Free your innovation

Freenove is an open-source electronics platform.
www.freenove.com

About

Freenove is an open-source electronics platform. Freenove is committed to helping customer quickly realize the creative idea and product prototypes, making it easy to get started for enthusiasts of programing and electronics and launching innovative open source products. Our services include:

- Electronic components and modules
- Learning kits for Arduino
- Learning kits for Raspberry Pi
- Learning kits for Technology
- Robot kits
- Auxiliary tools for creations

Our code and circuit are open source. You can obtain the details and the latest information through visiting the following web sites:
http://www.freenove.com
https://github.com/freenove

Your comments and suggestions are warmly welcomed, please send them to the following email address:
support@freenove.com

Support

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

- Quality problems of products
- Problems in using products
- Questions for learning and technology
- Opinions and suggestions
- Ideas and thoughts

Please send email to:
support@freenove.com
On working day, we usually reply to you within 24 hours.

Copyright

Contents

Preface

Processing software is used to write programs that run on computer. Processing software is free and open source, and runs on Mac, Windows, and GNU / Linux platforms, which is the same as Arduino software. In fact, Arduino software is based on Processing software. At present, they still have similar interface.

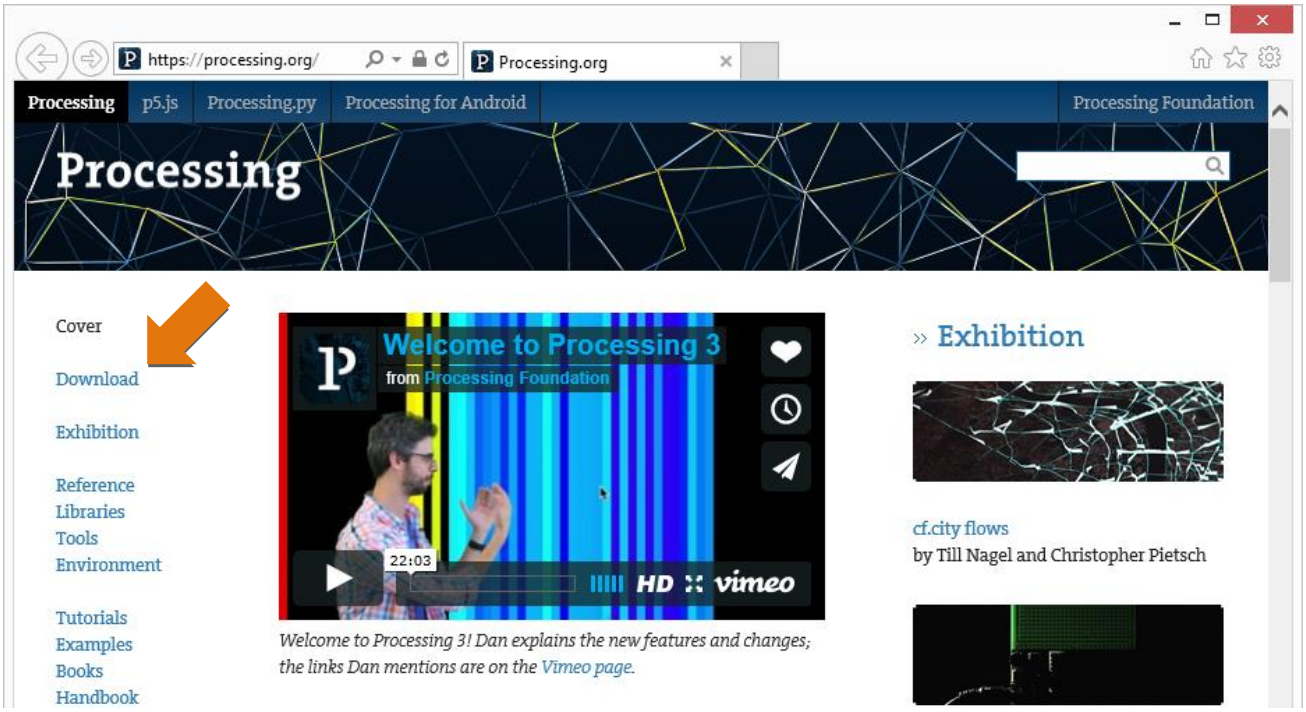
Programs written using Processing are also called sketches, and use Java language in default. Java language and C++ language has many similarities, the reader learned from our Starter Kit for Arduino tutorial, should be able to quickly understand and write simple Processing sketches.

Processing continues to be an alternative to proprietary software tools with restrictive and expensive licenses, making it accessible to schools and individual students. Its open source status encourages the community participation and collaboration that is vital to Processing's growth. Contributors share programs, contribute code, and build libraries, tools, and modes to extend the possibilities of the software. The Processing community has written more than a hundred libraries to facilitate computer vision, data visualization, music composition, networking, 3D file exporting, and programming electronics.

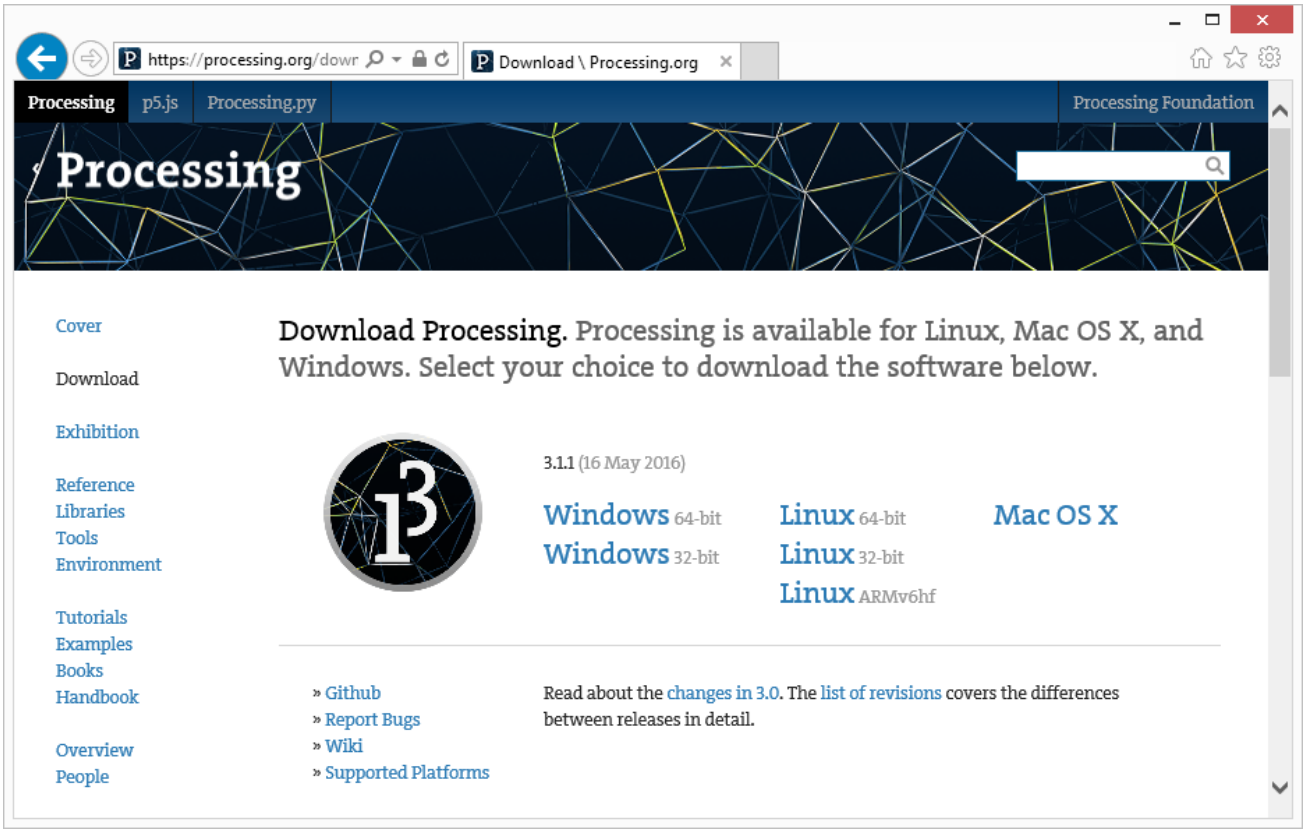
This tutorial will introduce how to install and use Processing software, and guide readers to complete some carefully crafted Arduino and Processing interactive project including virtual instruments, games (2D and 3D versions), etc.

Processing Software

Processing software / Processing Development Environment (PDE) makes it easy to write Processing programs. First, install Processing software: visit https://processing.org/, click "Download" to enter the download page.



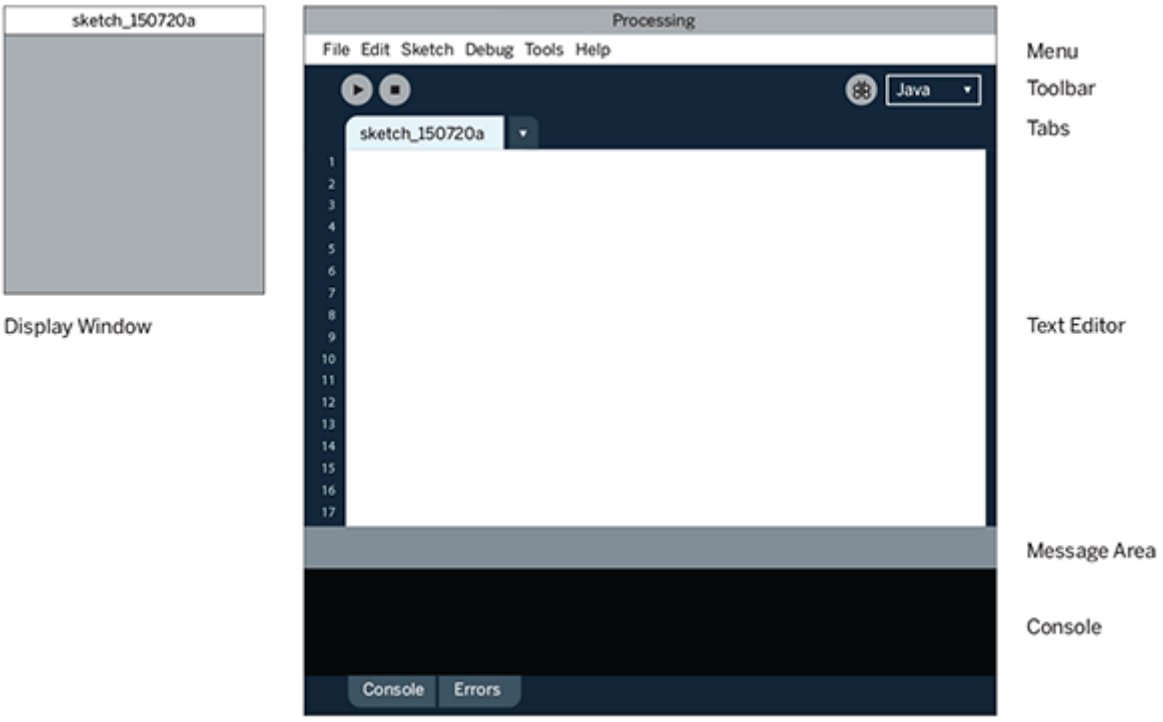
Select the Mac, Windows, or Linux version, depending on what machine you have.



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.



