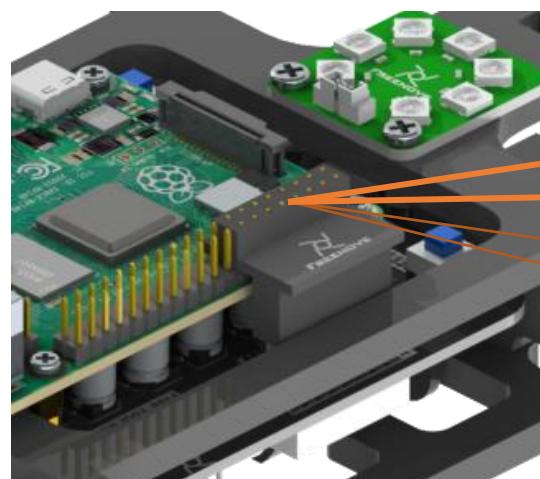
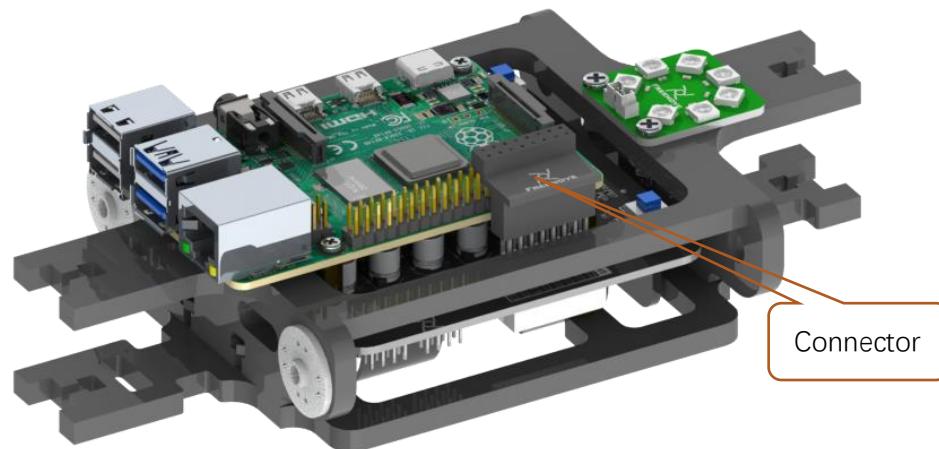


## Step 6 Install Raspberry Pi

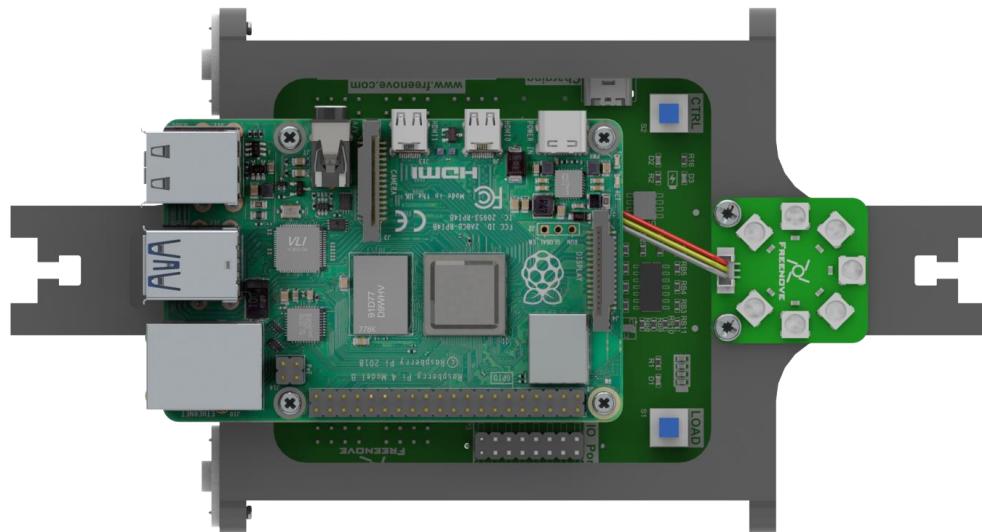


## Step 7 Install Connector

Install connector to connect Raspberry Pi and shield.

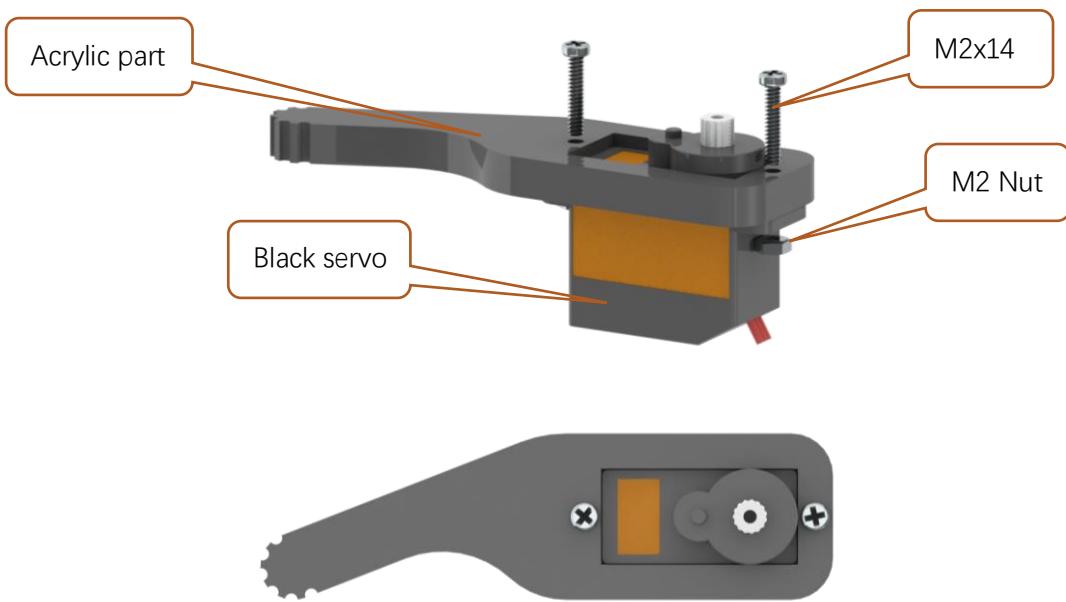


If you have any concerns, please feel free to contact us via [support@freenove.com](mailto:support@freenove.com)  
We will offer you satisfying solution.

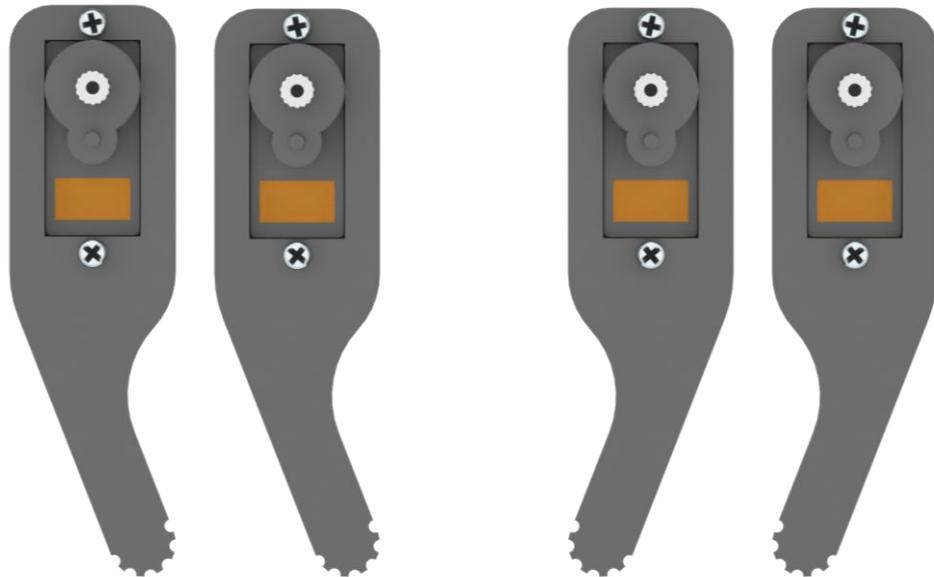


Now we have assembled the main body part. We will assemble leg parts later.

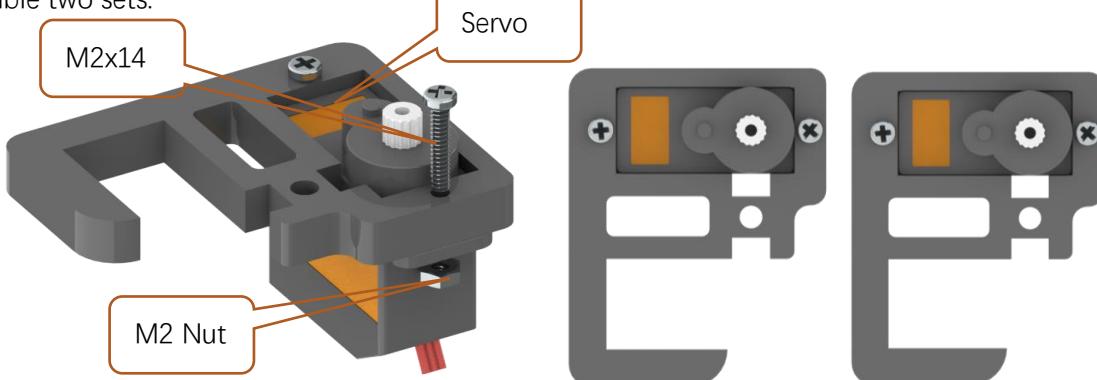
## Step 8 Install Servo to Acrylic Board



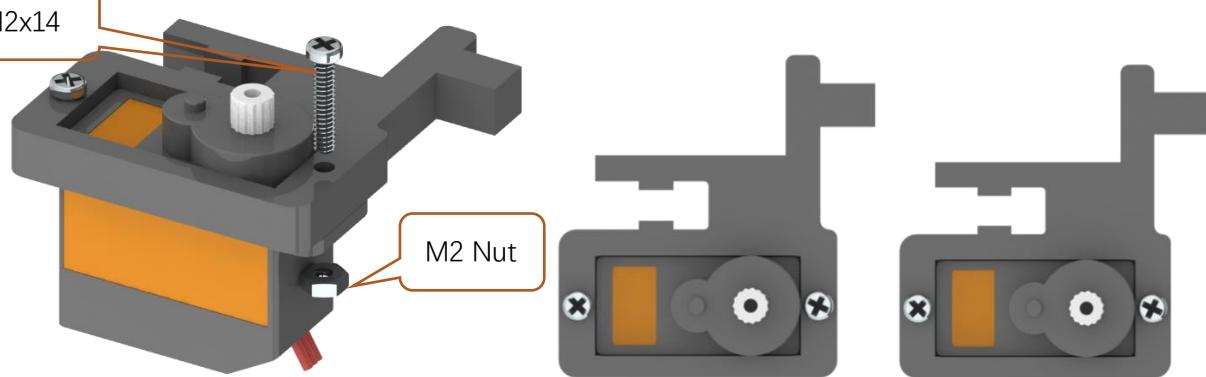
Note: There are four parts. They are different .



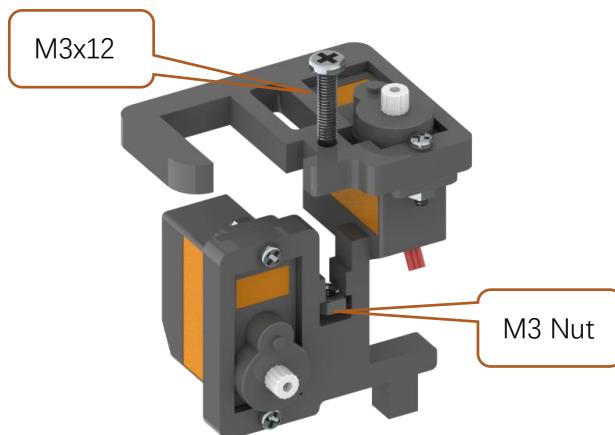
Assemble two sets.



Assemble two sets.



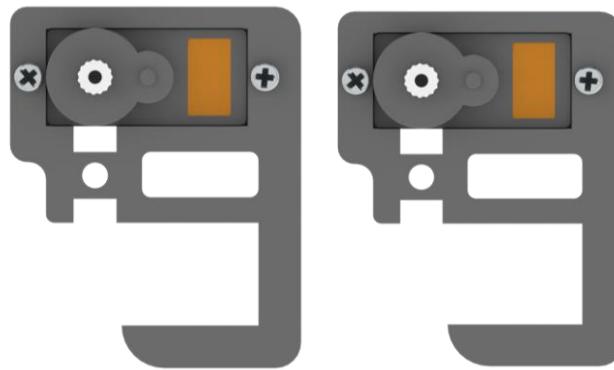
Assemble parts to the top.



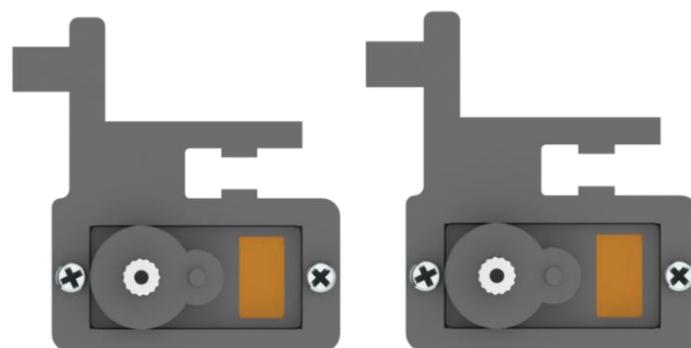
Now you get two sets of joint parts.



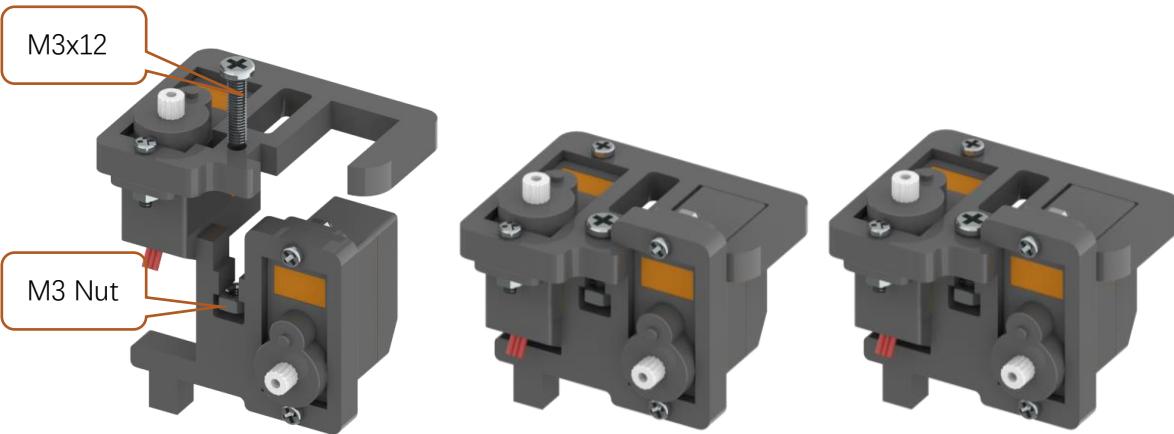
Assemble another two parts. **Note: they are different from parts above.**



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



Assemble them.

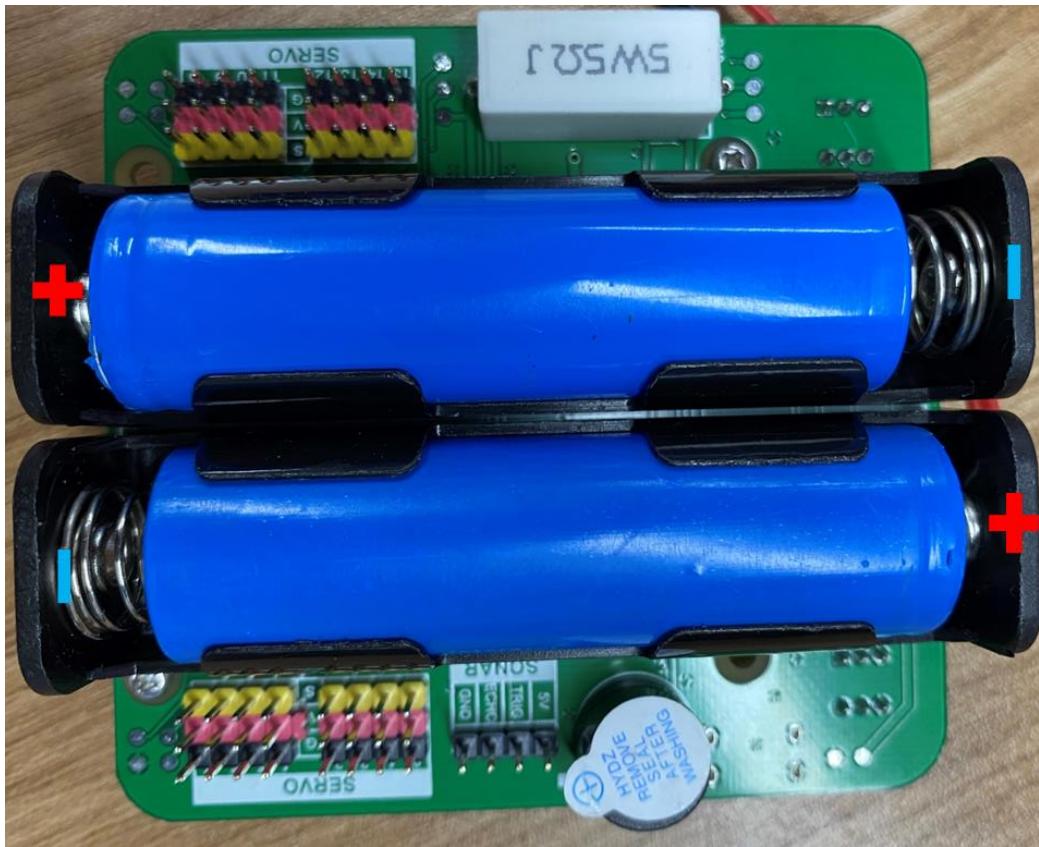
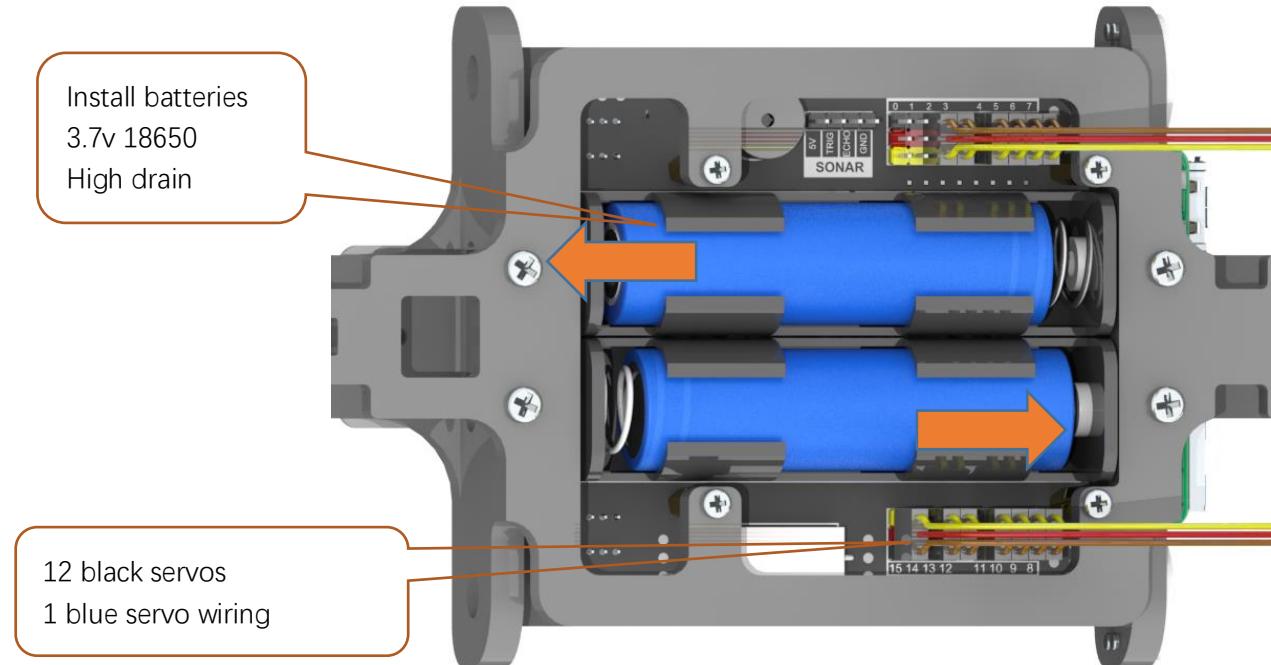


Now you will get four parts as below. **Note, they are different.**

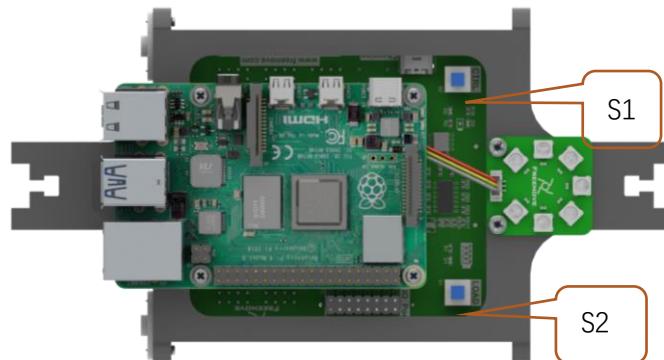


## Step 9 Run Servo Program (Necessary)

Connect **All** 12 **black** servos and 1 **blue** servo to servo port **Randomly**. And install **batteries**. Push batteries to “+” ends.



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** and there will be two indicators ON.



Turn on the Raspberry Pi. Make sure all three steps in [Chapter 1](#) have been performed correctly. If you haven't done that, please perform the steps in [Chapter 1 first](#).

- Type the following command to enter servo code folder "Server".

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

- Run Servo.py

```
sudo python Servo.py
```

After running the program, all servos will keep at 90°.

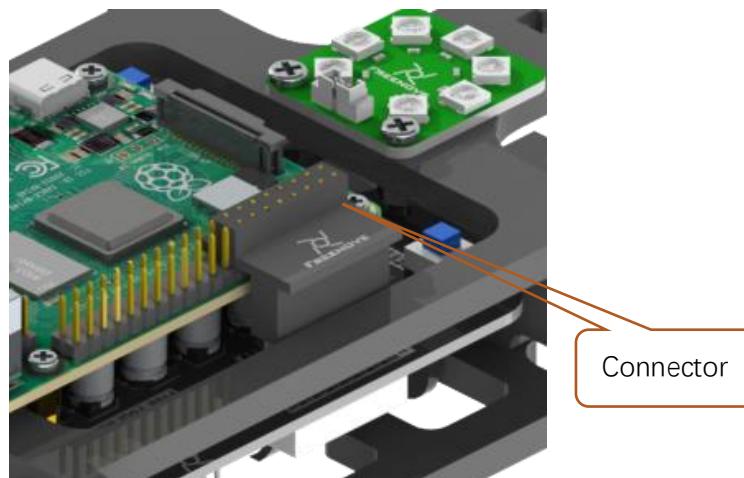
**Next we will connect the servos to disk arm.**

Keep the **power on** and all servos connected **during the assembly**. Don't disconnect **servos**.

