Preface

About SunFounder

As an open source electronics service provider, SunFounder is committed to developing open source electronics educational products, expanding related knowledge to let hobbyists have a good understanding about open source electronics and providing a platform through which people can learn, develop hands-on skills, and improve their innovative abilities.

About SunFounder Crawling Quadruped Robot Kit for Arduino

This learning kit is based on the popular open source electronics platform Arduino. It is different from most popular kits on the market. With this kit, you cannot only learn how to use Arduino, servo and wireless module but also DIY a cool crawling quadruped robot with wireless remote control. We provide a very detailed manual and technical support for free. And we are ready to answer your questions at any time. If you want to DIY your own robot, this kit is a good start.

SunFounder Crawling Quadruped Robot is a four-leg mobile robot, and each leg has three joints driven by a servo. It is powered by two 18650 rechargeable lithium batteries, compatible with Arduino Nano V3.0 board and uses the SunFounder Nano board as control. In addition, a SunFounder Servo Control Board integrates battery, servo, SunFounder Nano board, and nRF24l01 wireless module together. This kit is equipped with a SunFounder Mobile Robot Remote Controller so that you can observe and control the robot remotely.

Notes

- There are some 3D models showed in this manual, whose color and shape may be different from real objects.
- Please follow instructions in the manual in case of damage to the components.
- These components may be fragile, please do not attempt any operations that may cause damage.
- We provide free technical support, but man-made damages to the components are excluded.
- If you have any questions, suggestions or ideas, please send your email to support@sunfounder.com, or visit www.sunfounder.com and click **Contact us**. We will reply to you ASAP.

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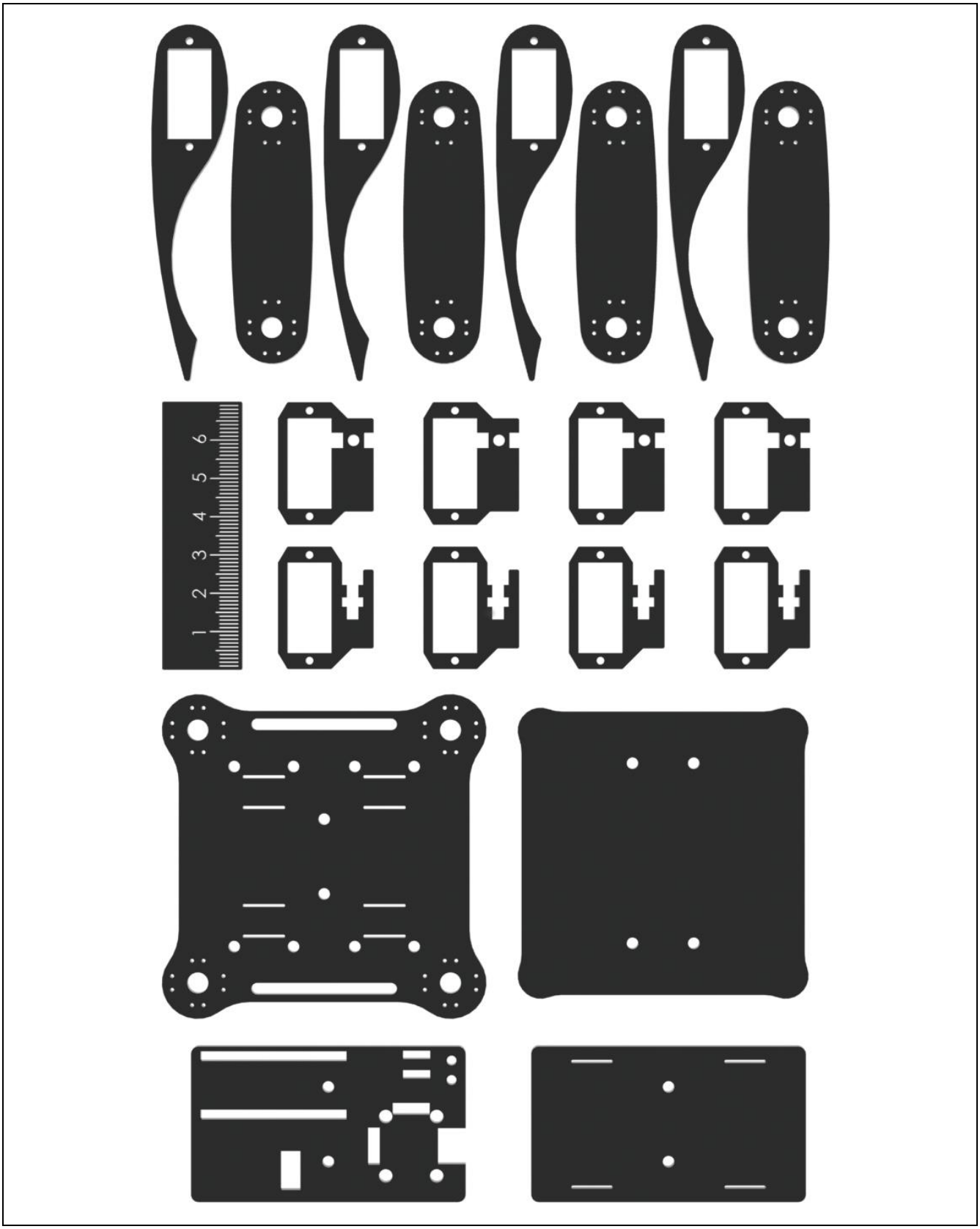
1. List