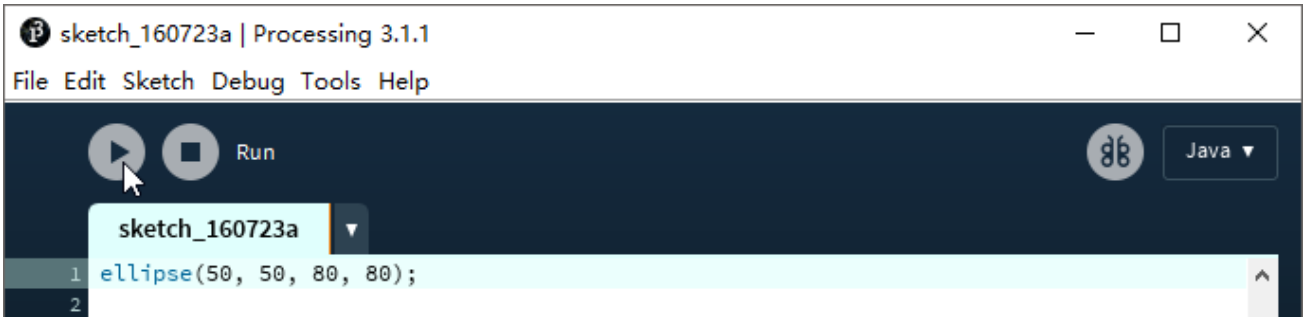
You're now running the Processing Development Environment (or PDE). There's not much to it; the large area is the Text Editor, and there's a row of buttons across the top; this is the toolbar. Below the editor is the Message Area, and below that is the Console. The Message Area is used for one line messages,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