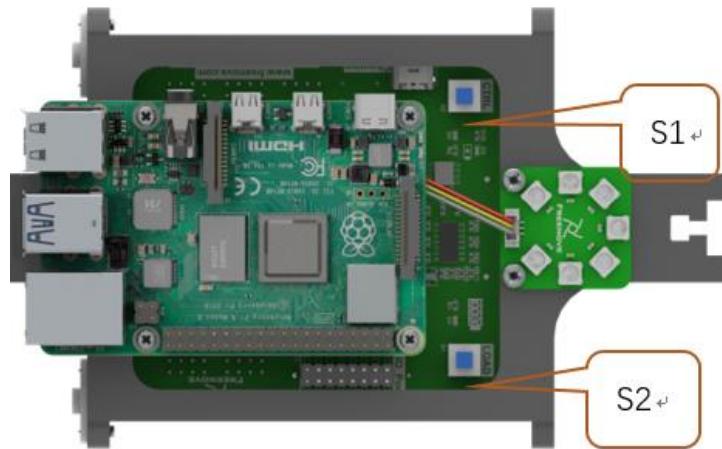
<https://www.youtube.com/watch?v=7GkMYdVrong>

**When running the code, if it reports "Remote I/O error", please check the following three aspects:**

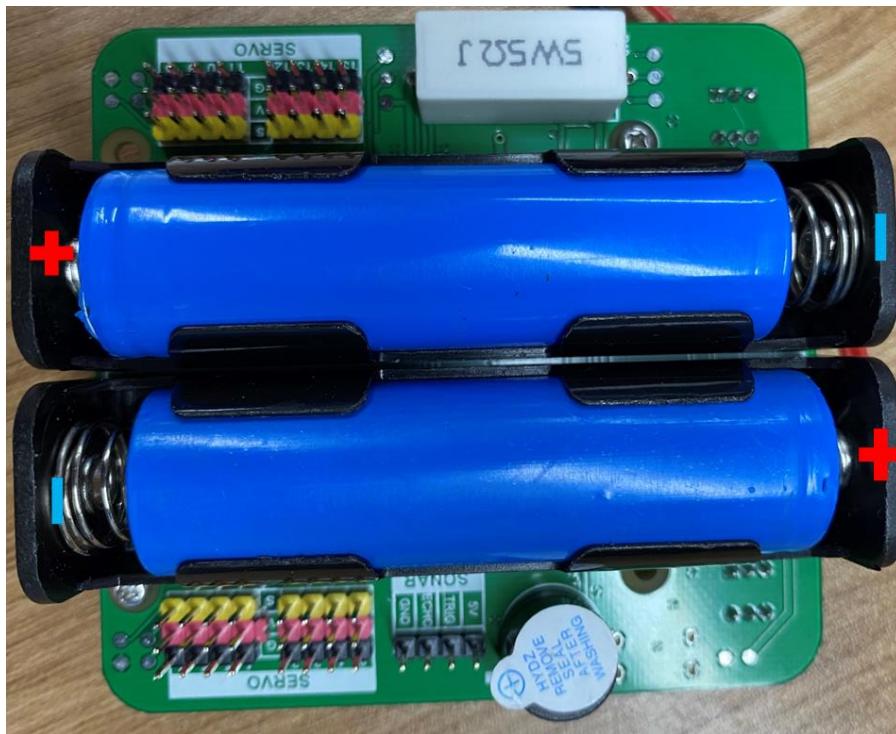
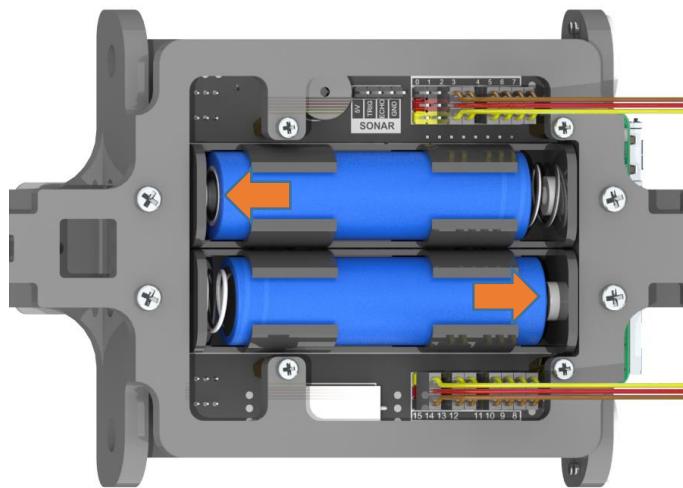
- Whether the connector is connected well



- Whether both S1 and S2 are turned ON



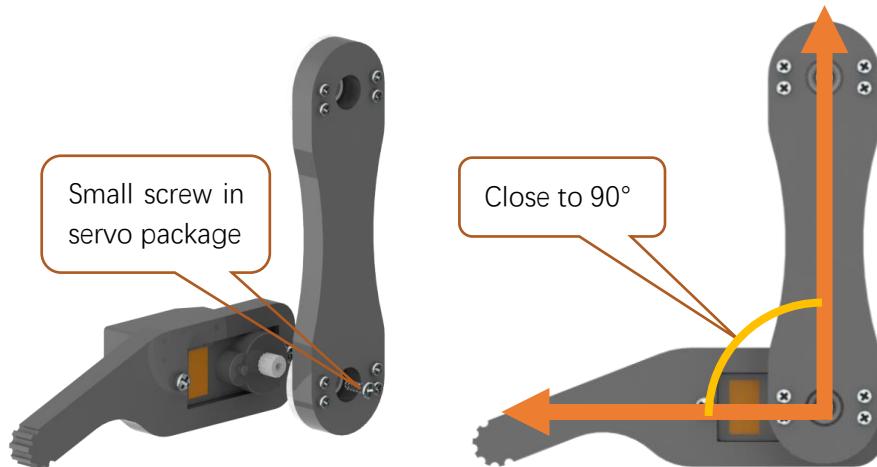
### 3. Whether the batteries are contacted well with the battery holder



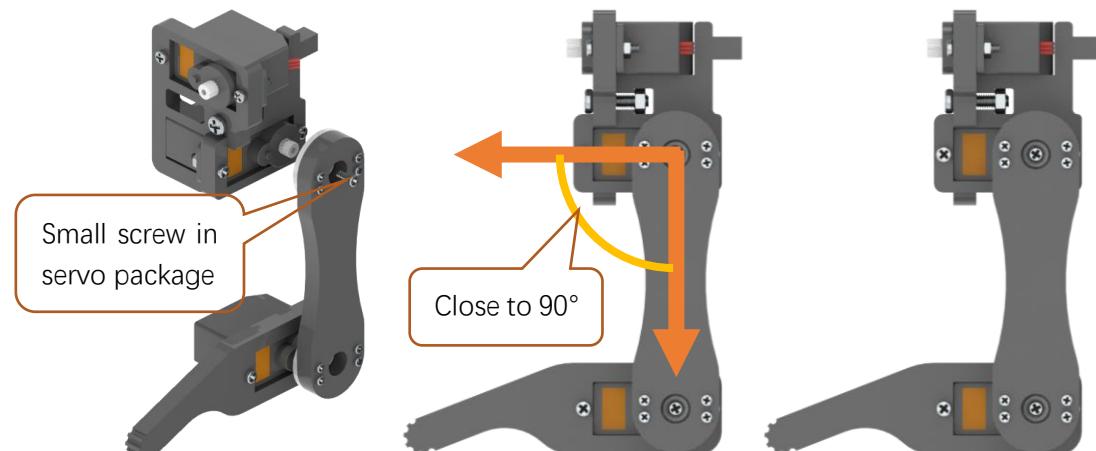
## Step 10 Assemble Legs to Body

Keep the power ON and all servos connected to shield. Do NOT disconnect wiring. We need to keep the servo at 90° when connected to them to servo arms. (servo wires are not shown in the following content.)

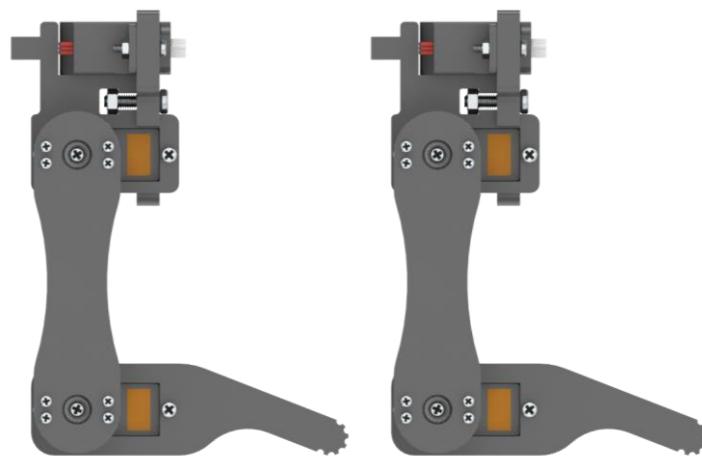
Try to install them close to 90°. The angles are acceptable within 65~115.



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

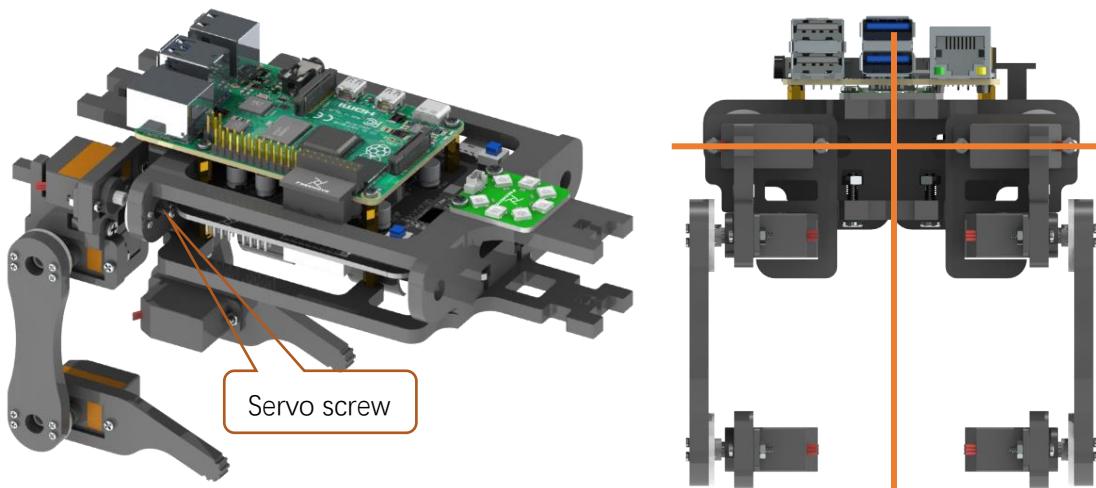


Assemble legs of the other side.

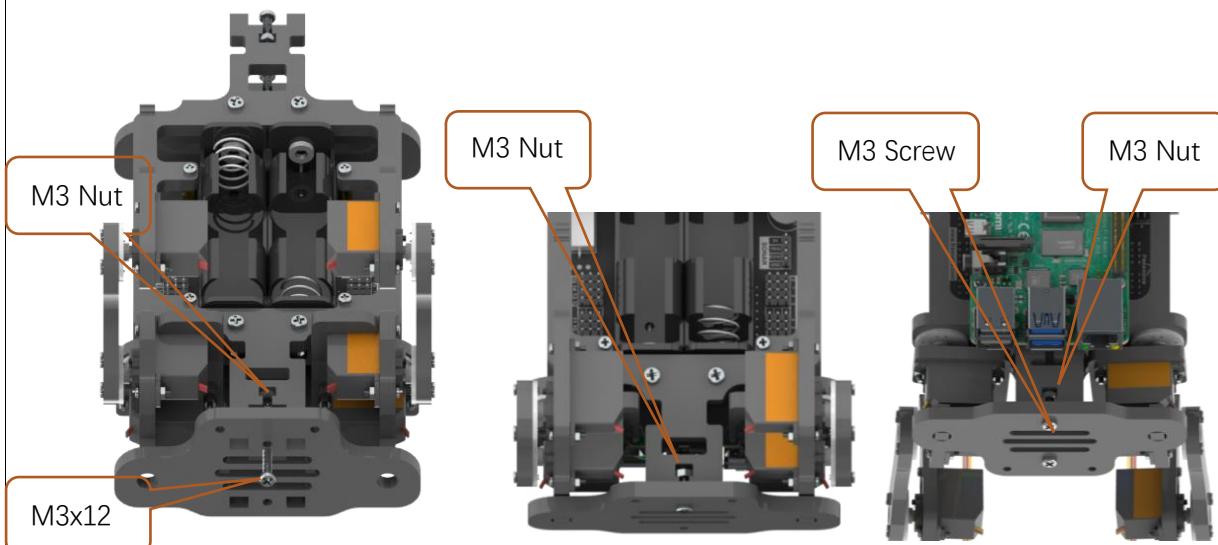


**Keep the power ON and all servos connected to shield. Do NOT disconnect wiring.**

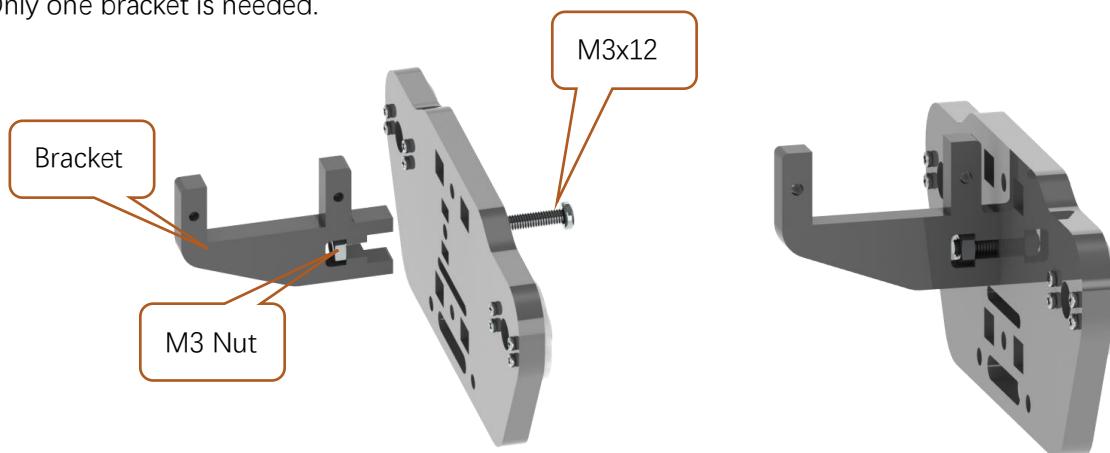
Select two legs of **different sides** as rear legs. And install them as below. Then install the servo screws.



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

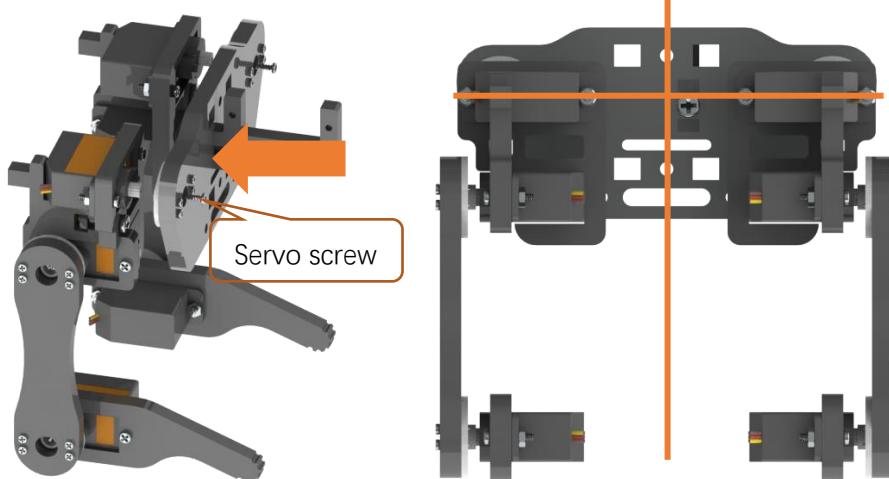


Only one bracket is needed.

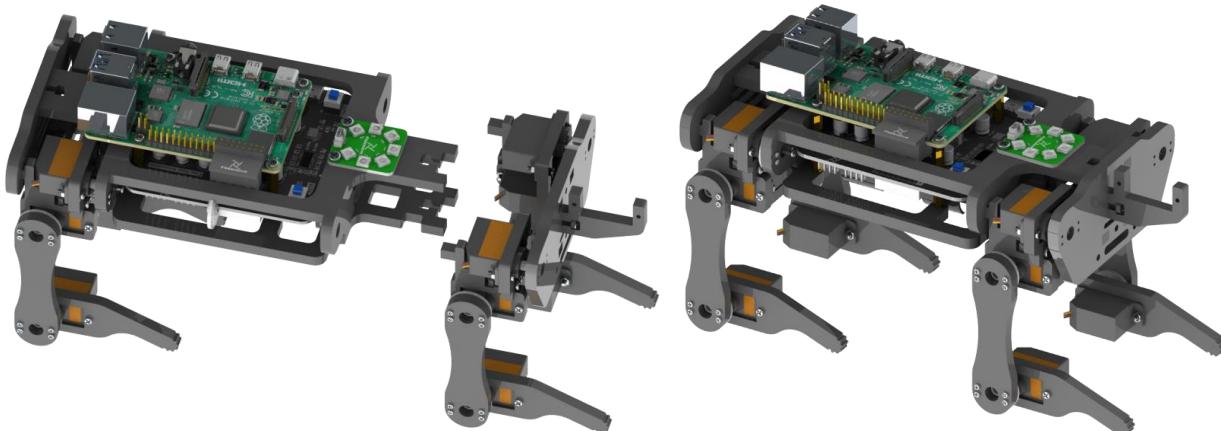


**Keep the power ON and all servos connected to shield. Do NOT disconnect wiring.**

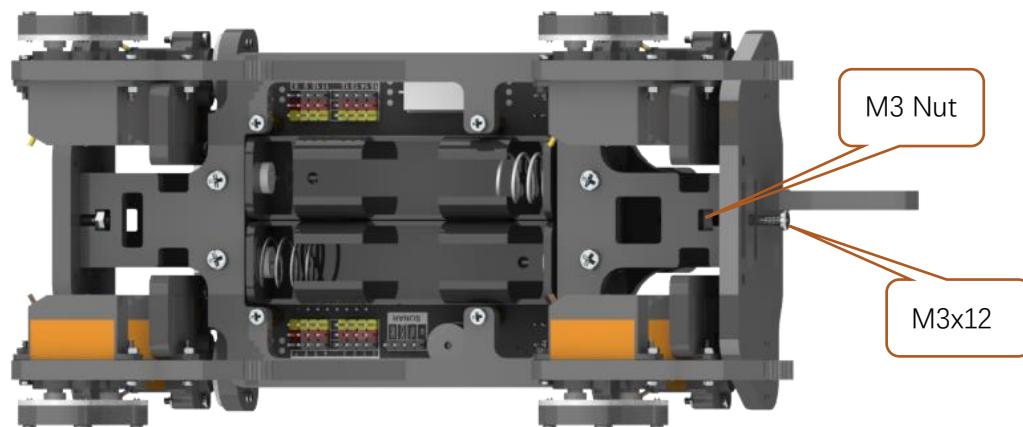
Assemble front legs and install the servo screw.

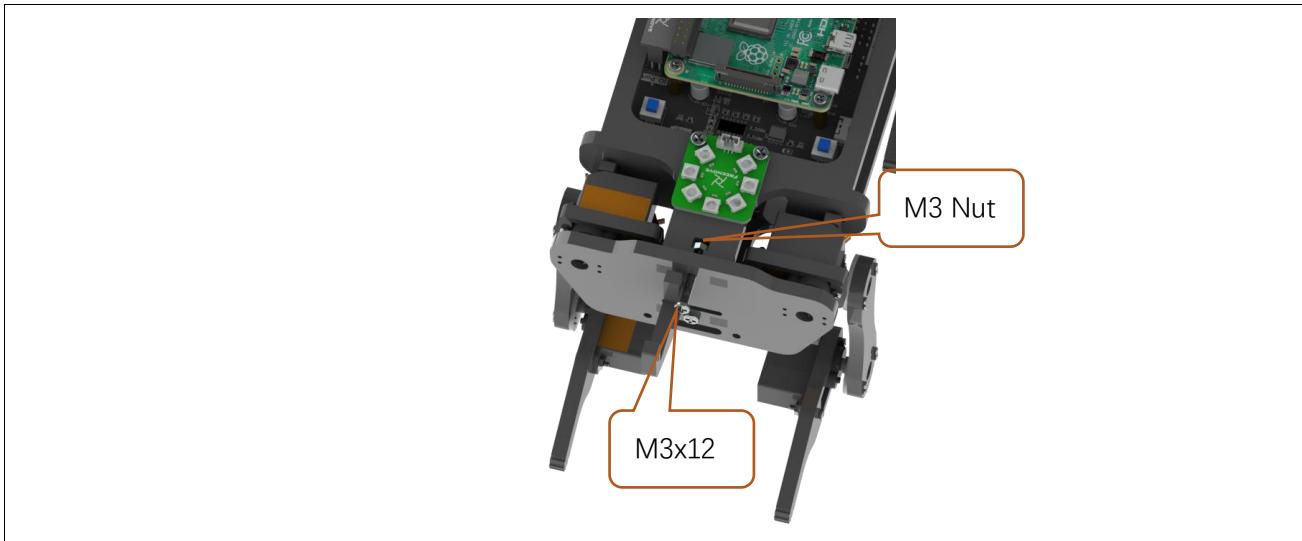


Assemble them.