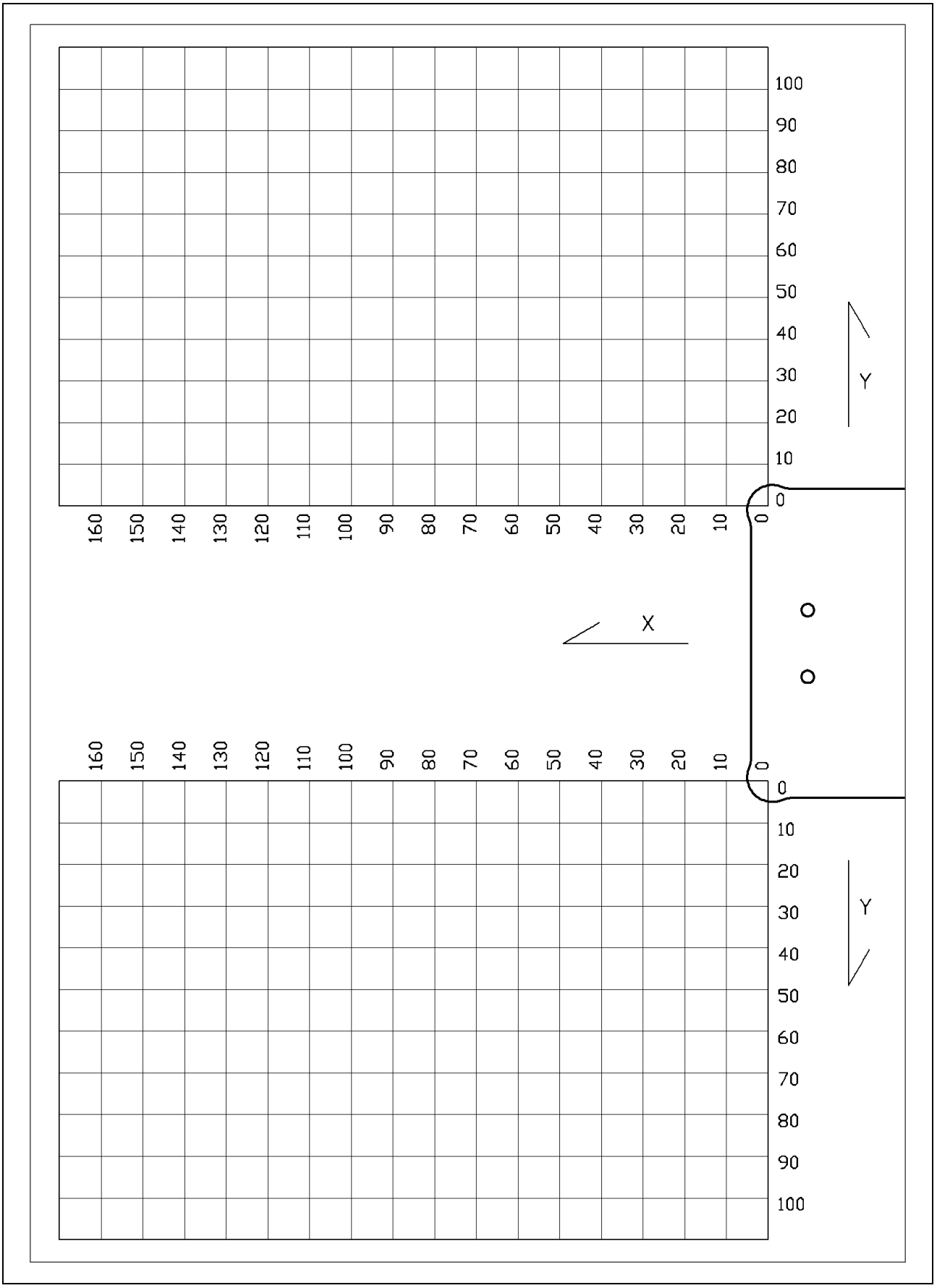
Acrylic Plates



You need to clean these acrylic boards before using them. We take one board for example.

<table>
<tr>
<td>1. There are some residues in the following holes.
 </td>
<td>2. Clean the residues with a sharp tool.
 </td>
</tr>
<tr>
<td>3. It is shown as below after it is cleaned.
 </td>
<td>4. Finally torn off the paper stucked on the two sides of the arcylic board.
 </td>
</tr>
</table>

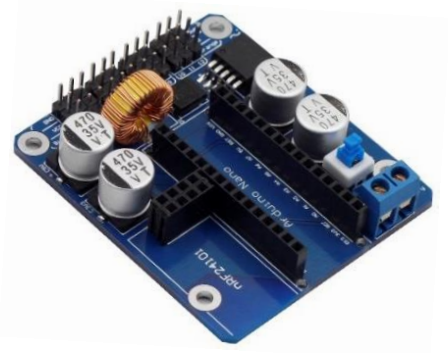
Calibration Chart



Mechanical Connectors

Accessory	Name	Quantity
	M1.2*5 Self-tapping Screw	100
	M2*8 Screw	26
	M2 Nut	26
	M3*12 Screw	6
	M3*8 Screw	6
	M3*6 Screw	6
	M3*14 Countersunk Screw	4
	M3*10 Countersunk Screw	4
	M3*30 Copper Standoff	6
	M3*8 Copper Standoff	6
	M3 Nut	20

Electronic Accessories

Accessory	Name	Quantity
	nRF24l01 Module	2
	SunFounder Nano Board	2
	SunFounder Mobile Robot Remote Controller	1
	SunFounder Servo Control Board	1
	2x18650 Battery Holder	2

	EMAX ES08AⅡ Analog Servo	12
	USB Data Cable	1
	Wire Harness Tube (80cm)	1
	Ribbon (50cm) (Divided into four equal parts)	1

Tools

Accessory	Name	Quantity
	Screwdriver	1

Self-provided Components

The following components are not included in this kit.