First Use

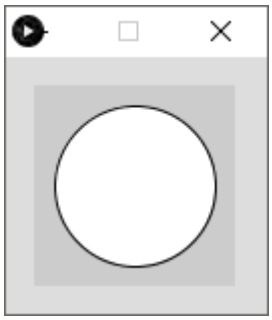
In the editor, type the following:

```
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).

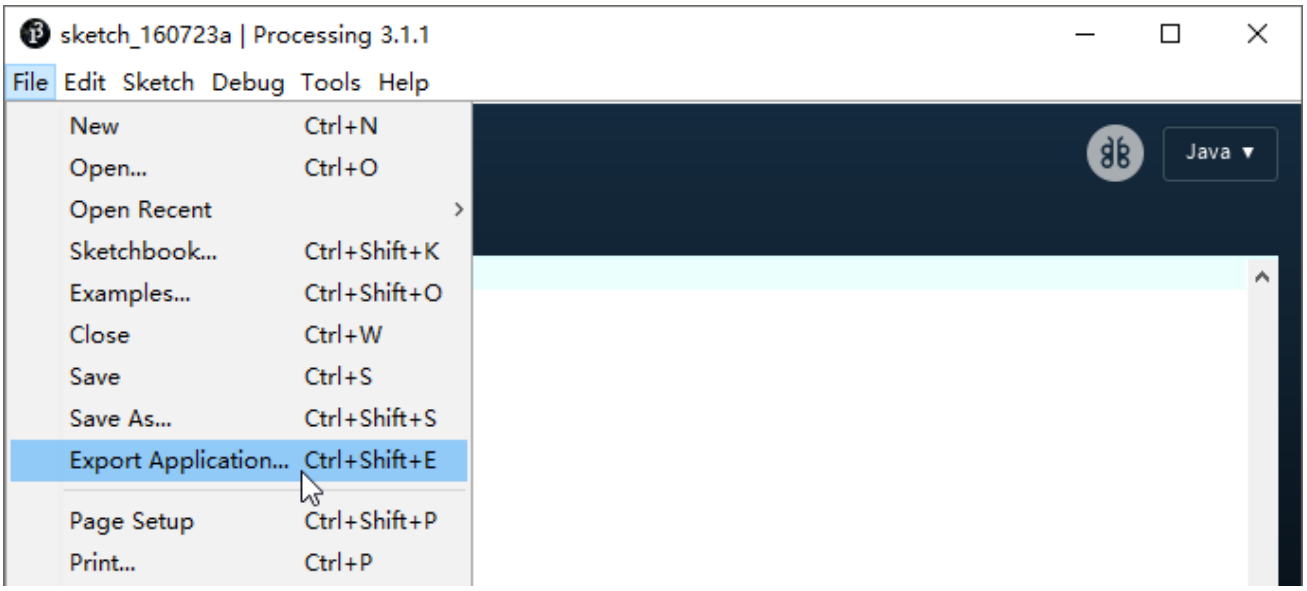


If you've typed everything correctly, you'll see a circle on your screen.



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.

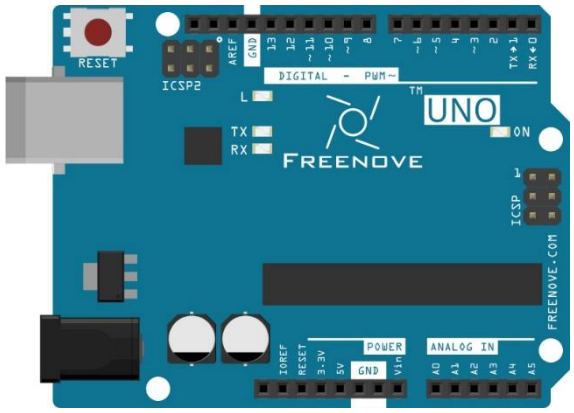
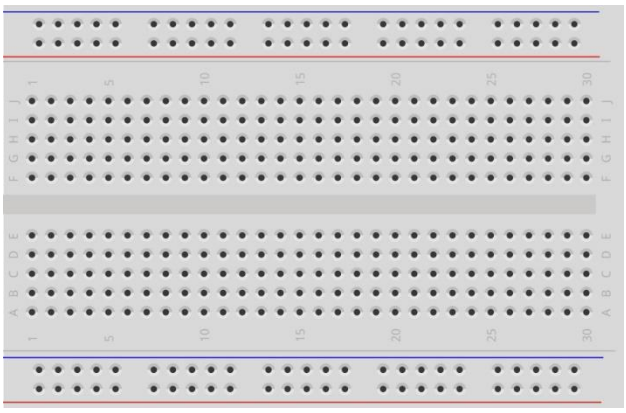
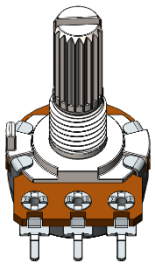
Chapter 1 Voltmeter

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

Project 1.1 Voltmeter

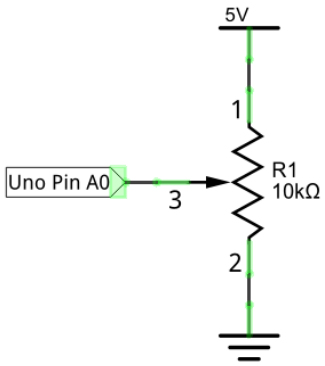
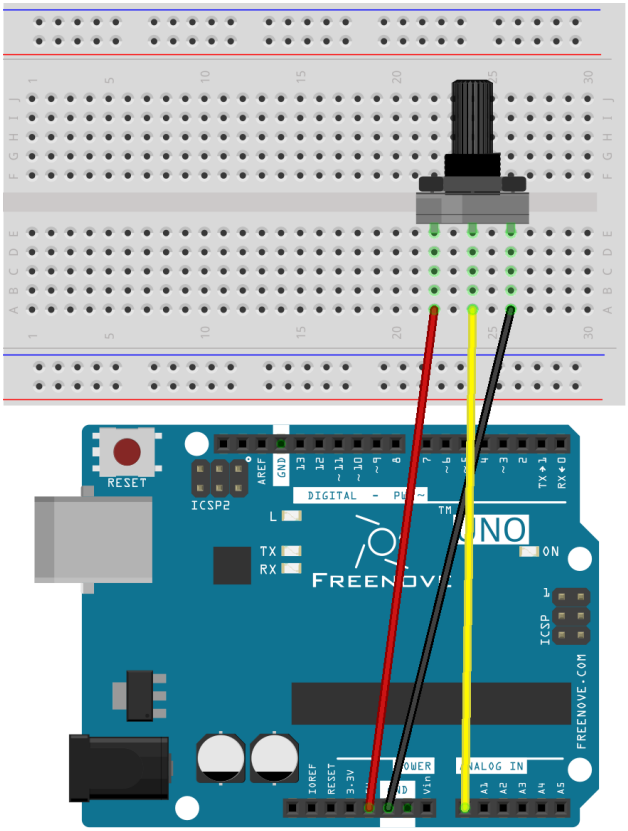
First, make a simple voltmeter.

Component list

Freenove UNO x1 	Breadboard x1 
USB cable x1 	Rotary potentiometer x1 
Jumper M/M x3 	

Circuit

Use A0 port on Freenove UNO to detect the voltage of rotary potentiometer.

Schematic diagram	Hardware connection
	

Communication protocol

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

In order to simplify and facilitate the operation, we prepared a SerialDevice class for Processing to communicate with Arduino. To use this class, we need to upload the following sketch to Arduino:
Processing\Arduino\SerialDevice\SerialDevice.ino.
This sketch only need to be uploaded once, so the latter projects of this tutorial does not need to upload again.

SerialDevice class and SerialDevice.ino defined the communication protocol between them. The futures include:

- Recognize the Arduino board uploaded SerialDevice.ino and establish connection with it, automatically. No need to view and set the serial number of Arduino boards connected to the computer, even if there are a number of Arduino board, it can be connected automatically.