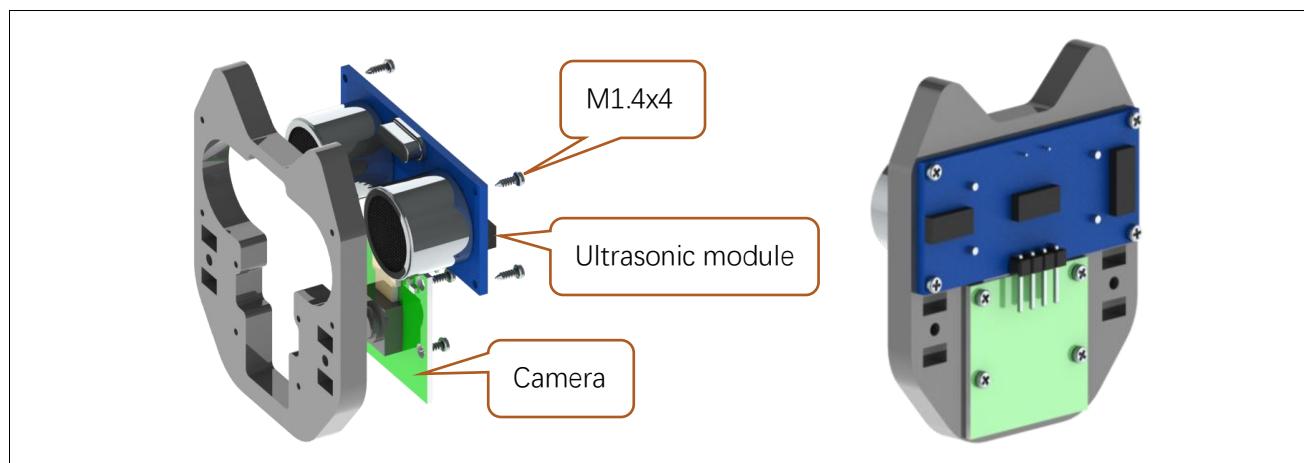


In this step, if you did not cover tape to the holes before, you can turn off **Load S1** to install the screw. After the screw is installed, turn on the **Load S1**.

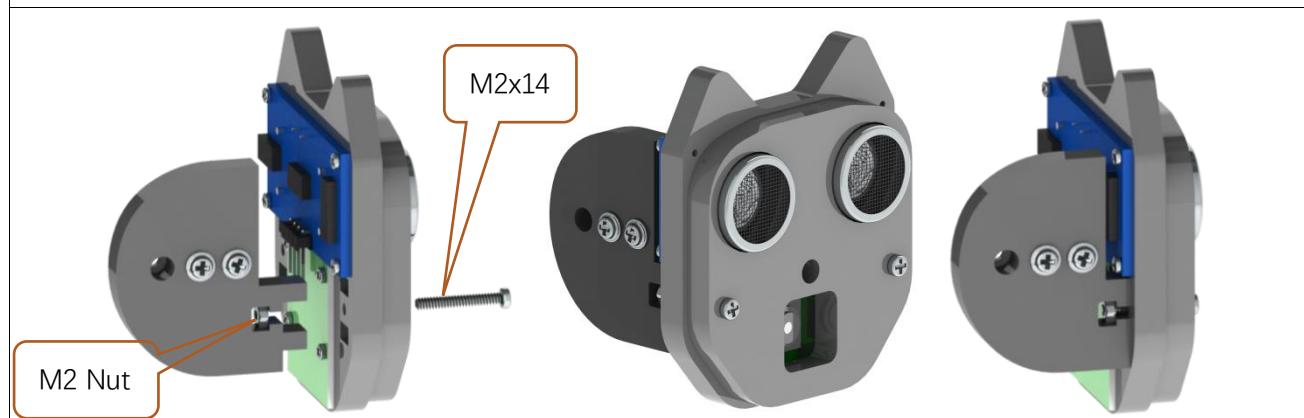




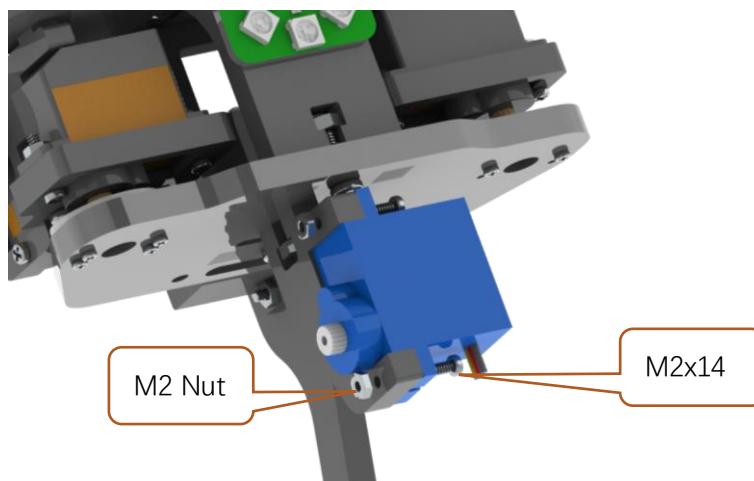
## Step 11 Assemble Head



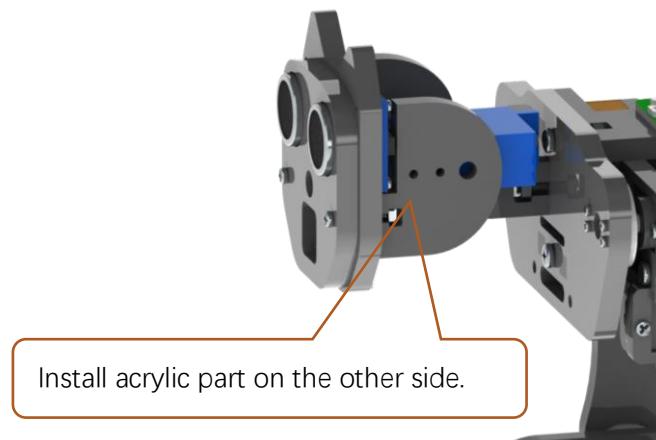
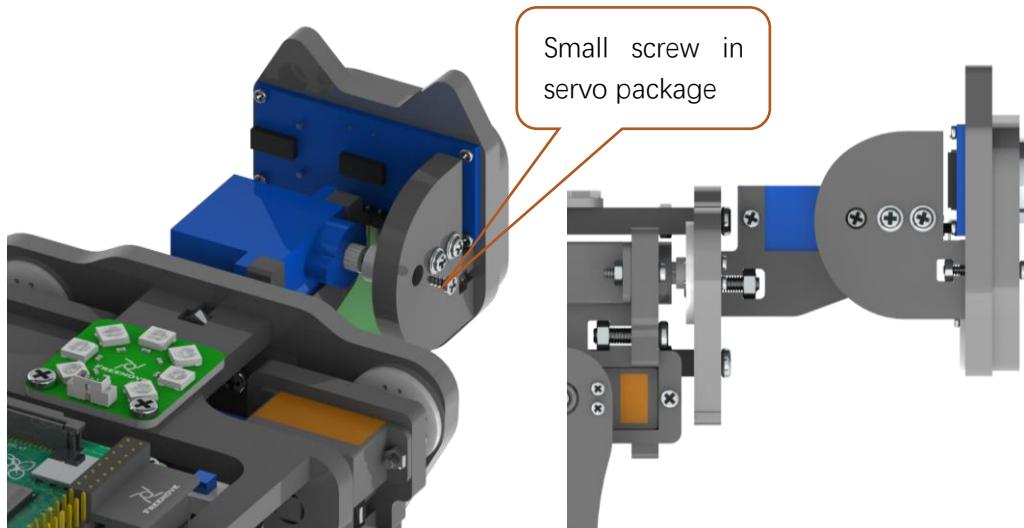
The servo arm and screws are included in the blue servo package.



## Step 12 Assemble Head to Body



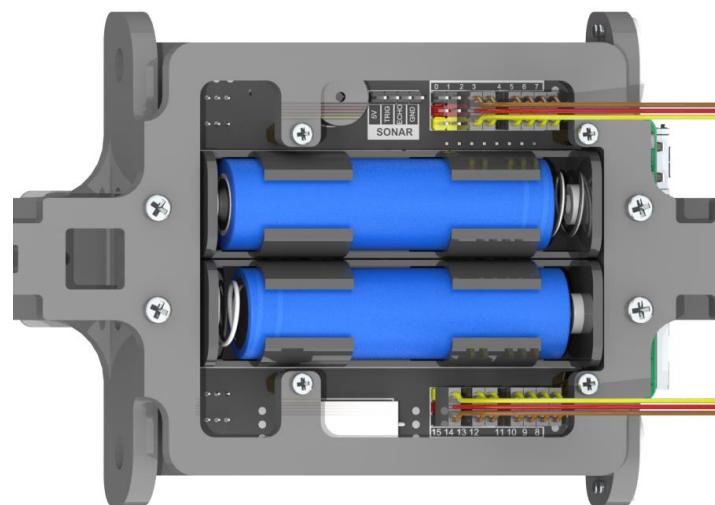
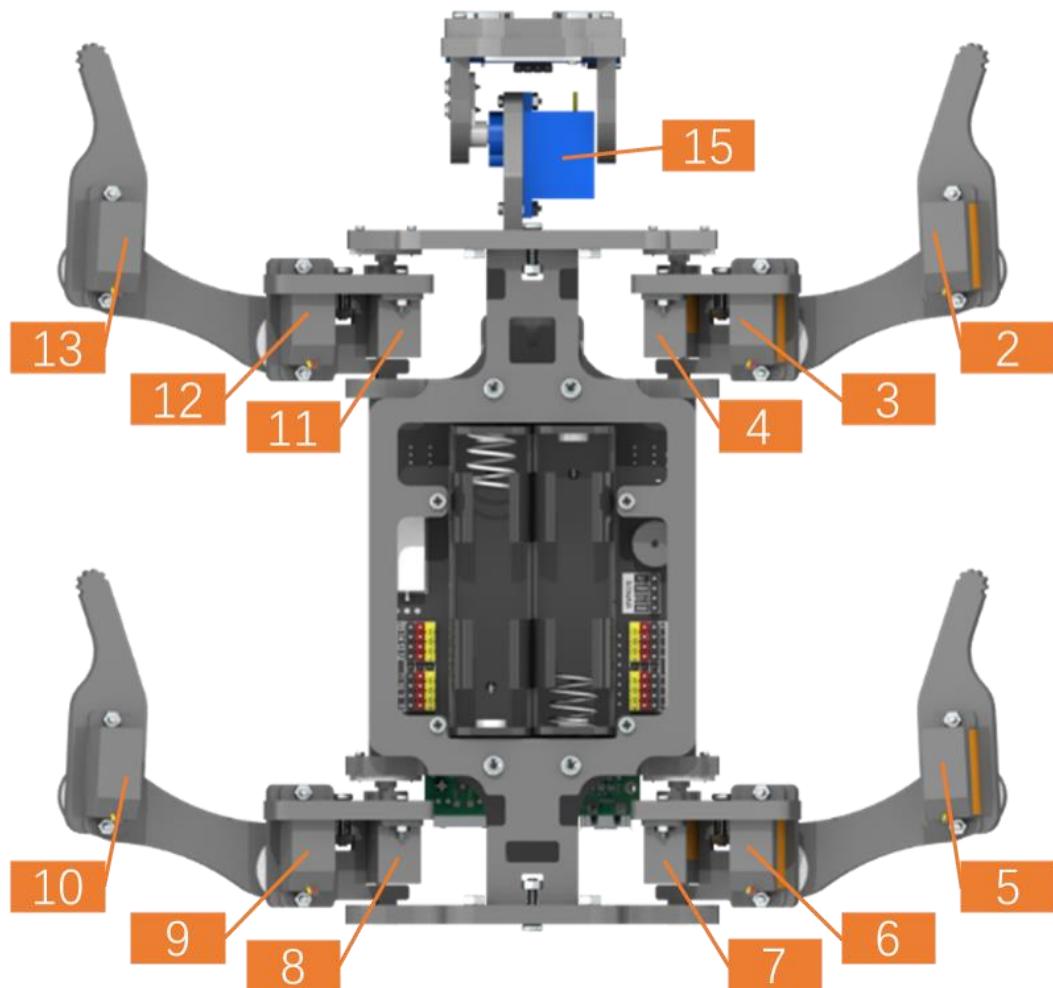
Keep the power ON and servos connected when installing arm to servo.



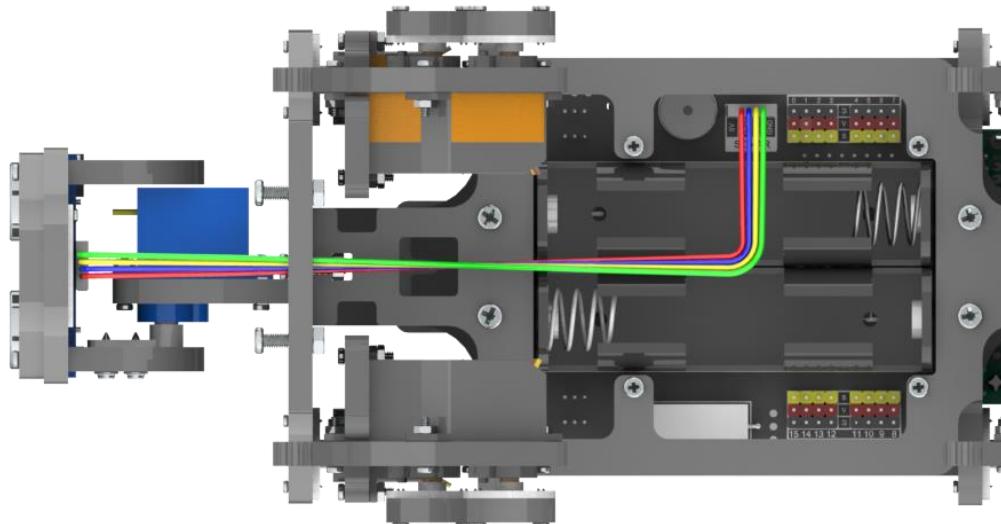
We will complete wiring in next section. Shut down the Raspberry Pi first. Do NOT turn on Raspberry Pi until chapter 3.

## Step 13 Wiring

Connect servos according to the numbers. **Note servo ports 0, 1, 14 are not connected to servo.** They are spare.

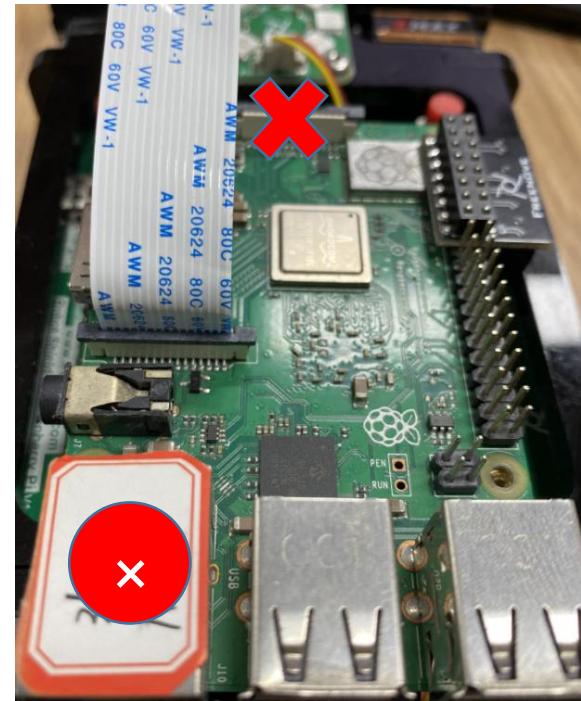


Wiring of Ultrasonic module (Note: **Do NOT connect wrongly. If you connect 5V to GND, it may damage the ultrasonic module**)

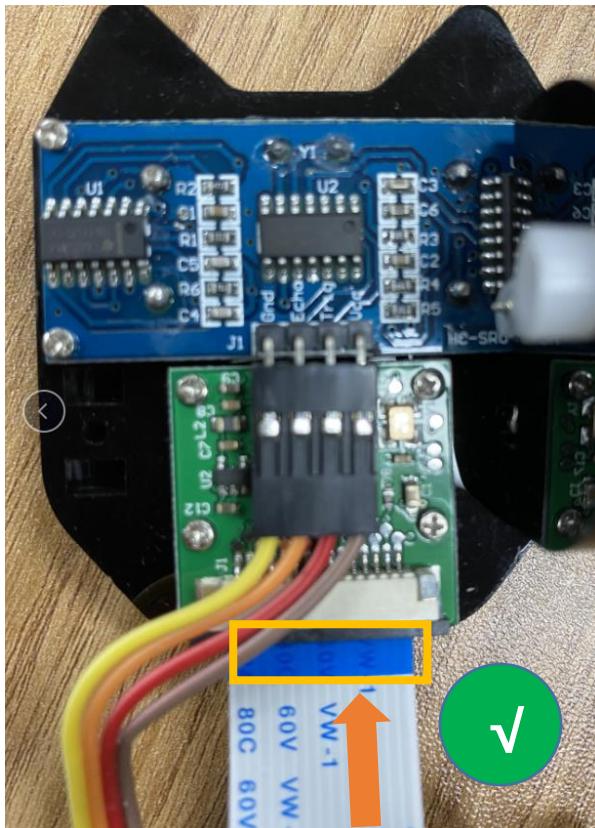


Pay attention to the **blue side** of camera cable.

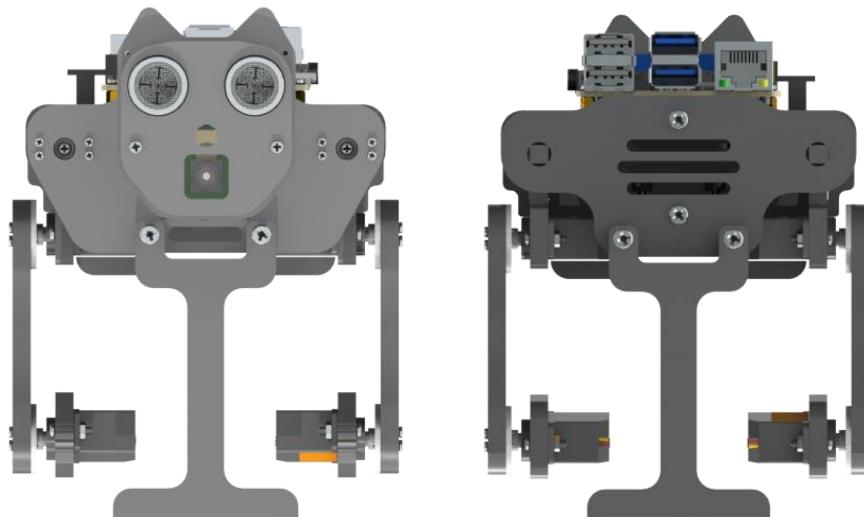
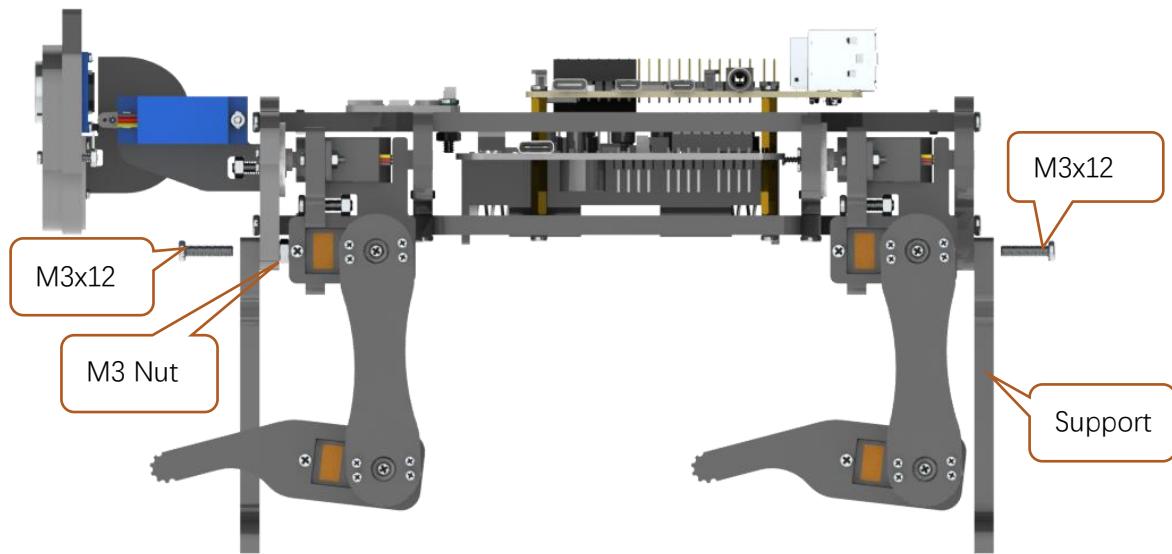
(Note: plugging and unplugging the cable requires the Raspberry Pi to be powered off, otherwise the camera module may be burned.)



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



## Step 14 Install Calibration Support



## Step 15 Verify Assembly

Turn on two switches and run following two commands again.

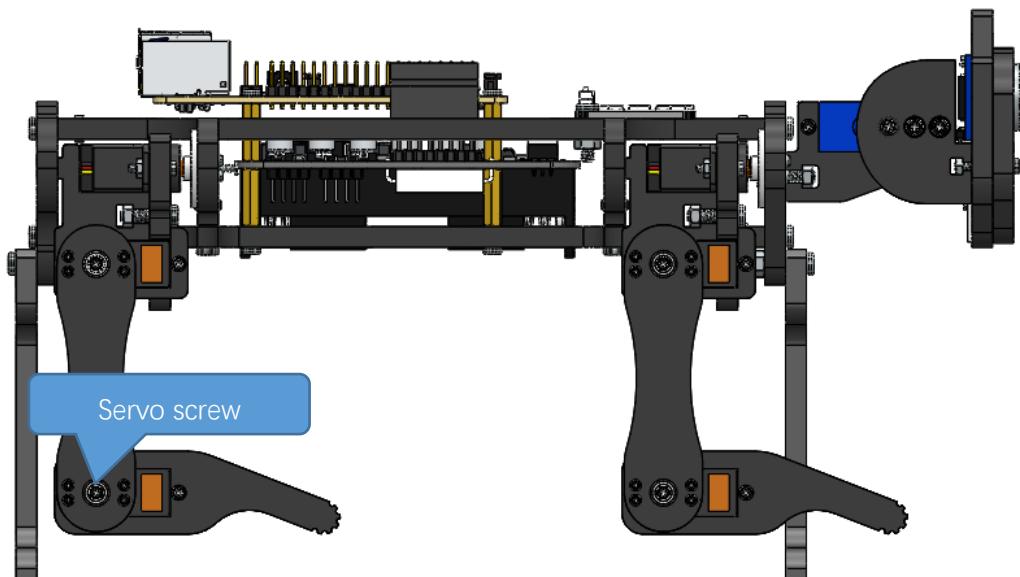
- Type the following command to enter servo code folder "Server".

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

- Run Servo.py

```
sudo python Servo.py
```

The robot should show the following posture.



If it does not look like this, you need to disassemble **servo screws** of incorrect servos. Then reassemble the incorrect servo to make the robot look like posture above.



# Chapter 3 Module test (Required)

If you have any concerns, please feel free to contact us at [support@freenove.com](mailto: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.

