

# Welcome

Thank you for choosing Freenove products!

## How to Start

When reading this, you should have downloaded the ZIP file for this product.

Unzip it and you will get a folder containing tutorials and related files. Please start with this PDF tutorial.

! Unzip the ZIP file instead of opening the file in the ZIP file directly.

! Do not move, delete or rename files in the folder just unzipped.

## Get Support

Encounter problems? Don't worry! Refer to "TroubleShooting.pdf" or contact us.

When there are packaging damage, quality problems, questions encountering in use, etc., just send us an email. We will reply to you within one working day and provide a solution.

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

## Attention

Pay attention to safety when using and storing this product:

- This product is not suitable for children under 12 years of age because of small parts and sharp parts.
- Minors should use this product under the supervision and guidance of adults.
- This product contains small and sharp parts. Do not swallow, prick and scratch to avoid injury.
- This product contains conductive parts. Do not hold them to touch power supply and other circuits.
- To avoid personal injury, do not touch parts rotating or moving while working.
- The wrong operation may cause overheat. Do not touch and disconnect the power supply immediately.
- Operate in accordance with the requirements of the tutorial. Fail to do so may damage the parts.
- Store this product in a dry and dark environment. Keep away from children.
- Turn off the power of the circuit before leaving.

## About

Freenove provides open source electronic products and services.

Freenove is committed to helping customers learn programming and electronic knowledge, quickly implement product prototypes, realize their creativity and launch innovative products. Our services include:

- Kits for learning programming and electronics
- Kits compatible with Arduino®, Raspberry Pi®, micro:bit®, ESP32®, ESP8266®etc.
- Kits for robots, smart cars, drones, etc.
- Components, modules and tools
- Design and customization

To learn more about us or get our latest information, please visit our website:

<http://www.freenove.com>

## Copyright

All the files provided in the ZIP file are released under [Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License](https://creativecommons.org/licenses/by-nc-sa/3.0/). You can find a copy of the license in the ZIP file.



It means you can use these files on your own derived works, in part or completely. But not for commercial use.

Freenove® brand and logo are trademarks of Freenove Creative Technology Co., Ltd. Must not be used without permission.



Other registered trademarks and their owners appearing in this document:

Arduino® is a trademark of Arduino LLC (<https://www.arduino.cc/>).

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

micro:bit® is a trademark of Micro:bit Educational Foundation (<https://www.microbit.org/>).

ESPRESSIF® and ESP8266® are trademarks of ESPRESSIF Systems (Shanghai) Co., Ltd (<https://www.espressif.com/>).

# Contents

Welcome .....	1
Contents .....	1
Preface .....	1
Processing Software .....	1
Install ControlP5 .....	3
First Use .....	5
Communication protocol (Important).....	7
Chapter 1 Voltmeter.....	9
Project 1.1 Voltmeter .....	9
Project 1.2 Dual-Channel Voltmeter .....	13
Chapter 2 Oscilloscope .....	16
Project 2.1 Oscilloscope.....	16
Chapter 3 Control 2D and 3D Figures.....	20
Project 3.1 Ellipse .....	20
Project 3.2 Box 3D .....	23
Chapter 4 Snake Game .....	25
Project 4.1 Snake Game.....	25
Project 4.2 Snake Game 3D .....	29
Chapter 5 Pick Apples.....	31
Project 5.1 Pick Apples .....	31
Chapter 6 Pong Game.....	36
Project 6.1 Pong Game .....	36
Project 6.2 Pong Game 3D .....	40
Chapter 7 Tetris .....	42
Project 7.1 Tetris.....	42
What's next?.....	46



# Preface

Processing is an easy-to-use, free and open source software for writing graphical programs to run on a computer.

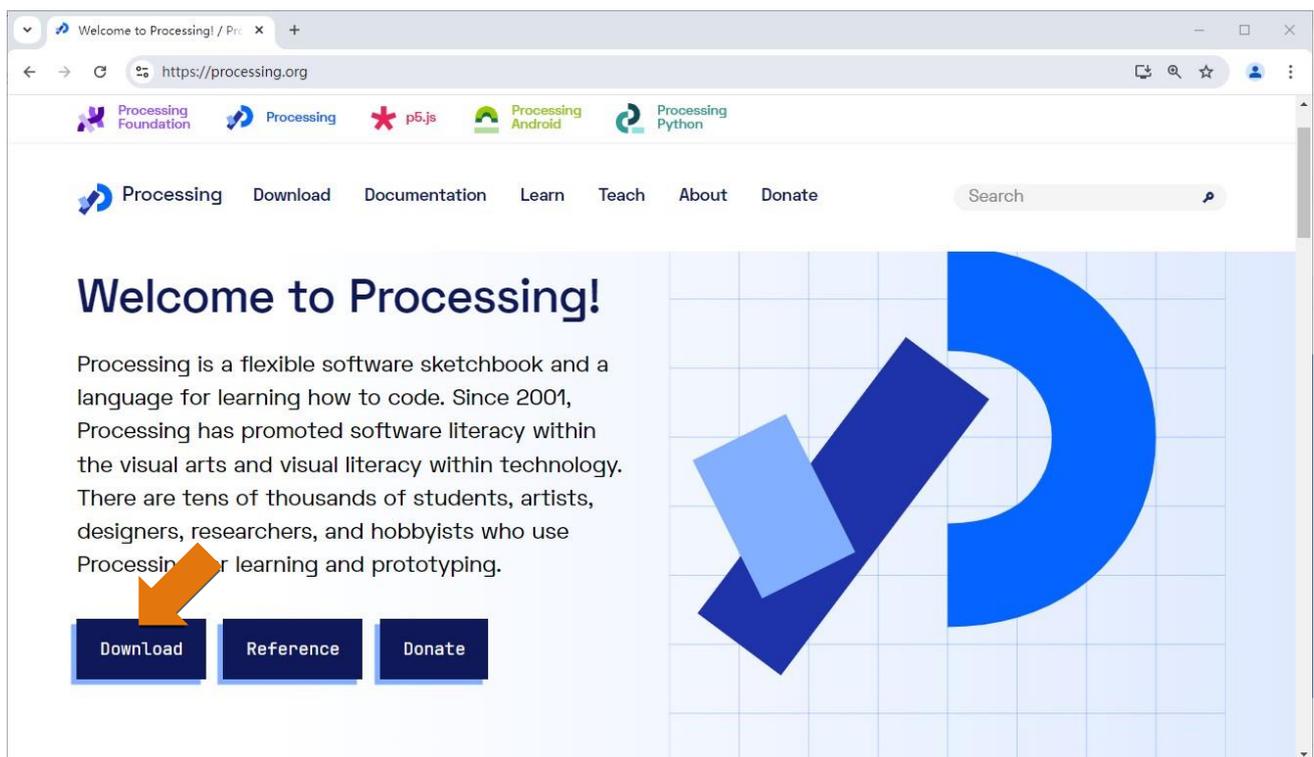
This document will show you how to use Processing to write programs to communicate with the control board. By doing this, we can make virtual instruments, game consoles and other projects.

## Processing Software

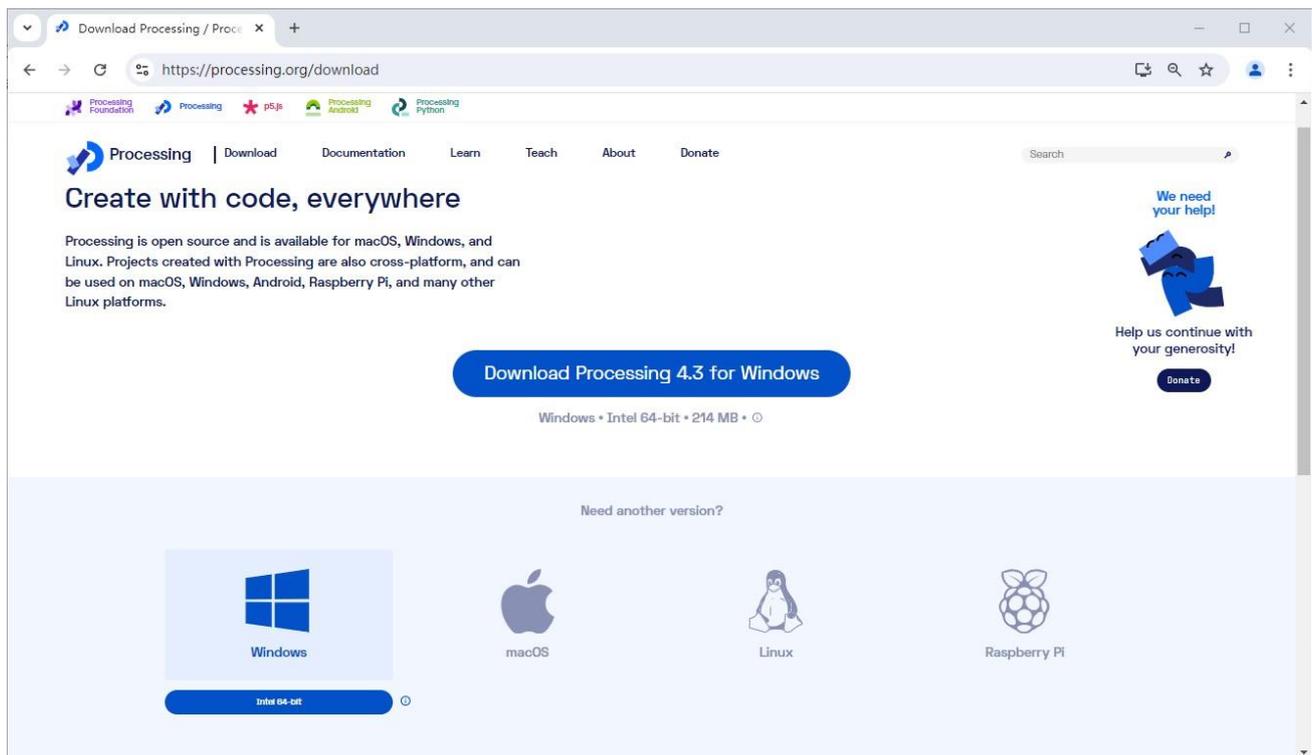
Processing software / Processing Development Environment (PDE) makes it easy to write programs.

Processing software uses Java programming language by default. Do not worry if you don't know Java, because we provide complete code. You can learn Java later if you are interested in it.

First, install Processing software. Visit <https://processing.org/>, click "Download" to enter the download page.



Select the Mac, Windows, or Linux version, depending on what machine you have.



Installation on each machine is straightforward:

- On Windows, you'll have a .zip file. Double-click it, and drag the folder inside to a location on your hard disk. It could be Program Files or simply the desktop, but the important thing is for the processing folder to be pulled out of that .zip file. Then double-click processing.exe to start.
- The Mac OS X version is also a .zip file. Double-click it and drag the Processing icon to the Applications folder. If you're using someone else's machine and can't modify the Applications folder, just drag the application to the desktop. Then double-click the Processing icon to start.
- The Linux version is a .tar.gz file, which should be familiar to most Linux users. Download the file to your home directory, then open a terminal window, and type:

```
tar xvfz processing-xxxx.tgz
```

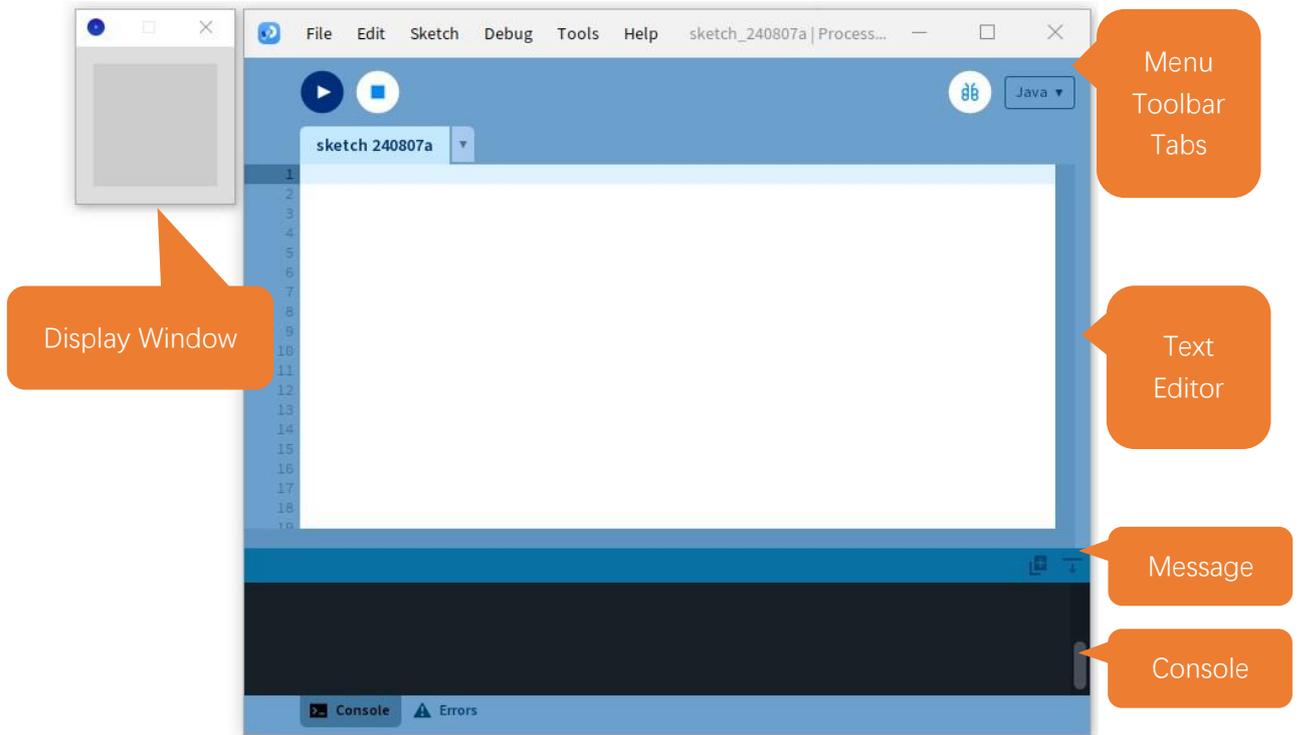
(Replace xxxx with the rest of the file's name, which is the version number.) This will create a folder named processing-2.0 or something similar. Then change to that directory:

```
cd processing-xxxx
```

and run it:

```
./processing
```

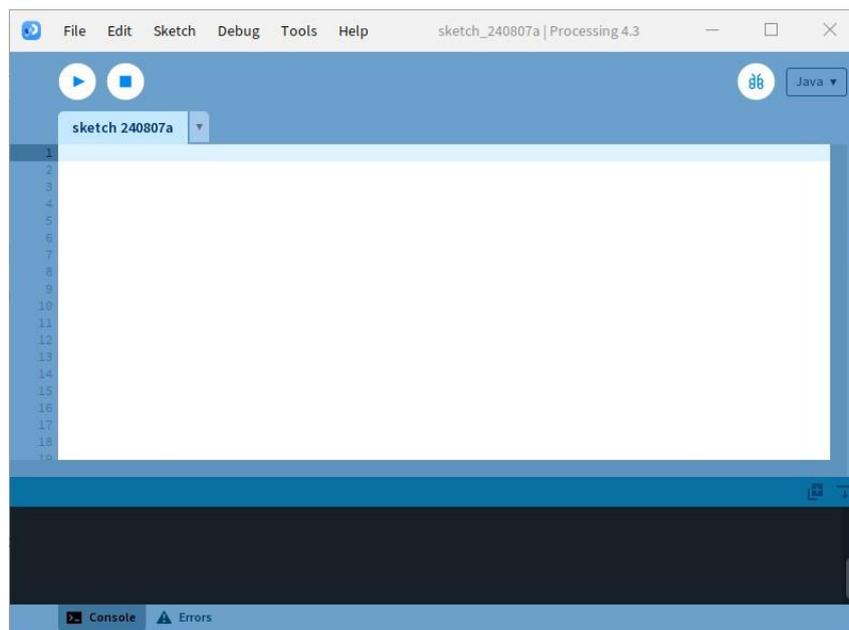
With any luck, the main Processing window will now be visible. Everyone's setup is different, so if the program didn't start, or you're otherwise stuck, visit the [troubleshooting page](#) for possible solutions.



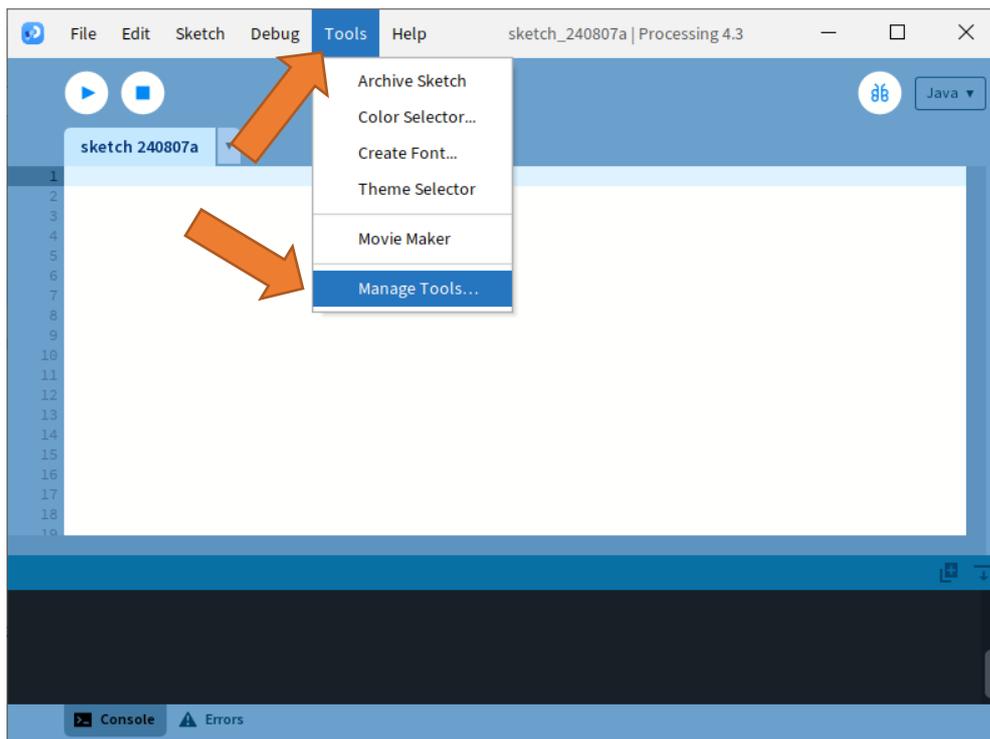
You're now running the Processing Development Environment (or PDE). There's not much to it; the large area is the Text Editor, and there's a row of buttons across the top; this is the toolbar. Below the editor is the Message Area, and below that is the Console. The Message Area is used for one line messages, and the Console is used for more technical details.