Accessory	Name	Quantity
	18650 Rechargeable Li-ion Battery (3.7V)	4

2. Getting Started

Arduino

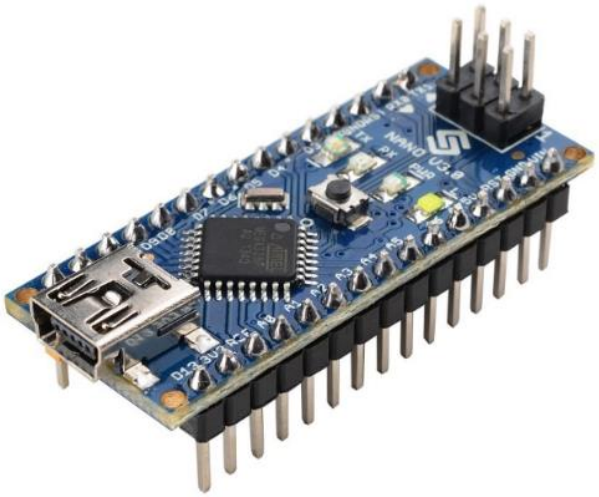
Description

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.

Arduino Board

Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators.

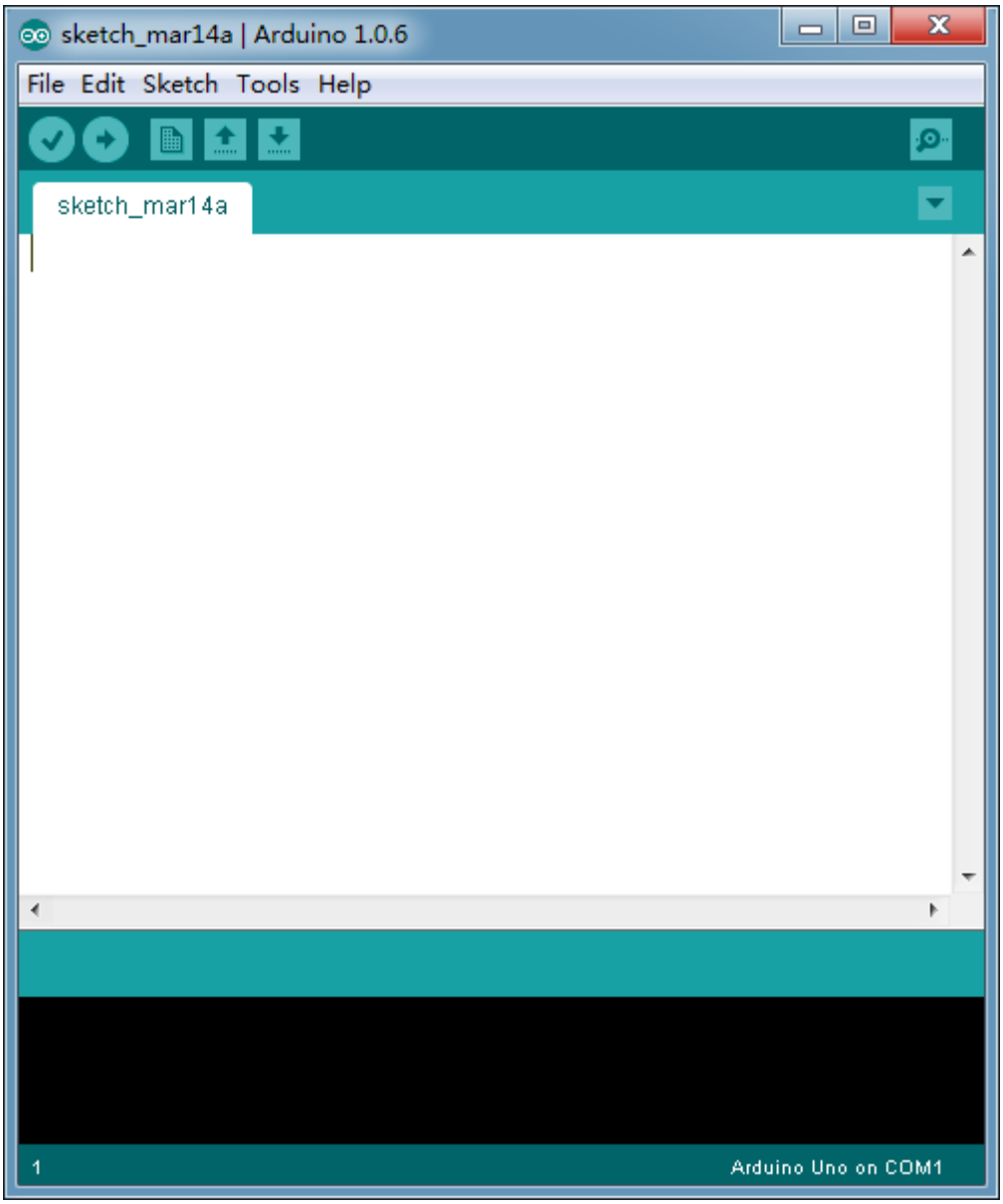
In this kit, SunFounder Nano board is used.



If the board cannot be identified by your PC, install *PL2303_Prolific_DriverInstaller_v1.10.0.exe* in CD.

Arduino Software

You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.



How to install:
Run *arduino-1.0.6-windows.exe* in CD (for Microsoft Windows users),
or visit http://arduino.cc/en/Main/Software to obtain other versions for more platforms.

After installation, the following icon will appear on the desktop. Double-click the icon to open Arduino Software.