**Please use [VNC Viewer](#) to build this robot when you use remote mode to login RPi, or there will be errors. Because other desktop remote 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 corresponds 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: -- - - - - - - - - - - - - - - - - - - - -
```

## 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
```

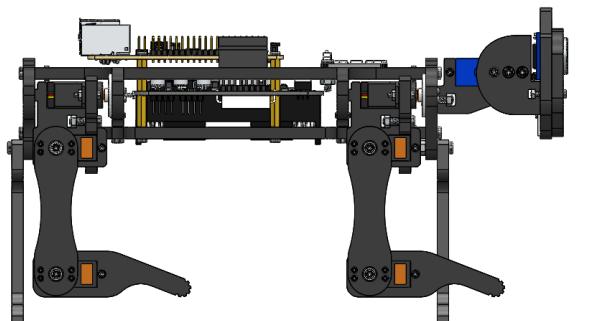
```
pi@raspberrypi: ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server ~ ~ ~  
File Edit Tabs Help  
pi@raspberrypi:~ $ cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server  
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ sudo python test.py Servo  
on test.py Servo  
Program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

**Result:**

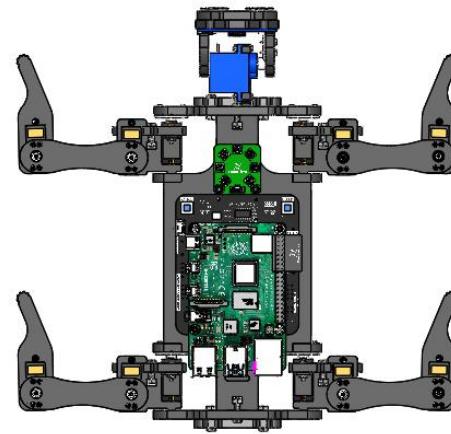
After assembly in the previous chapter, the robot should look as shown in picture A.

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

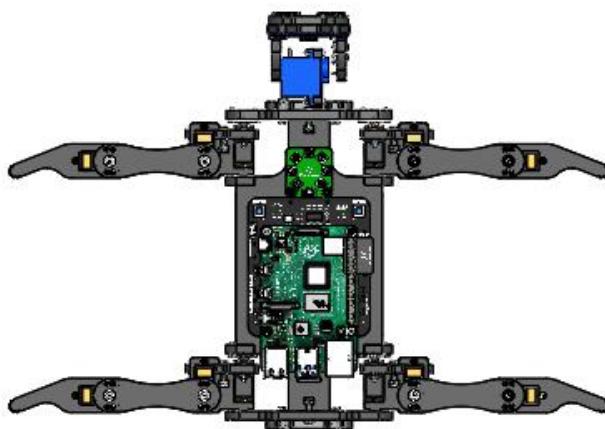
If the situation is not correct, check the servo [wiring](#).



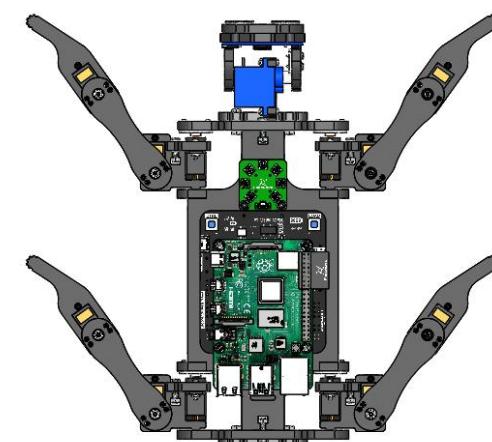
(A)



(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 the second command test.py.

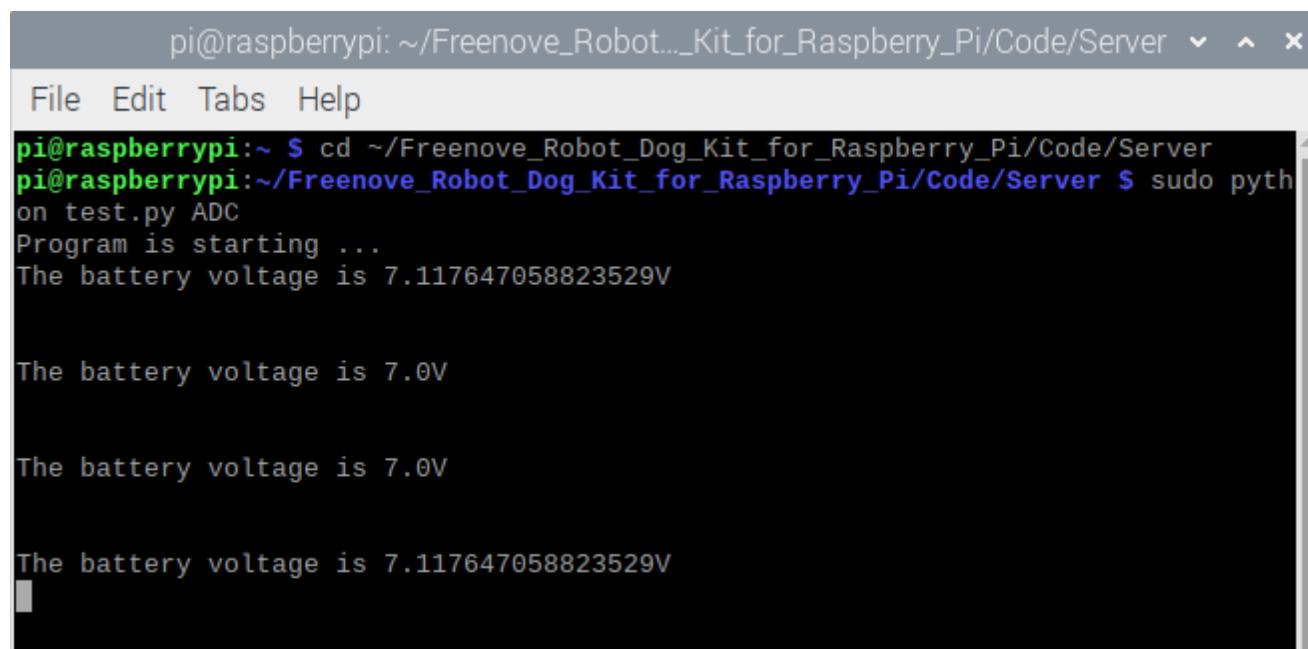
```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $
```

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: ~/" followed by the path to the Freenove code directory. Below that, the user runs the command "sudo python test.py ADC". The program starts with the message "Program is starting ...". It then prints the battery voltage twice: "The battery voltage is 7.117647058823529V" and "The battery voltage is 7.0V". Finally, it prints the voltage again: "The battery voltage is 7.117647058823529V". The terminal window has standard Linux-style window controls at the top right.

```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server $ 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 7.117647058823529V
```

### Result:

Print voltage value of batteries 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 ranges between 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
```

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 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 between ultrasonic module and the obstacle in front of it in centimeters.

## LED

There is an 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. It has three input parameters, among which, 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, waiting for 20ms, and then the LED1 color is also red, and repeat the same to all 8 LEDs until they are all 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 screenshot shows a terminal window with the following content:

```
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 $
```

The terminal shows the command being run, the program outputting "1S", "2S", and "3S" over three seconds, and finally the message "End of program".

### Result:

The buzzer will be turned 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

Detect camera:

```
vcgencmd get_camera  
pi@raspberrypi:~ $ vcgencmd get_camera  
supported=1 detected=1
```

If the result above does not appear, please check the camera [Wiring](#)

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

Run program

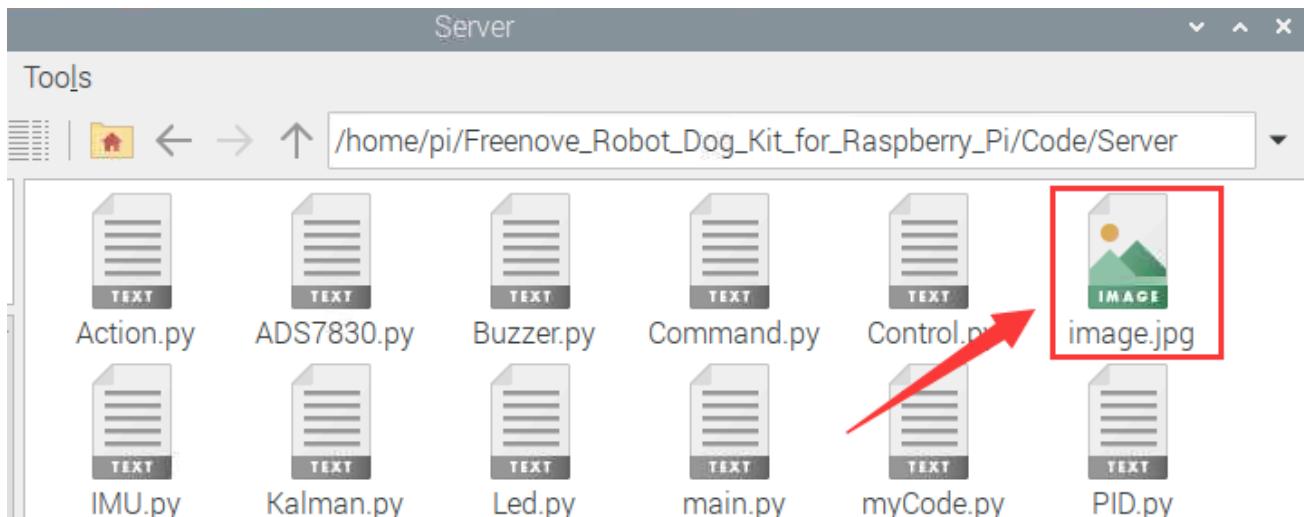
1. execute the cd command:

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

2. Execute test.py command:

```
python camera.py
```

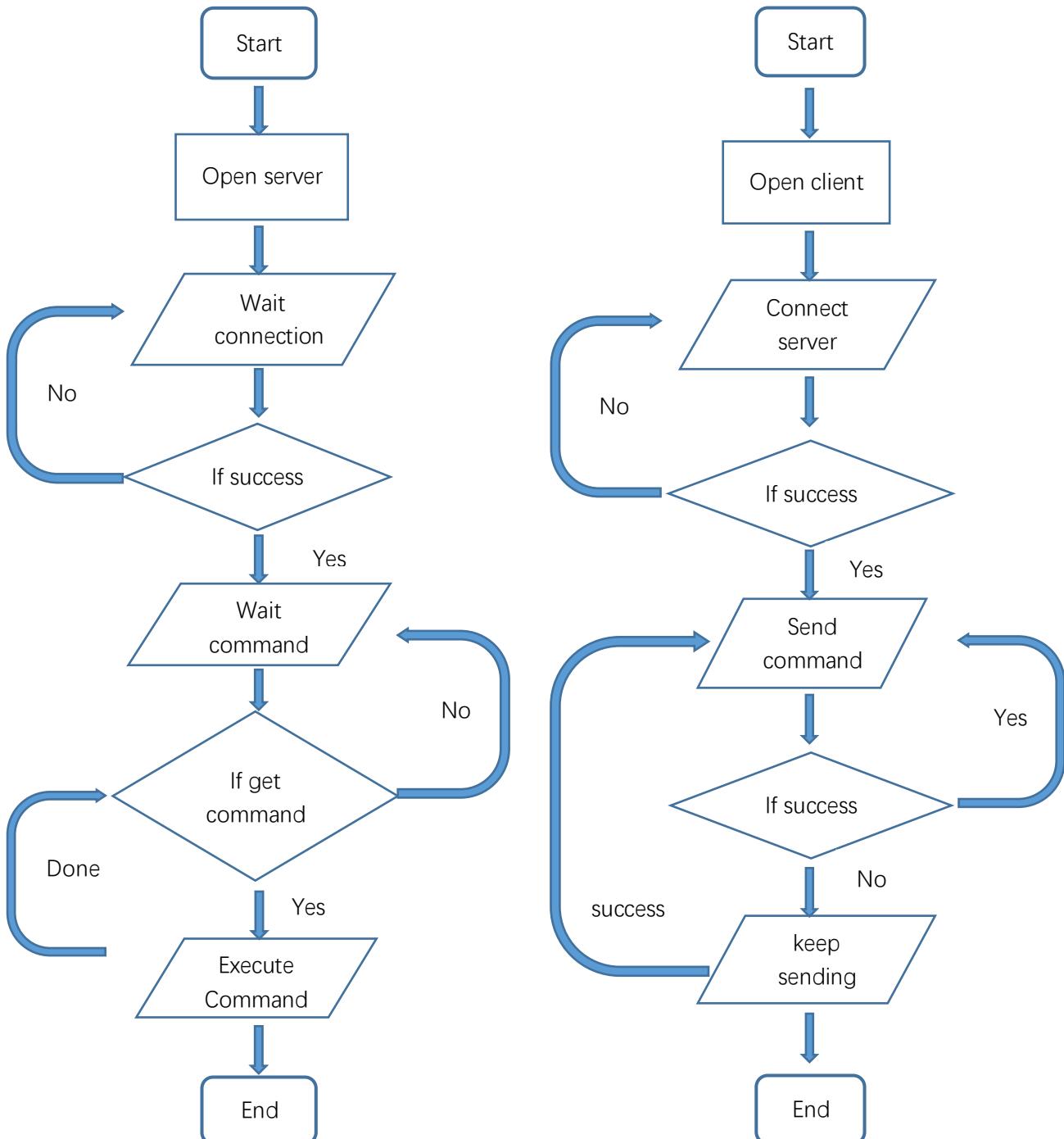
Then please open and check the generated image.jpg under  
/Freenove\_Robot\_Dog\_Kit\_for\_Raspberry\_Pi/Code/Server.



# Chapter 4 Robot Dog

If you have any concerns, please feel free to contact us at [support@freenove.com](mailto: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 (LAN).



## 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 adress
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” in 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

## Open Server

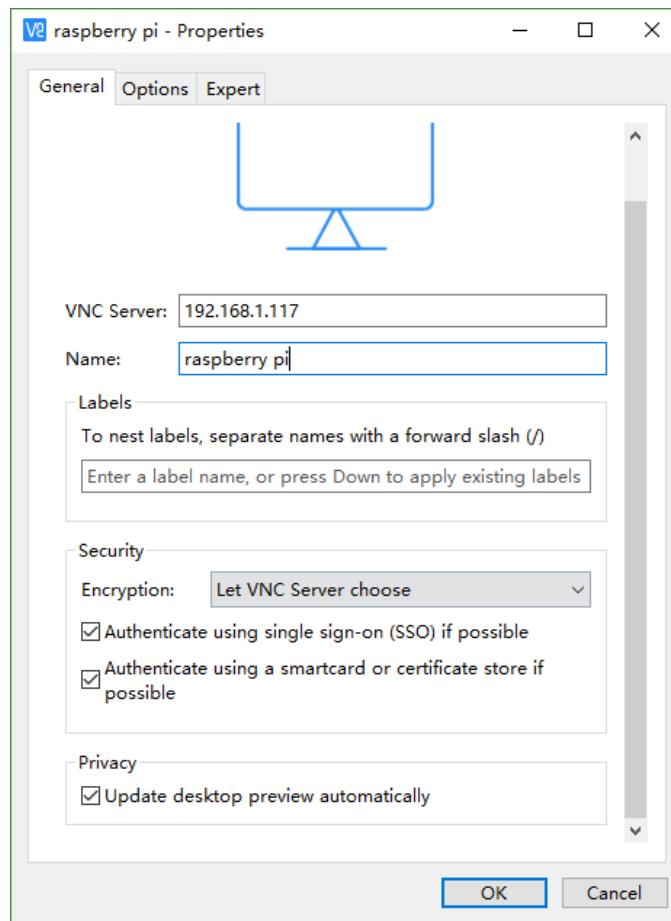
Step 1 Login Raspberry Pi via VNC viewer

**Because server and client use GUI. You need use VNC viewer as remote desktop way.**

Download and install VNC Viewer according to your computer system by clicking following link:

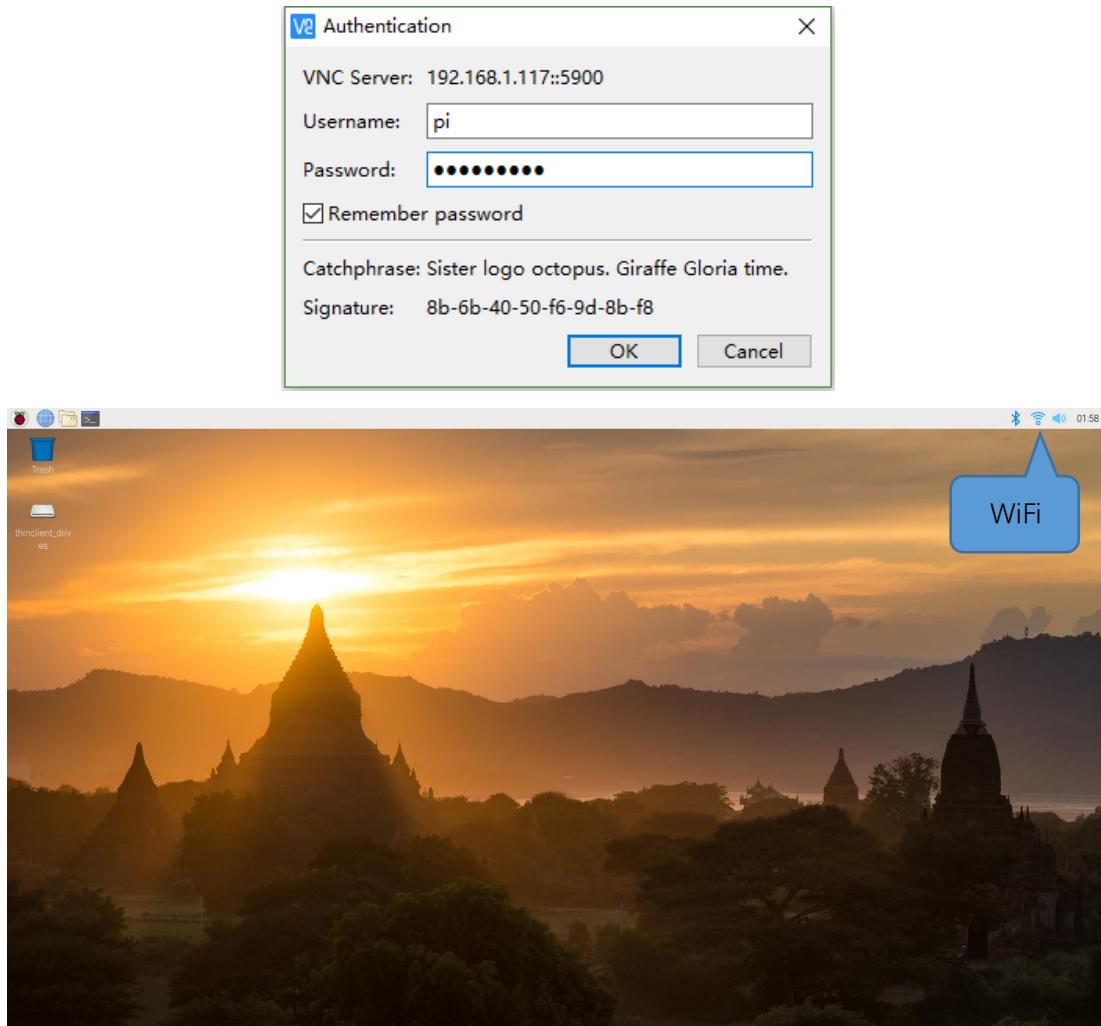
<https://www.realvnc.com/en/connect/download/viewer/>

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.

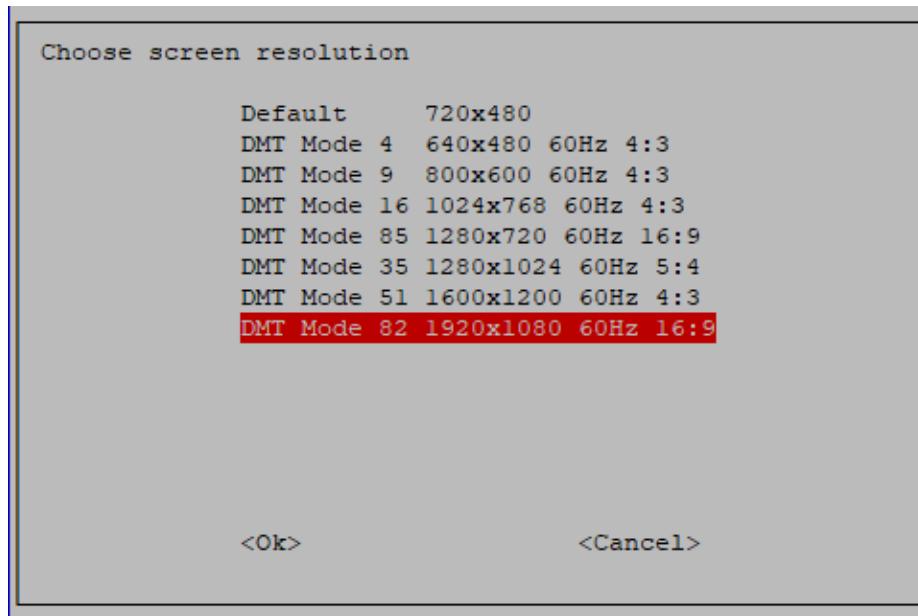
Then on the VNC Viewer panel, double-click new connection you just created, and the following dialog box pops up. Enter username: **pi** and Password: **raspberry**. And click OK.



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.

## Step 2 Run commands

Enter following command in the terminal.

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

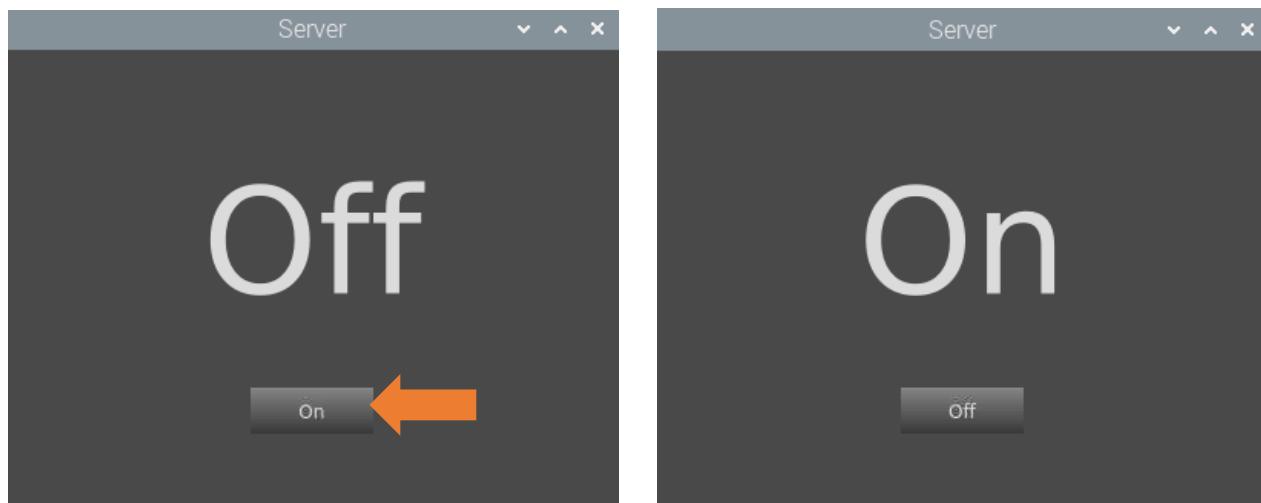
```
cd ~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server
```

2. Run main.py:

```
sudo python main.py
```

```
pi@raspberrypi:~/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server ~ ^ x
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
main.py
```

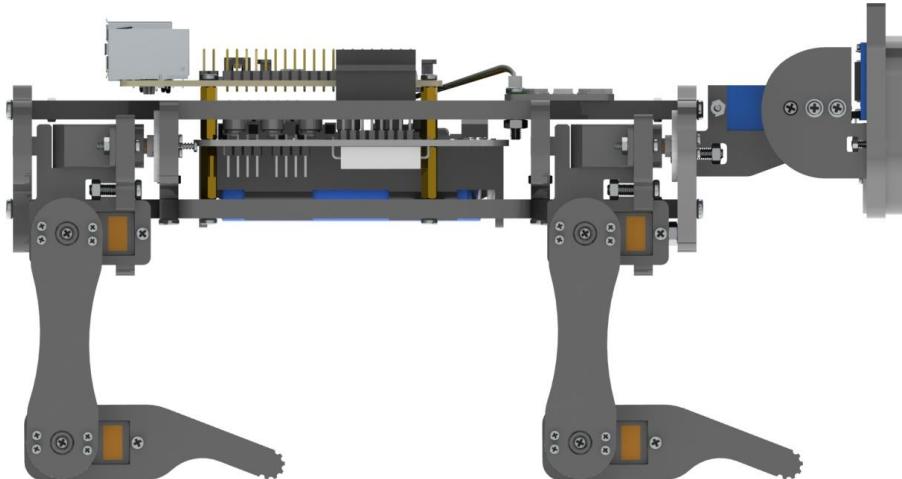
The interface is as below: Click “On” to open the server. The result is show as below:



You will see your server address (Raspberry Pi IP), Which is the LAN IP address of your Raspberry Pi. In the next chapter, you will need to enter this IP address to connect the Raspberry Pi client with the server.

```
pi@raspberrypi:~/Desktop/20200327Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server$ 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 referenced later.



If you don't like the interface, you can also enter the commands to open the server. It is more convenient.

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 -t -n
```

or Run main.py with following command:

```
sudo python main.py -tn
```

"-t" means open TCP communication. "-n" means don't show interface.