## Install ControlP5

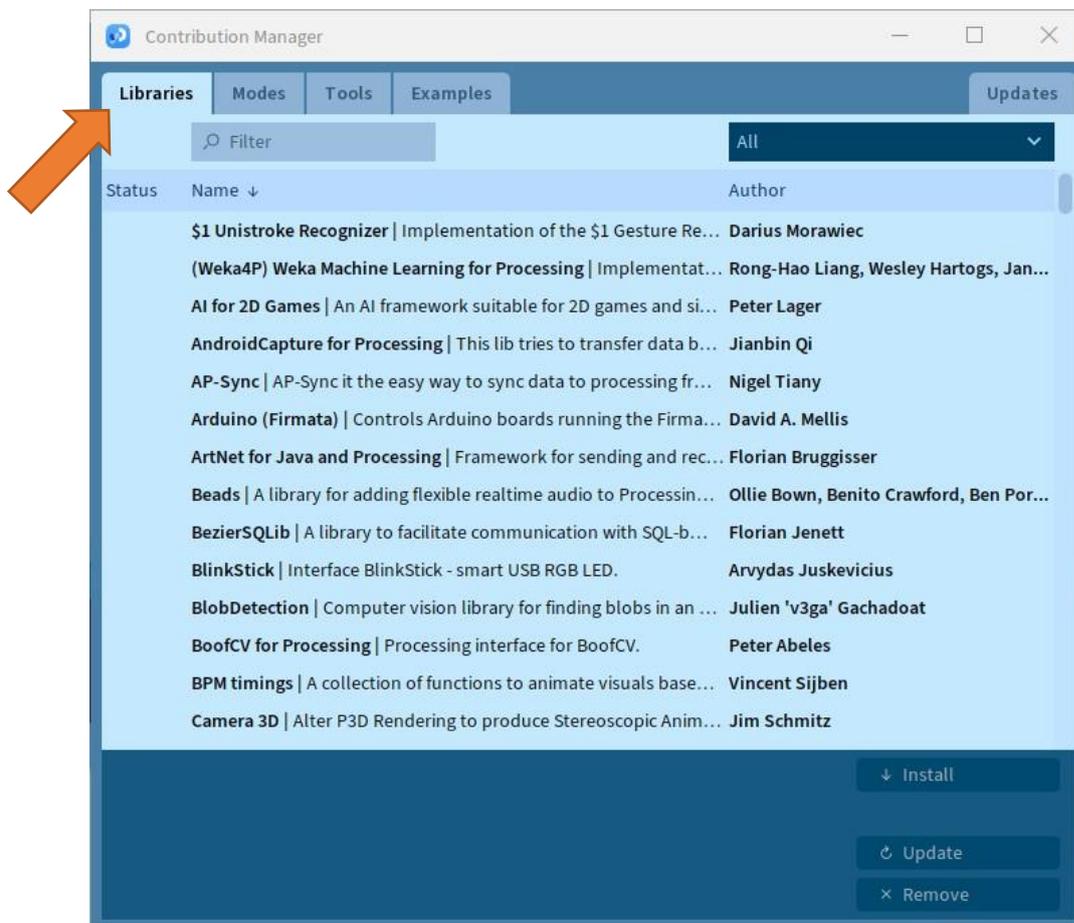
Open Processing.



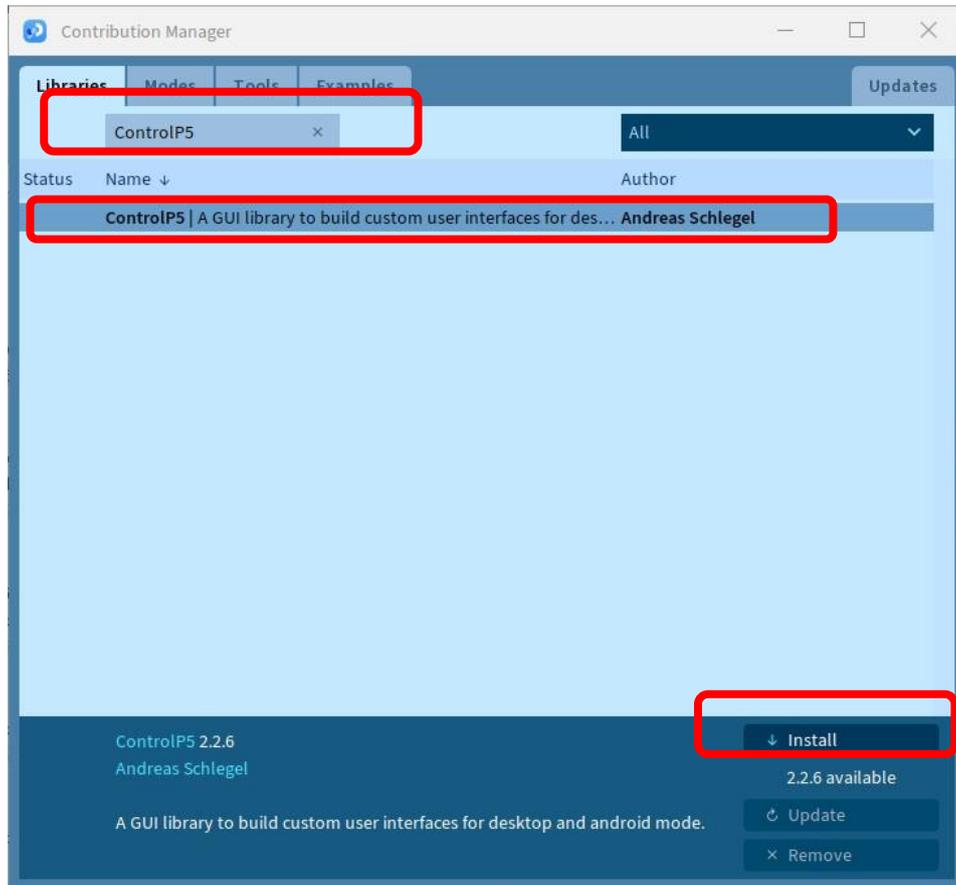
Click Manage Tools under Tools.



Select Libraries in the pop-up window.



Input "ControlP5" in the searching box, and then select the option as below. Click "Install" and wait for the installation to finish.

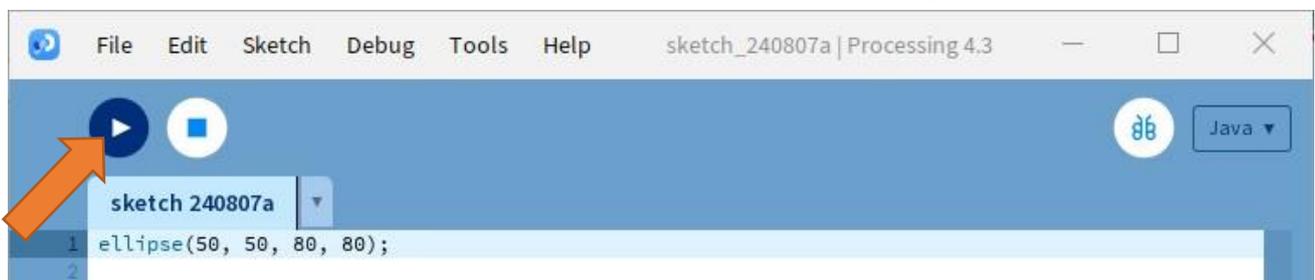


## First Use

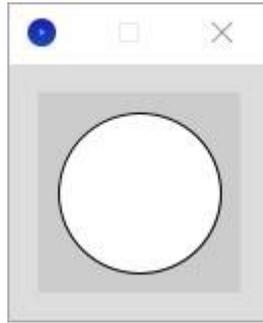
In the editor, type the following:

```
1 ellipse(50, 50, 80, 80);
```

This line of code means "draw an ellipse, with the center 50 pixels over from the left and 50 pixels down from the top, with a width and height of 80 pixels." Click the Run button (the triangle button in the Toolbar).



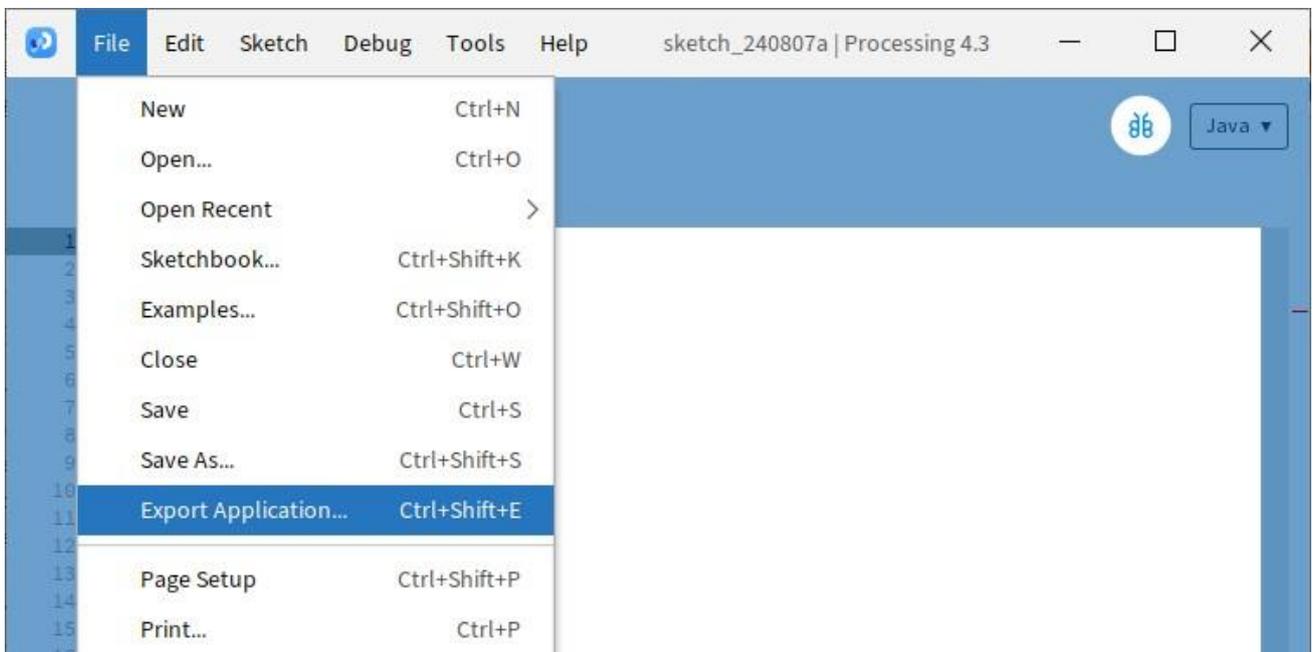
If you've typed everything correctly, you'll see a circle on your screen.



If you didn't type it correctly, the Message Area will turn red and complain about an error. If this happens, make sure that you've copied the example code exactly: the numbers should be contained within parentheses and have commas between each of them, and the line should end with a semicolon.



You can export this sketch to an application to run it directly without opening the Processing. To export the sketch to the application, you must first save it.



So far, we have completed the first use. I believe you have felt the joy of it.

## Communication protocol (Important)

We need to write code for control board and Processing respectively to complete the interaction project of them.

In order to simplify the operation, we have prepared a SerialDevice class for Processing to communicate with the control board. To use this class, we need to upload the following sketch to the control board:

### **Processing\ControlBoard\SerialDevice\SerialDevice.ino.**

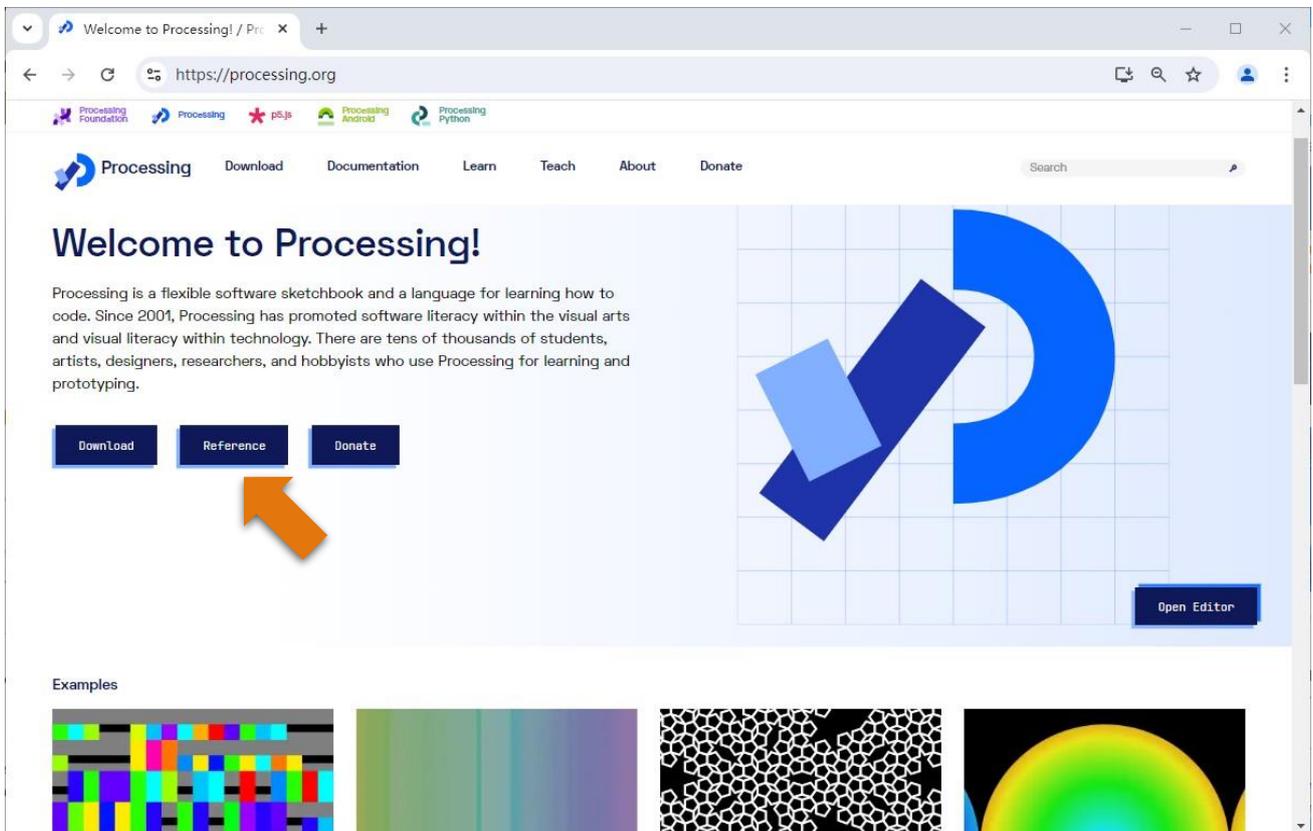
This sketch only need to be uploaded once and it will be available for the following projects in this tutorial. So the latter projects of this tutorial do not need to upload this code again.

SerialDevice class and SerialDevice.ino define the communication protocol between them. The features include:

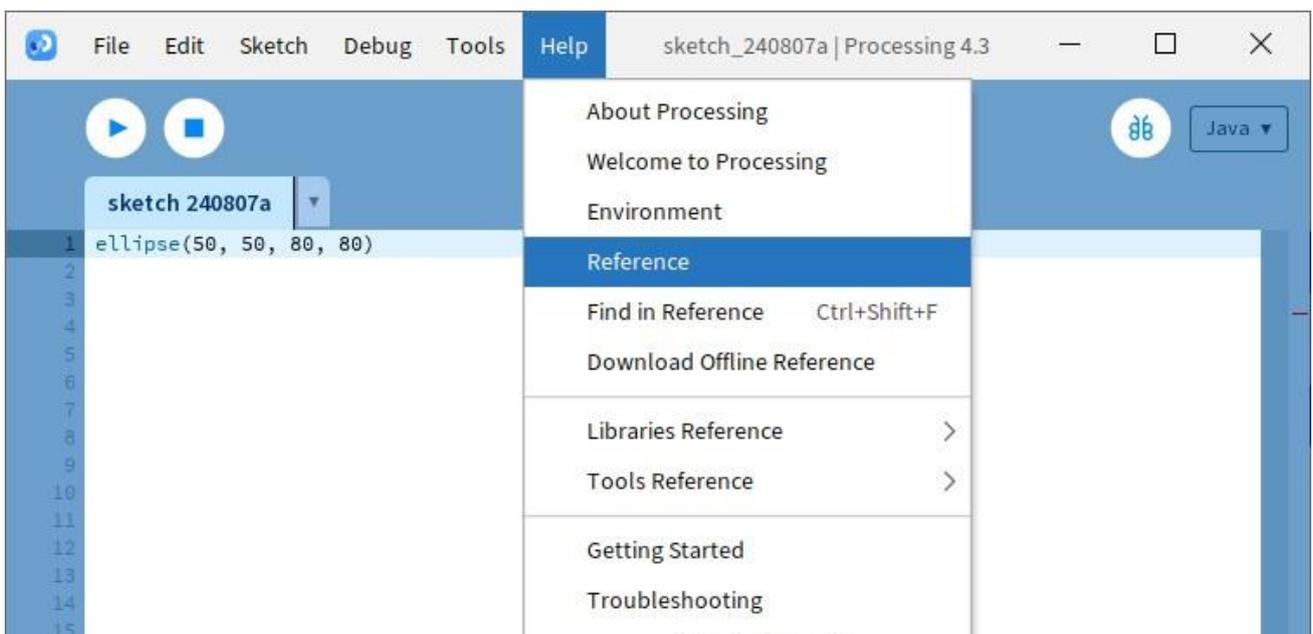
- Recognize the SerialDevice.ino uploaded by the control board and establish connection with it automatically. No need to view and set the serial number of the control board connected to the computer, even if there are a number of control boards. It can be connected automatically.
- If SerialDevice.ino uploaded by the control board is not connected to computer, the Processing code will not be executed until the connection is done. The Processing sketch does not need to be run again after the connection is done.
- Send data to control board and receive data from it.

Here, Processing sketch code will not be introduced in detail. Interested readers can learn it by yourself.

And as for syntax and standard functions of Processing, you can visit <https://processing.org/> and click Reference to view.



Or in the Processing software menu bar, click Help-Reference to view offline documents.



# Chapter 1 Voltmeter

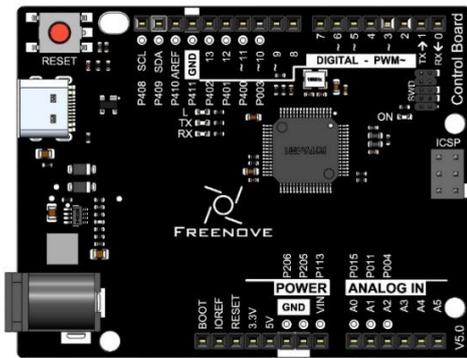
In this chapter, we will use a control board and Processing to make a simple voltmeter to understand the mutual communication between them.