- If Arduino board uploaded SerialDevice.ino 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 Arduino and receive data from it.

Sketch

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

Sketch Voltmeter

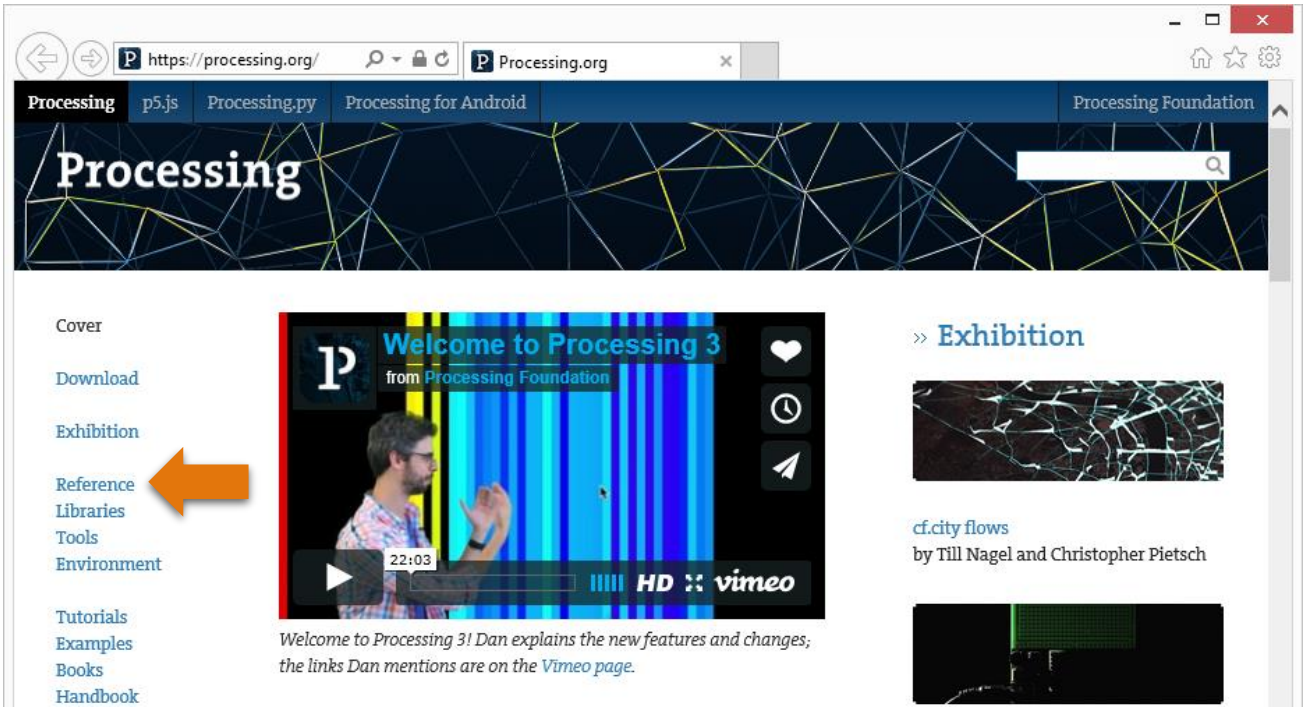
Use Processing to open Voltmeter.pde and click Run. Then, the following window will pop up and its connection to UNO board will be started.

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

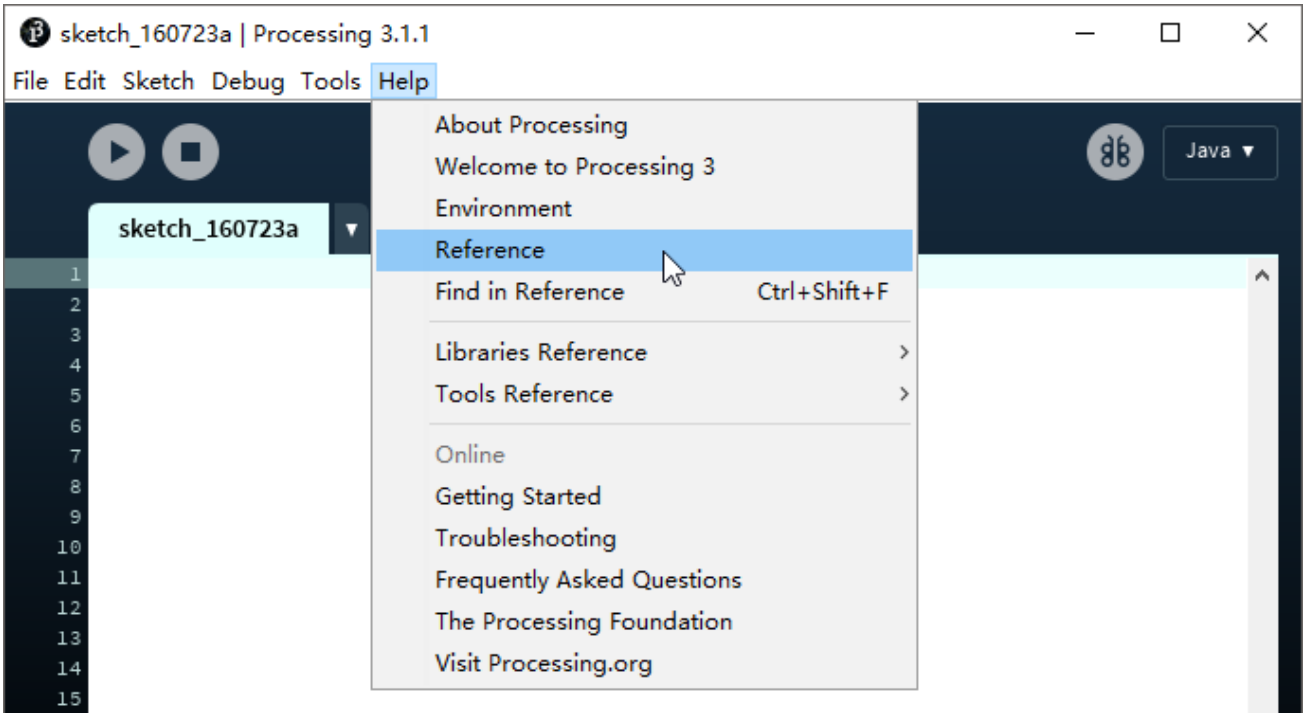
This sketch will obtain analog value from A0 port of UNO board, and convert it to voltage value to display. You can adujust the potentiometer to observe the change of value, and you can also use the A0 port to measure voltage value of other circuits. Note that the measurement voltage can not exceed 5V, which will do damage to the UNO board.

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.



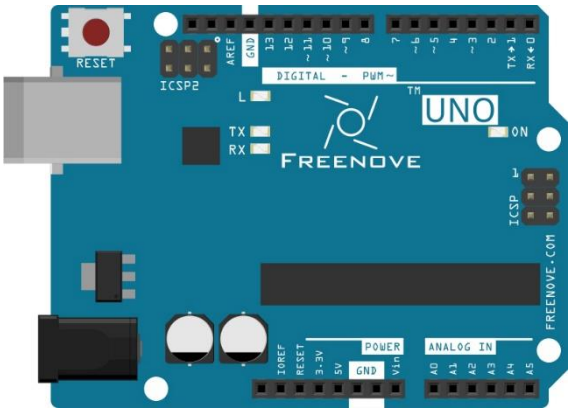
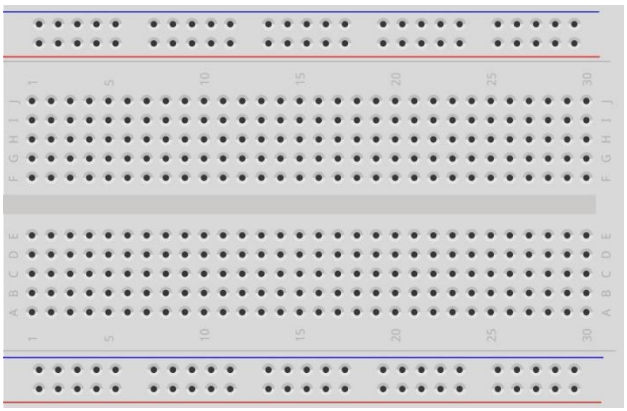
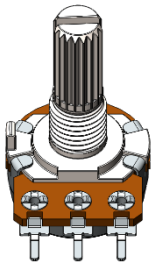
Or in the Processing software menu bar, click Help-Reference to view offline documents.



Project 1.2 Voltmeter Dual Channel

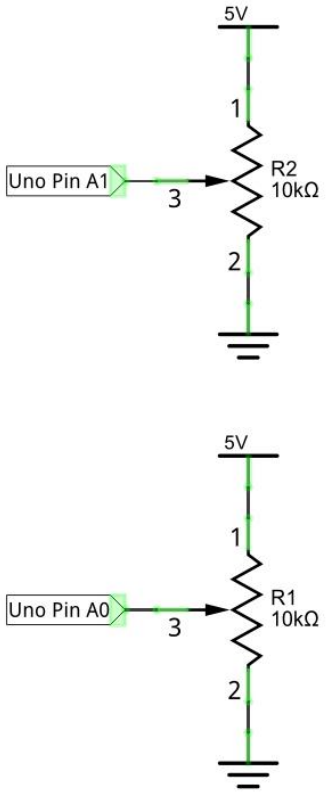
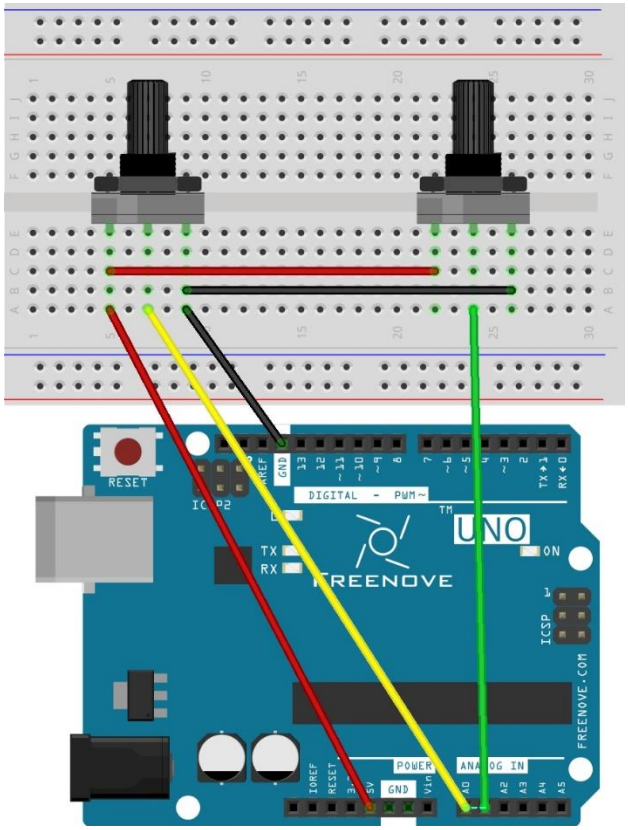
Now, let's make a dual channel voltmeter.

Component list

Freenove UNO x1 	Breadboard x1 
USB cable x1 	Rotary potentiometer x2 
Jumper M/M x6 	

Circuit

Use A0, A1 ports on Freenove UNO to detect the voltage of rotary potentiometers.