### Server Auto Start

- 1 Open the terminal and execute the following two commands respectively to create a "start.sh" file.

[Need support? ✉ support@freenove.com](mailto:support@freenove.com)

```
cd ~  
sudo touch start.sh
```

2 Open “start.sh”.  
sudo nano start.sh

3 Add the following contents to “start.sh” file.

```
#!/bin/sh  
cd "/home/pi/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server"  
pwd  
sleep 10  
sudo cp point.txt /home/pi  
sudo python main.py
```

Press Ctrl + O and then press Enter to save it. Press Ctrl+X to exit.

The screenshot shows a terminal window titled "pi@raspberrypi: ~". The menu bar includes "File", "Edit", "Tabs", and "Help". The title bar shows "GNU nano 3.2" and the file name "start.sh". The status bar indicates "Modified". The main area of the window displays the following text:

```
#!/bin/sh  
cd "/home/pi/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/Code/Server"  
pwd  
sudo cp point.txt /home/pi  
sudo python main.py
```

At the bottom of the window, there is a toolbar with various keyboard shortcuts:

AG Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos  
AX Exit ^R Read File ^\ Replace ^U Uncut Text ^T To Spell ^\_ Go To Line

4 Modify permissions.

```
sudo chmod 777 start.sh
```

5 Enter the following command to create a directory.

```
mkdir ~/.config/autostart/
```

6 create and open “start.desktop” file

```
sudo nano .config/autostart/start.desktop
```

7 Add the following content to “start.desktop” file.

```
[Desktop Entry]  
Type=Application  
Name=start
```

```
NoDisplay=true  
Exec=/home/pi/start.sh
```

Press Ctrl + O and then press Enter to save it. Press Ctrl+X to exit.

8 Modify permissions.

```
sudo chmod +x .config/autostart/start.desktop
```

9 Finally enter the following content to reboot Raspberry Pi.

```
sudo reboot
```

Note: To cancel auto start, please delete the files "start.sh" and "start.desktop" created above.



## 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 running 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" in 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 ()`

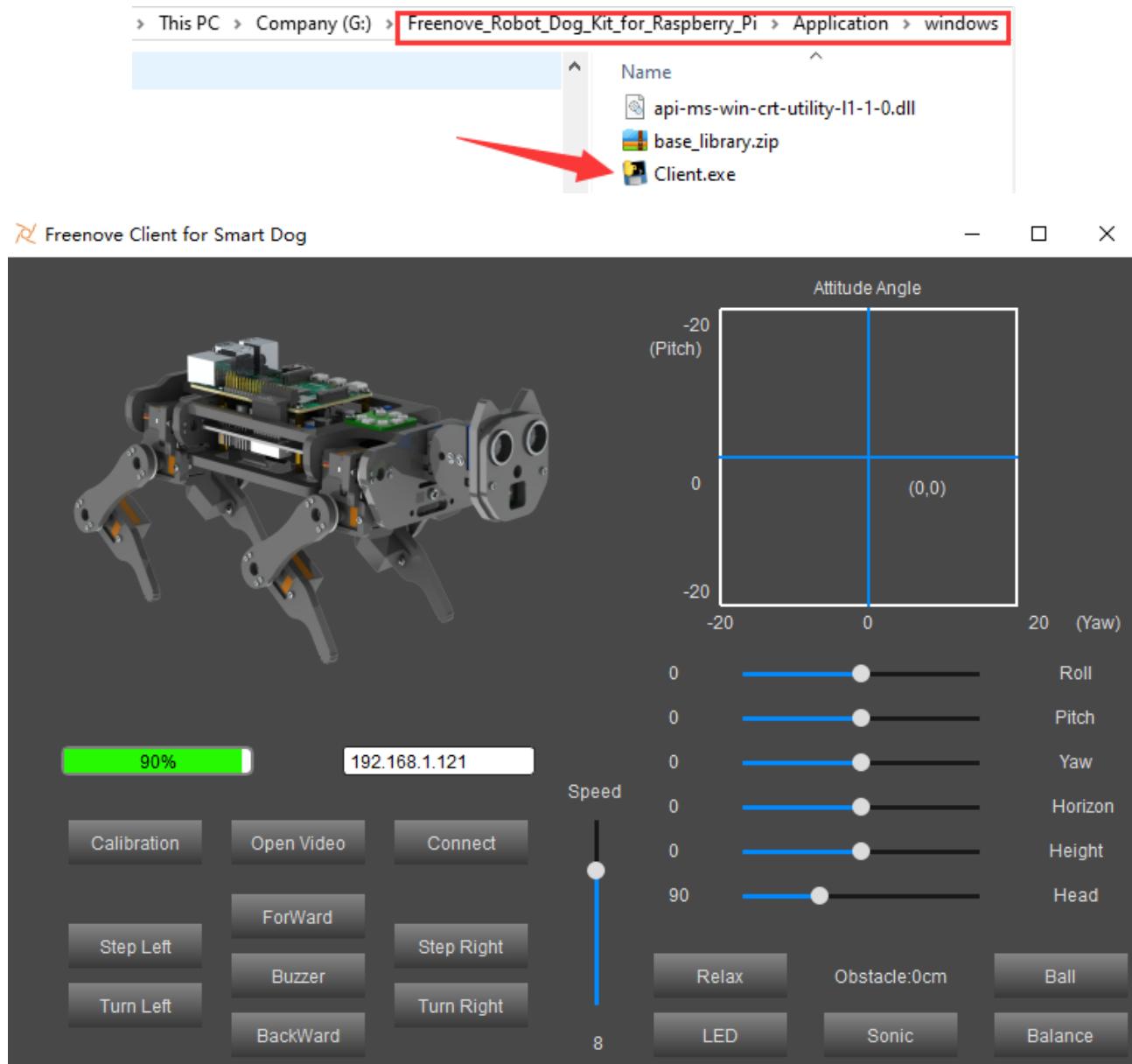
This function is used to receive commands from the server.

## Run Client on Windows system

There are two ways to run Client on Windows.

### Option 1 Running executable file directly

Find the "Client.exe" file in the specified directory, double click it and the Client is opened.



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.

You can refer to this video: <https://youtu.be/I2v9PdwQdvY>

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

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## Option 2 Install python3 and some related python libraries to run client

If you want to modify the client, you can follow this section.

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, which takes some time. During this process, it does not need to run a server and a Raspberry Pi. You can turn off the Raspberry Pi first. After the installation is completed, turn on the Raspberry Pi and the server.

### Install python3

Download the installation file via the below link:

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

Python >>> Downloads >>> Windows

## Python Releases for Windows

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

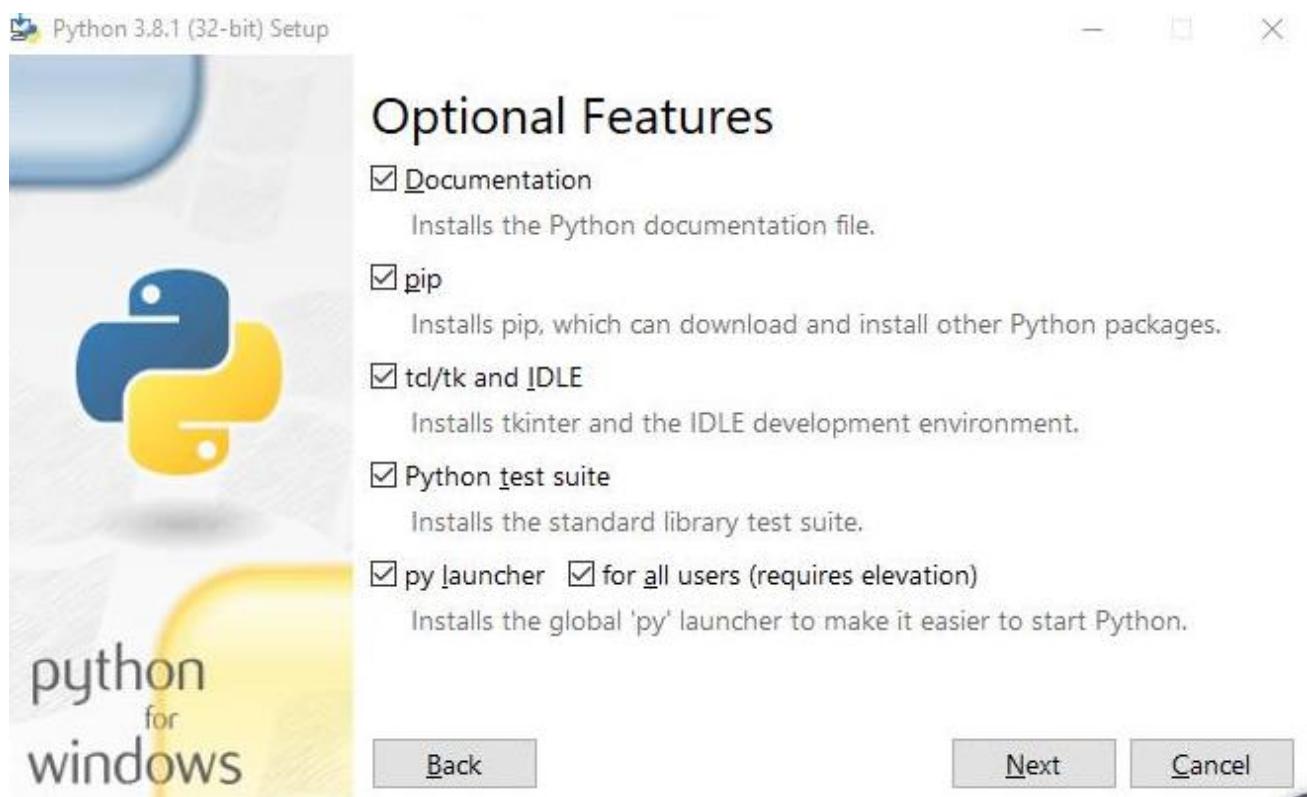
Click **Latest Python 3 Release** - Python 3.8.1 (as an example).

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

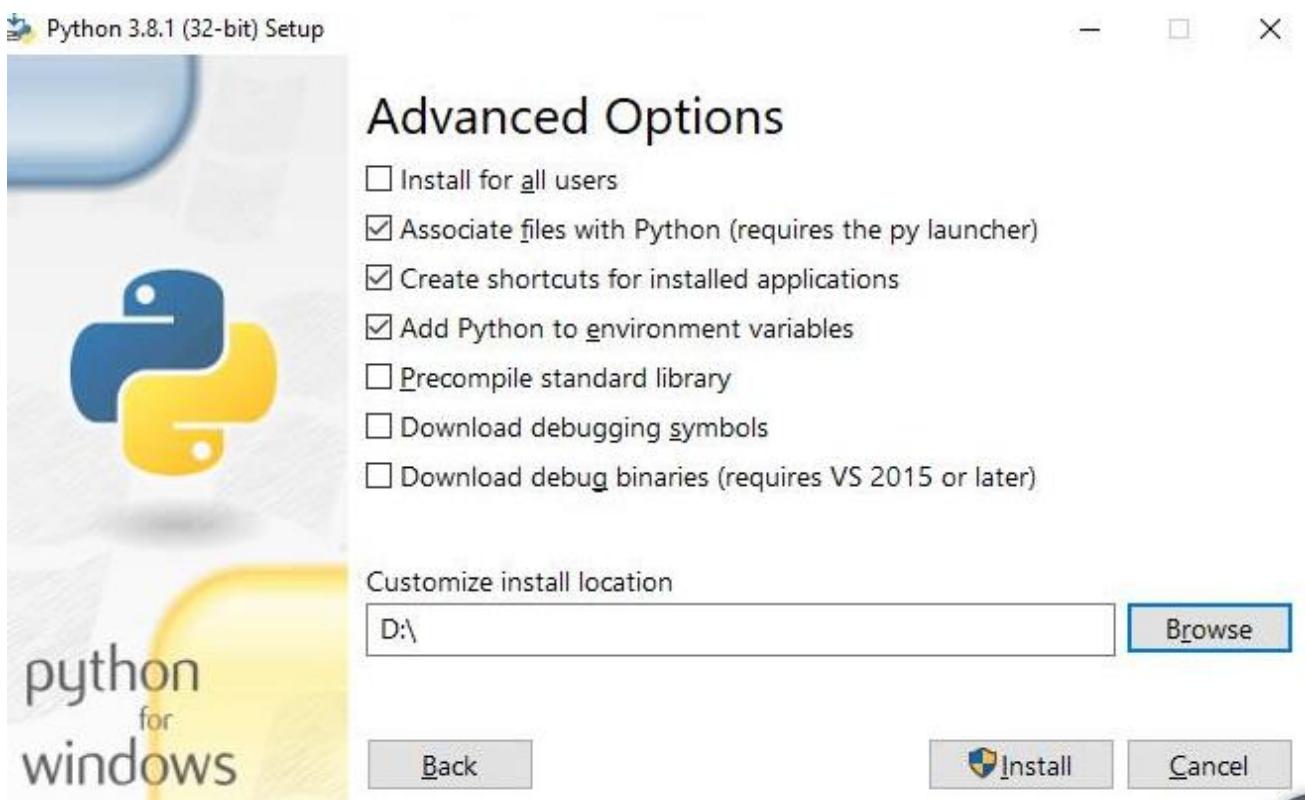
Choose “Windows x86-64 executable installer” to download and install.



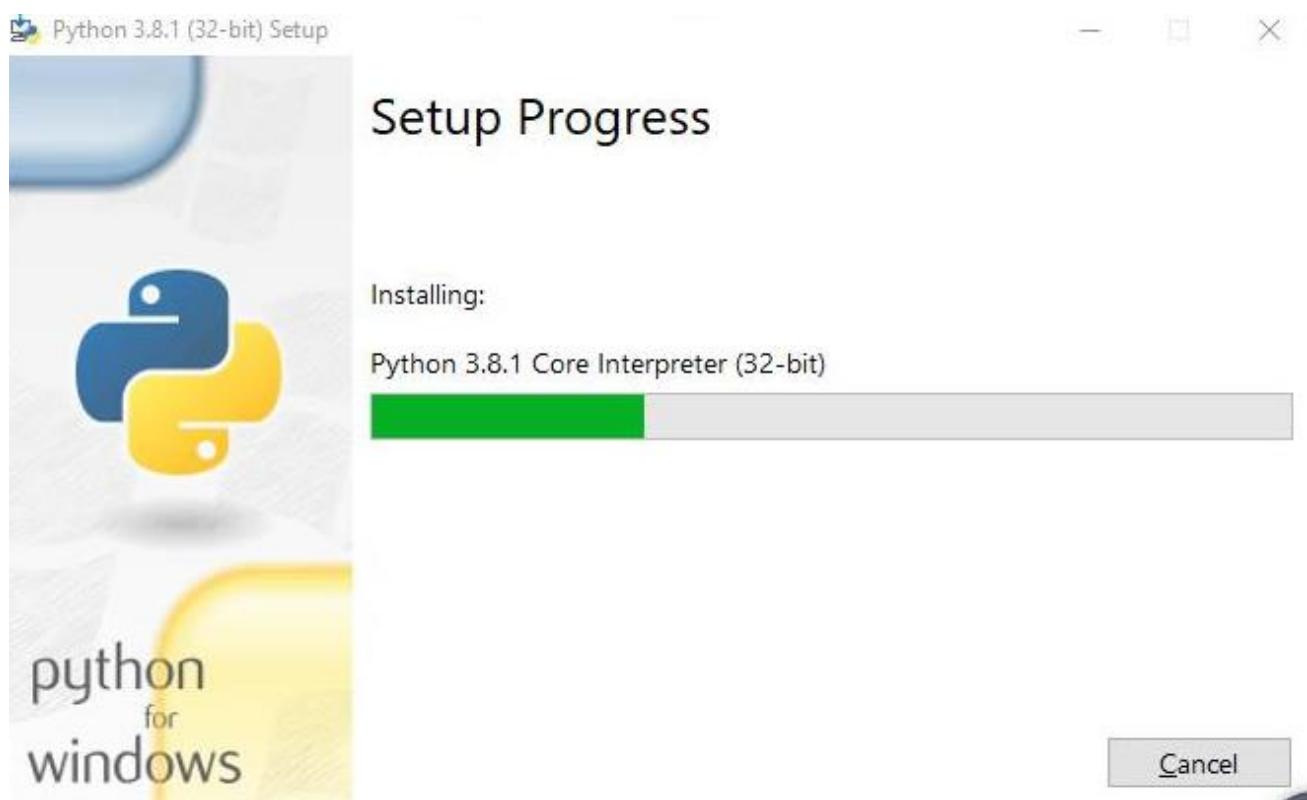
Select "Add Python 3.8 to PATH". And choose Customize installation.



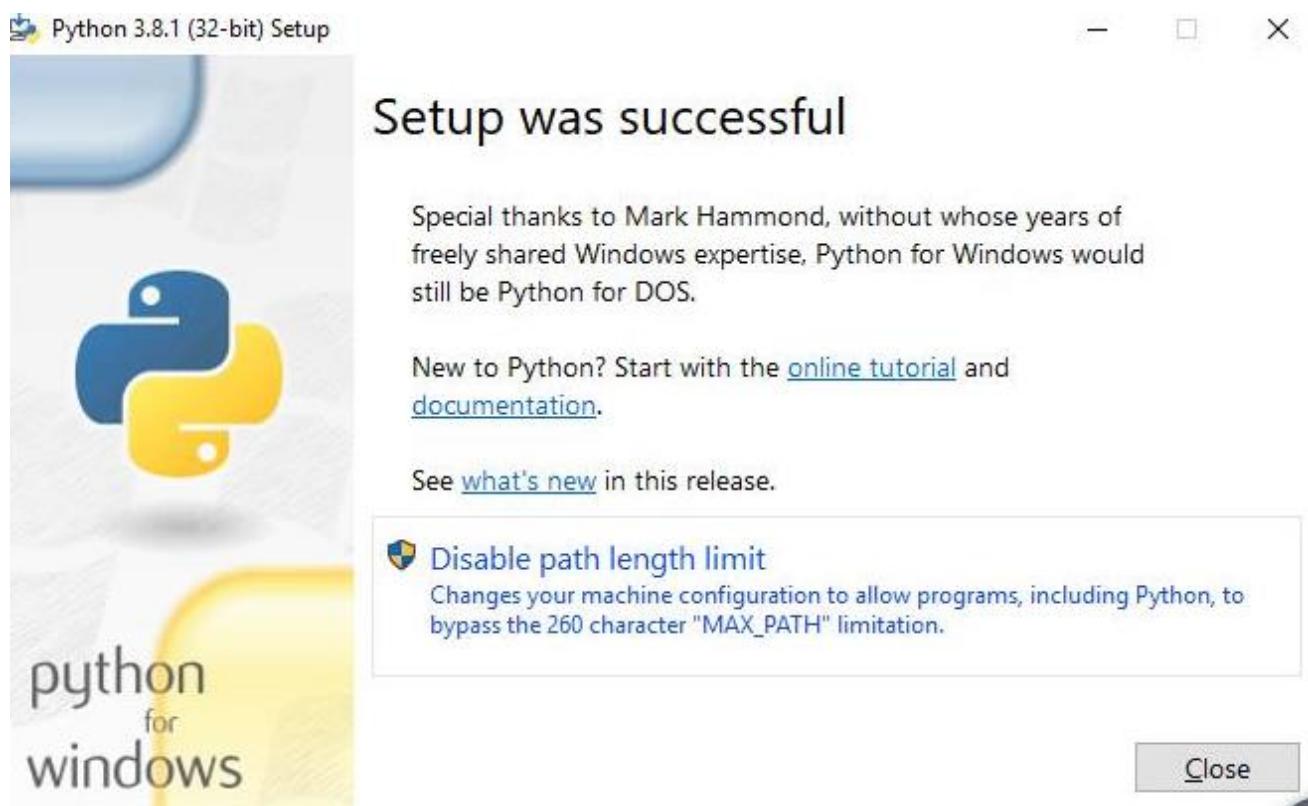
Select all options and click Next.



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



Wait for installation.



Installation is successful.