## Project 1.1 Voltmeter

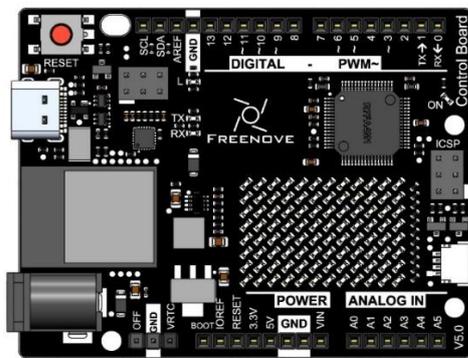
First, make a simple voltmeter.

### Component list

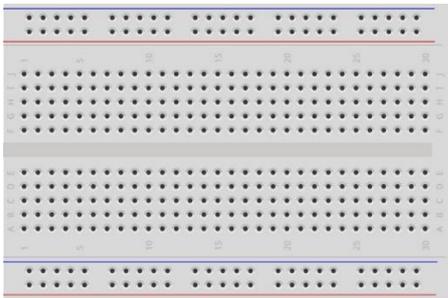
Control board x1



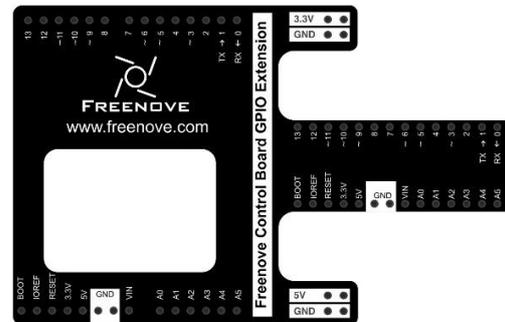
or

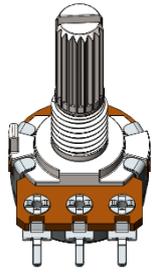


Breadboard x1



GPIO Extension Board x1

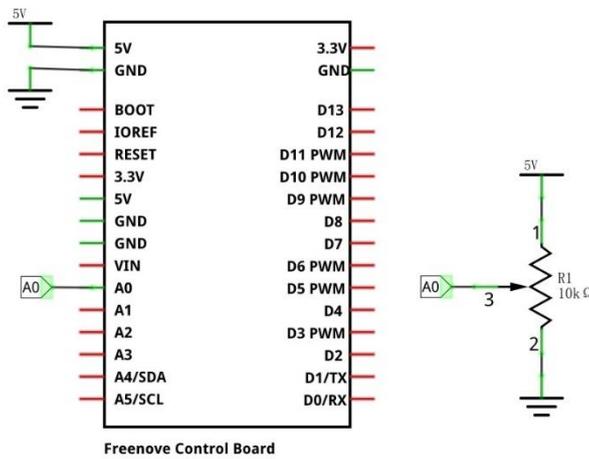


<p>USB cable x1</p> 	<p>Rotary potentiometer x2</p> 
<p>Jumper M/M x3</p> 	

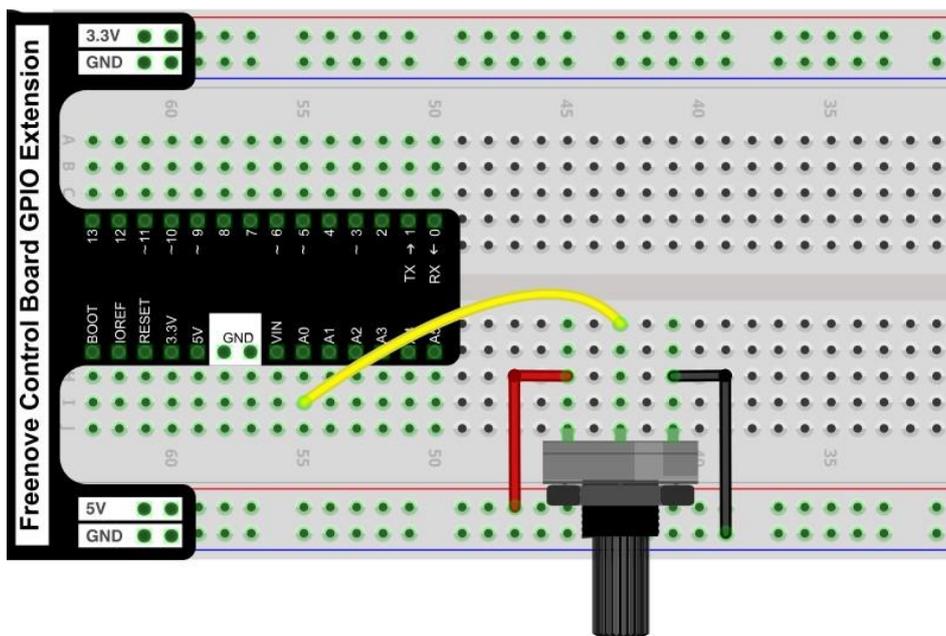
## Circuit

Use A0 port to detect the voltage of rotary potentiometer.

Schematic diagram



Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



## Sketch

Before running Processing sketch, make sure that SerialDevice.ino is uploaded to the control board. Processing sketches is stored under the Processing\Processing folder.

### Sketch Voltmeter

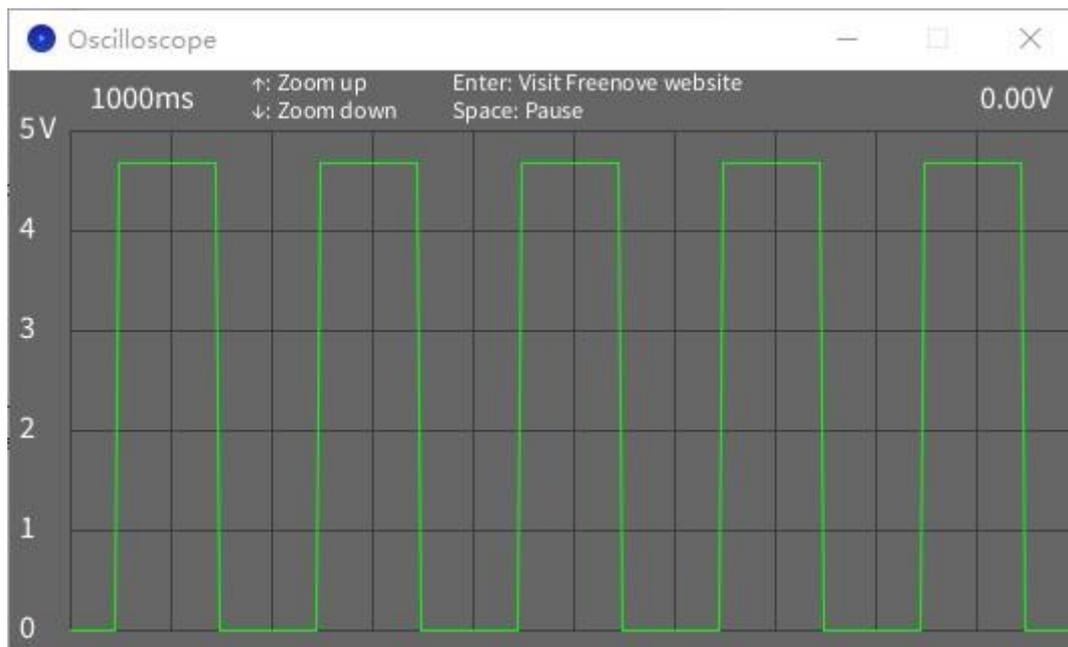
Use Processing to open `.\Processing\Processing\Voltmeter\Voltmeter.pde` and click Run. Then, the following window will pop up and its connection to the control board will be started.



If the control board has not been connected to computer, please connect the control board to your computer. If the connection succeeds, the following will be shown:



This sketch will obtain analog value from A0 port of control board, and convert it to voltage value to display. You can adjust the potentiometer to observe the change of value, and you can also use the A0 port to measure voltage value of other circuits. Note that the measurement voltage cannot exceed 5V, otherwise it will cause damage to the control board.



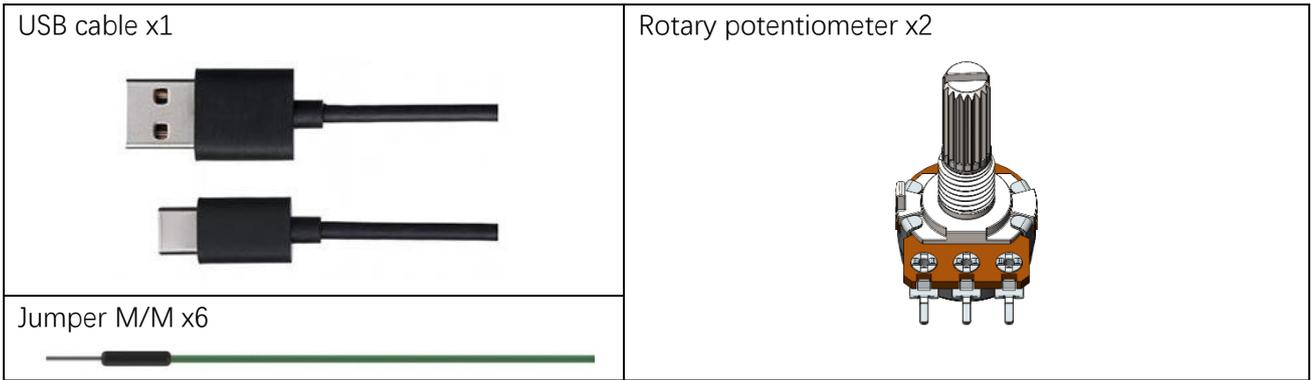
The left side of the software interface is a voltage scale, which is used to indicate the voltage of the waveform. The "1000ms" on top left corner is the time of a square, and you can press "↑" and "↓" key on keyboard to adjust it.

The "0.00V" on top right corner is the voltage value of current signal.

You can press the space bar on keyboard to pause the display waveform, which is easy to view and analysis.

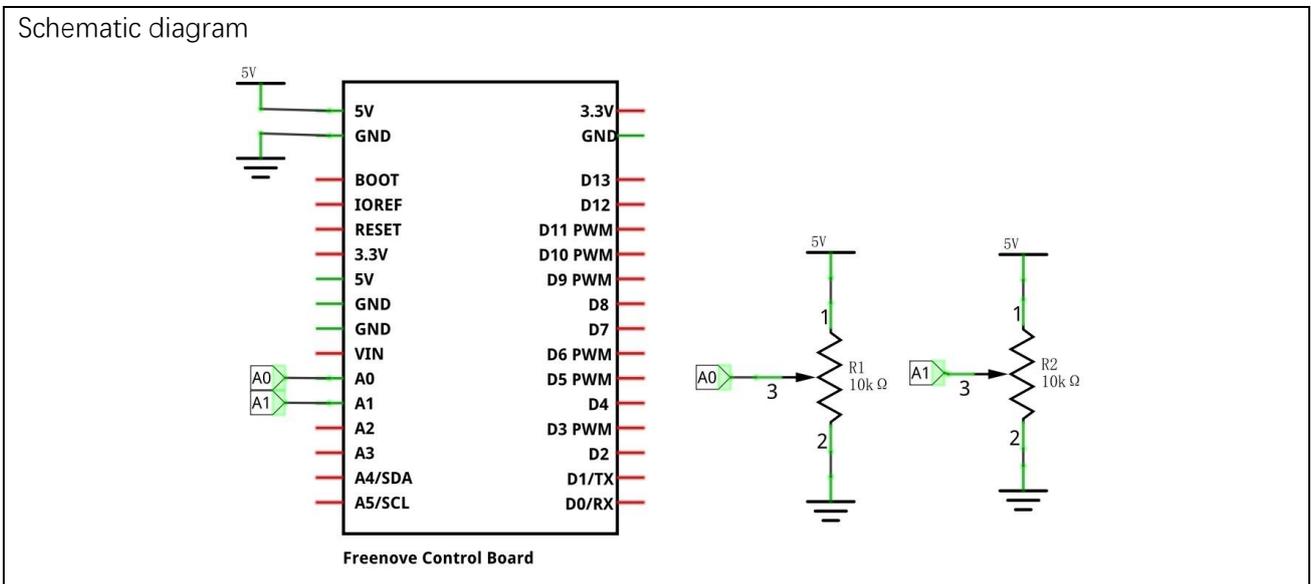
We believe that with the help of this oscilloscope, you can obtain more intuitive understanding of the actual work of some electronic circuits. It will help you complete the project and eliminate the trouble. You can export this sketch to an application used as a tool.



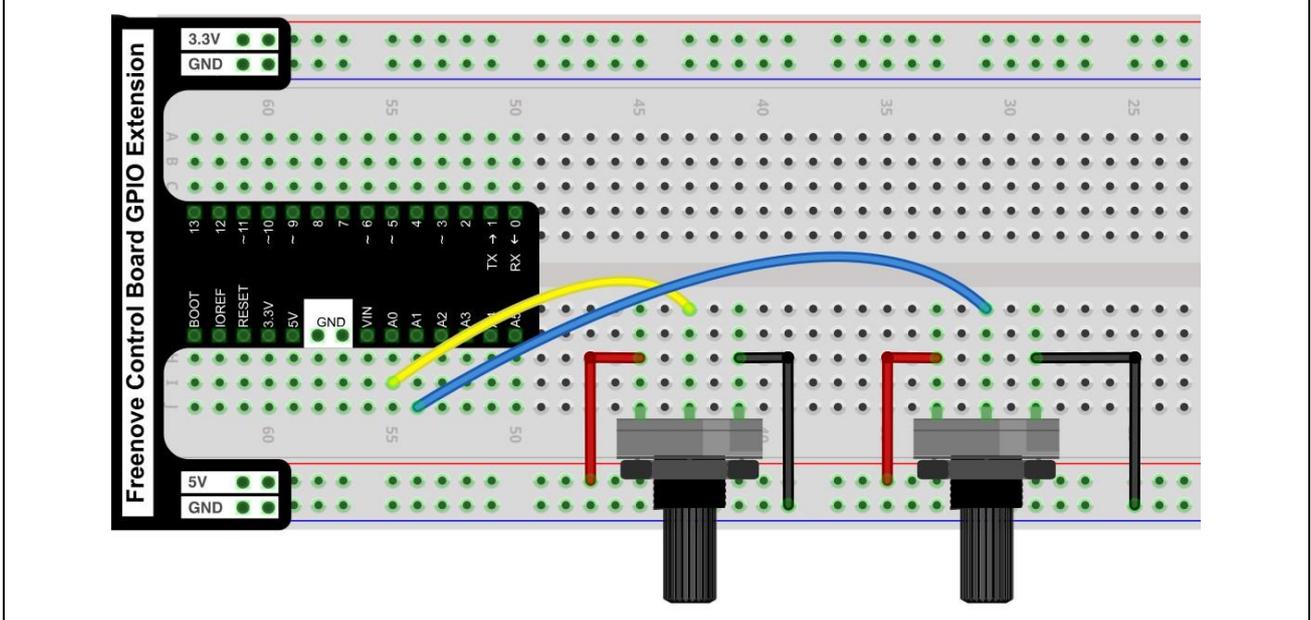


## Circuit

Use A0, A1 ports on the control board to detect the voltage of rotary potentiometers.



Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



## Sketch

### Sketch Voltmeter\_Dual\_Channel

Use Processing to open `.\Processing\Processing\Voltmeter_Dual_Channel\Voltmeter_Dual_Channel.pde` and click Run.

Then, the following window will pop up and its connection to control board will be started.



If you have not yet connect the control board to your computer, please do so. If the connection succeeds, the following will be shown:



This sketch will obtain analog values from A0 and A1 ports of control board, and convert them to voltage value to display. You can adjust the potentiometers to observe the change of value, and you can also use the

A0 and A1 ports to measure voltage value of other circuits. Note that the measurement voltage cannot exceed

5V, otherwise it will cause damage to the control board.

You can export the two Processing sketches in this chapter to the application as common tools.

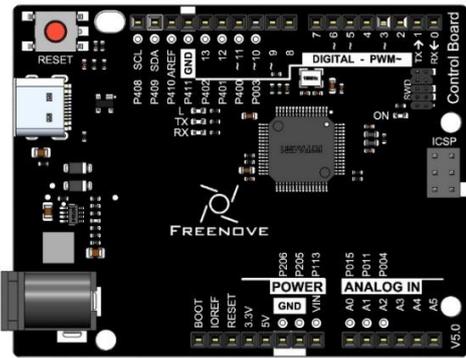
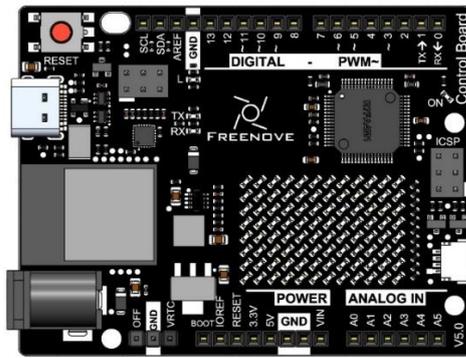
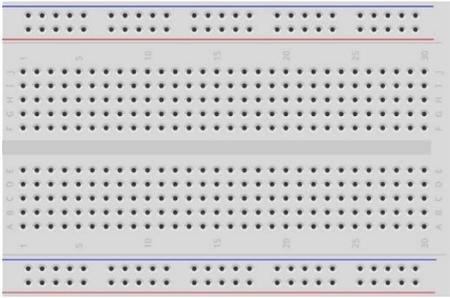
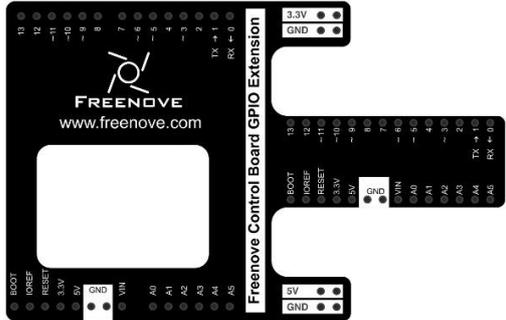
# Chapter 2 Oscilloscope

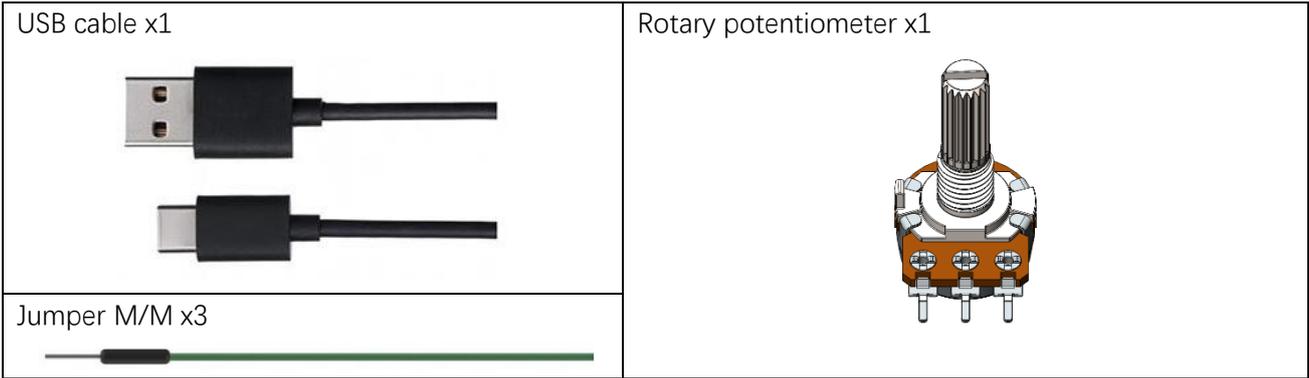
We have implemented a simple virtual instrument voltmeter earlier. In this chapter, we will make a more complex virtual instrument, oscilloscope. Oscilloscope is a widely used electronic measuring instrument. It can get the electrical signals that cannot be observed directly into visible image to facilitate the analysis and study the changing process of various electrical signals.