Schematic diagram	Hardware connection
	

Sketch

Sketch Voltmeter_Dual_Channel

Use Processing to open Voltmeter_Dual_Channel.pde and click Run. Then, the following window will pop up and its connection to UNO board will be started.

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

This sketch will obtain analog value from A0 and A1 ports of UNO board, and convert them to voltage value to display. You can adujust 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 can not exceed 5V, which will do damage to the UNO board.

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

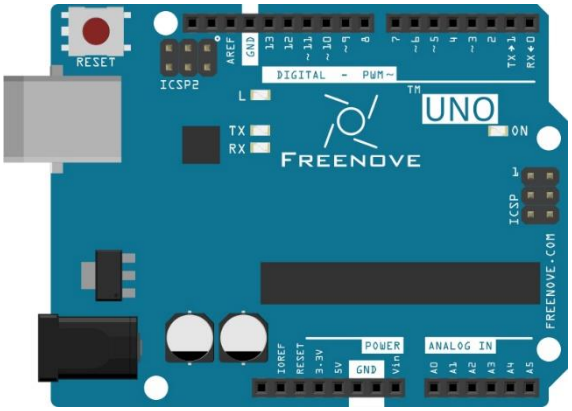
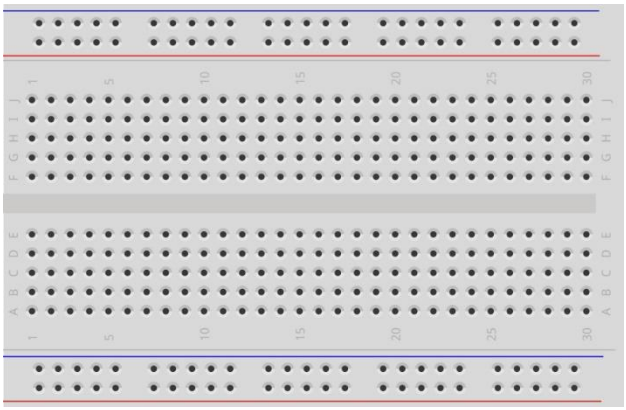
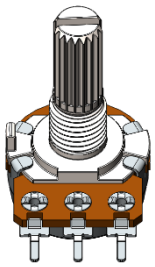
Chapter 2 Oscilloscope

We have implemented a simple virtual instrument voltmeter, before. 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 not directly observed into visible image to facilitate the analysis and study of various electrical signals change process.

Project 2.1 Oscilloscope

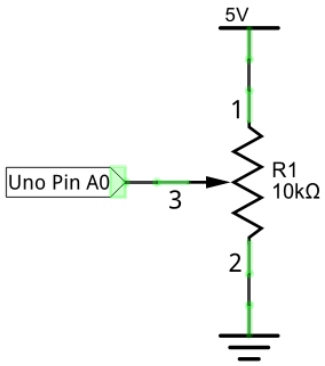
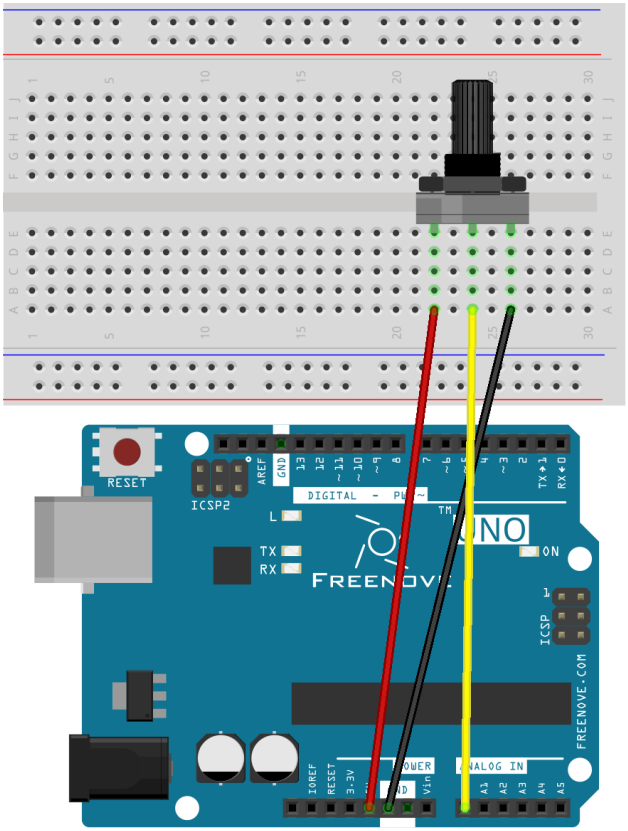
Now, let's use Processing and Arduino to achieve an oscilloscope.

Component list

Freenove UNO x1 	Breadboard x1 
USB cable x1 	Rotary potentiometer x1 
Jumper M/M x3 	

Circuit

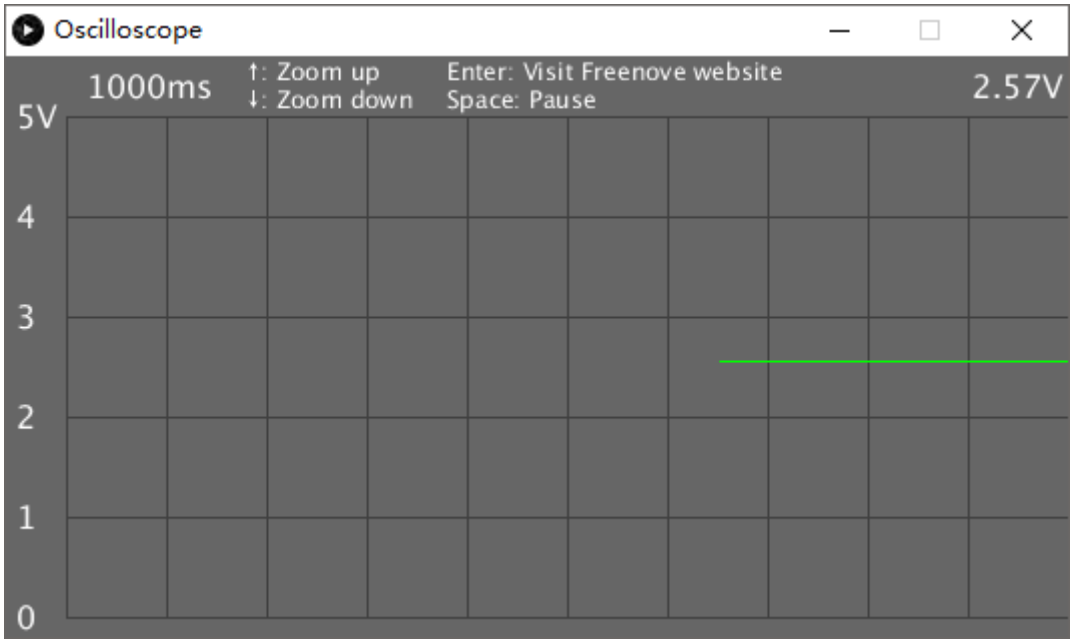
Use A0 port on Freenove UNO to detect the voltage of rotary potentiometer.

Schematic diagram	Hardware connection
	

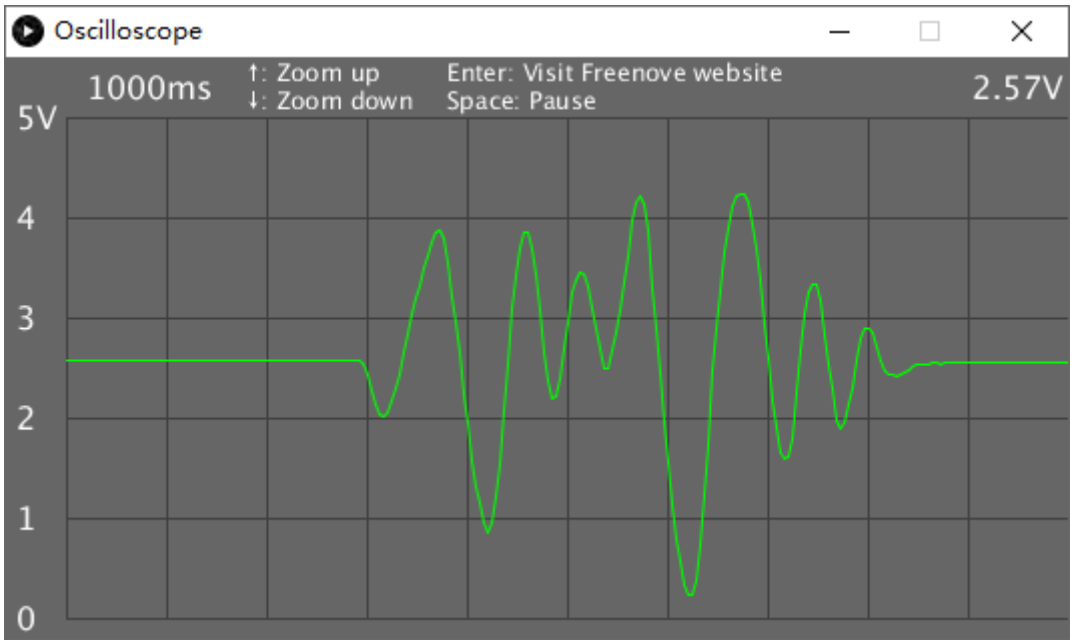
Sketch

Sketch Oscilloscope

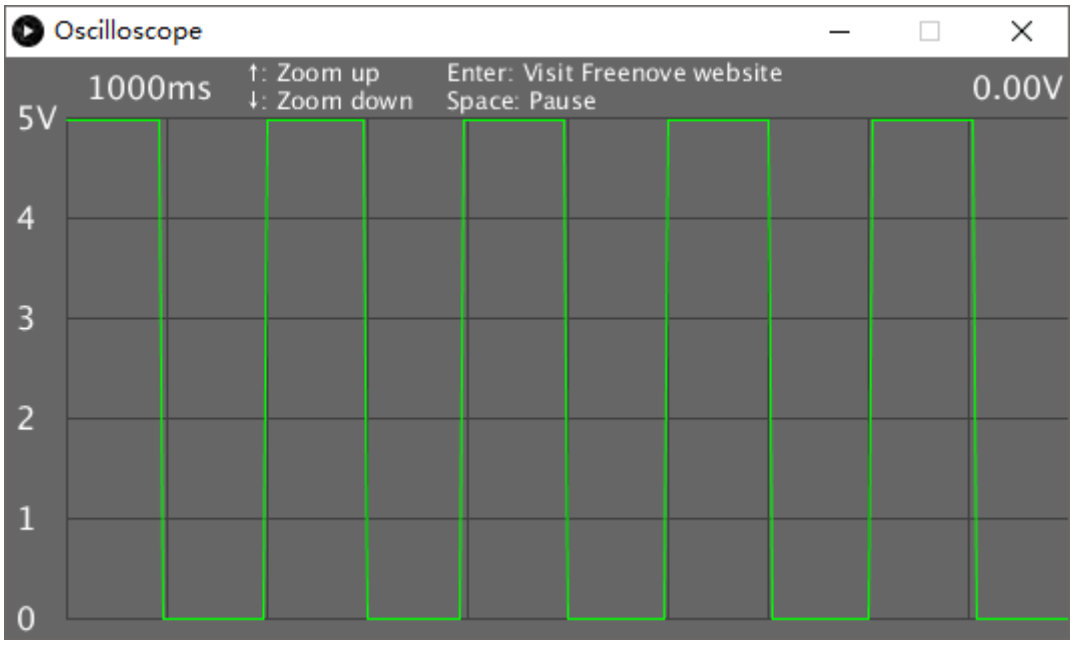