Install PyQt5, opencv, numpy and other libraries

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

[https://github.com/Freenove/Freenove\\_Robot\\_Dog\\_Kit\\_for\\_Raspberry\\_Pi/archive/master.zip](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\Code>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 the default python in your windows system is 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 installations are 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 poor 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:

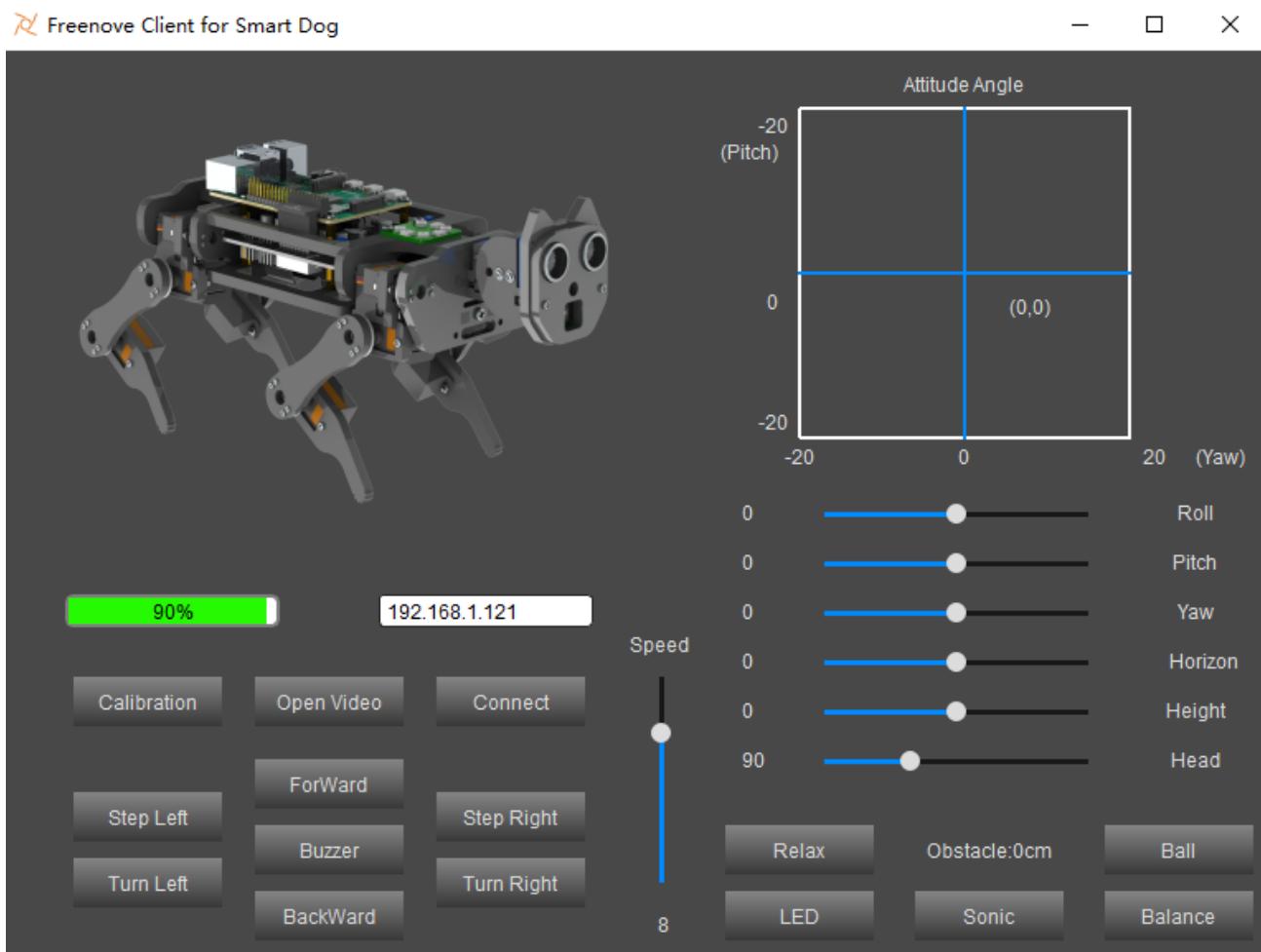
**Freenove\_Robot\_Dog\_Kit\_for\_Raspberry\_Pi\Code\Client**

Or use python3 to run "Main.py".

Note: If the 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 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. During the installation, 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 completed, 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/>

<a href="#">Python 3.8.1</a>	Dec. 18, 2019	 Download
<a href="#">Python 3.7.6</a>	Dec. 18, 2019	 Download

Click Python 3.8.2.

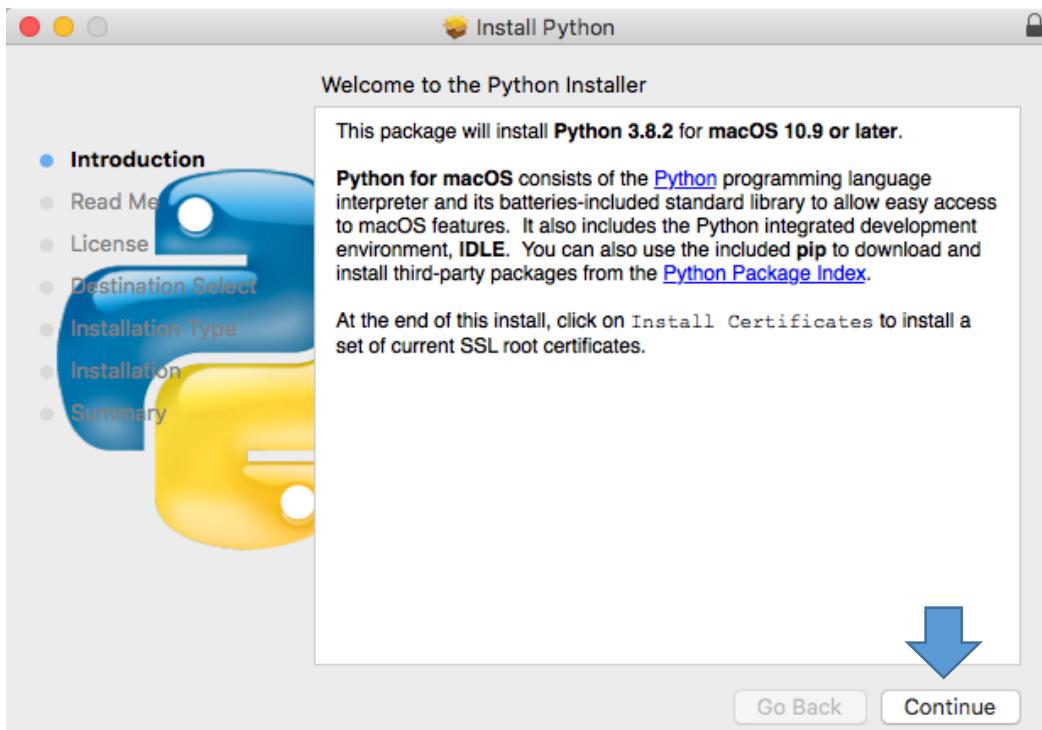
If your macOS is 11. Like 11.0, please install **python 3.9**.

If your macOS is NOT 11, like 10.15, please install **python 3.8**. If you have installed python 3.9. You need uninstall it first.

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

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

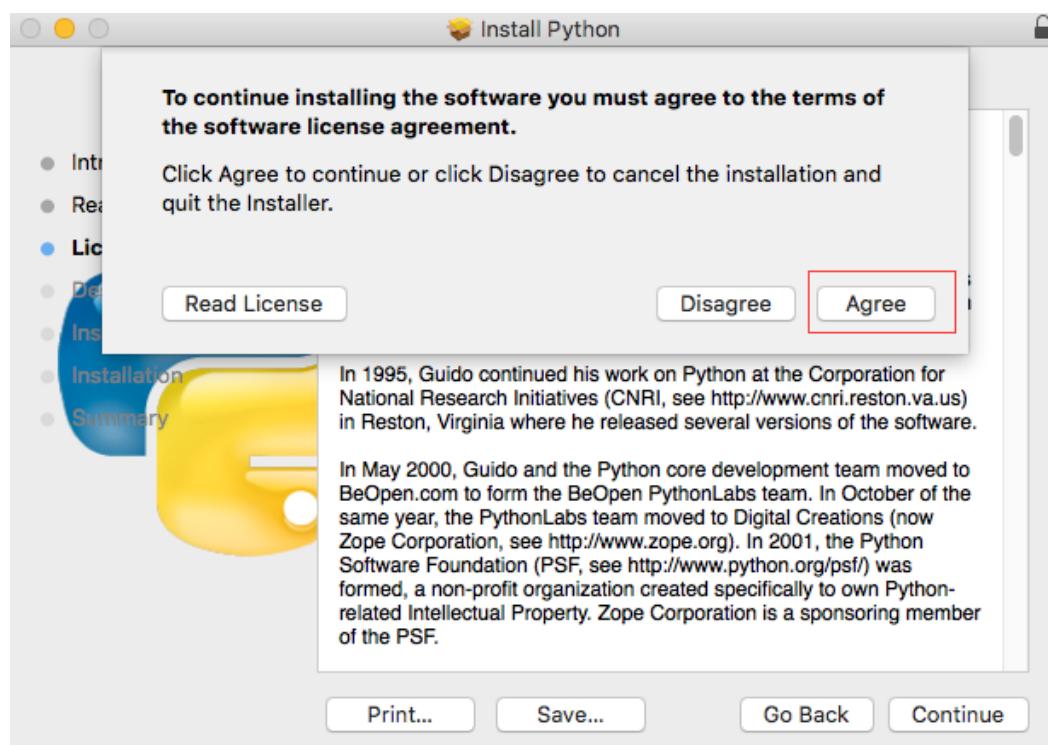
Then install python.



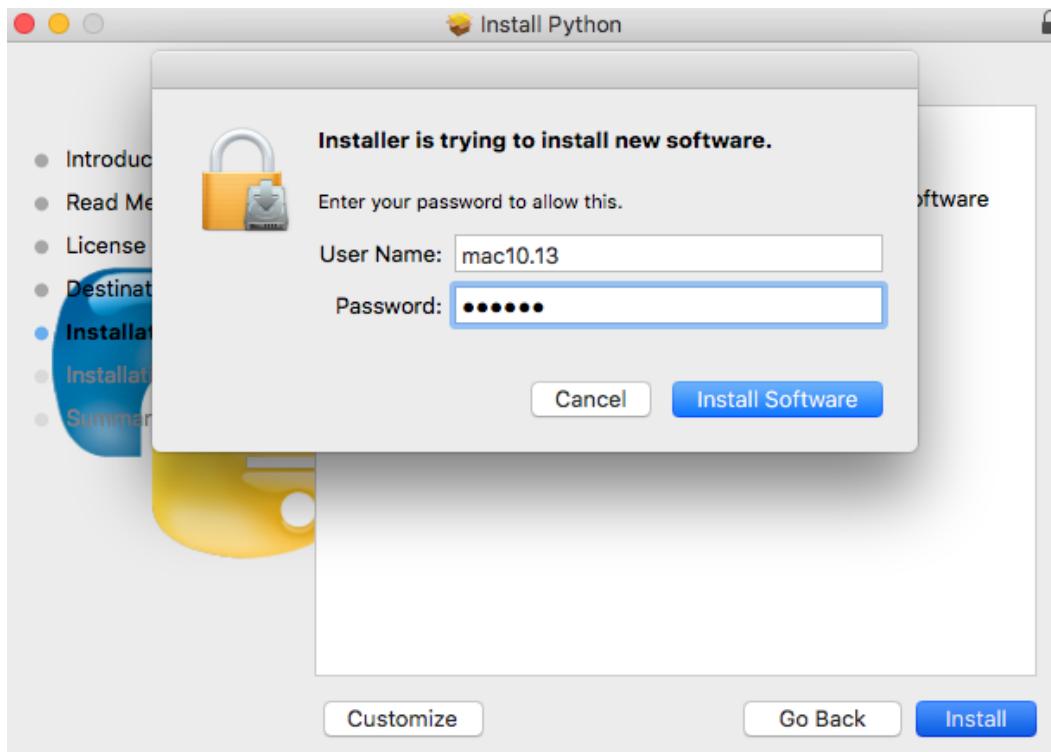
Click Continue.



Click Continue.



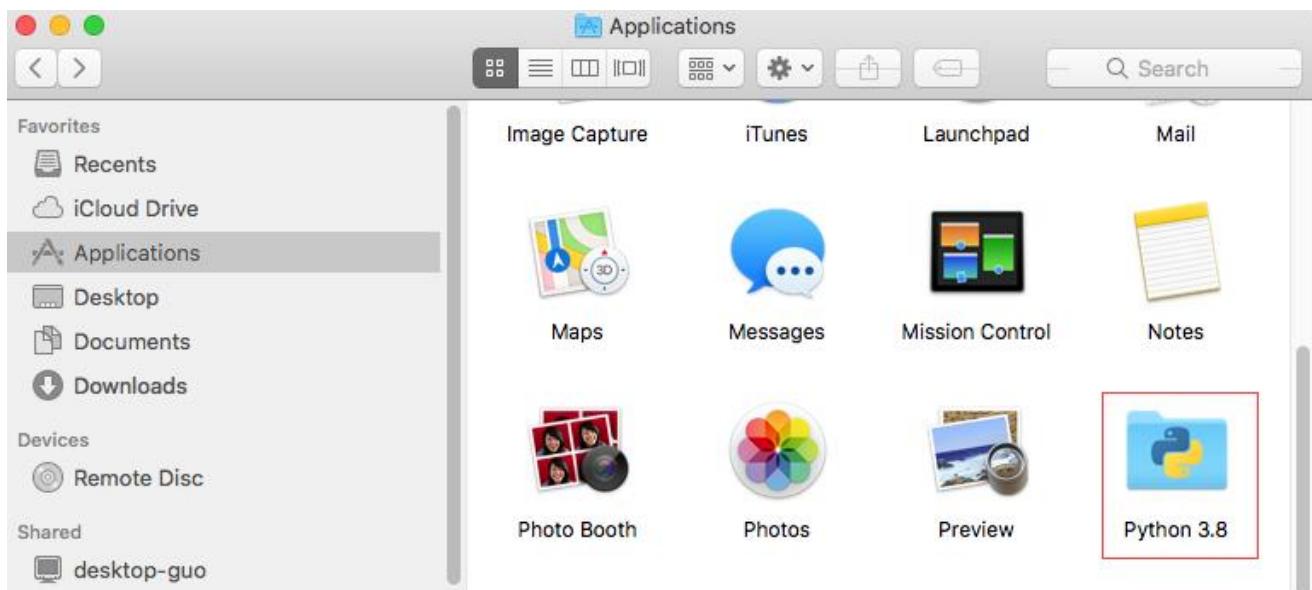
Click Agree.



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



Now the installation is completed successfully.



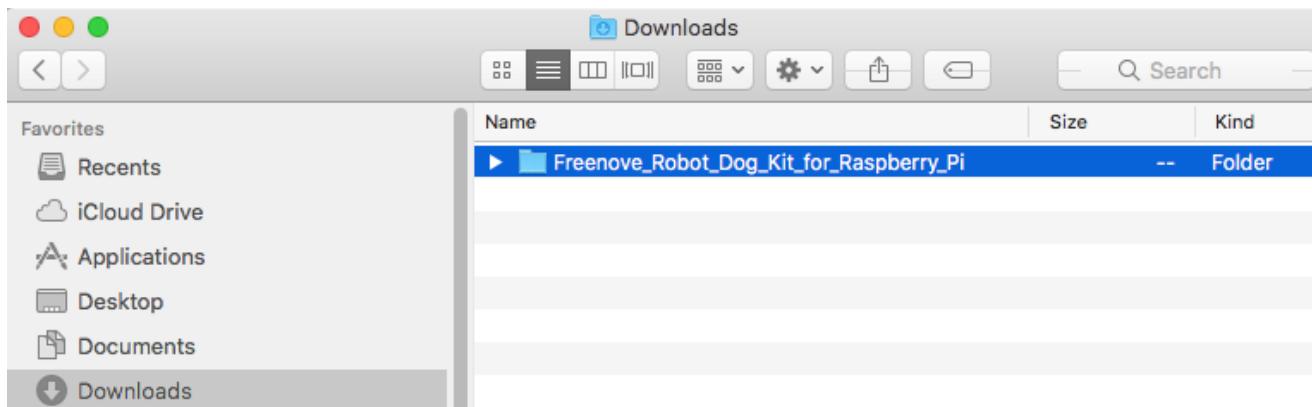
You can find in Applications.

### 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](https://github.com/Freenove/Freenove_Robot_Dog_Kit_for_Raspberry_Pi/archive/master.zip)

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



Open “Terminal”.

Need support? ✉ [support@freenove.com](mailto:support@freenove.com)



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 takes some time, please wait patiently.

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$
```

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 poor network. You can check the network before installing.

If you are using **macOS under 11.0, like 10.15**. Just skip to "Open client".

If you are using **macOS 11.0 or later version**. Please run commands below:

```
pip3 uninstall PyQt5  
pip3 install PyQt5
```

## Open client

After installation is completed in previous step, now it is in the directory that 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
```

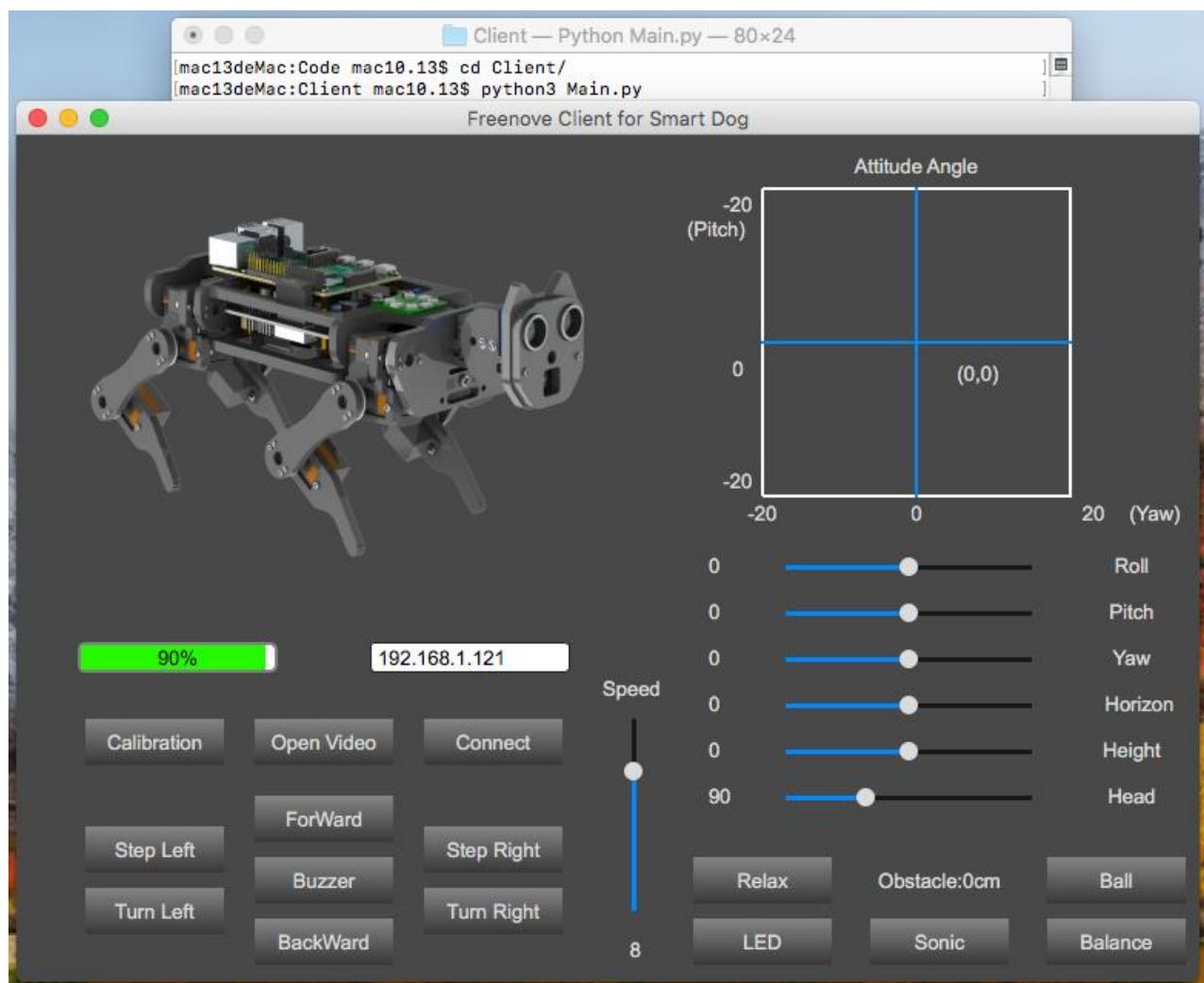
```
All libraries installed successfully
mac13deMac:Code mac10.13$
```

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, 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

### Install openCv library

Execute following 3 commands in turn.

```
sudo apt-get install -y libopencv-dev python3-opencv
```

```
sudo pip3 install opencv-contrib-python
```

```
sudo apt-get install -y libatlas-base-dev libjasper-dev
```

### Open client

Enter the following commands at the terminal.