## Project 2.1 Oscilloscope

Now, let's use Processing and control board to achieve an oscilloscope.

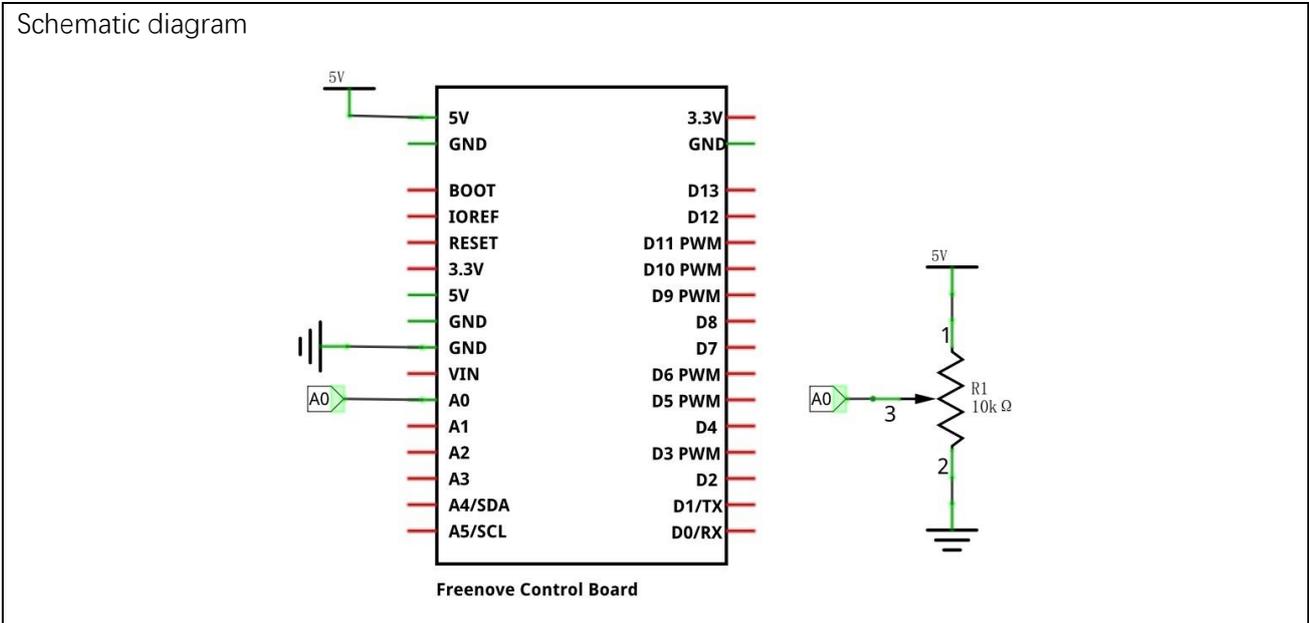
### Component list

<p>Control board x1</p>  <p>The image shows a black PCB labeled 'FREENOVE Control Board'. It features a USB Type-C port, a red push-button labeled 'RESET', and various pin headers. The headers include 'DIGITAL - PWM-' (pins 1-13), 'ANALOG IN' (pins A0-A5), 'POWER' (pins GND, VIN, 3.3V), and 'ICSP'. Other components like a microcontroller, capacitors, and a USB connector are visible.</p>	<p>or</p>  <p>This is another view of the same 'FREENOVE Control Board', showing the opposite side of the components. It highlights the microcontroller, various passive components, and the layout of the board.</p>
<p>Breadboard x1</p>  <p>The image shows a standard white breadboard with a grid of holes for electronic components. It has two power rails (red and blue) and a central ground rail.</p>	<p>GPIO Extension Board x1</p>  <p>The image shows a black 'GPIO Extension Board' with a large cutout for a microcontroller. It has headers for '3.3V', 'GND', '5V', and 'GND'. The pin headers are labeled with numbers 1-13 and 'TX', 'RX'. The board also features the 'FREENOVE' logo and website.</p>

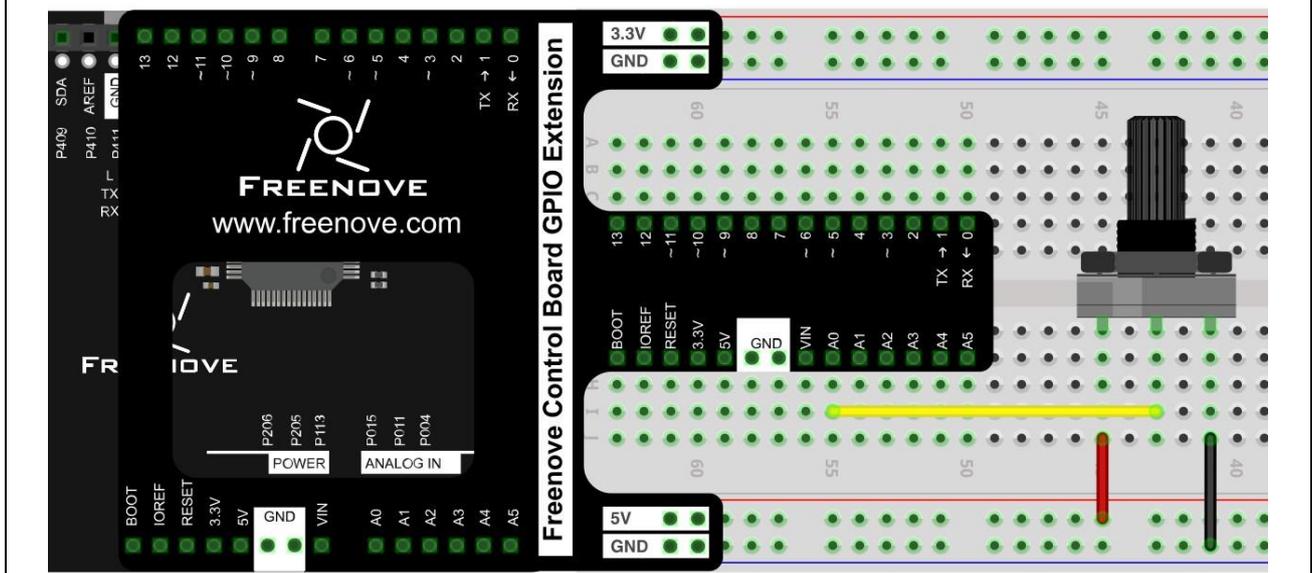


## Circuit

Use A0 port to detect the voltage of rotary potentiometer.



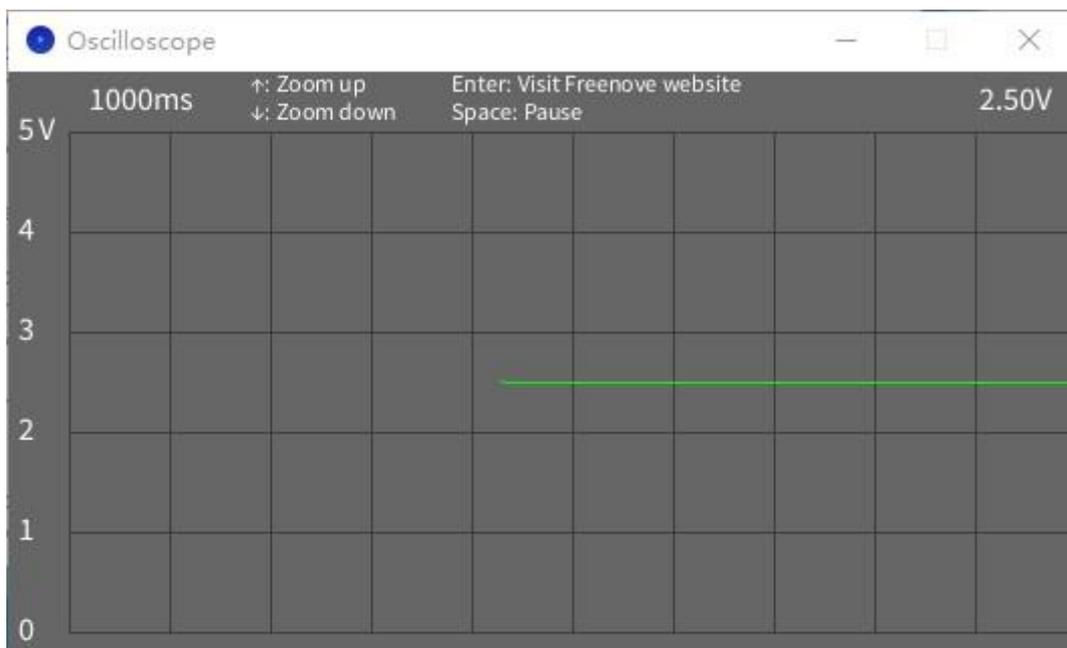
Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



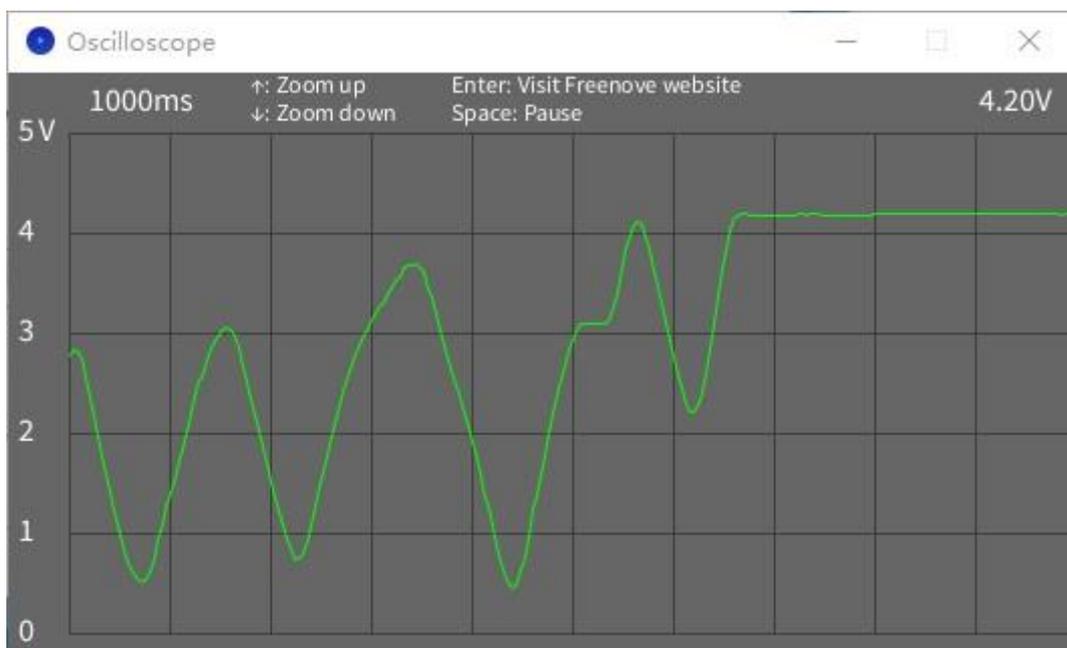
## Sketch

### Sketch Oscilloscope

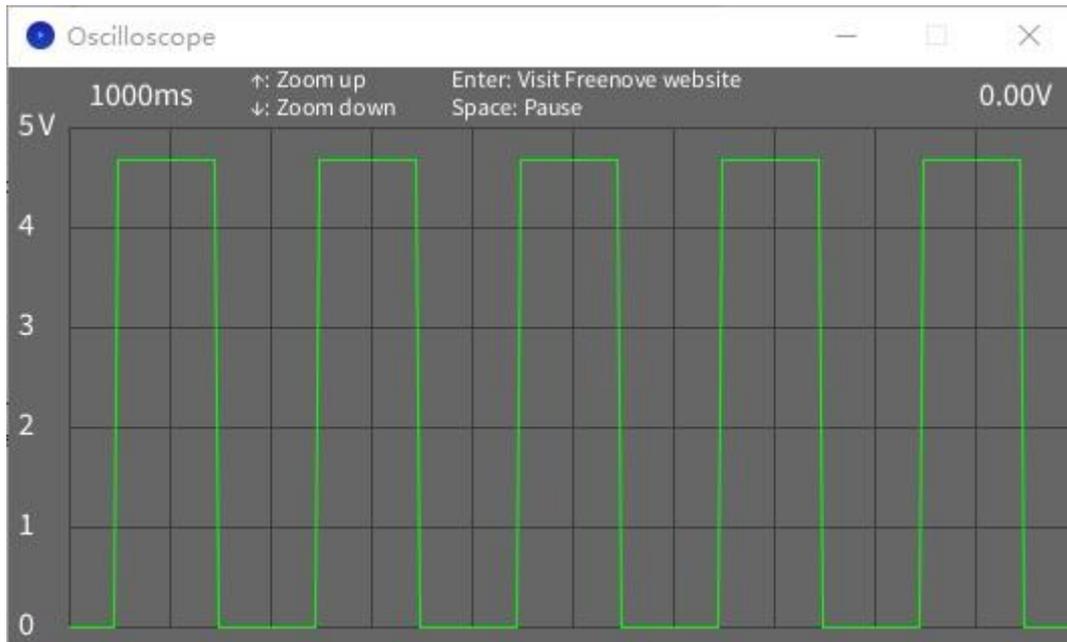
Use Processing to open `.\Processing\Processing\Oscilloscope\Oscilloscope.pde` and click Run. If the connection succeeds, the following will be shown:



The green line is the waveform acquired. Rotate the potentiometer, then you can see changes of the waveform:



Disconnect the A0 port from the potentiometer and connect it to the Pin 13 port. Pin 13 port output is 0.5Hz square wave. As is shown below:



The left side of the software interface is a voltage scale, which is used to indicate the voltage of the waveform. The "1000ms" on top left corner is the time of a square, and you can press "↑" and "↓" key on keyboard to adjust it.

The "0.00V" on top right corner is the voltage value of current signal.

You can press the space bar on keyboard to pause the display waveform, which is easy to view and analysis.

We believe that with the help of this oscilloscope, you can obtain more intuitive understanding of the actual work of some electronic circuits. It will help you complete the project and eliminate the trouble. You can export this sketch to an application used as a tool.

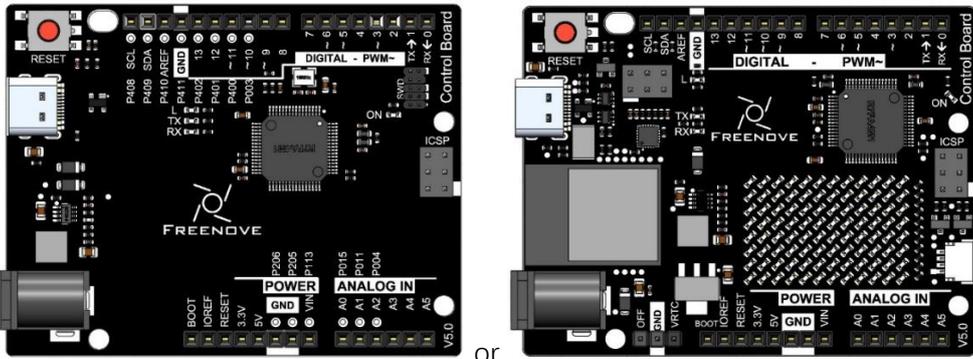
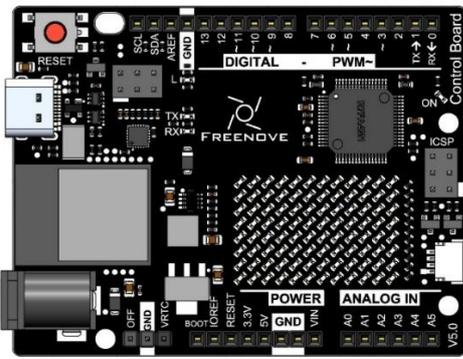
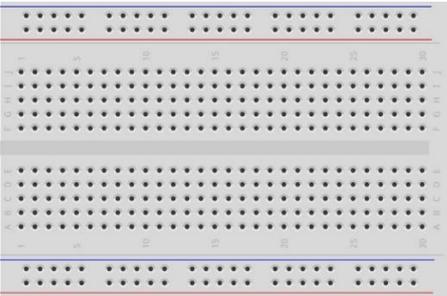
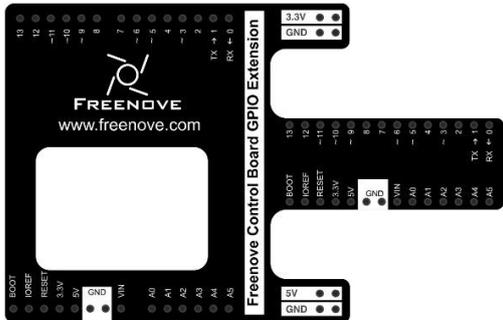
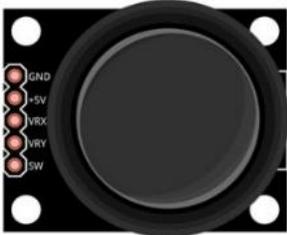
# Chapter 3 Control 2D and 3D Figures

In this chapter, we will use the connect board to make Processing program display changes of figures. And we will control 2D and 3D figures respectively.

## Project 3.1 Ellipse

Now, let's use Processing and control board to achieve an oscilloscope.