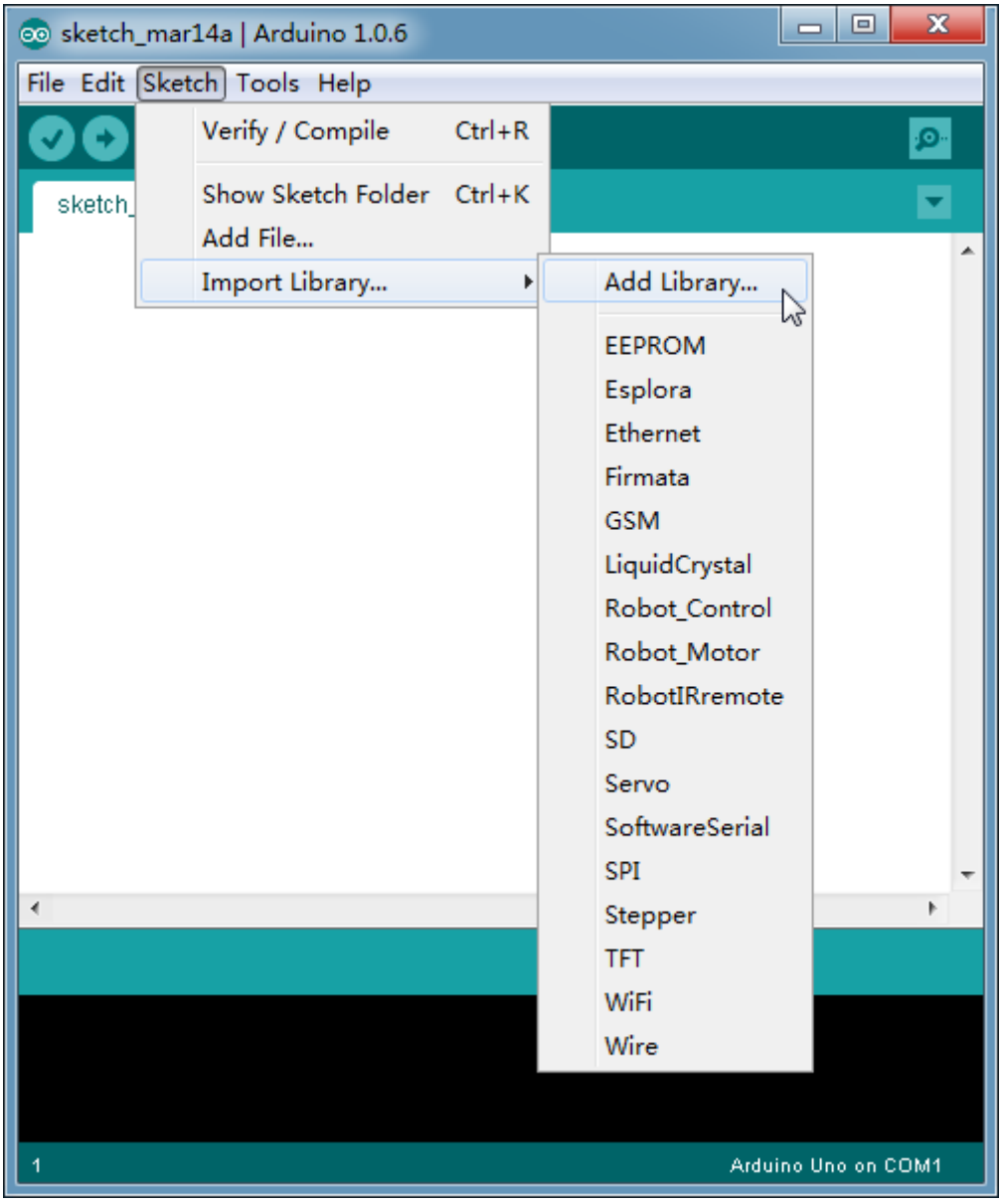
Arduino Libraries

Libraries are a collection of code that makes it easy for you to connect to a sensor, display, module, etc. There are hundreds of additional libraries available on the Internet for download.

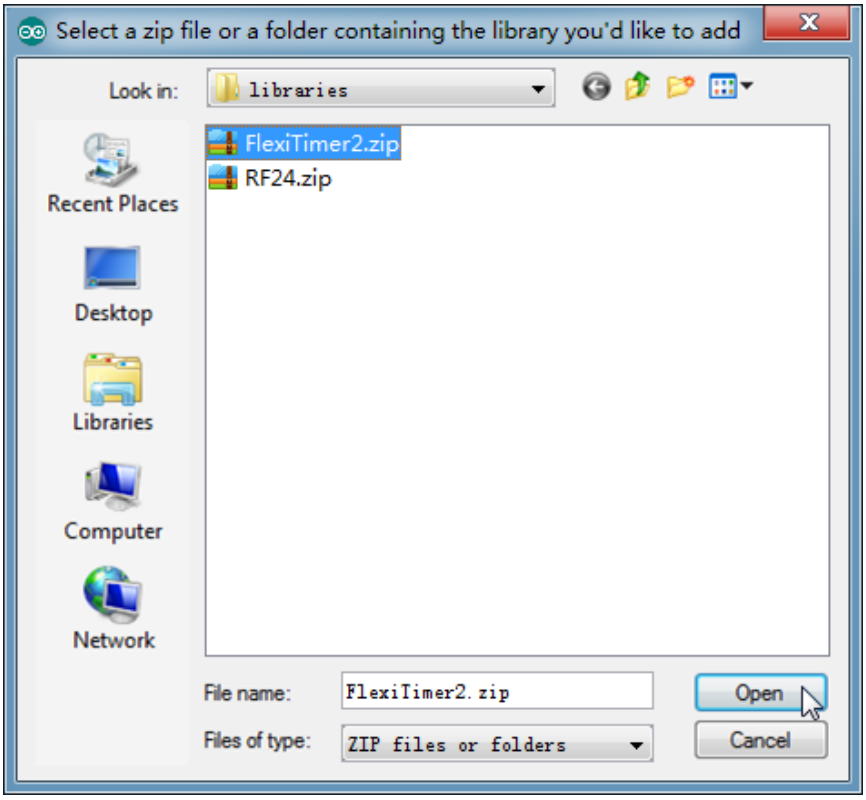
The Arduino environment can be extended through the use of libraries, just like most programming platforms. Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. A number of libraries come installed with the IDE, but you can also download or create your own.