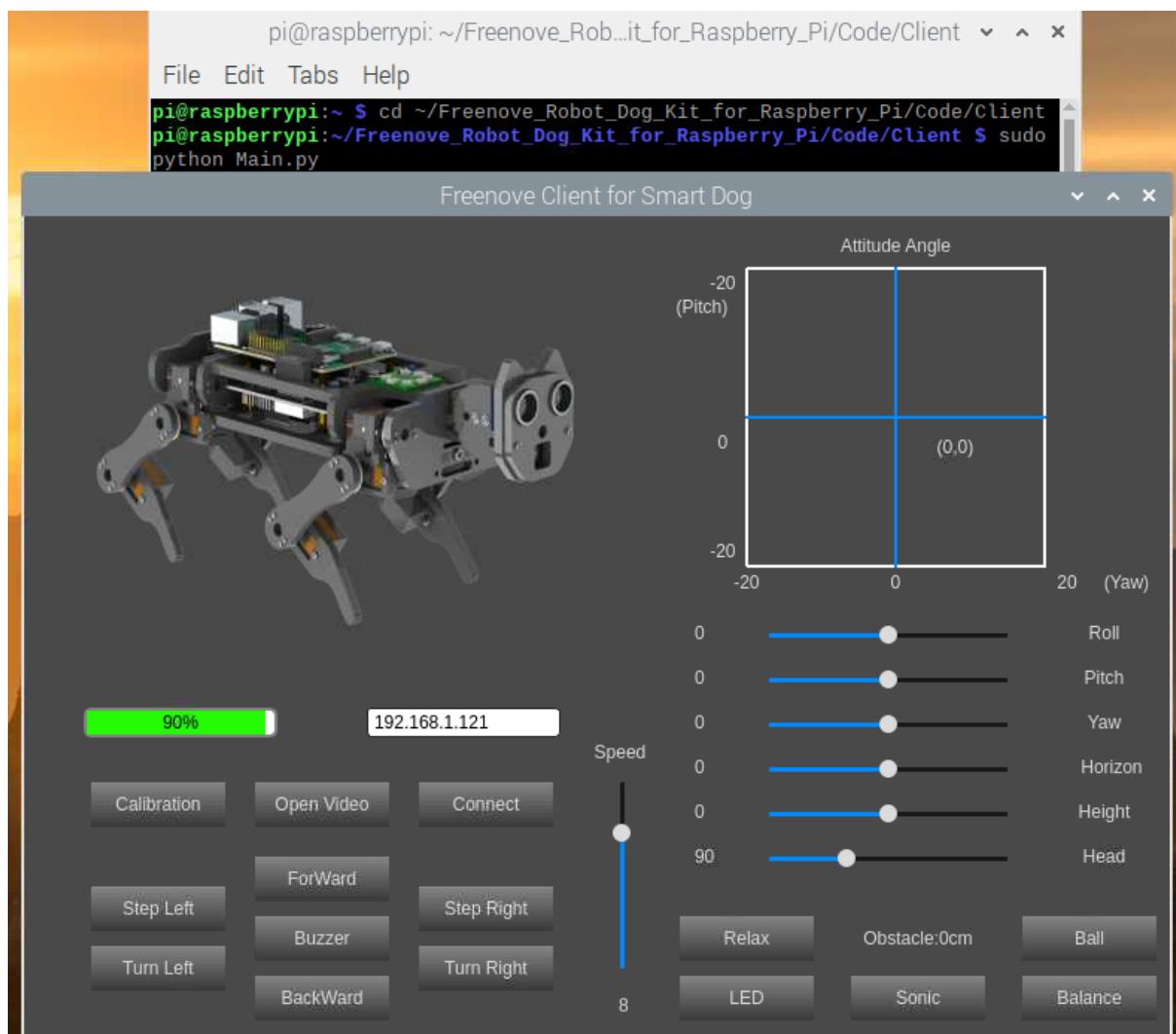
1. Use the cd command to go to the directory where Main.py is located.

```
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 has.



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, the robot dog can be controlled to move.

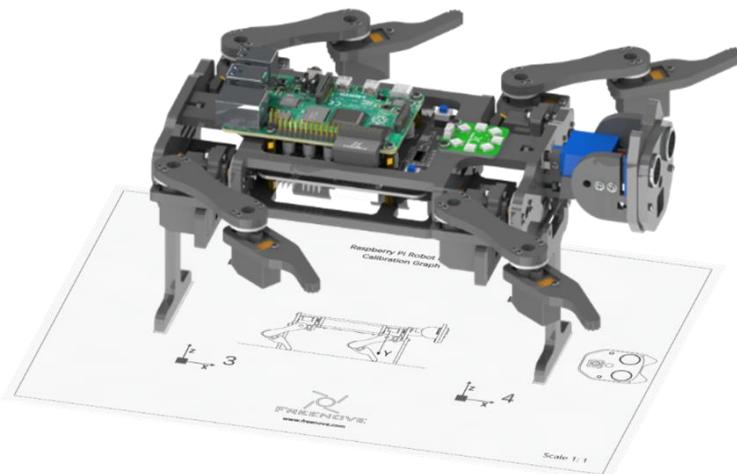
**Note: when Raspberry Pi is shut down, server will be closed. You need open server again the next time.**

## Calibration

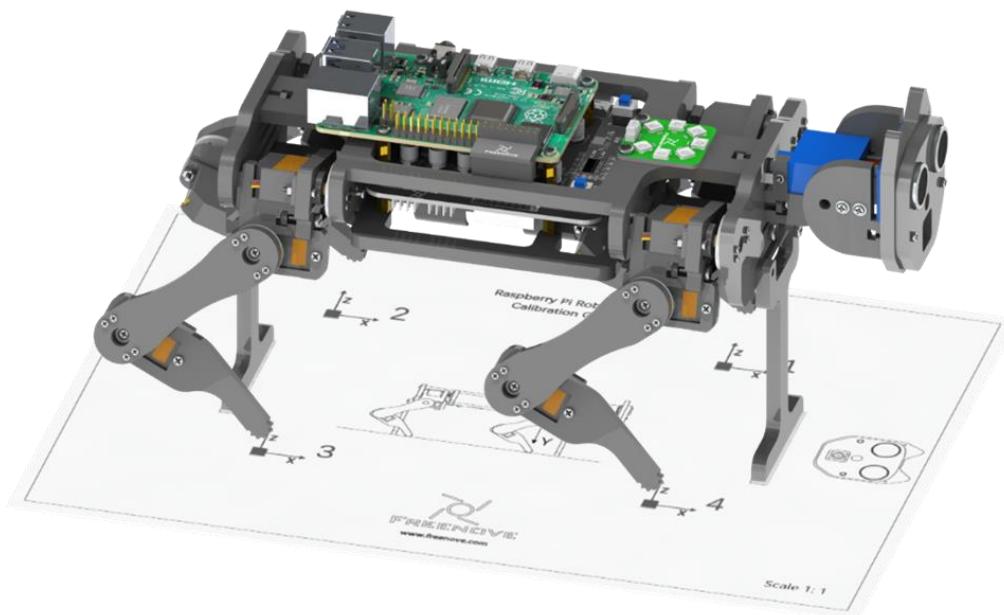
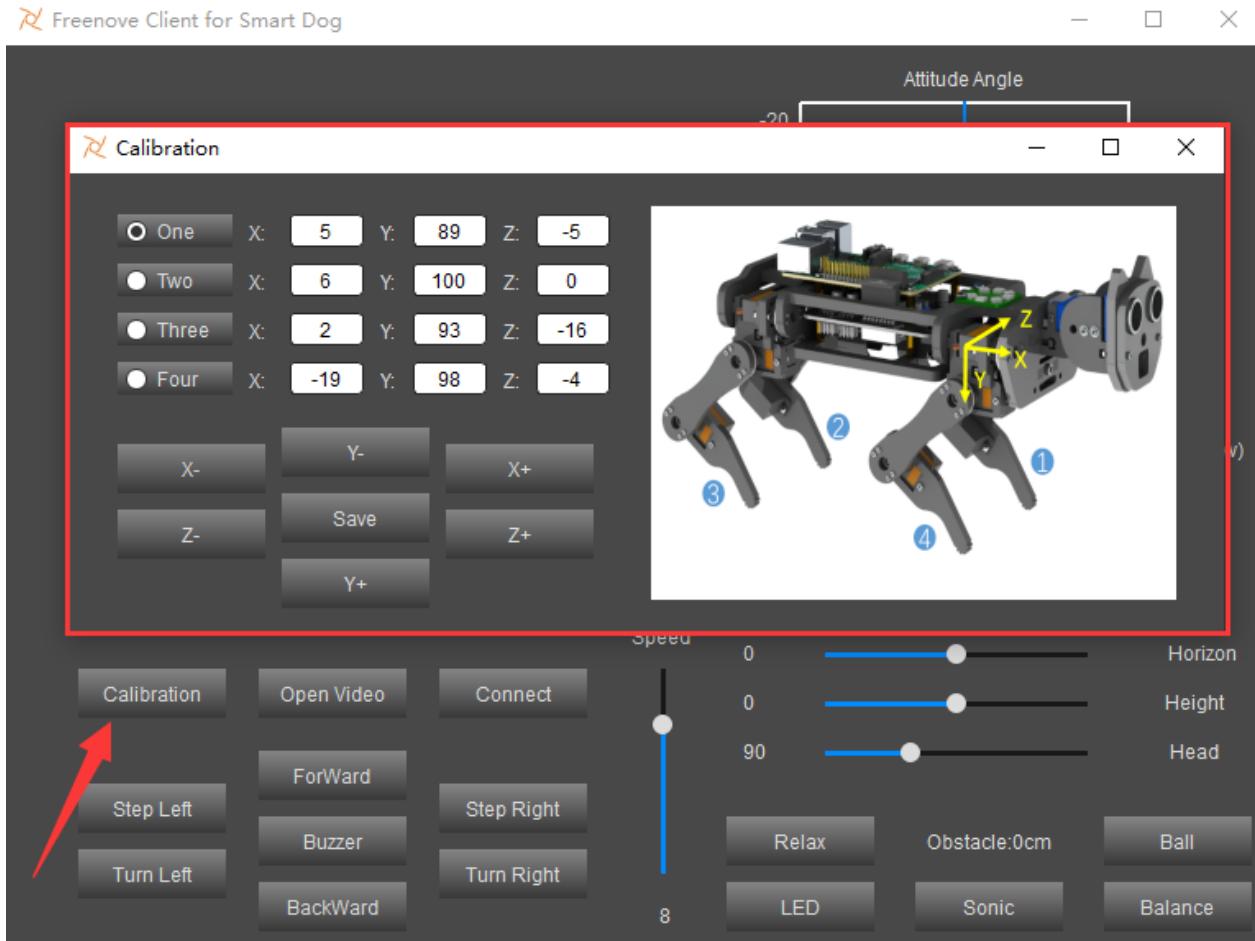
You can refer to this video: <https://youtu.be/l2v9PdwQdvY>

Calibrate the robot.

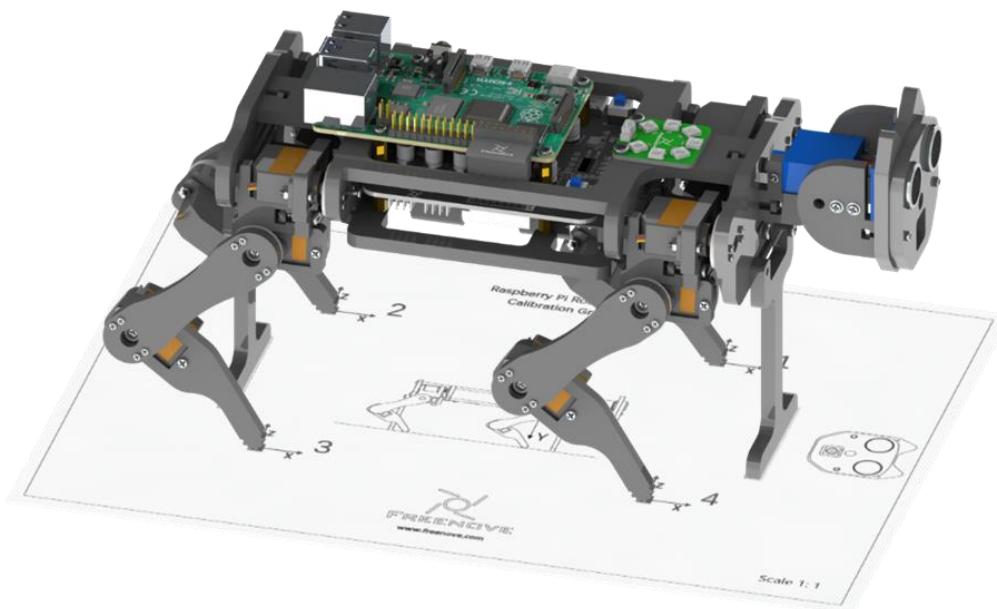
1. Lay the calibration paper on a horizontal hard table.
2. Install the calibration supports on the robot dog and place it on the corresponding position on the calibration paper.



3. Connect client with server successfully, click the "Calibration" button on the client, then a calibration window pops up. And the robot's legs will automatically put to the following position.



- Calibrate the four legs to make 4 foot points fall to the corresponding positions. Feel the contact force between the robot dog and the ground during calibration. Future control depends on this step.



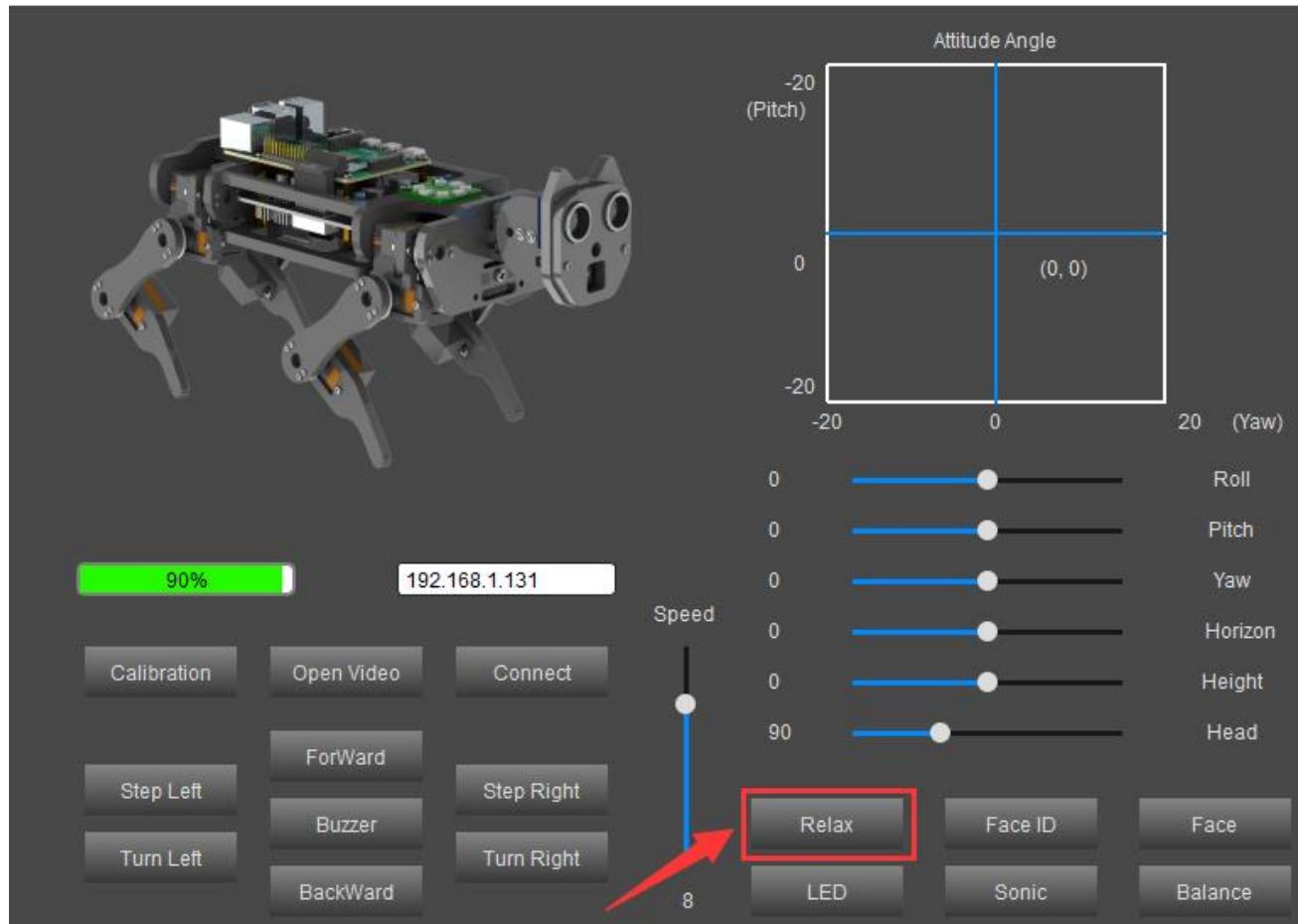
5. After all the 4 points have reached the designated position, click "Save" to save. Now calibration is completed.

**NOTE:**

1. It is best to have the robot dog walk on a **flat hard** floor. The robot dog may not walk well on other grounds.
2. **There is an offset when controlling 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 a 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.

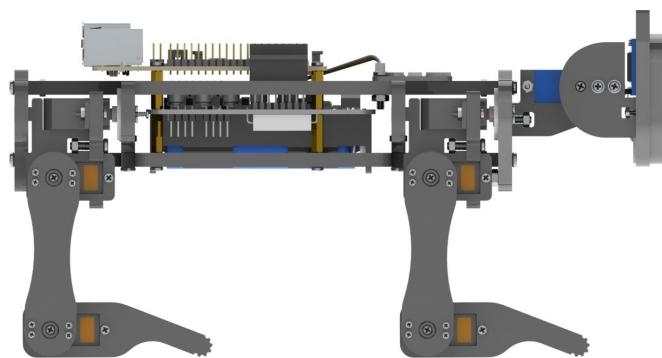
## Control

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

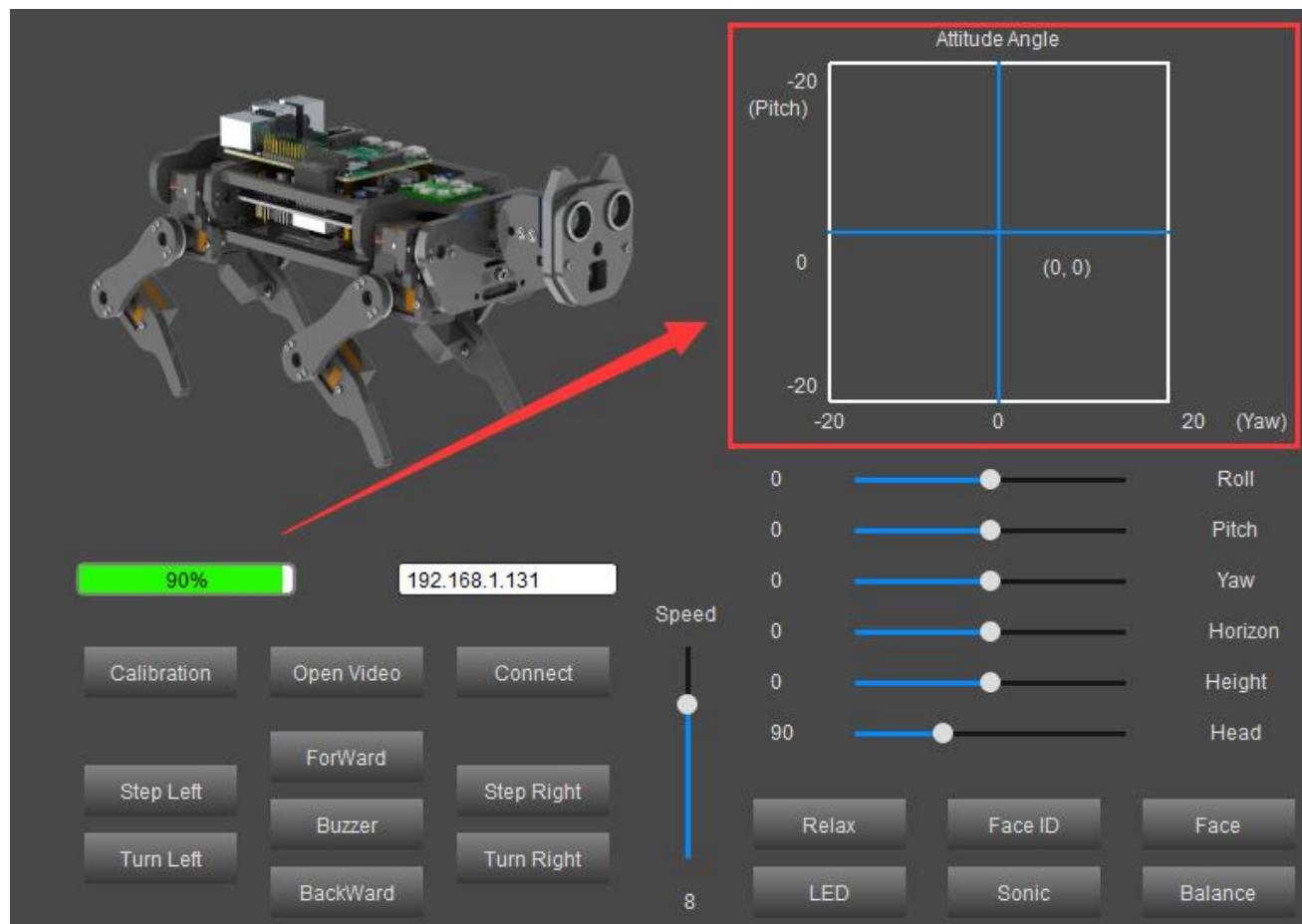


### Relax mode.

- When the robot dog moves for 3 minutes at a time, 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 any motion command.** You can still use the functions of LED, buzzer, real-time video and so on.
- When the robot dog moves for less than 3 minutes and rests 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 does not receive motion command for 10s, it will get into relax mode. In this situation, it will respond to all commands.



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



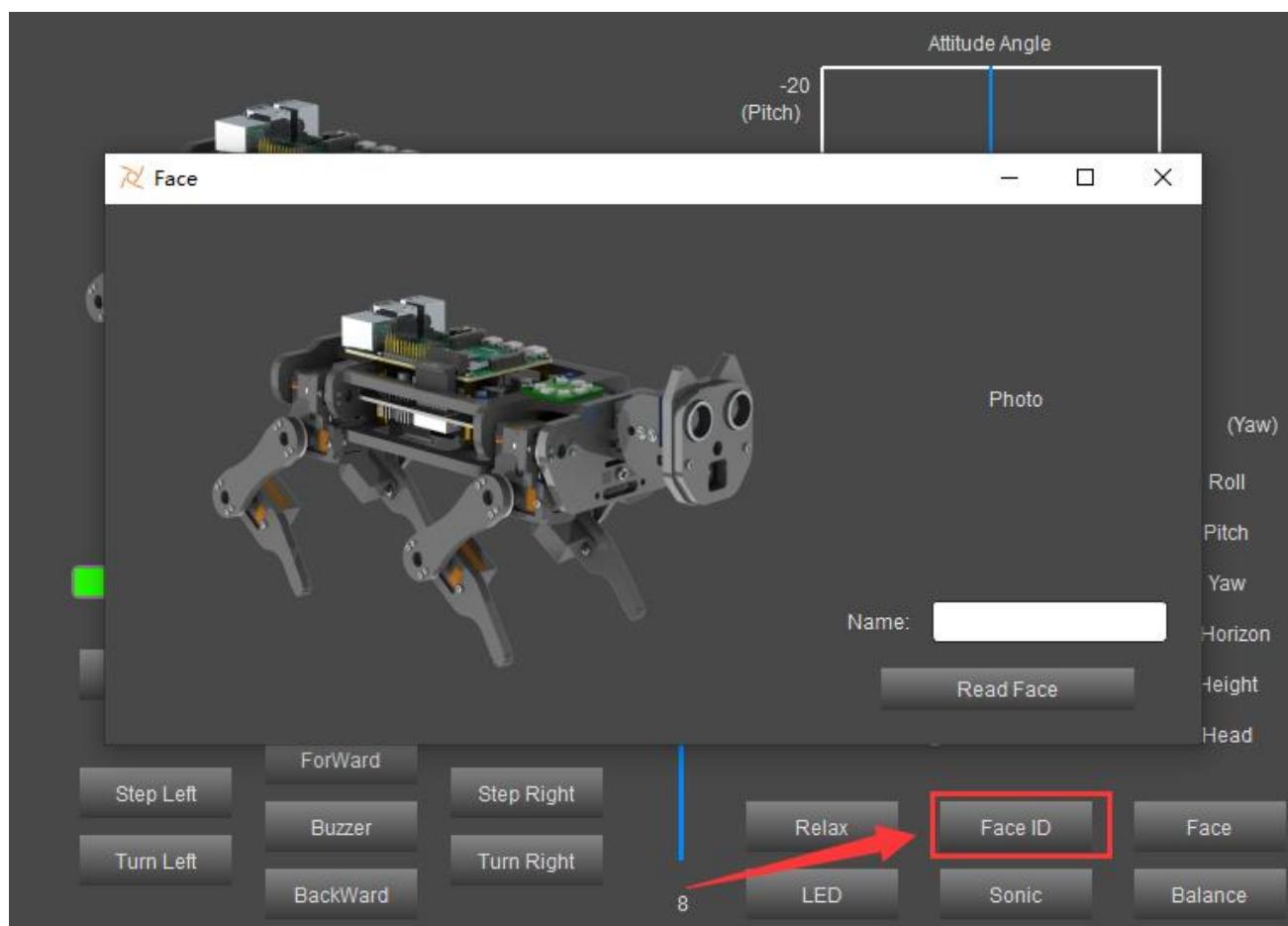
The following is the corresponding operation of the buttons and keyboards.

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

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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](mailto: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](mailto:support@freenove.com)

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

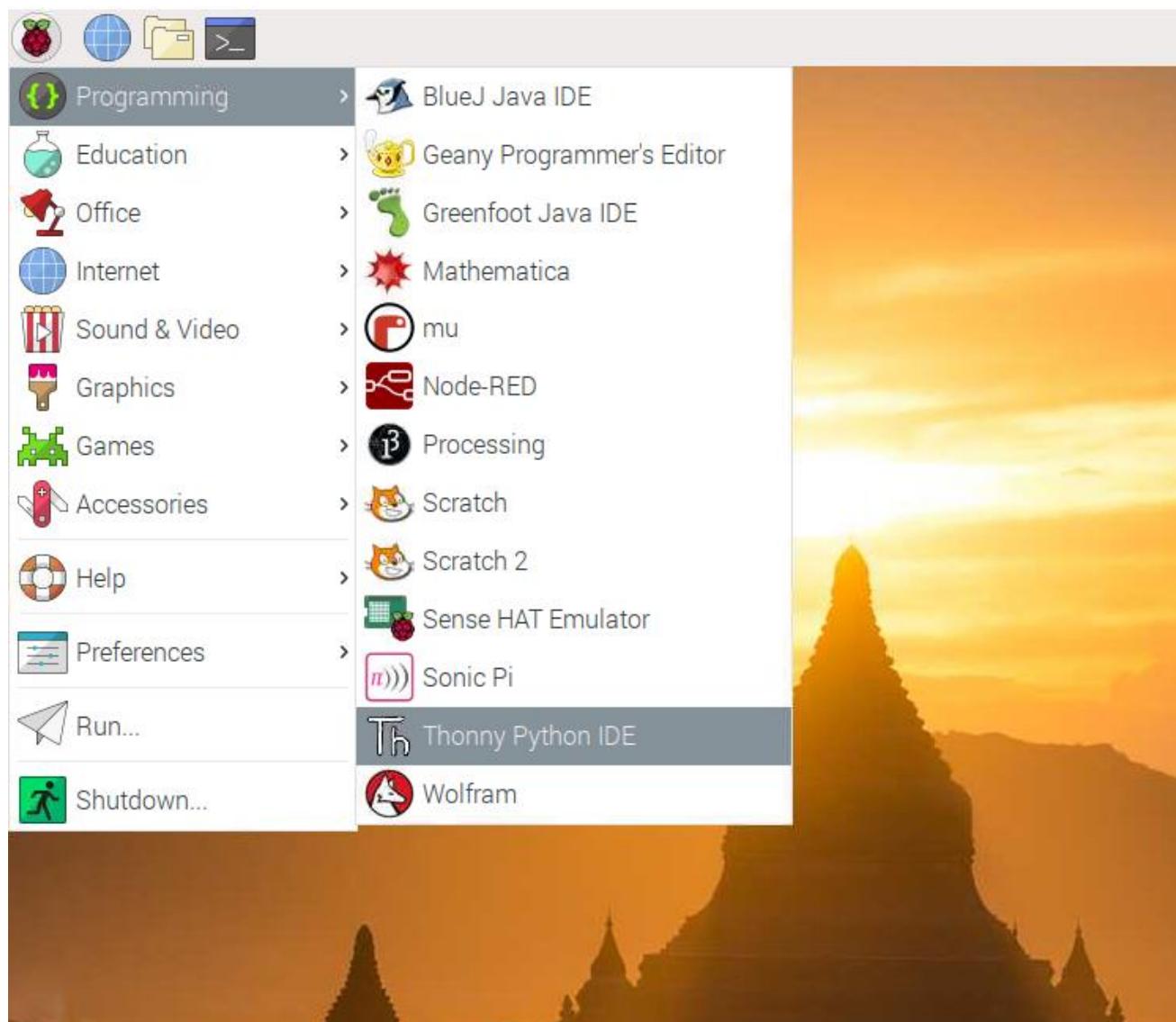
The robot dog program is based on python3. If your python is python2 by default, please change to python3.

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

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

## Program

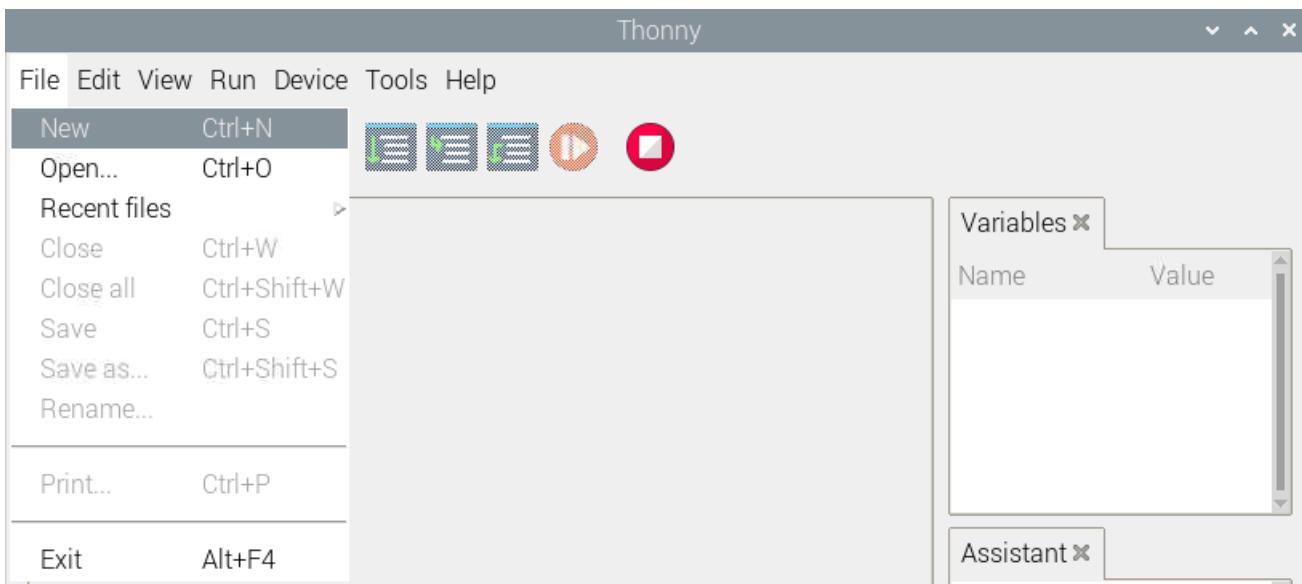
First, open Thonny Python IDE which is easy to use for beginners.



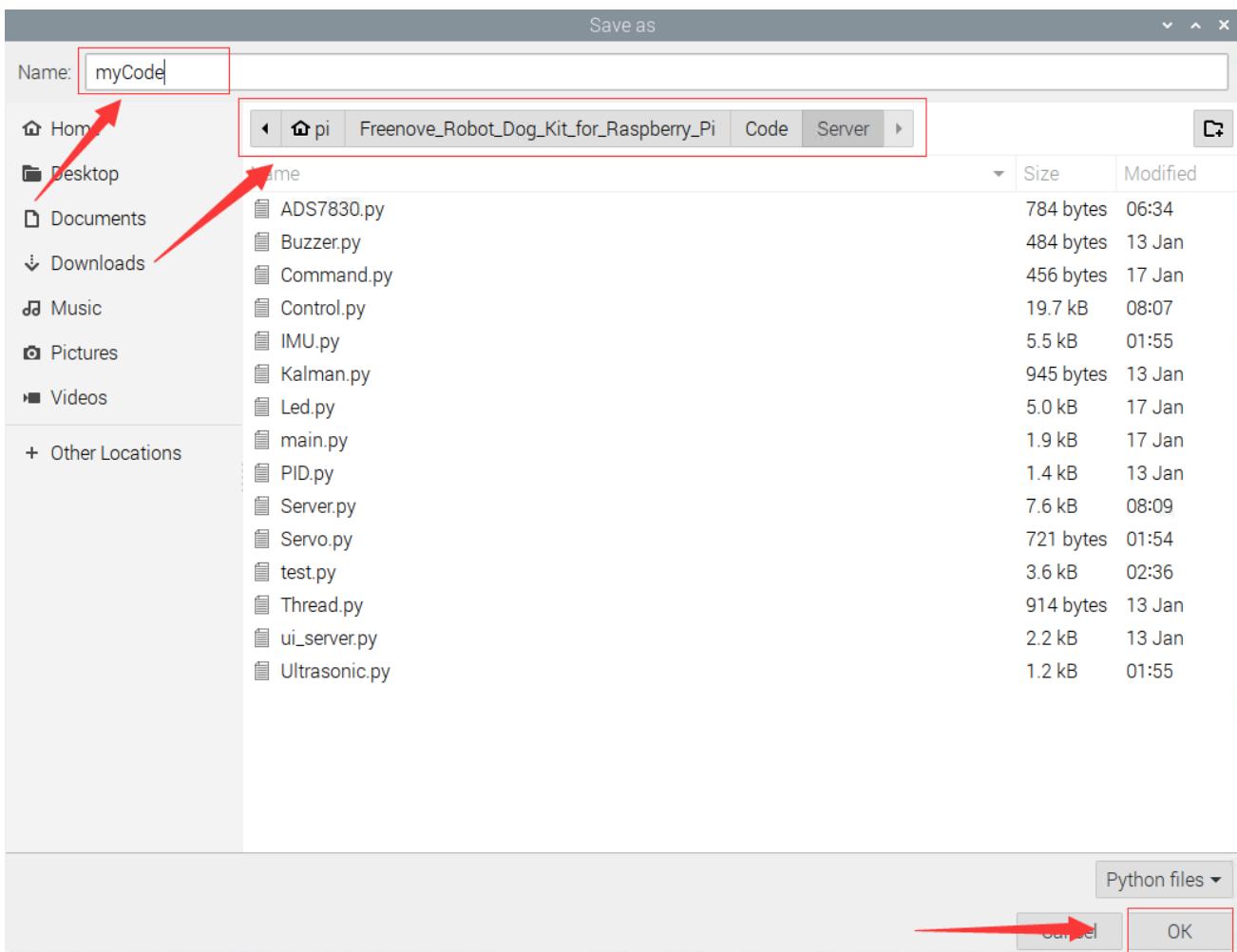
Need support? ✉ [support@freenove.com](mailto:support@freenove.com)



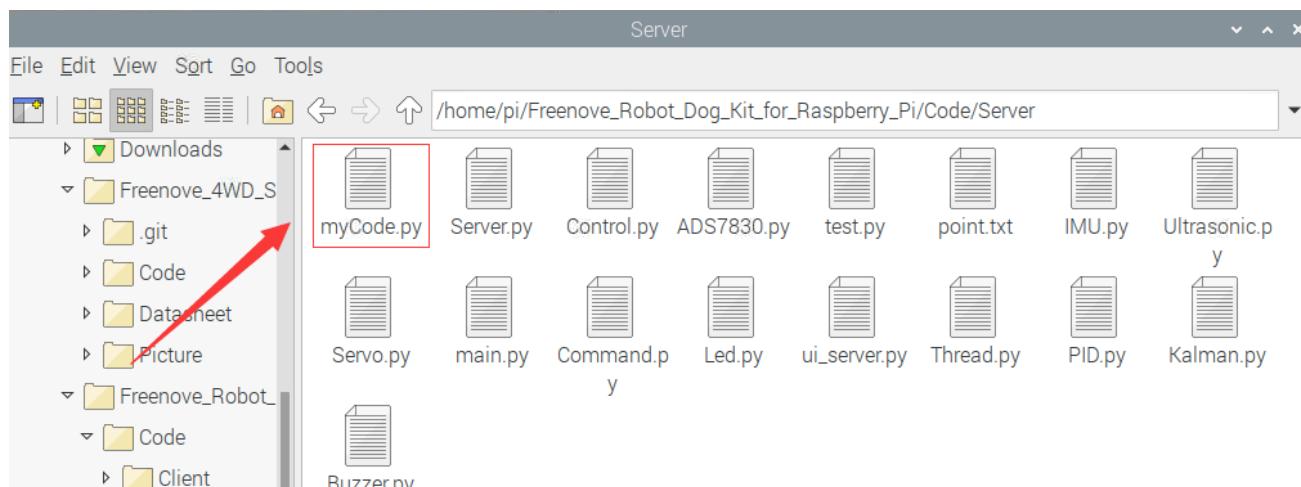
Create a new file.



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



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



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