Use Processing to open Oscilloscope.pde and click Run. If the connection succeeds, the follow will be shown:



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



Disconnect the A0 port from the potentiometer and connect it to the D13 port. D13 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.

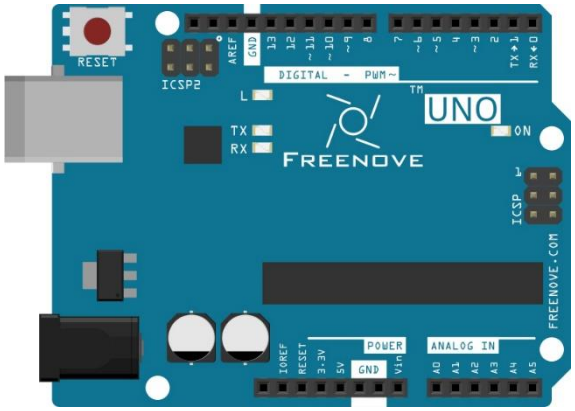
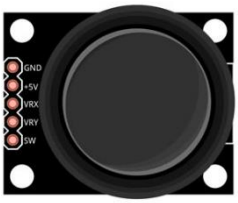
Chapter 3 Control 2D and 3D Figures

In this chapter, we will use Arduino to make Processing program display figure changes. And we will control 2D and 3D figures, respectively.

Project 3.1 Ellipse

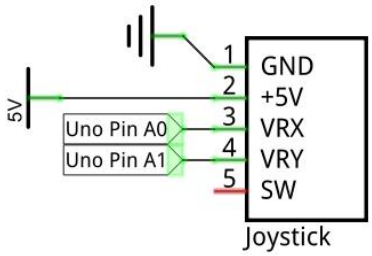
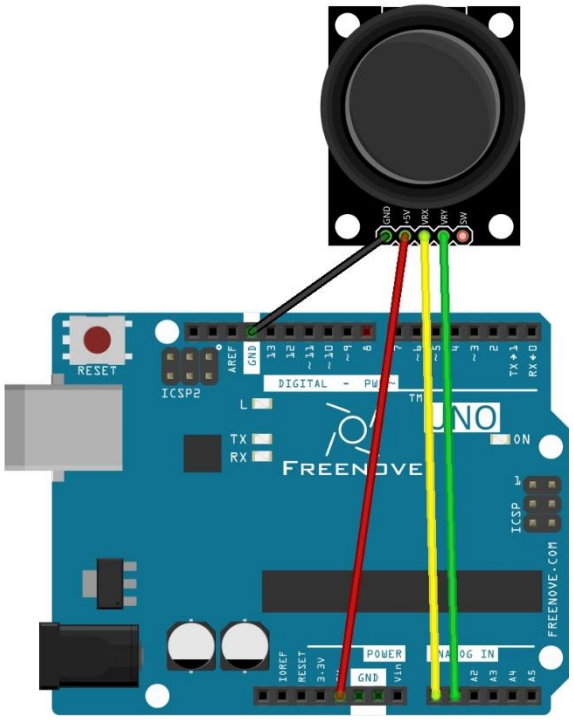
First, control a 2D figure.

Component list

Freenove UNO x1 	Joystick x1 
USB cable x1 	Jumper F/M x4 

Circuit

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

Schematic diagram	Hardware connection
	

Sketch

Sketch Ellipse

Use Processing to open Ellipse.pde, then click Run. If the connection succeeds, the following will be shown:

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

Project 3.2 Box 3D

Now control 3D figures.

Component list

The same as last section.

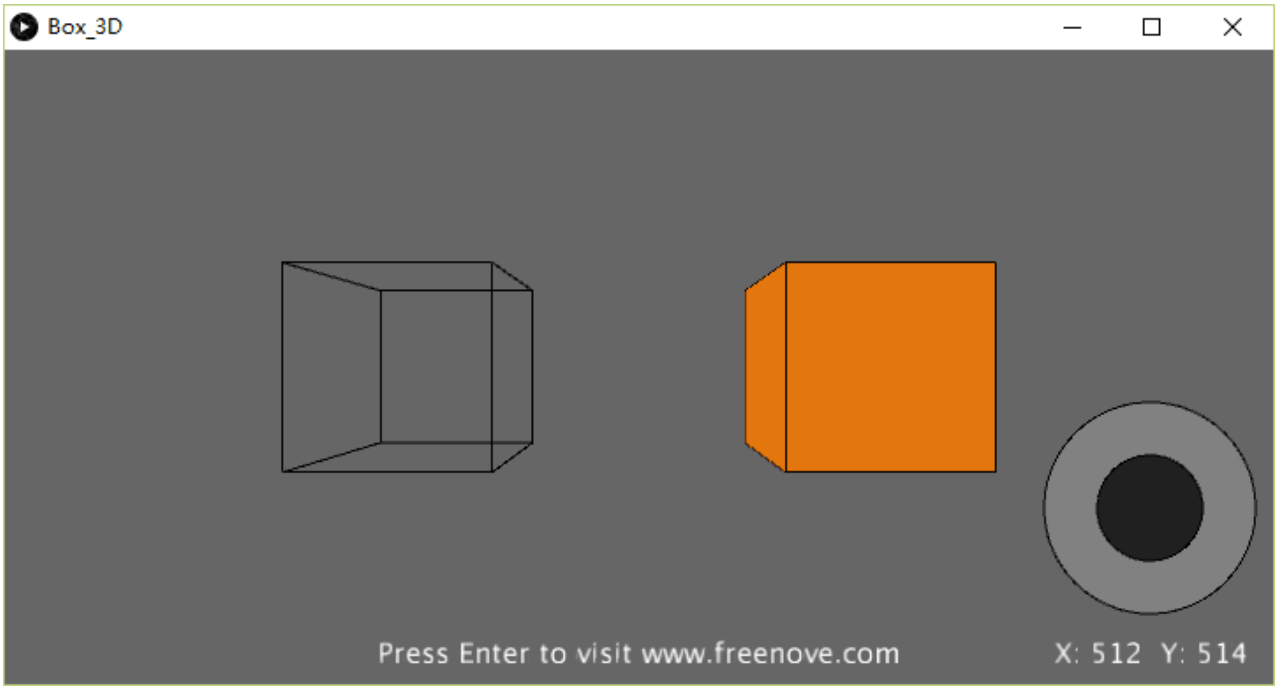
Circuit

The same as last section.

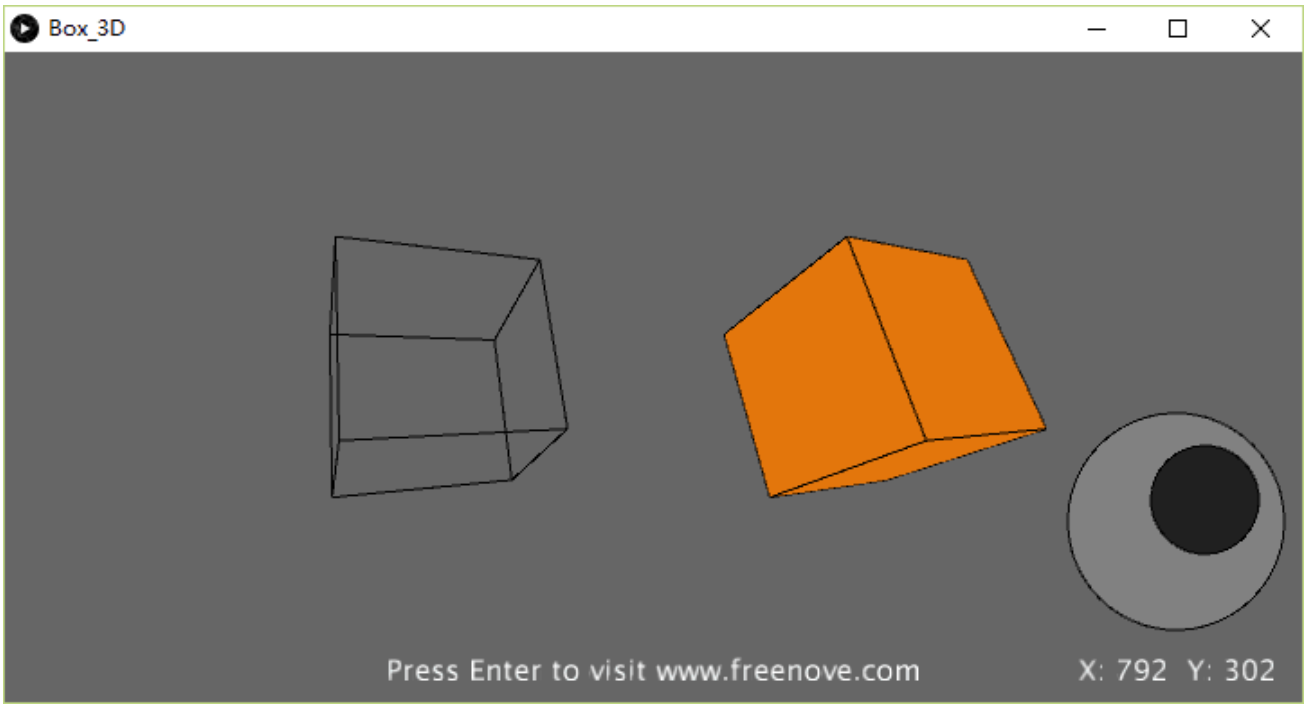
Sketch

Sketch Box_3D

Use Processing to open 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 box by shifting the joystick:



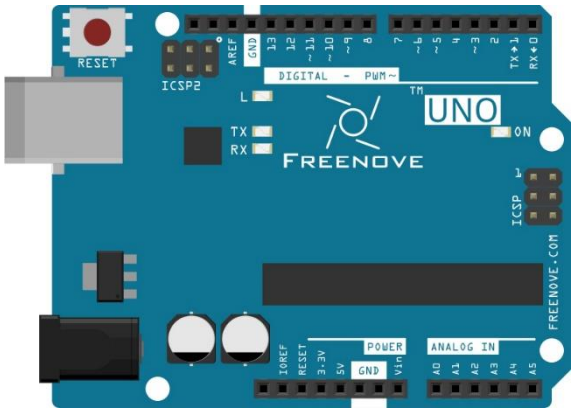
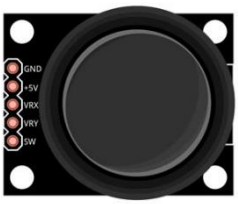
Chapter 4 Snake Game

We have experienced controlling 2D and 3D figures before. Now, we use Arduino to play the classic snake game. You will experience both 2D and 3D version.