Next, import some library files used in this manual.

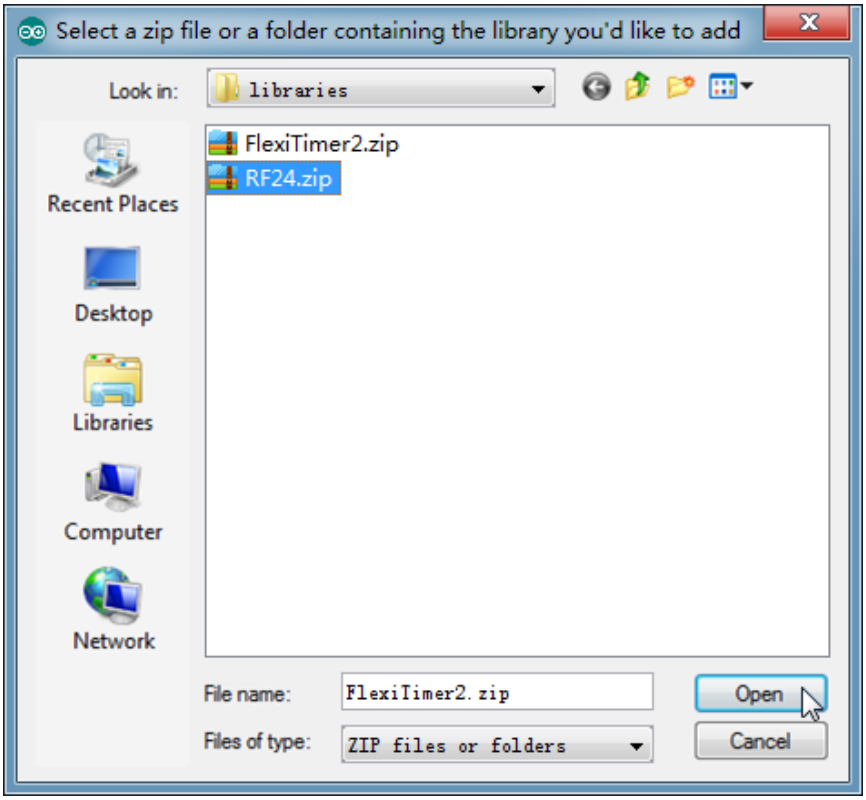
1. Select **Sketch** -> **Import Library** -> **Add Library**.



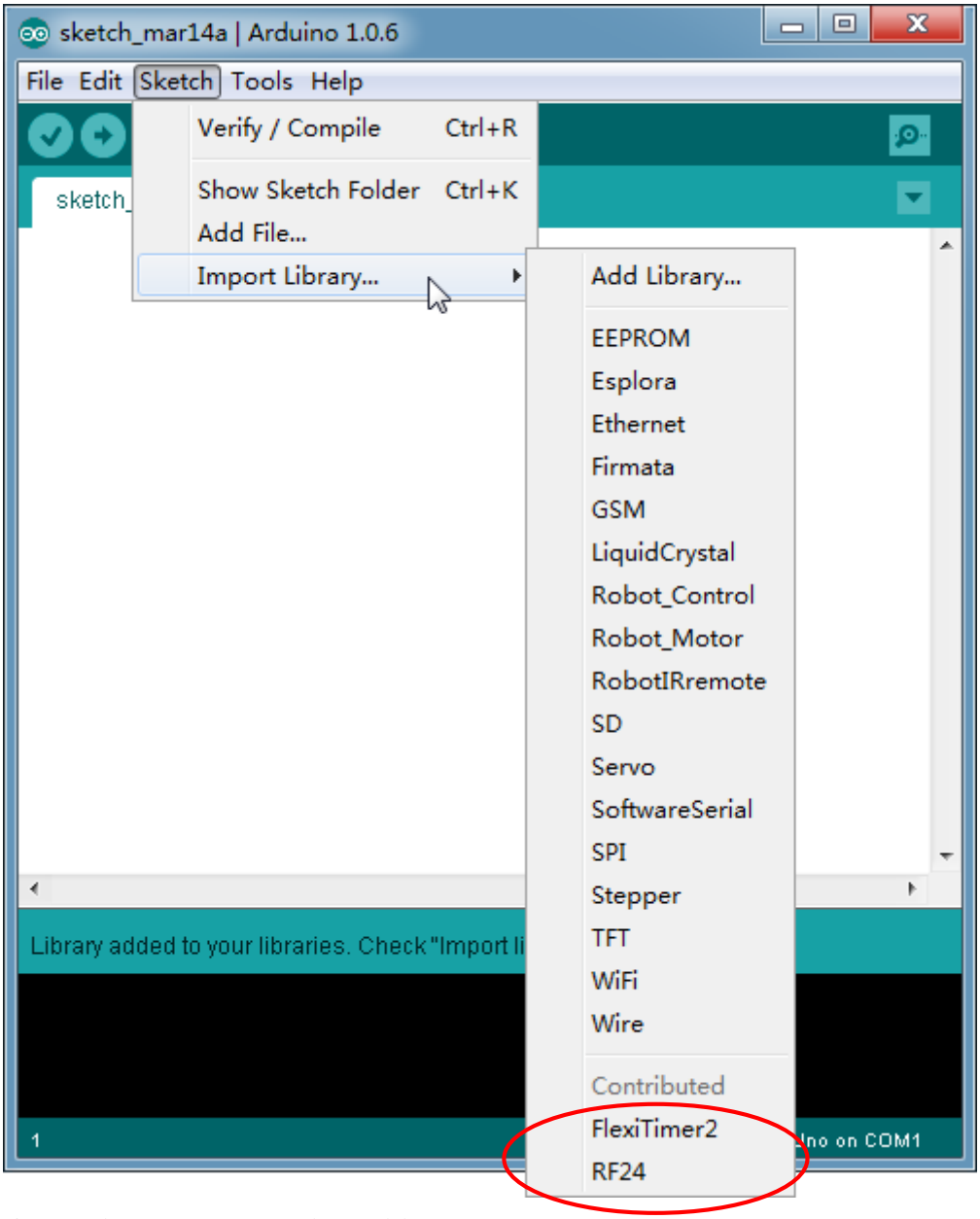
2. Find the *FlexiTimer2.zip* library under the *libraries* folder in the CD. Click **Open**.