```

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()

```

The Thonny IDE interface includes a menu bar (File, Edit, View, Run, Device, Tools, Help), a toolbar with icons for new file, open file, save, run, and stop, and a status bar at the bottom indicating 'Python 3.7.3 (/usr/bin/python3)' and '>>>'. A red arrow points to the 'Save' icon in the toolbar.

Need support? ✉ support@freenove.com



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 for 5 steps, then twists its body at 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.
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## 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

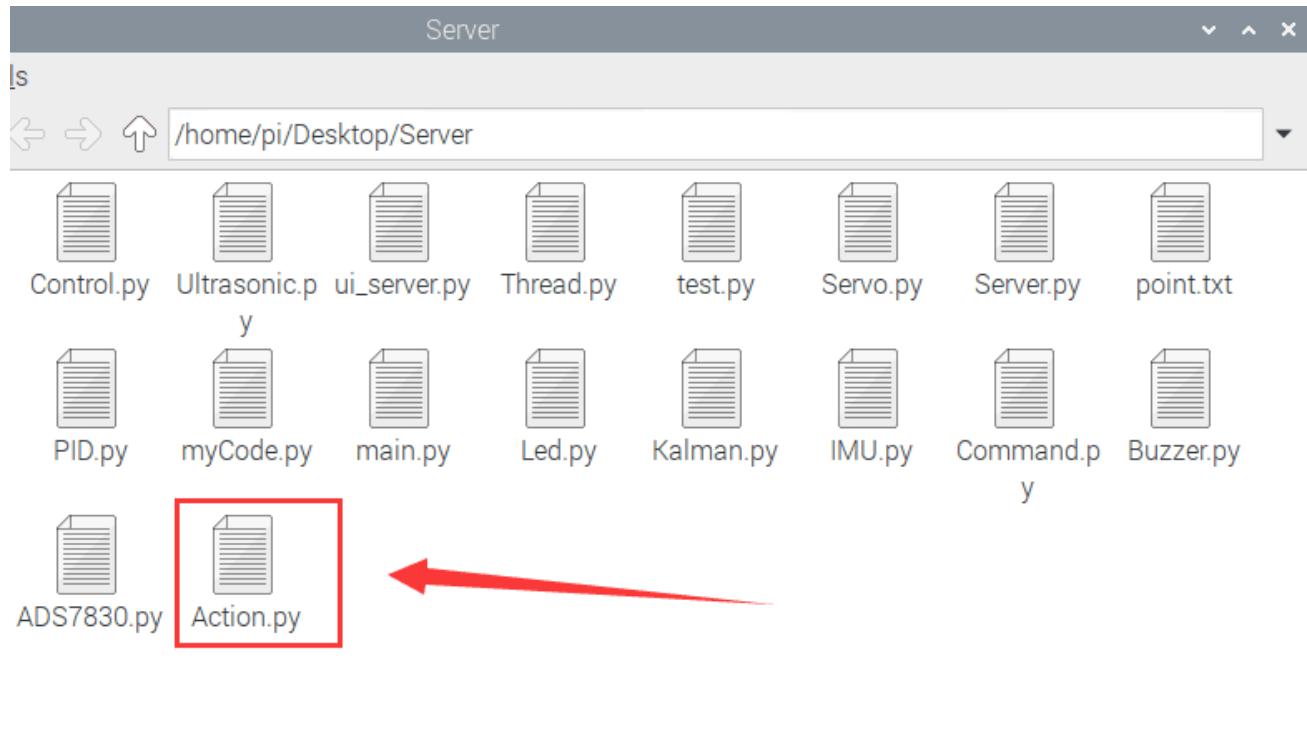
Function	Description
setServoAngle(channel, angle)	Turn the servo of the specified channel to specified angle.

## 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 links:

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](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.



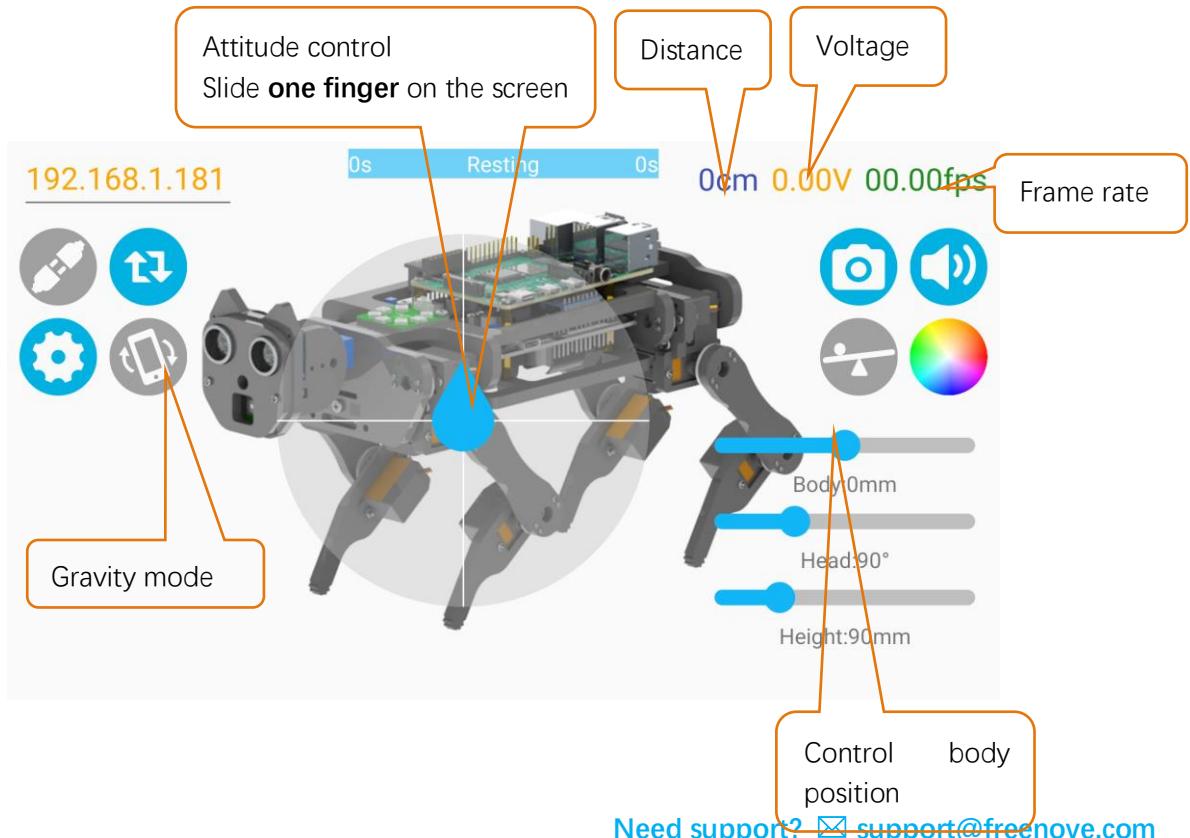
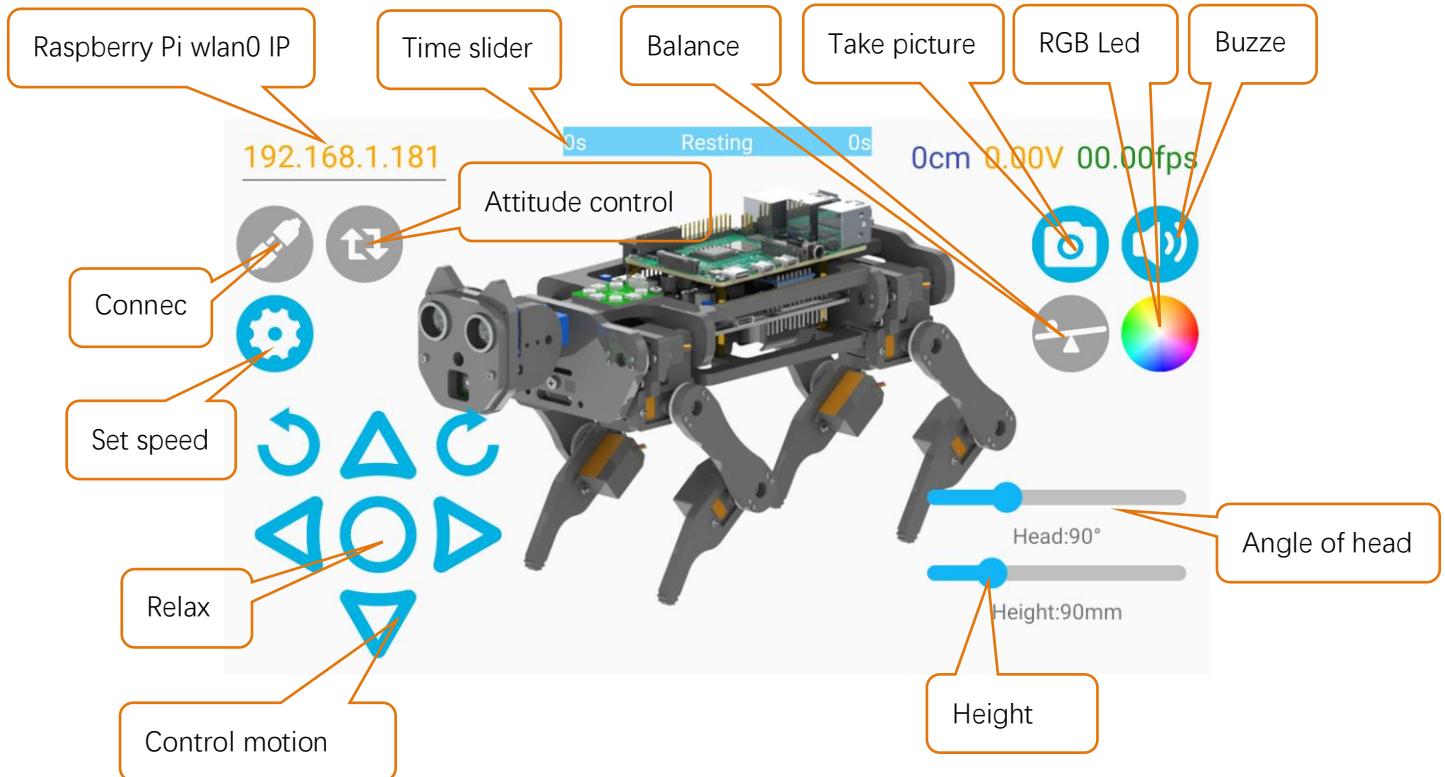
### Relax mode.

- 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 does not receive motion command for 10s, it will get into relax mode. In this situation, it will respond to any commands.

The followings are the features of this app.

First, you need to 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?

THANK YOU for participating in this learning experience!

We have reached the end of this Tutorial. If you find errors, omissions or you have suggestions and/or questions about the Tutorial or component contents of this Kit, please feel free to contact us:  
[support@freenove.com](mailto:support@freenove.com)

We will make every effort to make changes and correct errors as soon as feasibly possible and publish a revised version.

If you want to learn more about Arduino, Raspberry Pi, Smart Cars, Robotics and other interesting products in science and technology, please continue to visit our website. We will continue to launch fun, cost-effective, innovative and exciting products.

<http://www.freenove.com/>

Thank you again for choosing Freenove products.