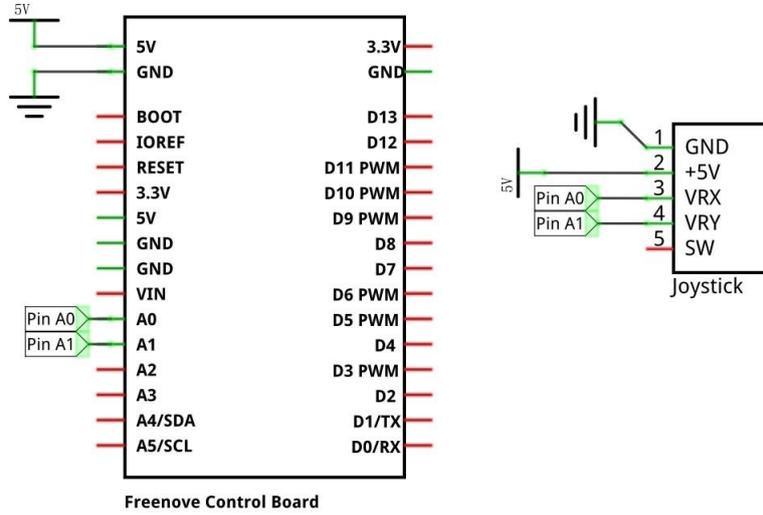
### Component list

<p>Control board x1</p> 	<p>or</p> 
<p>Breadboard x1</p> 	<p>GPIO Extension Board x1</p> 
<p>USB cable x1</p> 	<p>Joystick x1</p> 
<p>Jumper M/M x4</p> 	

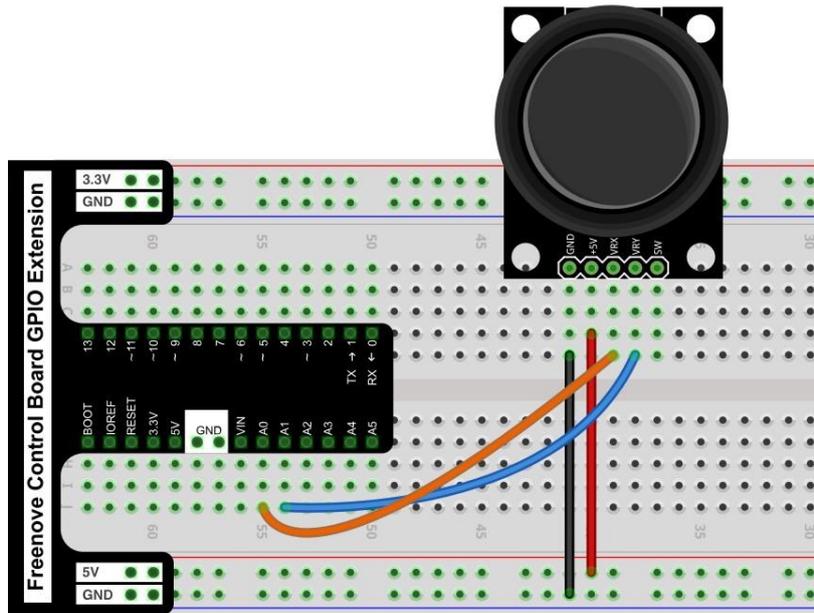
# Circuit

Use A0 port to detect the voltage of rotary potentiometer.

Schematic diagram



Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



# Sketch

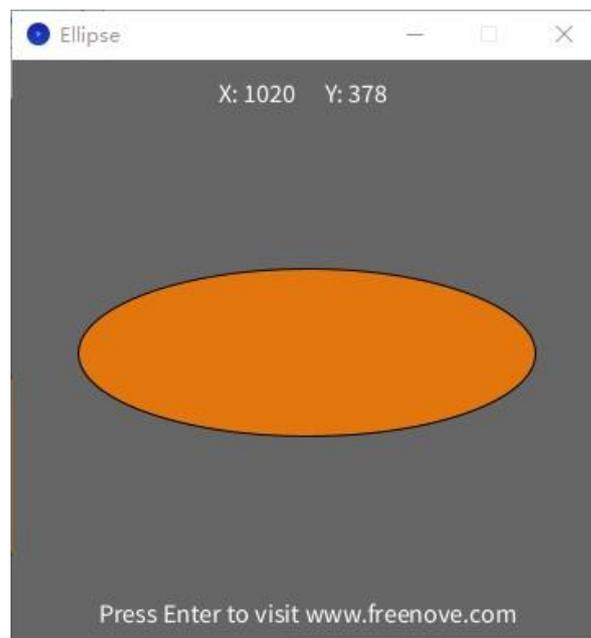
## Sketch Ellipse

Use Processing to open `.\Processing\Processing\Ellipse\Ellipse.pde` and click Run.

If the connection succeeds, the following will be shown:



Then you can change the shape of the ellipse by shifting the joystick:



## Project 3.2 Box 3D

Now control 3D figures.

### Component list

The same as previous section.

### Circuit

The same as previous section.

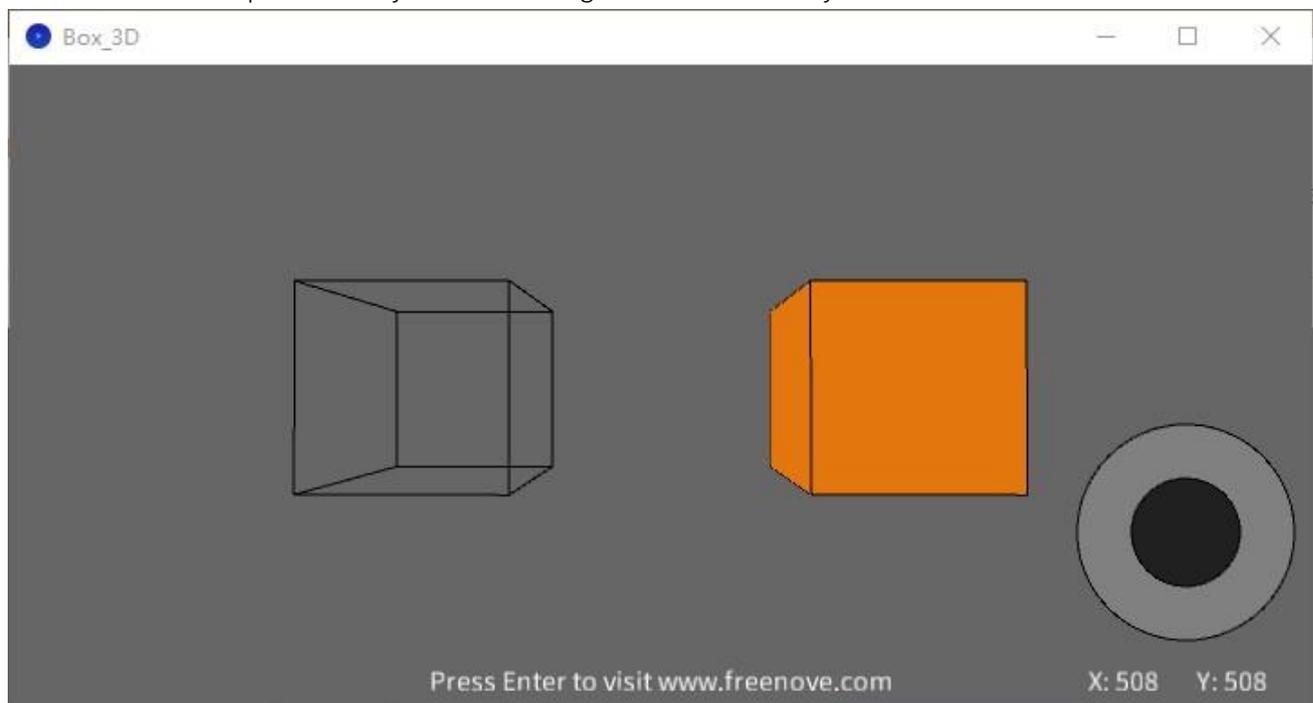
### Sketch

#### Sketch Box\_3D

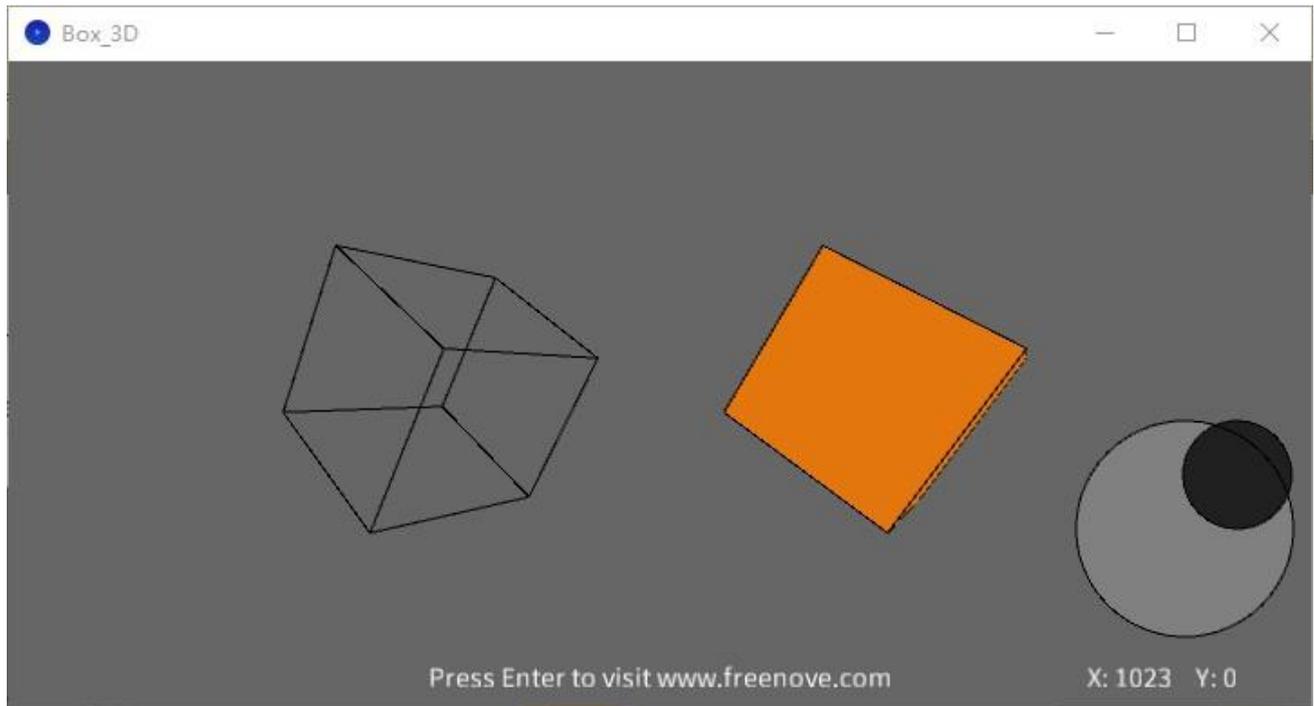
Use Processing to open `.\Processing\Processing\Box_3D\Box_3D.pde` and click Run.

If the connection succeeds, the following will be shown.

The left is a 3D box presented by line and the right is a 3D box entity.



Then you can change the space angle of two 3D boxes by shifting the joystick:



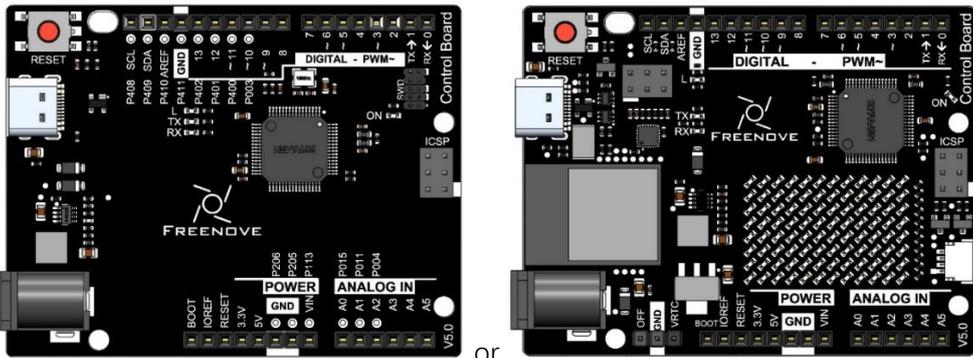
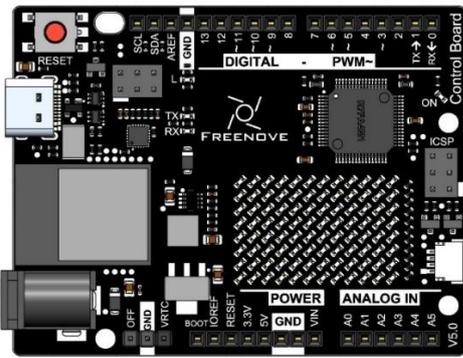
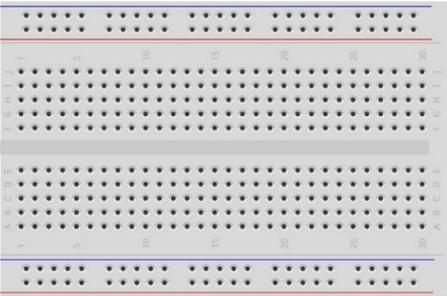
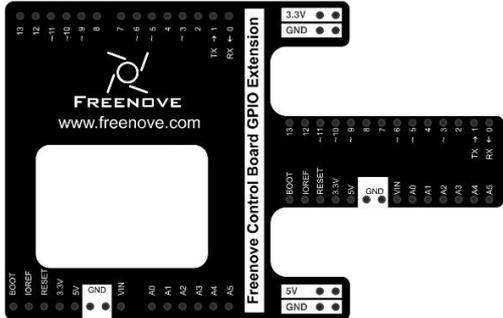
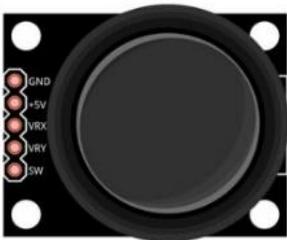
# Chapter 4 Snake Game

We have learned how control 2D and 3D figures. Now, we will use control board to play the classic snake game. There are both 2D and 3D version.

## Project 4.1 Snake Game

First, let's play a 2D snake game.

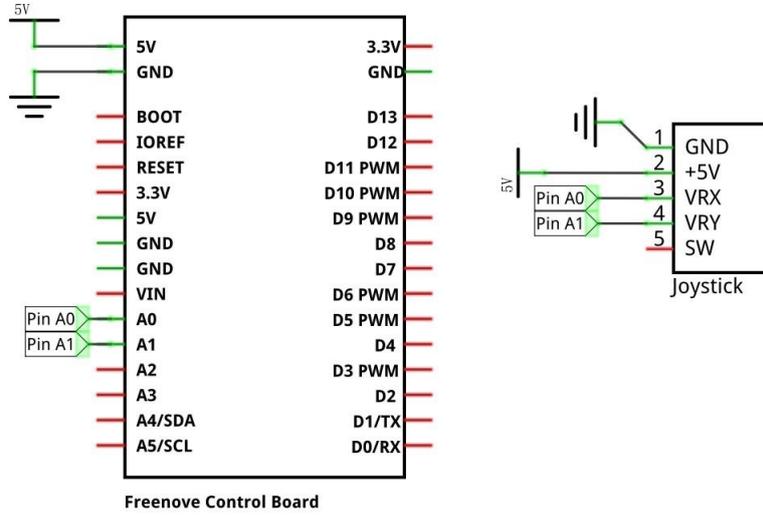
### Component list

<p>Control board x1</p> 	<p>or</p> 
<p>Breadboard x1</p> 	<p>GPIO Extension Board x1</p> 
<p>USB cable x1</p> 	<p>Joystick x1</p> 
<p>Jumper M/M x4</p> 	

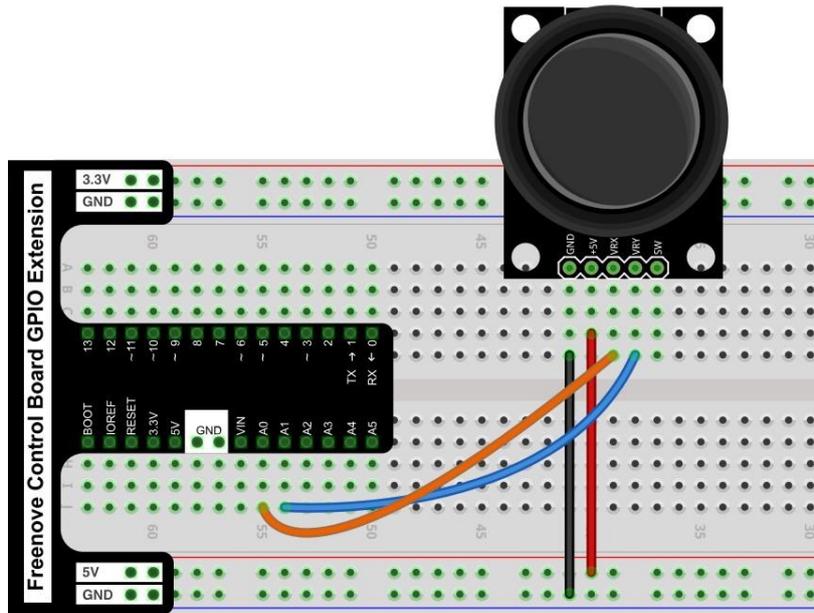
## Circuit

Use A0 and A1 ports on connect board to detect the voltage value of two rotary potentiometers inside joystick.