Project 4.1 Snake Game

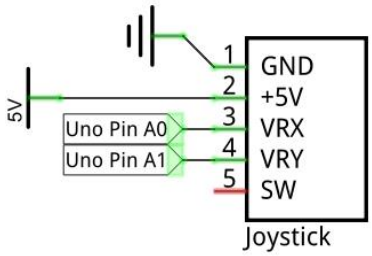
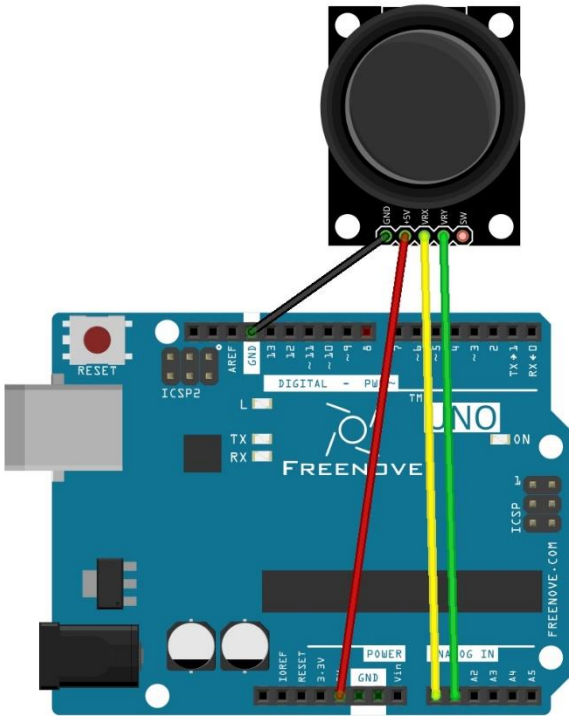
First, let's experience the 2D version game.

Component list

Freenove UNO x1 	Joystick x1 
USB cable x1 	Jumper F/M x4 

Circuit

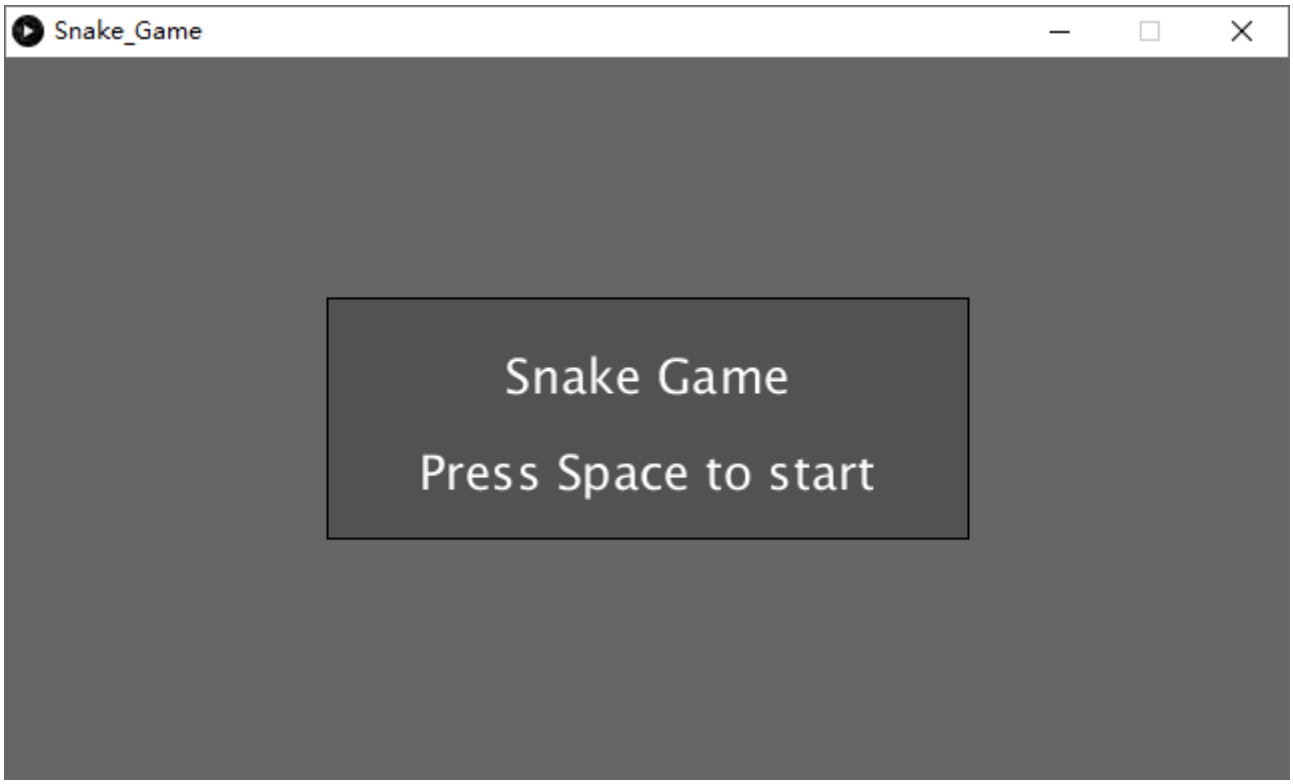
Use A0 and A1 ports on Freenove UNO board to detect the voltage value of two rotary potentiometers inside joystick.

Schematic diagram	Hardware connection
	

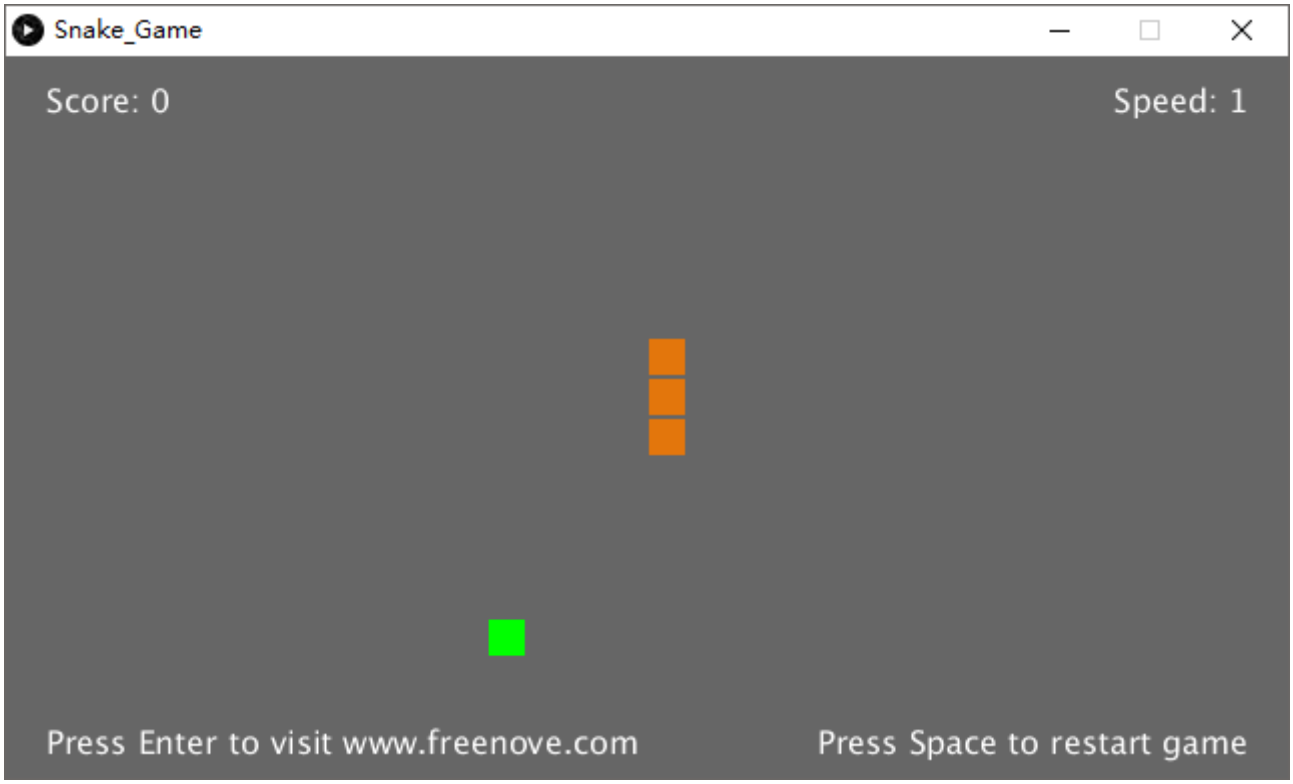
Sketch

Sketch Snake_Game

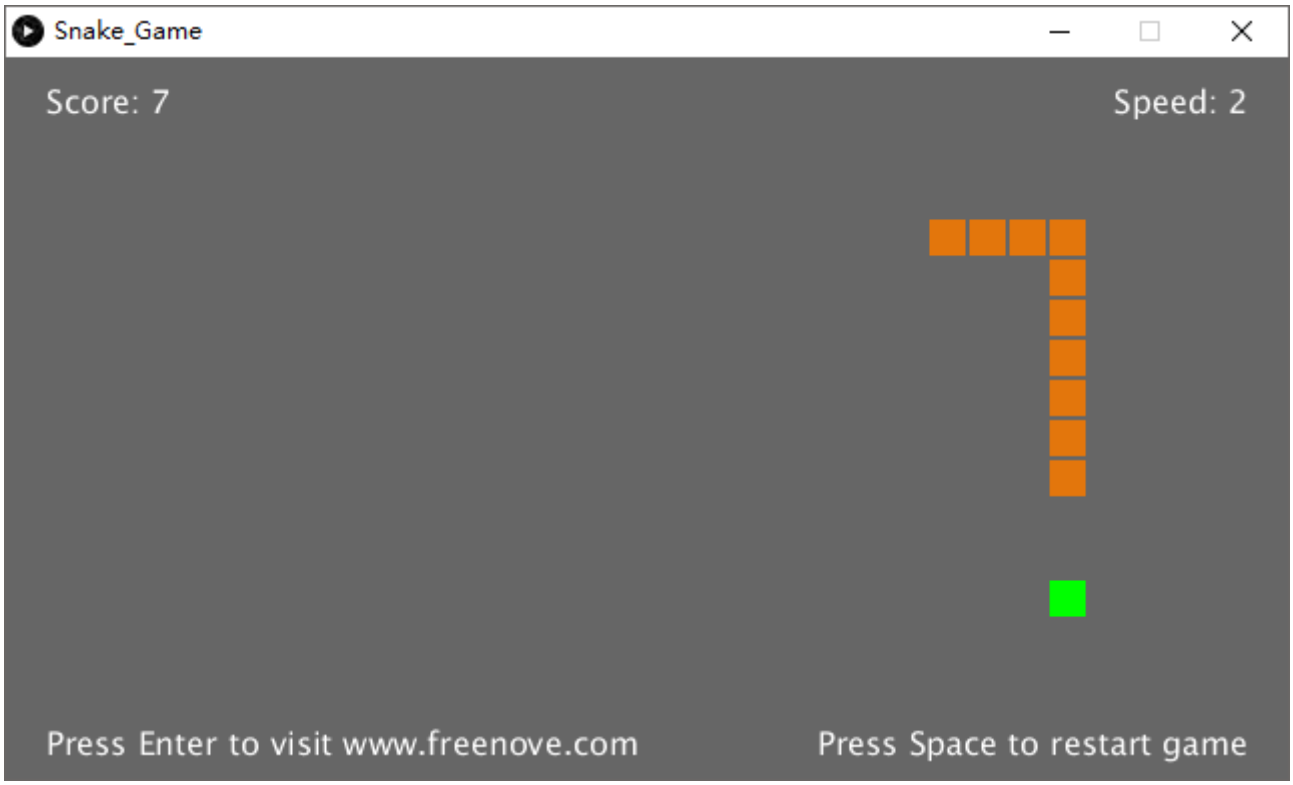
Use Processing to open Snake_Game.pde and click Run. If the connection succeeds, the follow will be shown:



Press the space bar on keyboard to start the game:



Shift the joystick to control the snake action. 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.

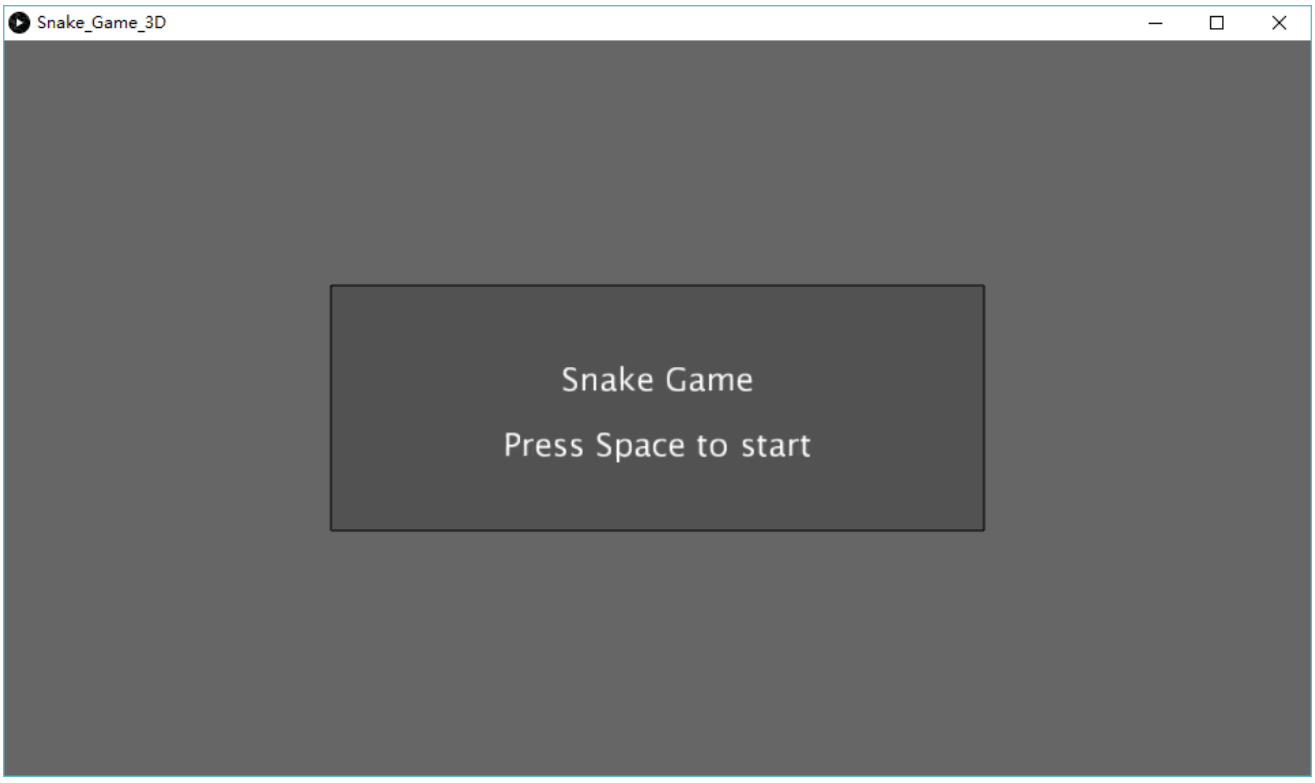
Circuit

The same as last section.

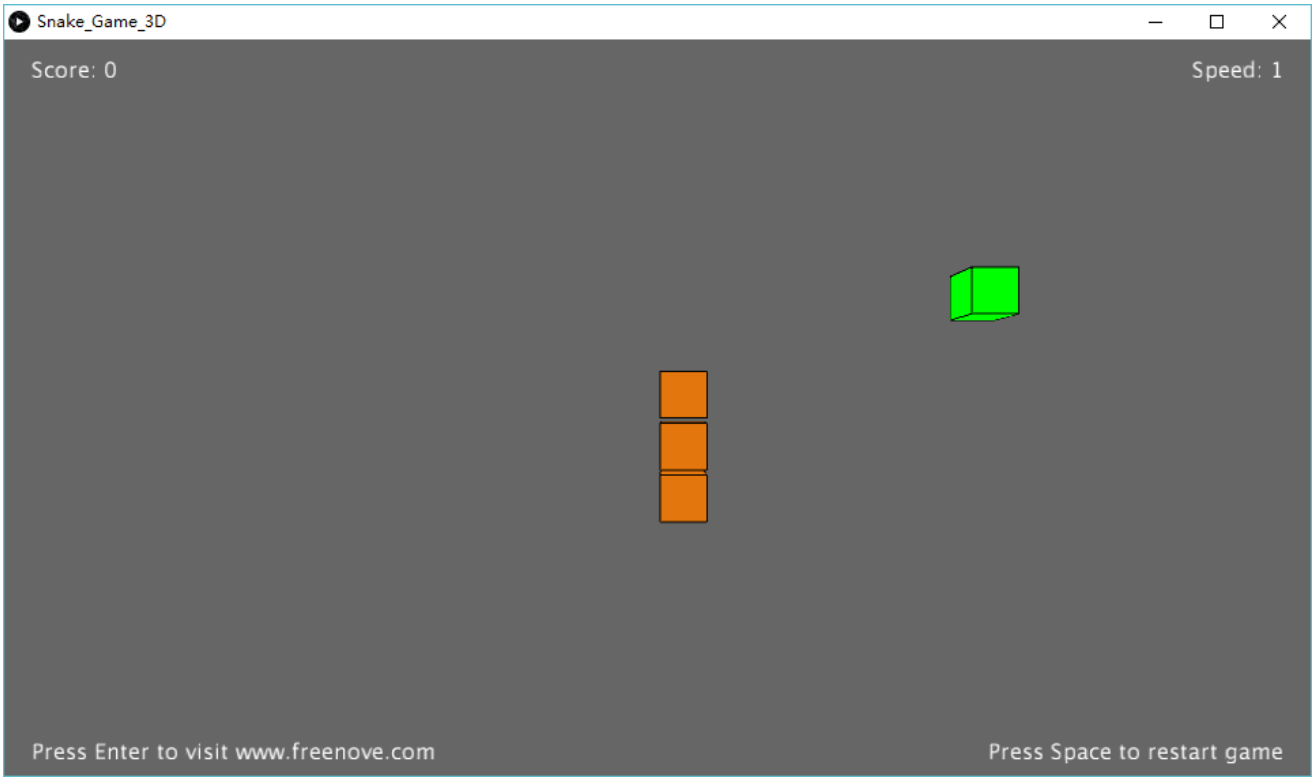
Sketch

Sketch Snake_Game_3D

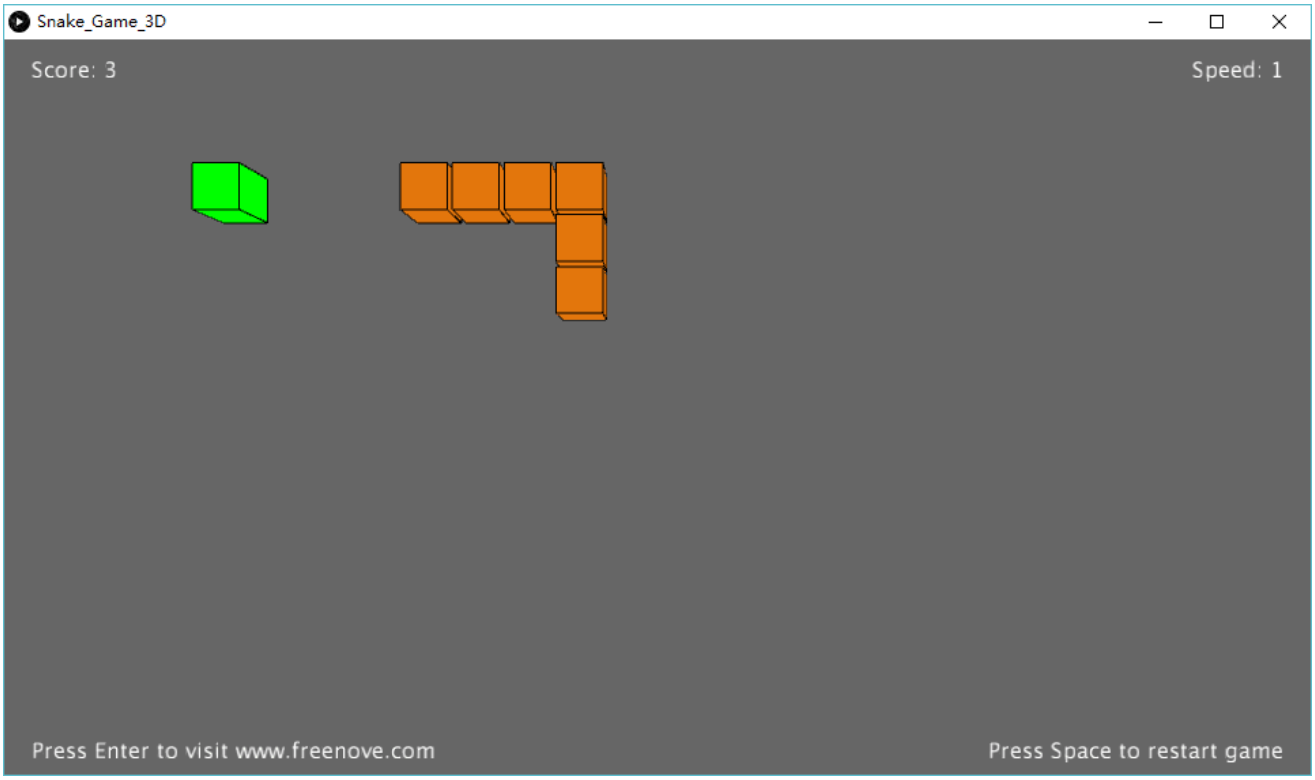
Use Processing to open Snake_Game_3D.pde and click Run. If the connection succeeds, the follow will be shown:



Press the space bar on keyboard to start the game:



Shift the joystick to control the snake action. The game rules are the same as the classic snake game:



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

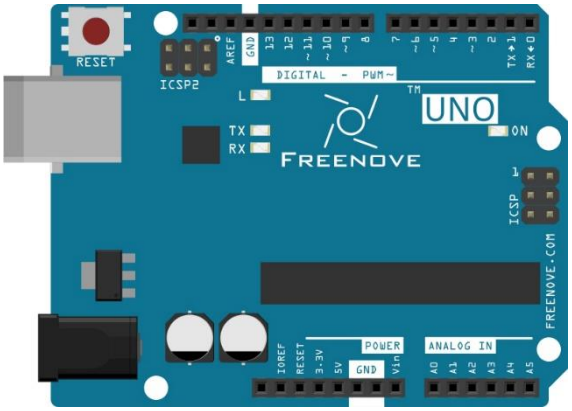
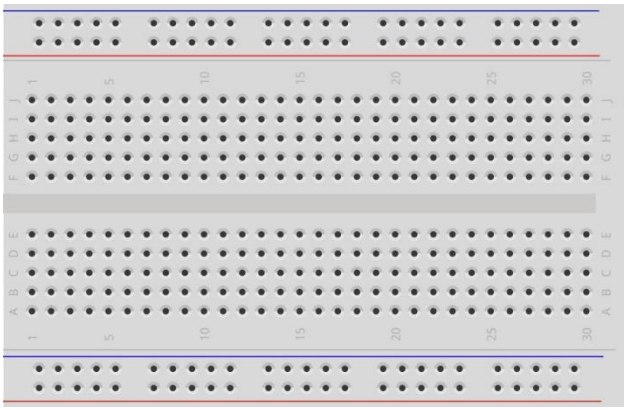
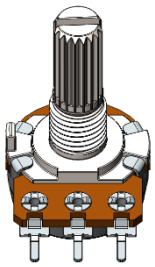
Chapter 5 Pong Game

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