3. Import the *RF24.zip* library from the *libraries* folder in the same way.



4. Here you should see the libraries just imported have appeared on the list.



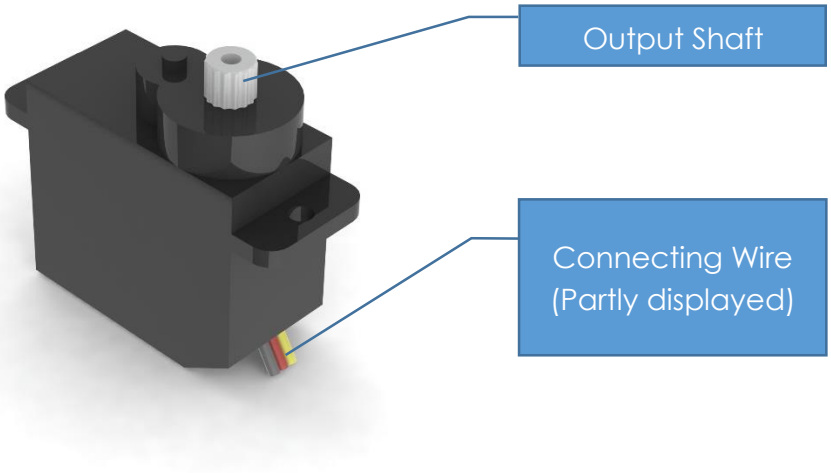
For more information about Arduino, visit:
http://arduino.cc/
http://www.sunfounder.com/

Servo

Description

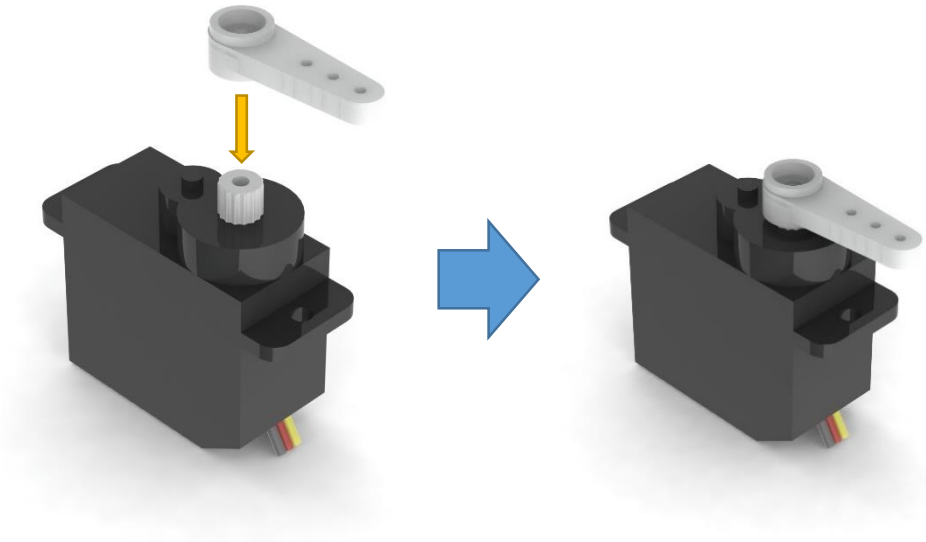
Servo is a set of automatic control system composed of DC motors, reduction gear set, sensors and control circuits. The output shaft can be rotated to a certain angle by sending signals. The servo can only rotate in a certain range, for example, 180°. It cannot rotate any circles like the DC motor. The servo enables you to easily rotate an object in a certain angle, so it is widely used in model planes and robot joints.

In this kit, twelve EMAX ES08A II servos are used to drive the joints of the robot.