Schematic diagram



Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)

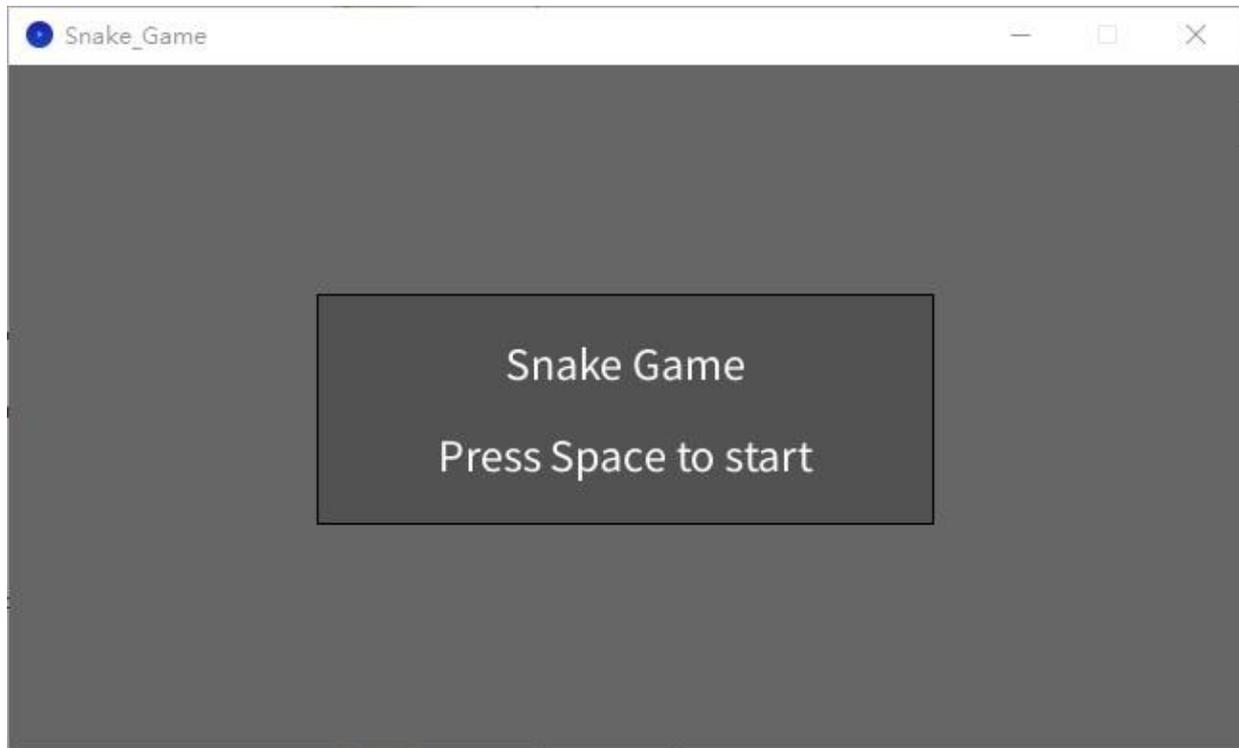


## Sketch

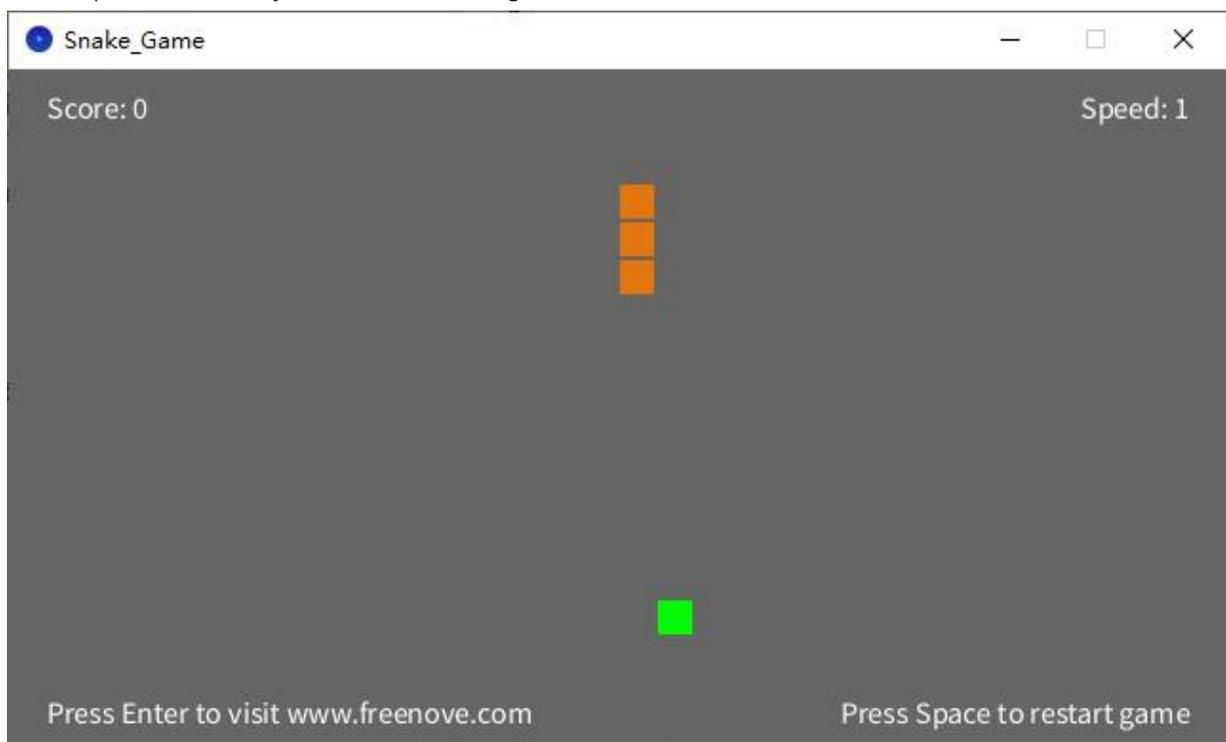
### Sketch Snake\_Game

Use Processing to open `.\Processing\Processing\Box_3D\Box_3D.pde`, and click Run.

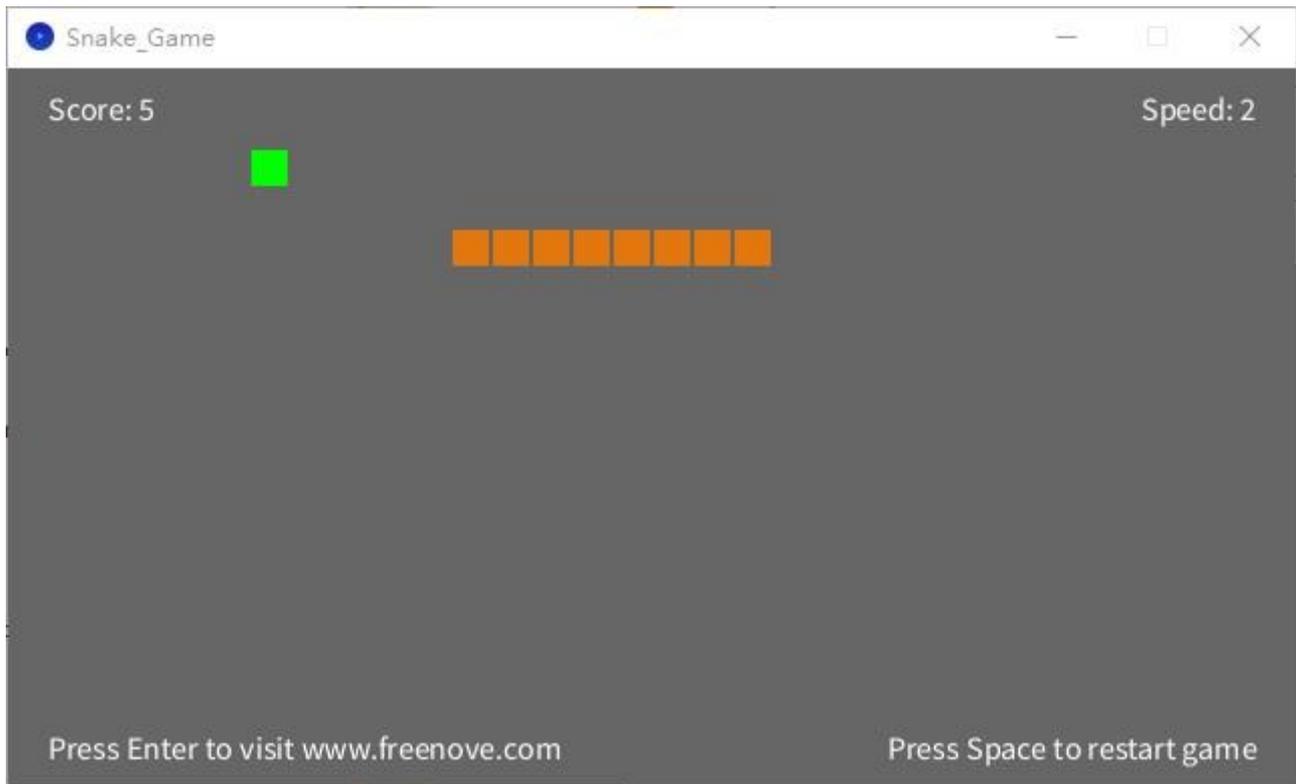
If the connection succeeds, the follow will be shown:



Press the space bar on keyboard to start the game:



Press the corresponding button to control the snake's movements. The game rules are the same as the classic snake game:



When the game fails, press space bar to restart the game:



Additionally, you can restart the game by pressing the space bar at any time.

## Project 4.2 Snake Game 3D

Now, let's experience the 3D version game.

### Component list

The same as last section.

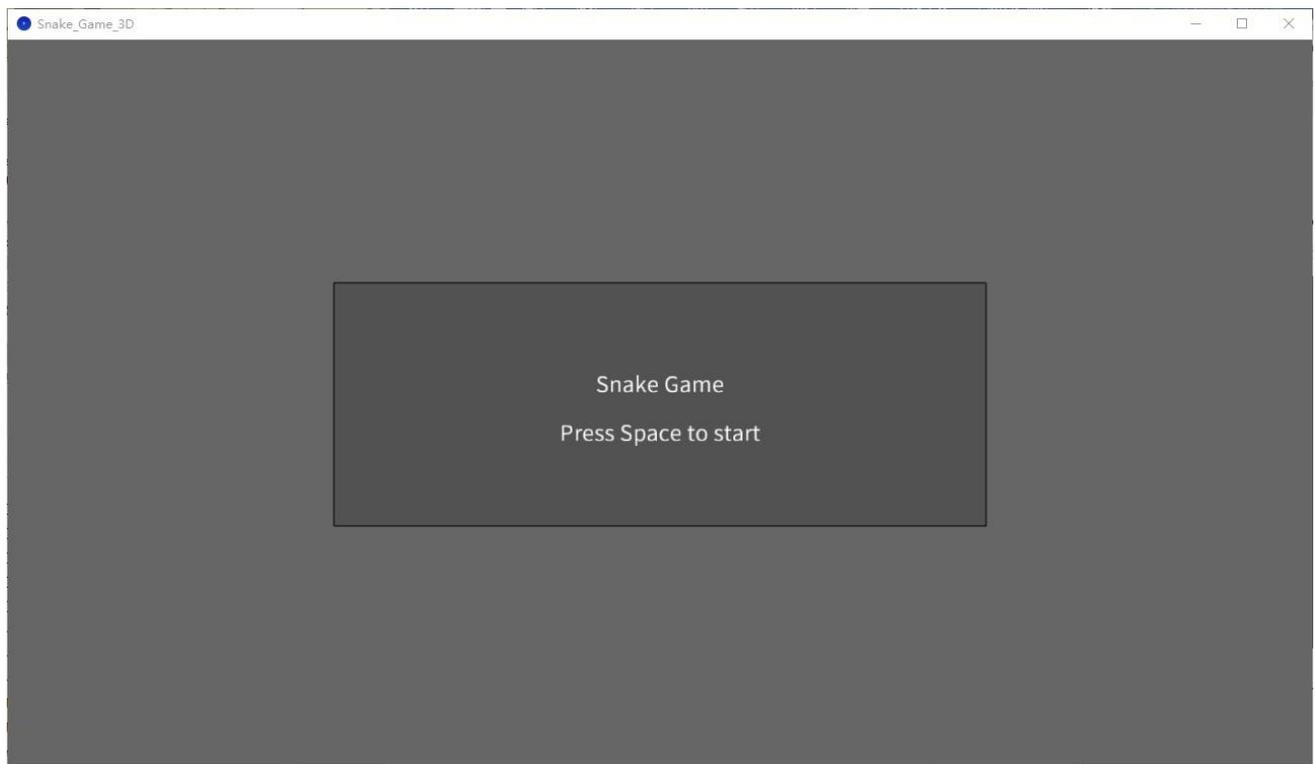
### Circuit

The same as last section.

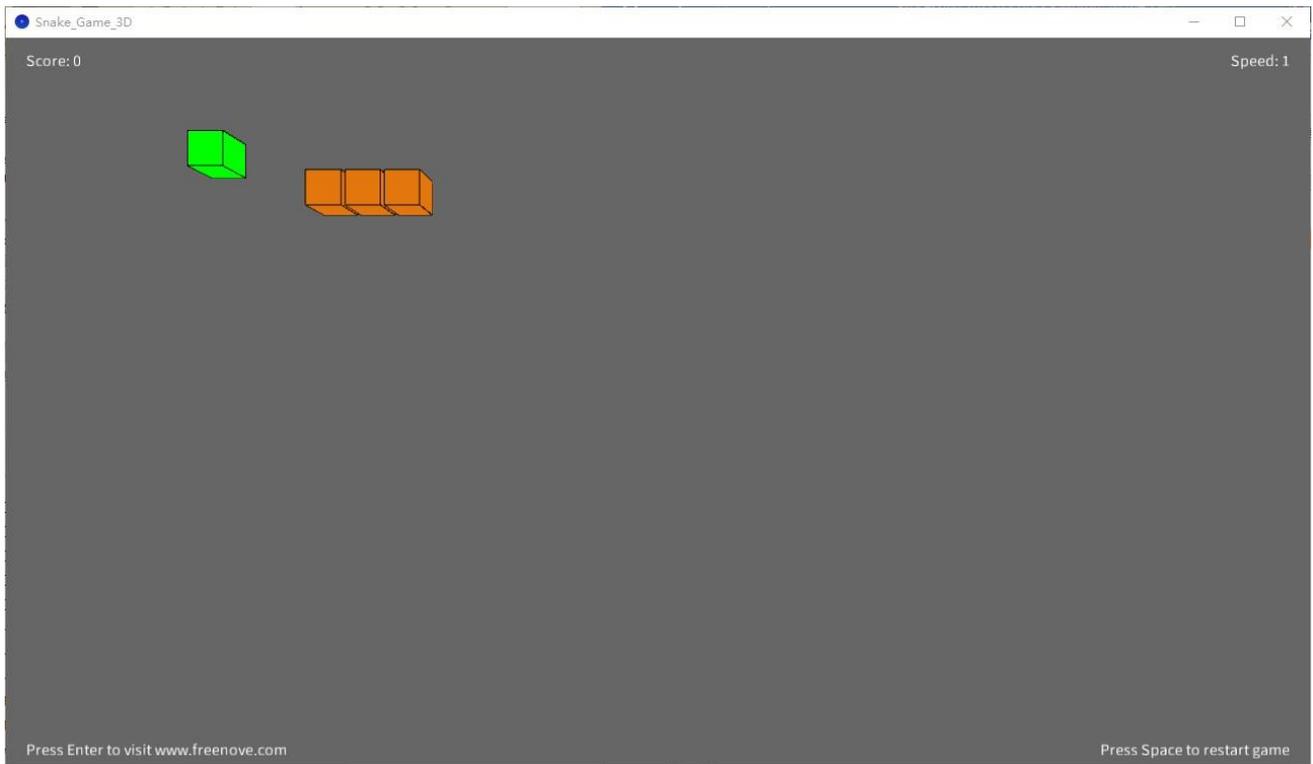
### Sketch

#### Sketch Snake\_Game\_3D

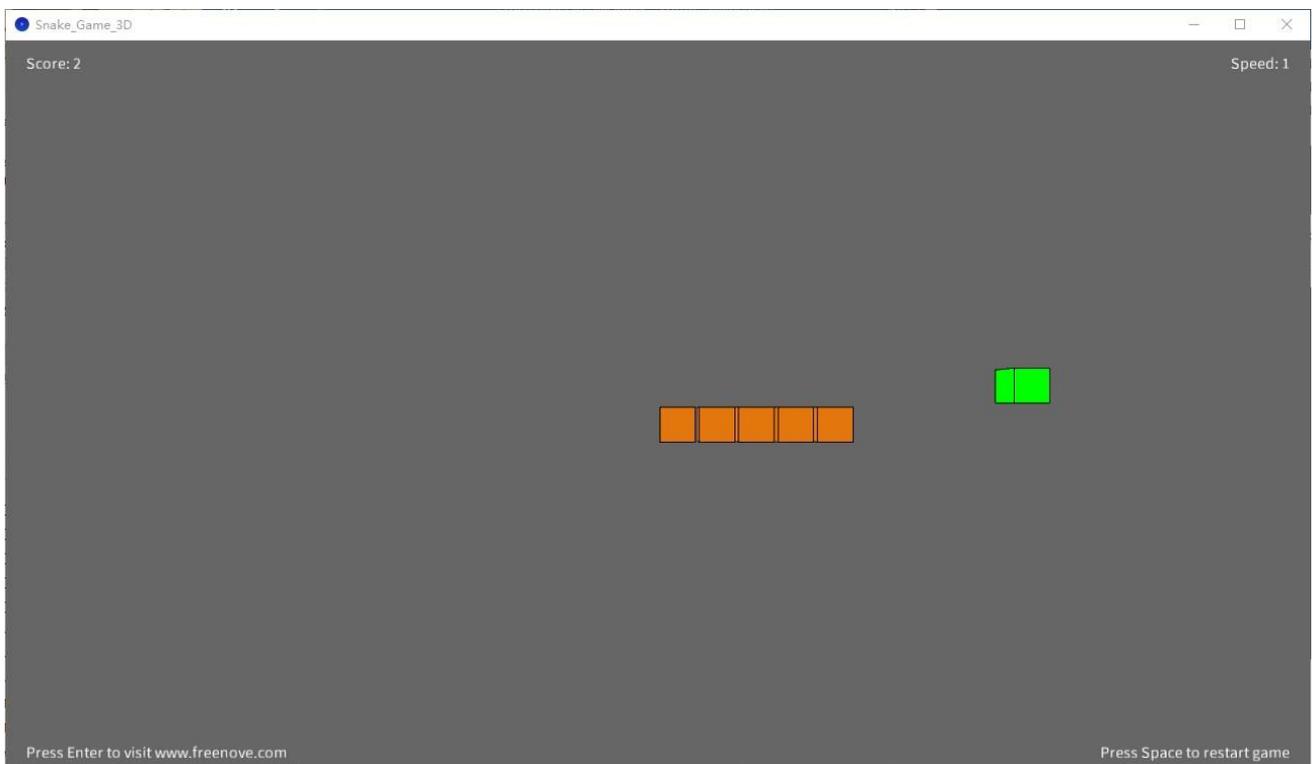
Use Processing to open `.\Processing\Processing\Snake_Game_3D\Snake_Game_3D.pde` and click Run. If the connection succeeds, the follow will be shown:



Press the space bar on keyboard to start the game:



Press the corresponding button to control the snake's movements. The game rules are the same as the classic snake game:



The rest operation is the same as the 2D version.