Project 5.1 Pong Game

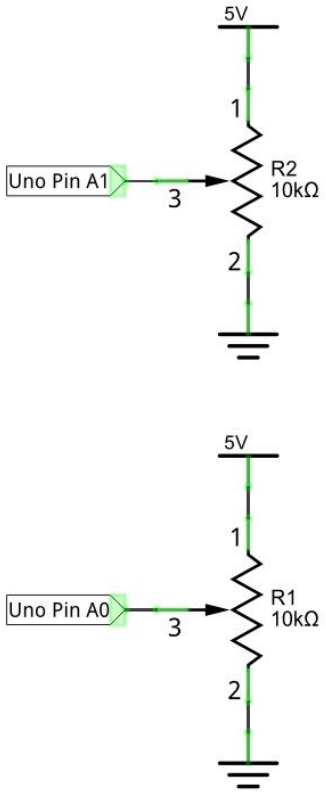
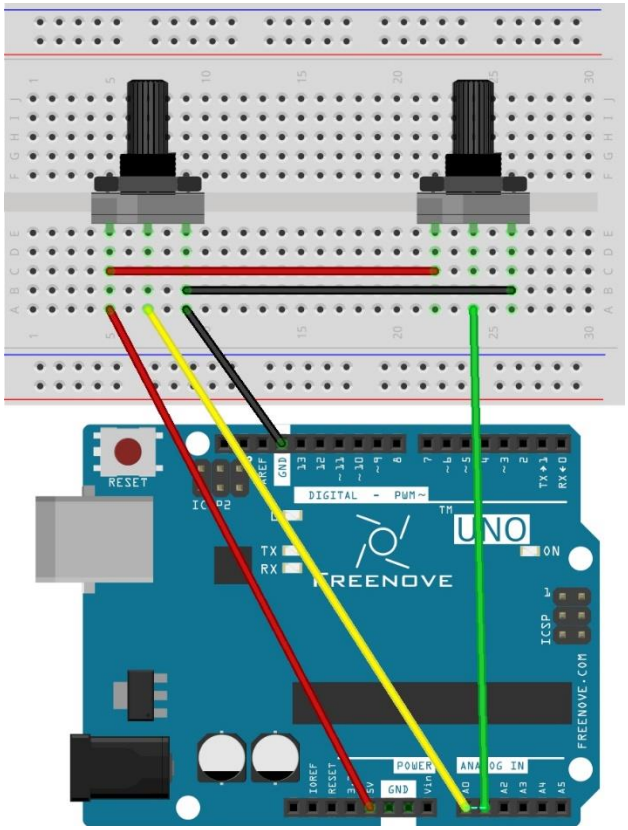
First, let's experience the 2D version game.

Component list

Freenove UNO x1 	Breadboard x1 
USB cable x1 	Rotary potentiometer x2 
Jumper M/M x6 	

Circuit

Use A0, A1 ports on Freenove UNO to detect the voltage of rotary potentiometers.

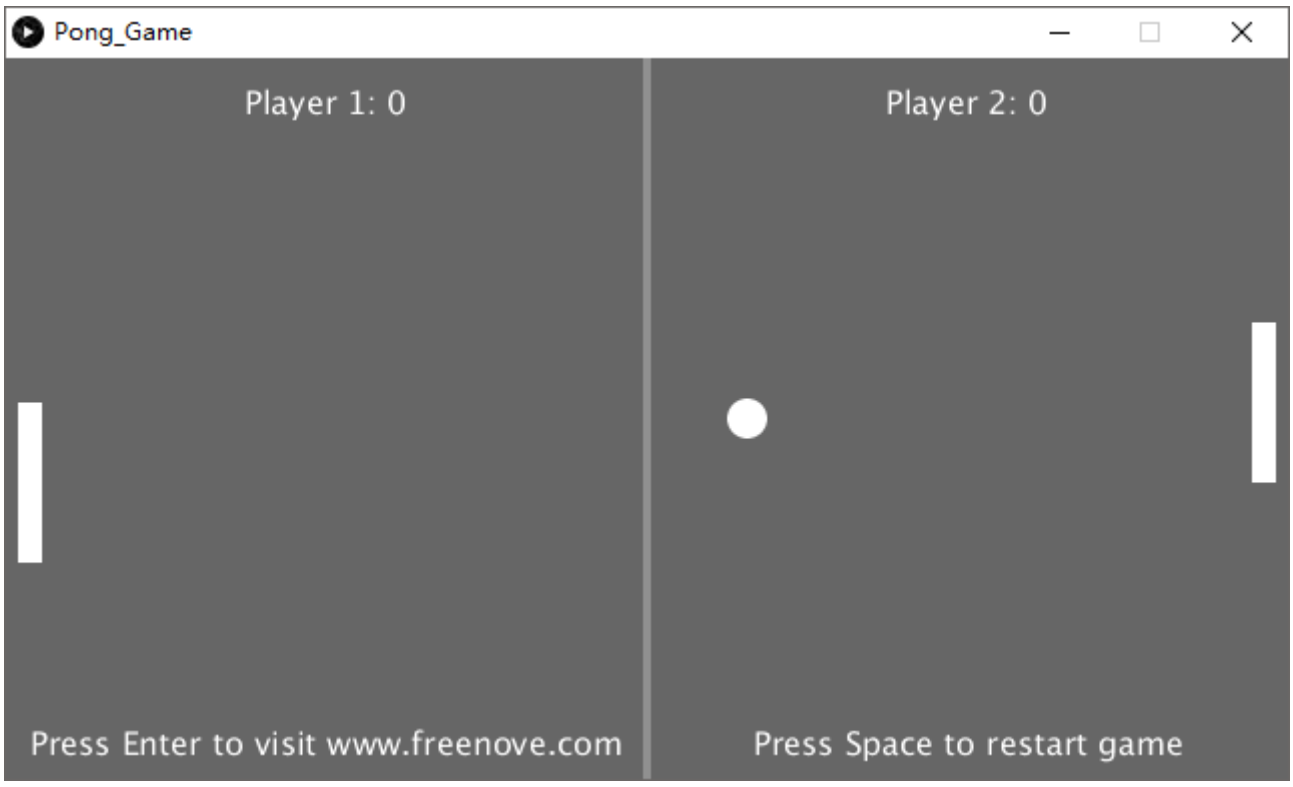
Schematic diagram	Hardware connection
	

Sketch

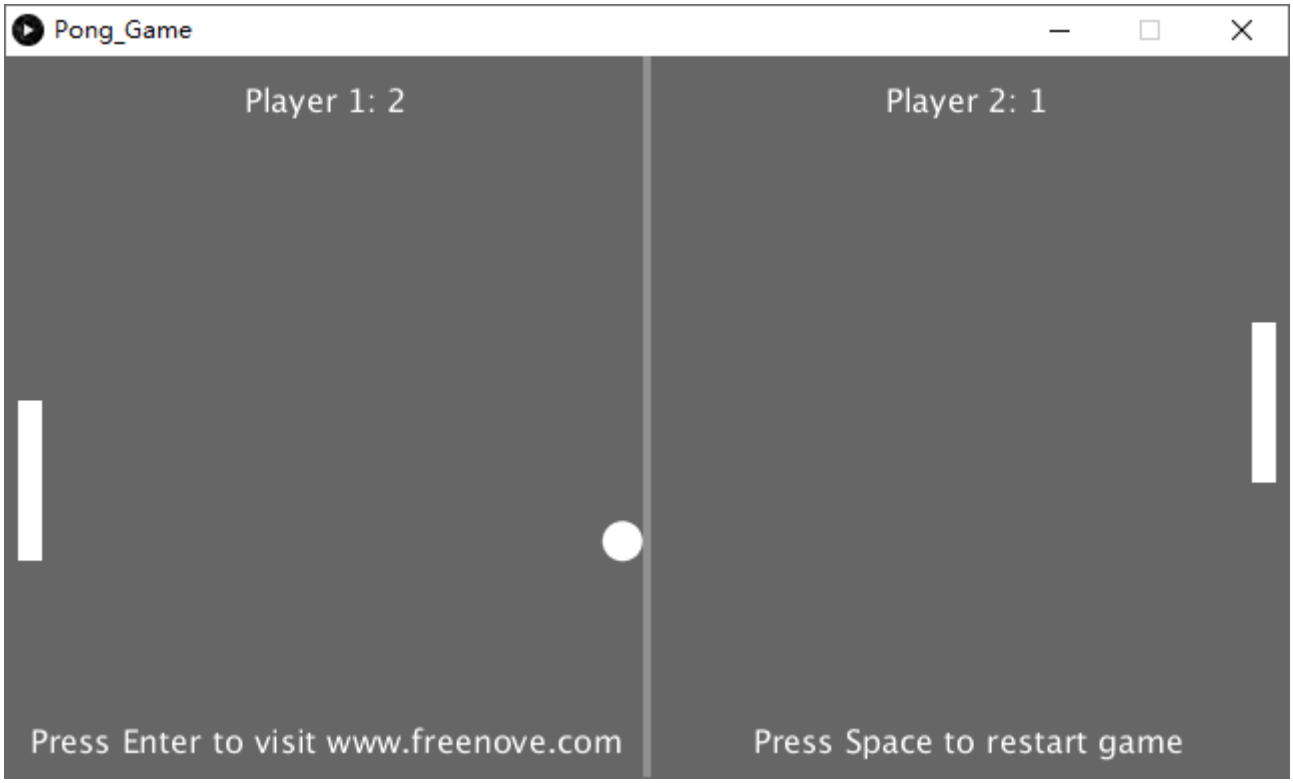
Sketch Pong_Game

Use Processing to open Pong_Game and click Run. If the connection succeeds, the follow will be shown:

Now you can try to turn the potentiometer to control the movement of paddle without ball. Press space bar to start the game:



Use potentiometer 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 reachs 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 5.2 Pong Game 3D

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

Component list

The same as last section.

Circuit

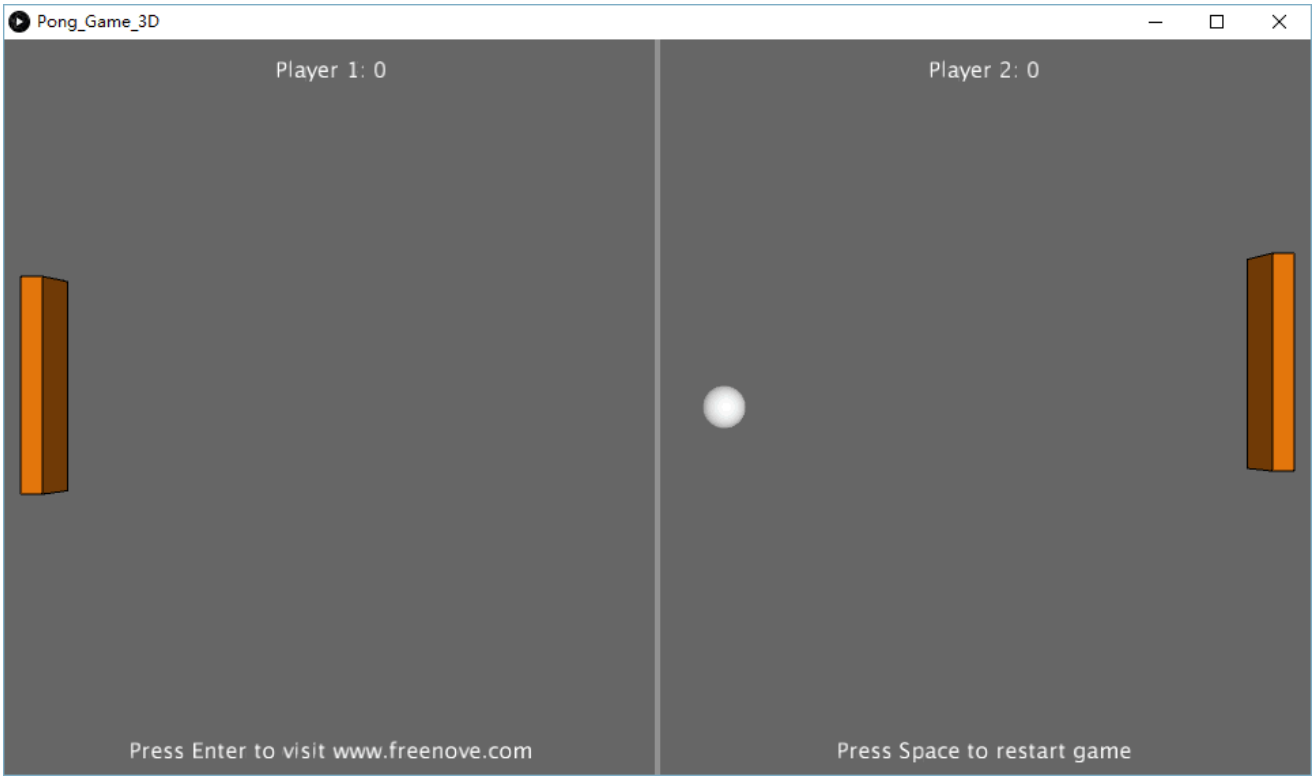
The same as last section.

Sketch

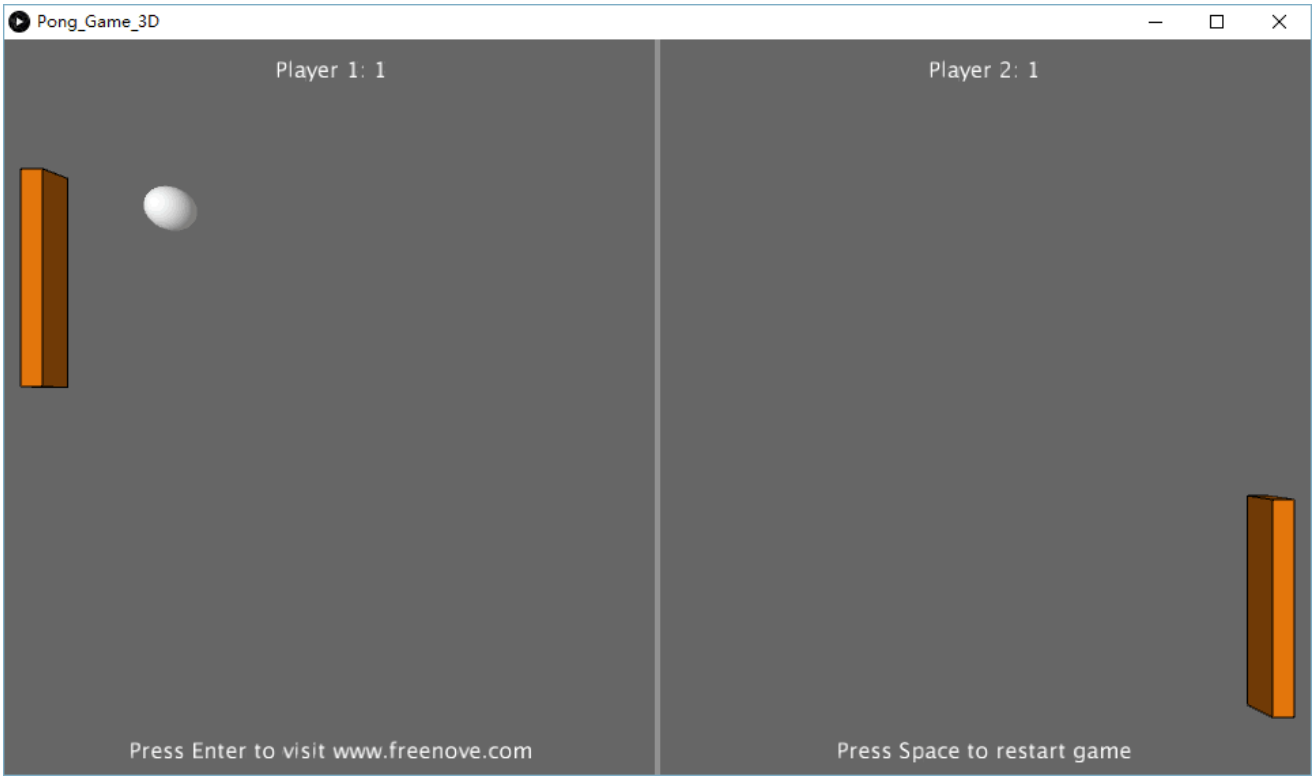
Sketch Pong_Game_3D

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

Now you can try to turn the potentiometer to control the movement of paddle without ball. Press space bar to start the game:



Use potentiometer 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.

What's next?

Thanks for your reading.

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

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

Thank you again for choosing Freenove products.