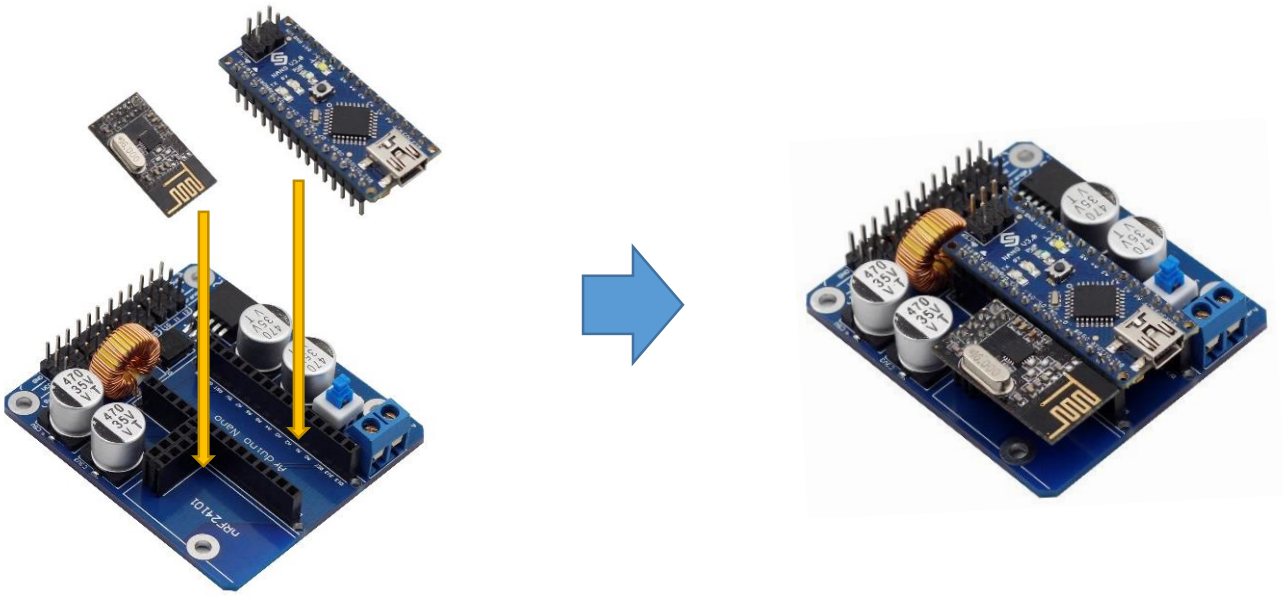


Servo Test

1. Find the rocker arm packaged with the servo, and mount it onto the servo.

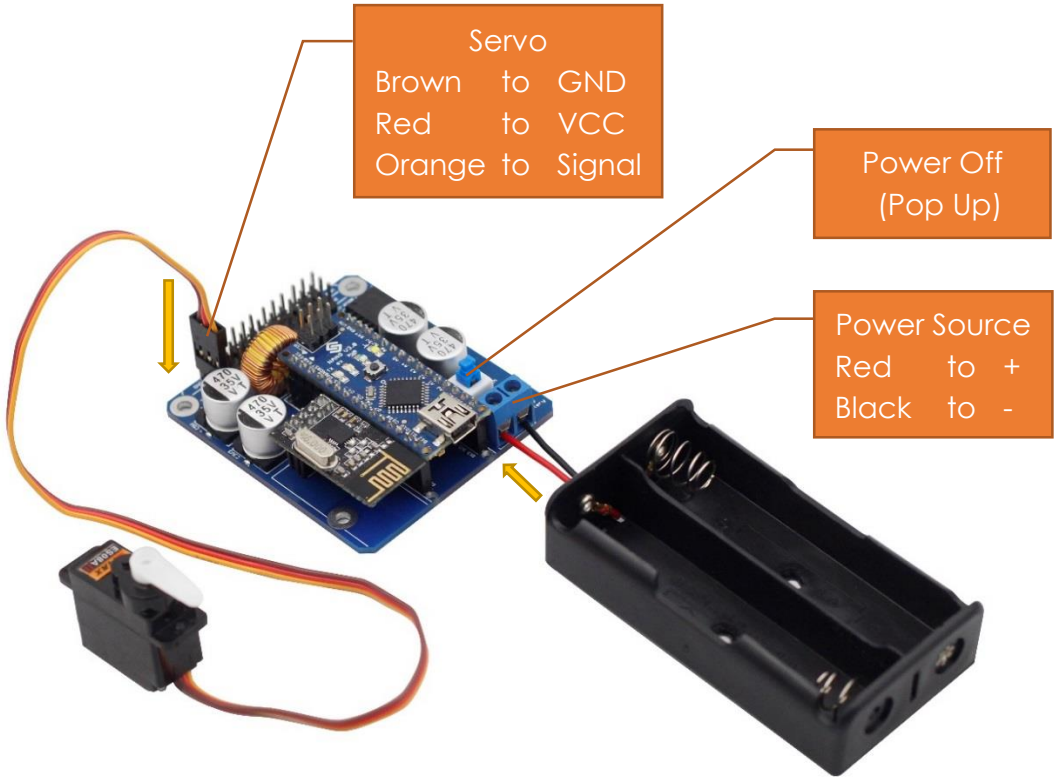


2. Assemble the SunFounder Servo Control Board.



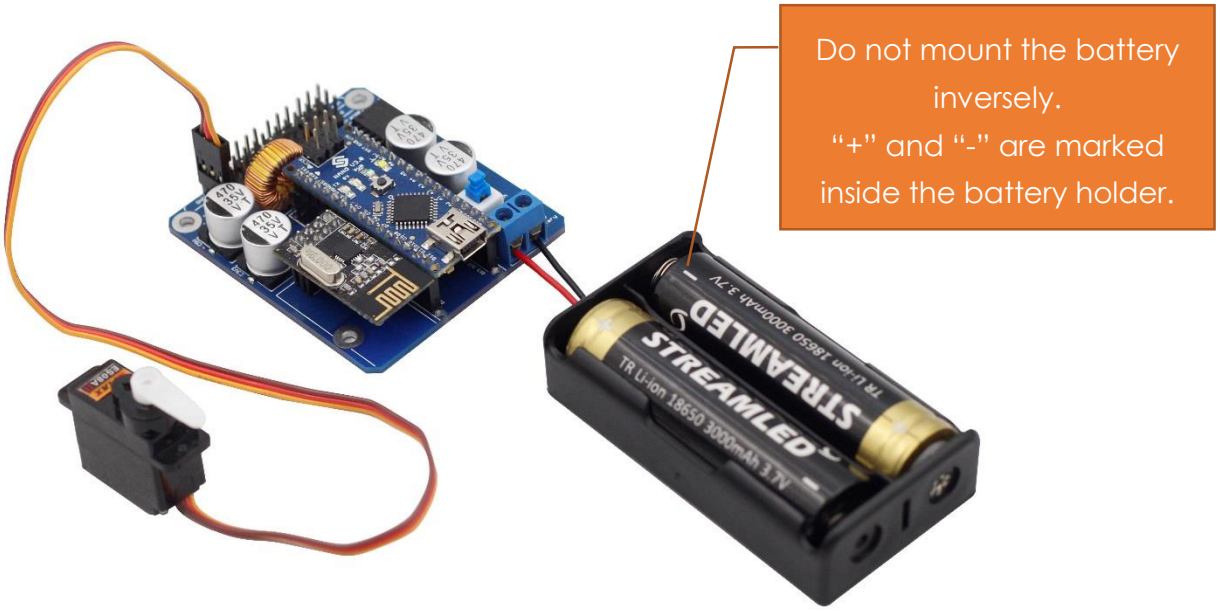
3. Connect the battery holder and the servo. Make sure the power source is connected in the right way and that the power is kept off.

   Plug the servo to the pins marked with **1** on the SunFounder Servo Control Board. The name of the pins and the color of