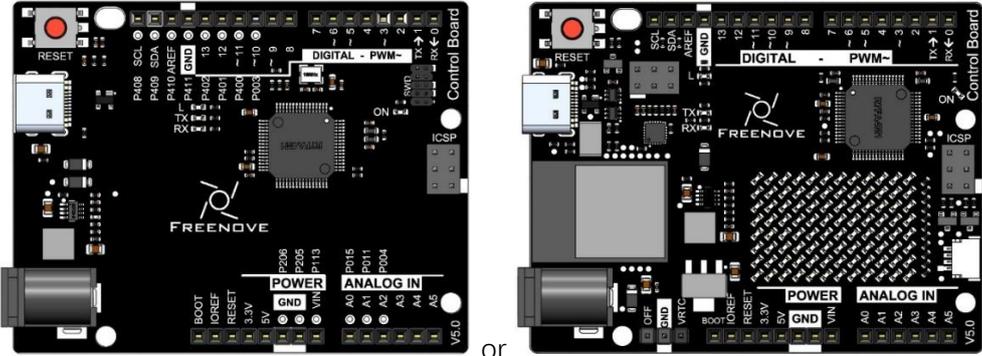
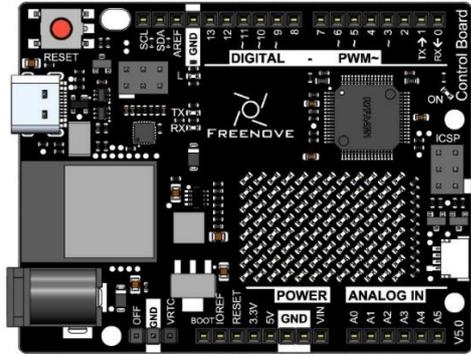
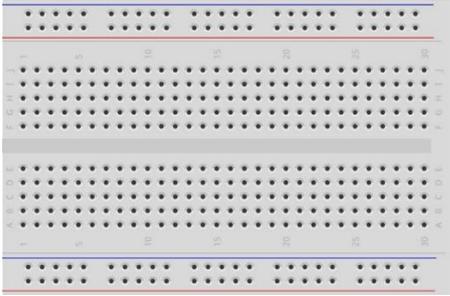
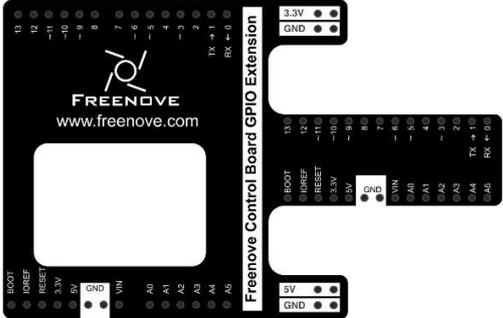
# Chapter 5 Pick Apples

In this chapter, we prepare pick apples game. You can pick apples with four buttons.

## Project 5.1 Pick Apples

Now, let's use Processing and control board to achieve the game.

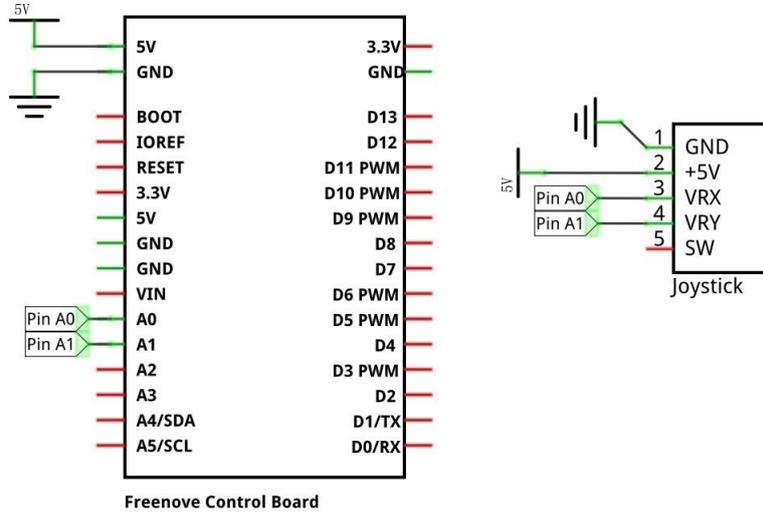
### Component list

<p>Control board x1</p> 	<p>or</p> 
<p>Breadboard x1</p> 	<p>GPIO Extension Board x1</p> 
<p>USB cable x1</p> 	<p>Joystick x1</p> 
<p>Jumper M/M x4</p> 	

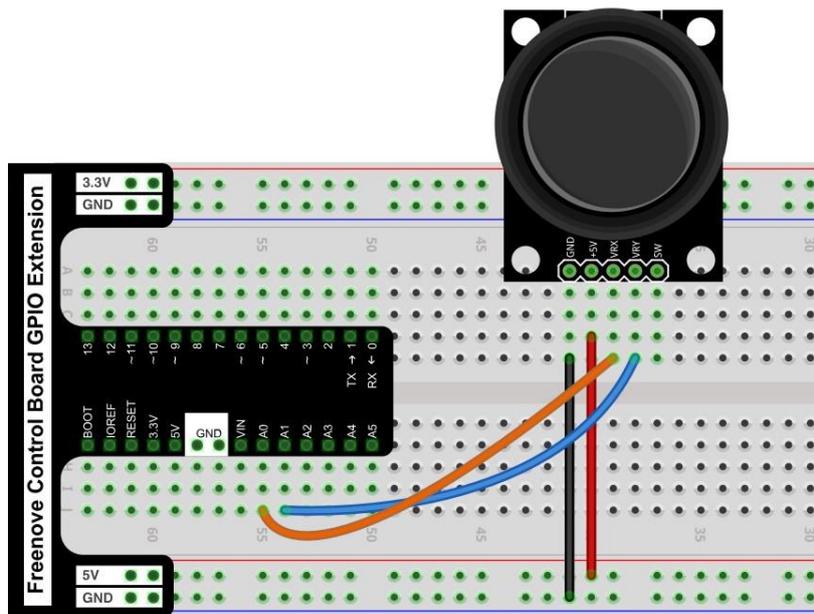
## Circuit

Use A0 and A1 ports to detect the voltage value of two rotary potentiometers inside joystick.

Schematic diagram



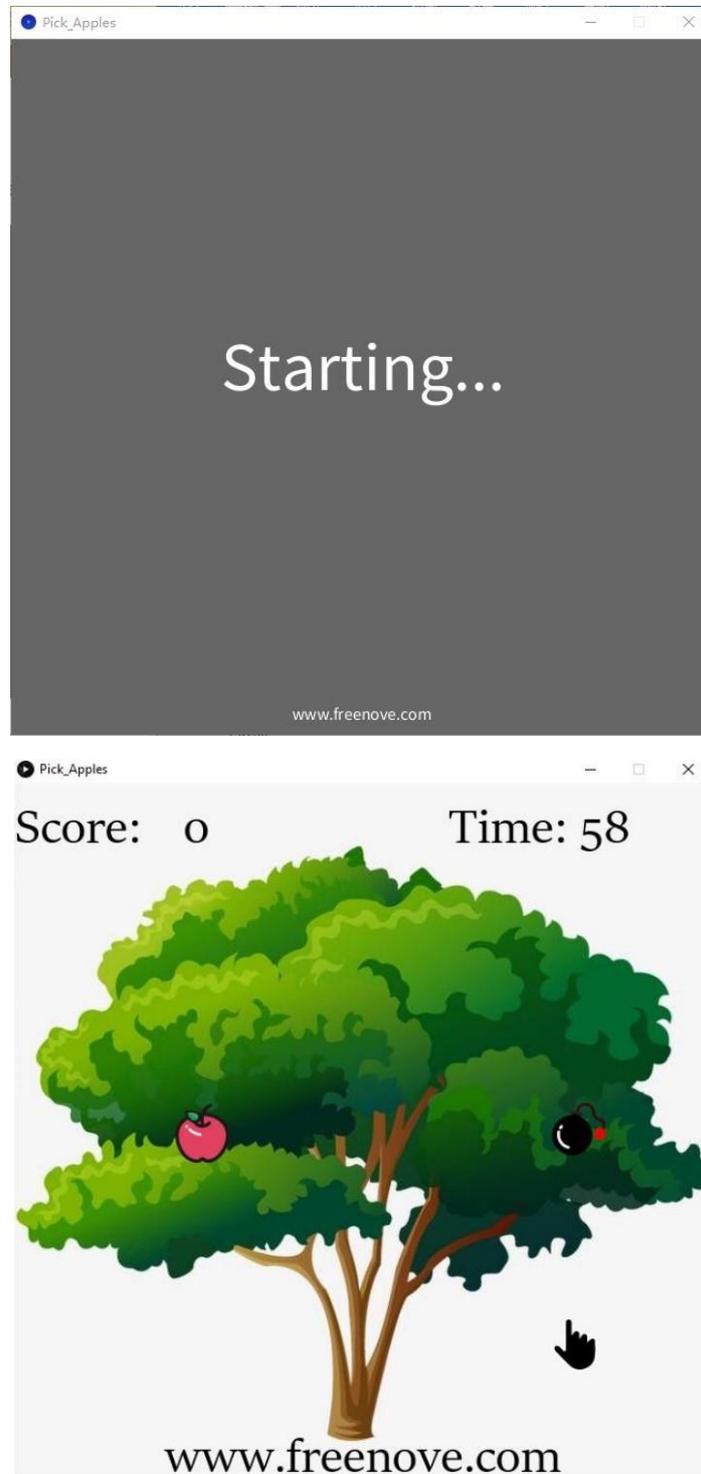
Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



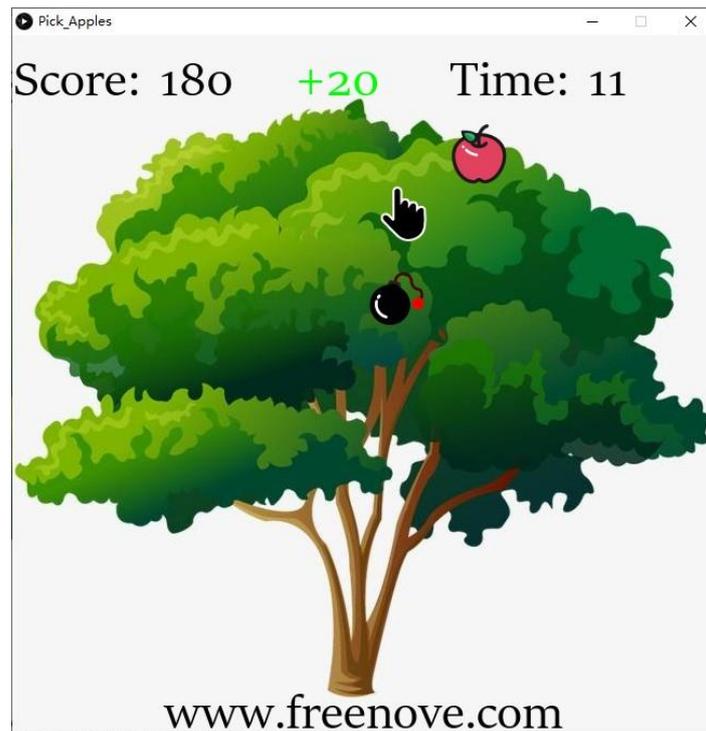
## Sketch

### Sketch Pick Apples

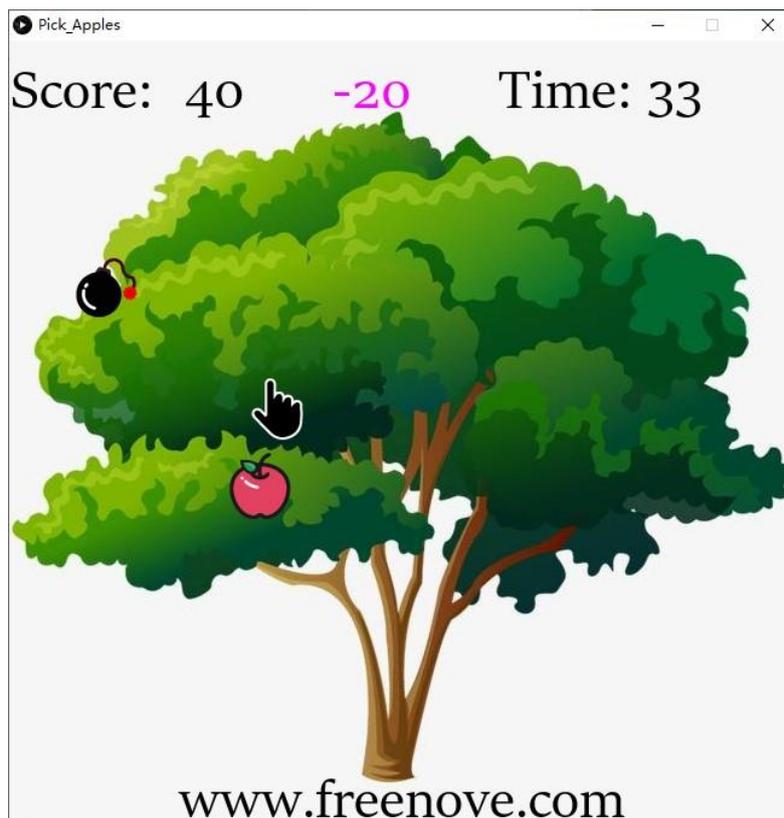
Use Processing to open `.\Processing\Processing\Pick_Apples\Pick_Apples.pde`, and click Run. If the connection succeeds, the follow will be shown:



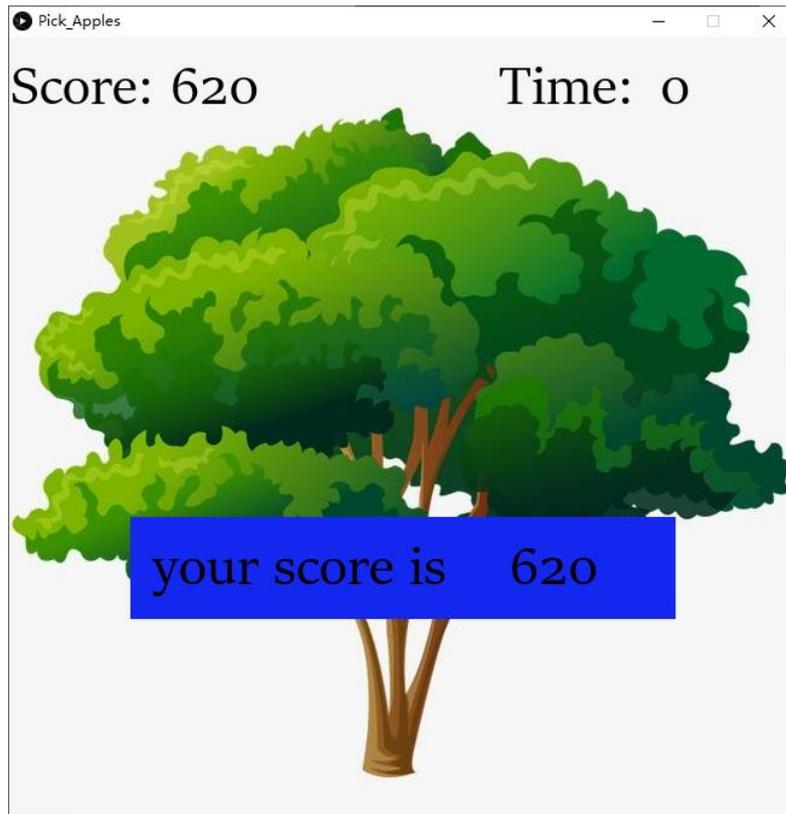
You can control the game with the corresponding buttons. When the palm picked the apple, score +20.



If the palm touches the bomb, the score is -20.



At the same time, you need to pick as many apples as possible before the countdown is over. When the game fails, press space bar to restart the game:



Additionally, you can restart the game by pressing the space bar at any time.

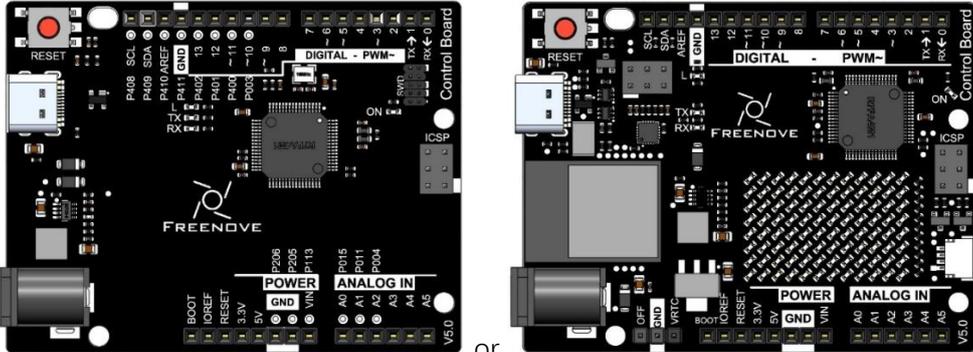
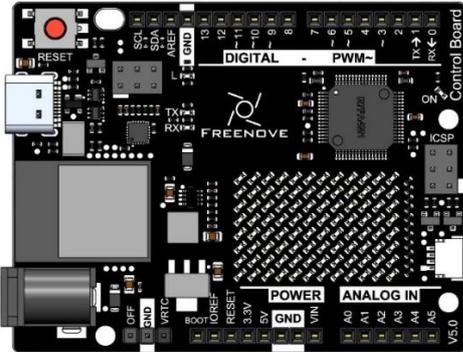
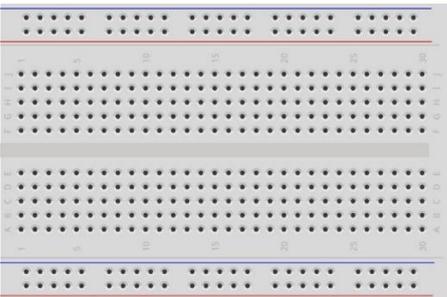
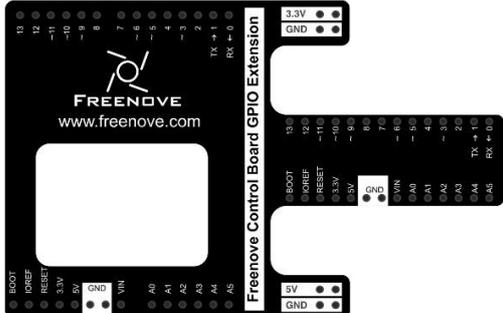
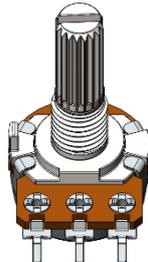
# Chapter 6 Pong Game

We have experienced single-player game snake before. Now, let's use control board to play classic two-player pong game. You will experience both 2D and 3D version.

## Project 6.1 Pong Game

First, let's experience the 2D version game.

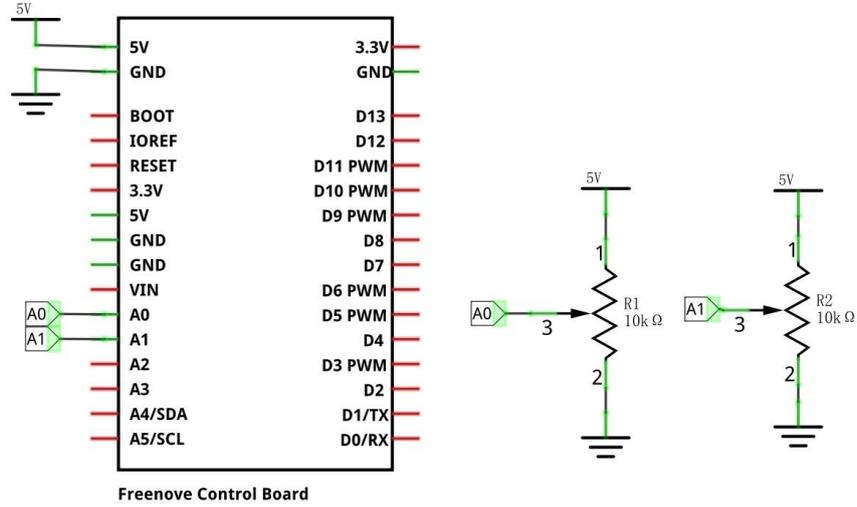
### Component list

<p>Control board x1</p> 	<p>or</p> 
<p>Breadboard x1</p> 	<p>GPIO Extension Board x1</p> 
<p>USB cable x1</p> 	<p>Rotary potentiometer x2</p> 
<p>Jumper M/M x4</p> 	

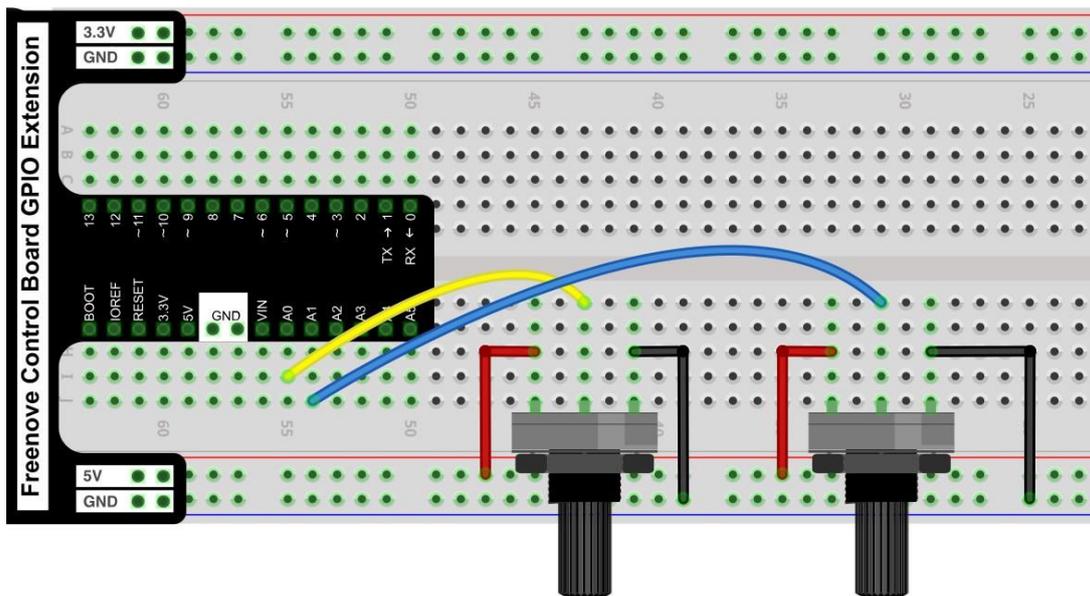
# Circuit

Use A0, A1 ports on connect board to detect the voltage of rotary potentiometers.

Schematic diagram



Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)



## Sketch

### Sketch Pong\_Game

Use Processing to open `.\Processing\Processing\Pong_Game\Pong_Game.pde`, and click Run.

If the connection succeeds, the follow will be shown:



Now you can try to control the racket motion by pressing the corresponding button. Press space bar to start the game:



Use button to control the movement of paddle to block the ball back. The game rules are the same as classic pong game:



The game will be over when one side reaches three points. Pressing the space bar can restart the game:



Additionally, you can restart the game by pressing the space bar at any time.

## Project 6.2 Pong Game 3D

Now, let's experience the 3D version game.

### Component list

The same as last section.

### Circuit

The same as last section.

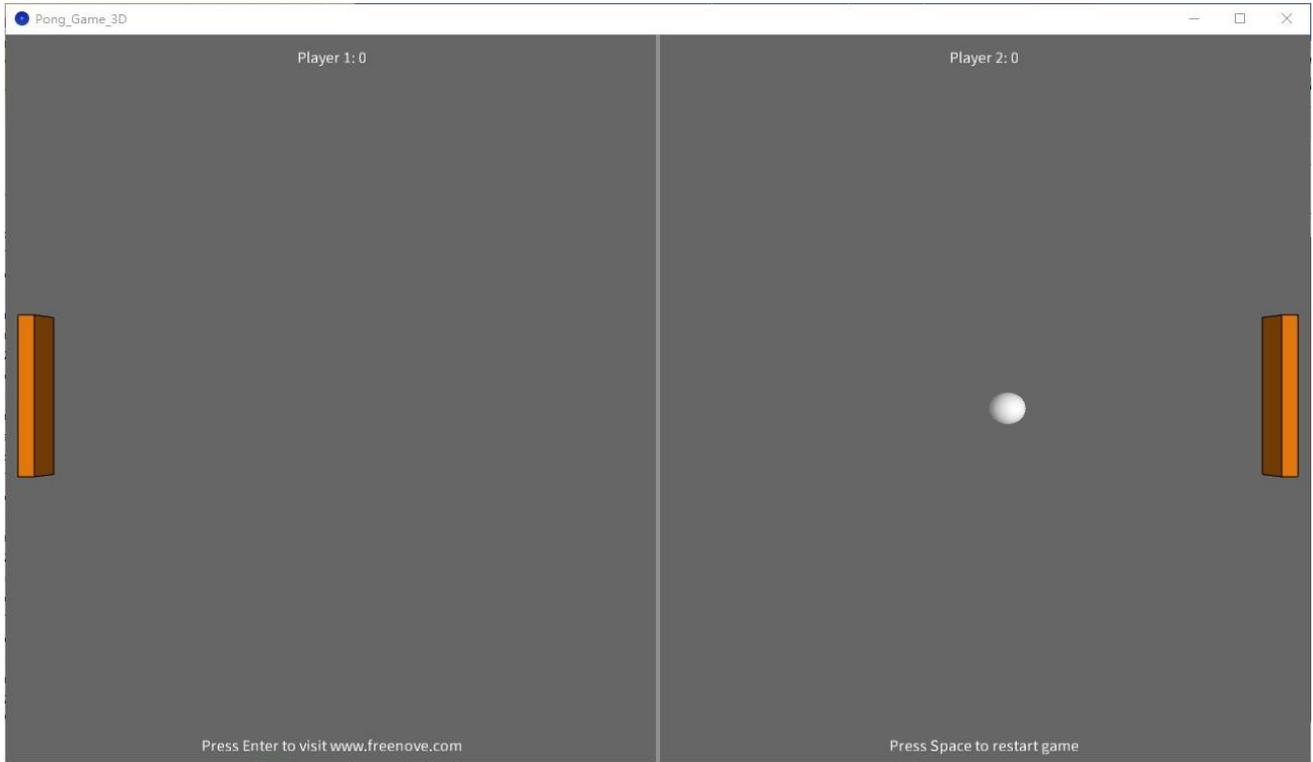
### Sketch

#### Sketch Pong\_Game\_3D

Use Processing to open `.\Processing\Processing\Pong_Game_3D\Pong_Game_3D.pde`, and click Run. If the connection succeeds, the follow will be shown:



Now you can try to control the racket motion by pressing the corresponding button. Press space bar to start the game:



Use button to control the movement of paddle to block the ball back. The game rules are the same as classic pong game:



The rest operation is the same as the 2D version.

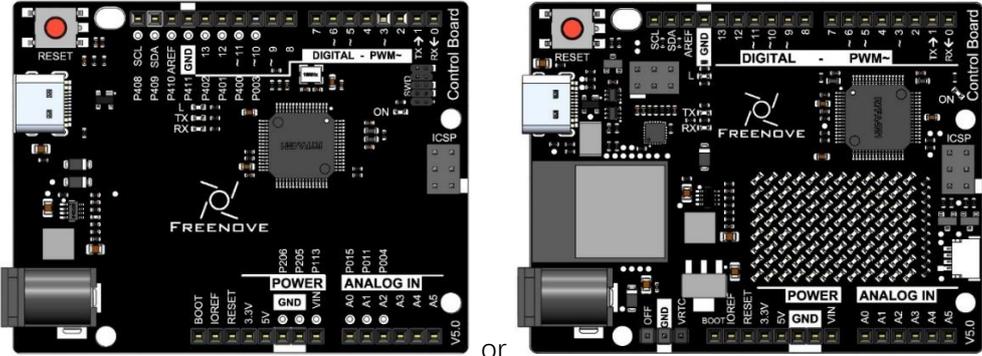
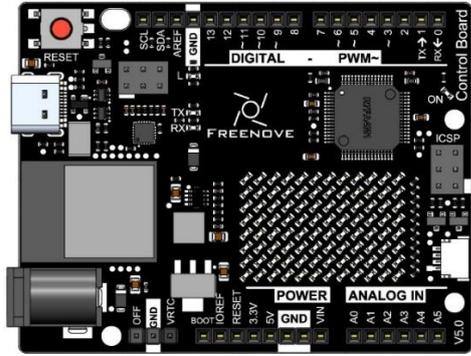
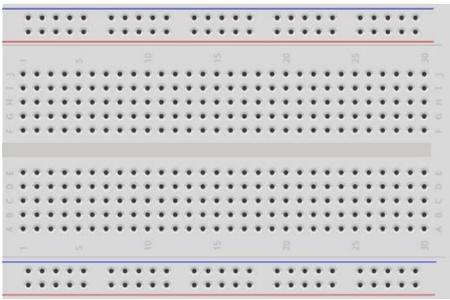
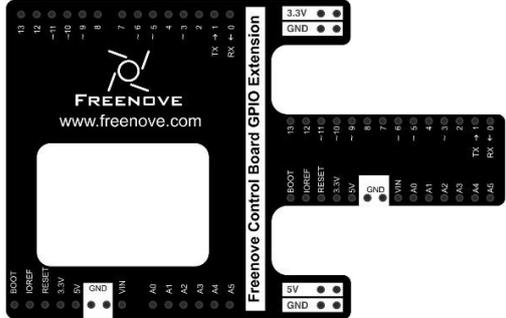
# Chapter 7 Tetris

In this chapter, we prepare a tetris game for you. You can play the game by pressing the buttons.

## Project 7.1 Tetris

Now, let's use Processing and control board to achieve the tetris game.

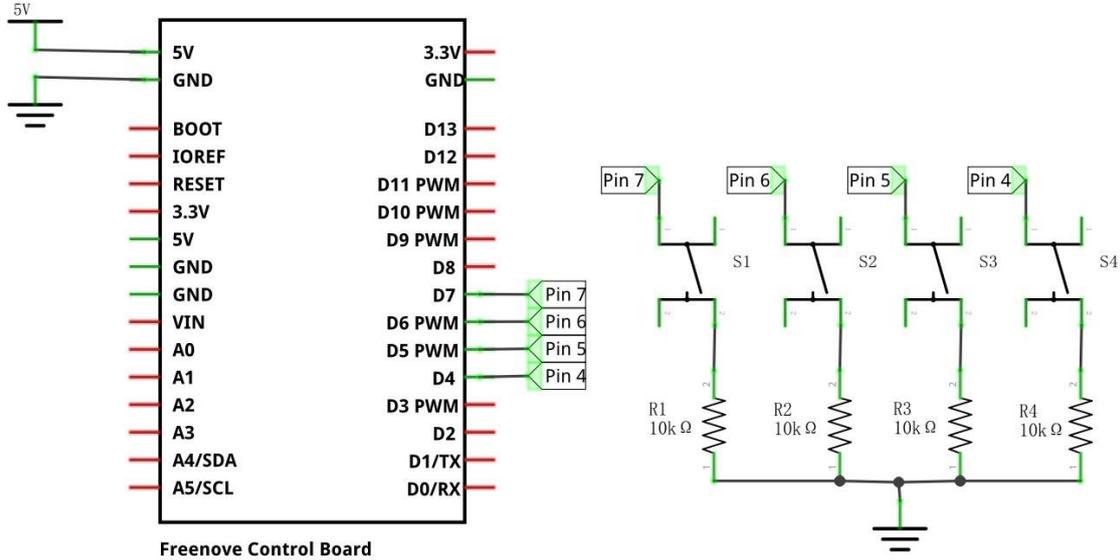
### Component list

<p>Control board x1</p> 	<p>or</p> 	
<p>Breadboard x1</p> 	<p>GPIO Extension Board x1</p> 	
<p>USB cable x1</p> 	<p>Push button x4</p> 	<p>Resistor 10kΩ x4</p> 
<p>Jumper M/M x4</p> 		

# Circuit

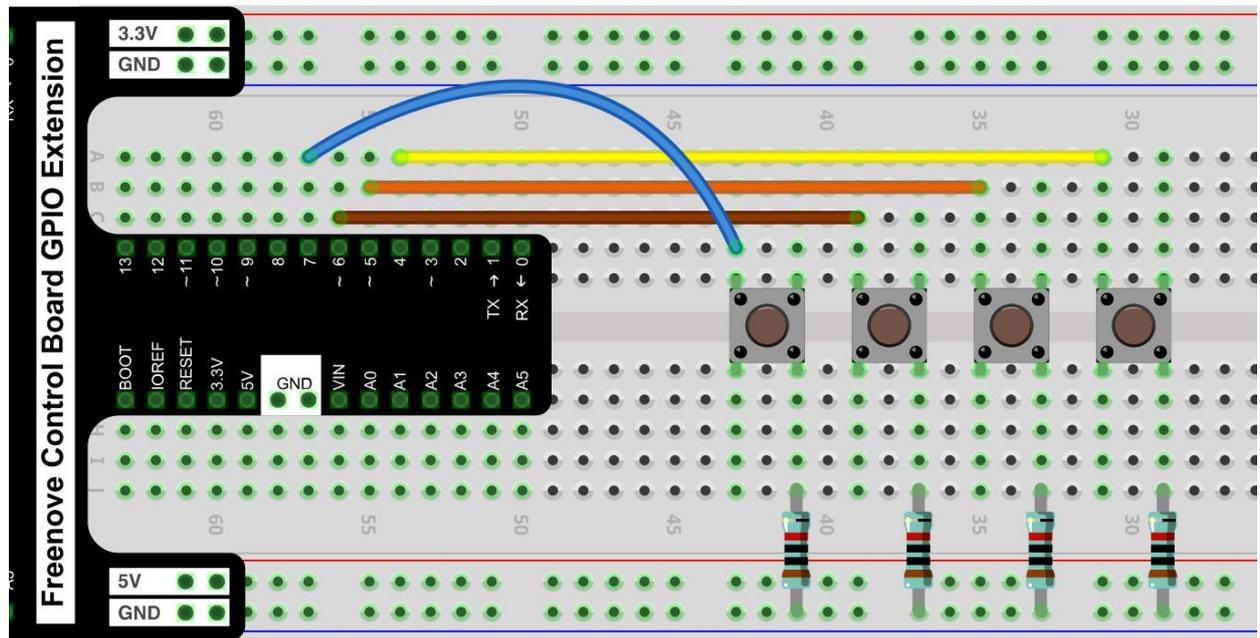
Use GPIO4, GPIO5, GPIO6, GPIO7 port on control board to control the movement of the block.

Schematic diagram



Freenove Control Board

Hardware connection. If you need any support, please feel free to contact us via: [support@freenove.com](mailto:support@freenove.com)

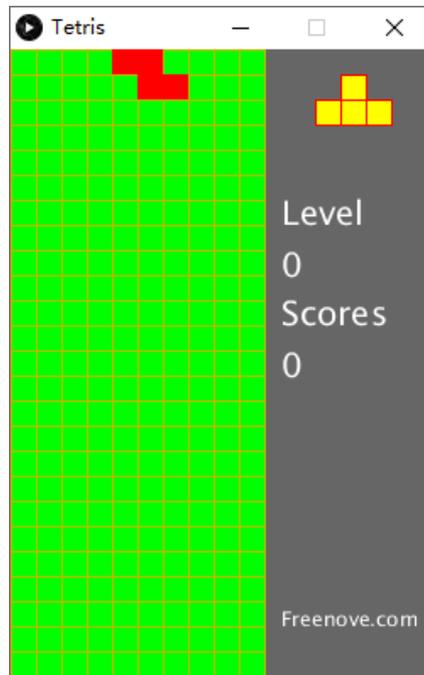


## Sketch

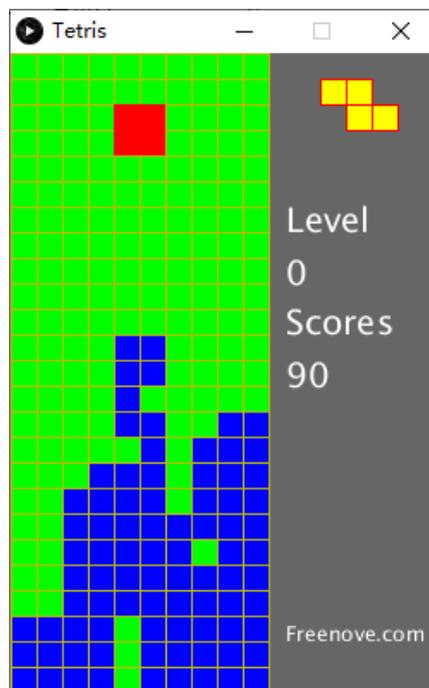
### Sketch Tetris

Use Processing to open `.\Processing\Processing\Tetris.pde\Tetris.pde`, and click Run.

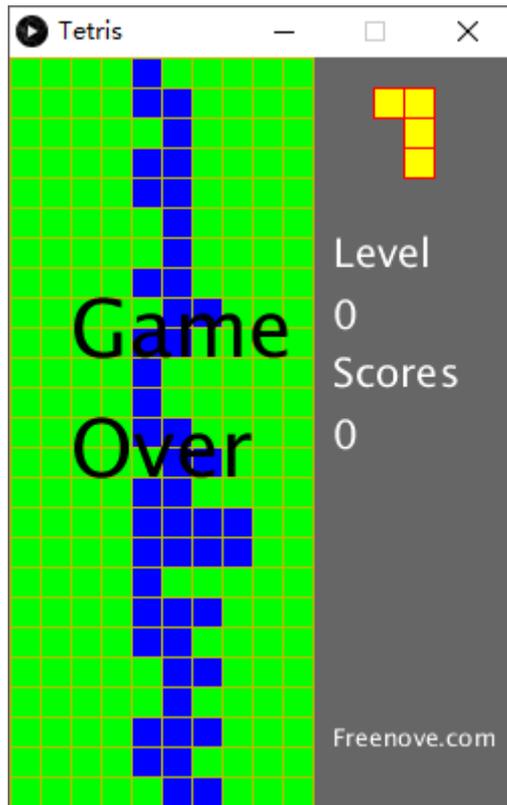
If the connection succeeds, the follow will be shown:



Now you can try using the buttons to control the falling block. Press the space bar to pause the game.



When the game is over, you can press the space bar to play the game again. Press ESC to exit the game.



## What's next?

Thanks for your reading! This document is all over here.

If you find any mistakes, please feel free to contact us at [support@freenove.com](mailto:support@freenove.com). We would love to hear from you.

If you want to learn more about electronics and programming, interesting robots and projects, please continue to follow our website. We will continue to launch cost-effective, innovative and exciting products.

[www.freenove.com](http://www.freenove.com)

Thank you again for choosing Freenove products.