the wires are marked on two sides of all the pins. Pay attention not to get them wrong.

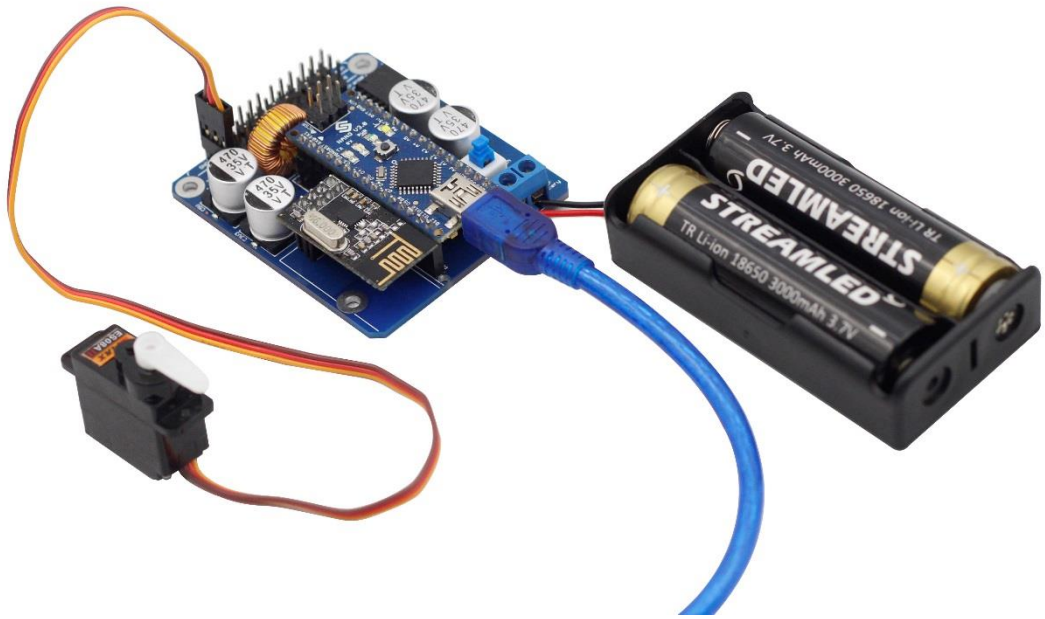


4. Mount two 18650 batteries (please pay attention not to mount it inversely).

   Check to see whether the battery holder and the battery are wired correctly. If everything looks good, switch it on. Then the blue LED on SunFounder Nano board will light up. Keep the power on.

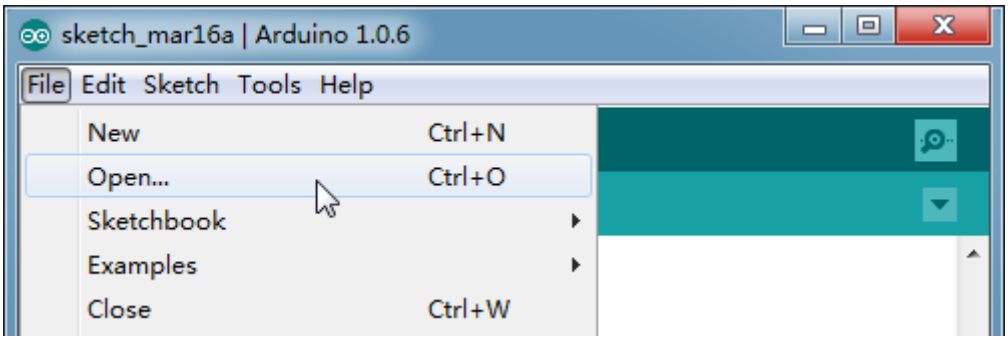


5. Connect the SunFounder Servo Control Board to your PC with a USB cable.

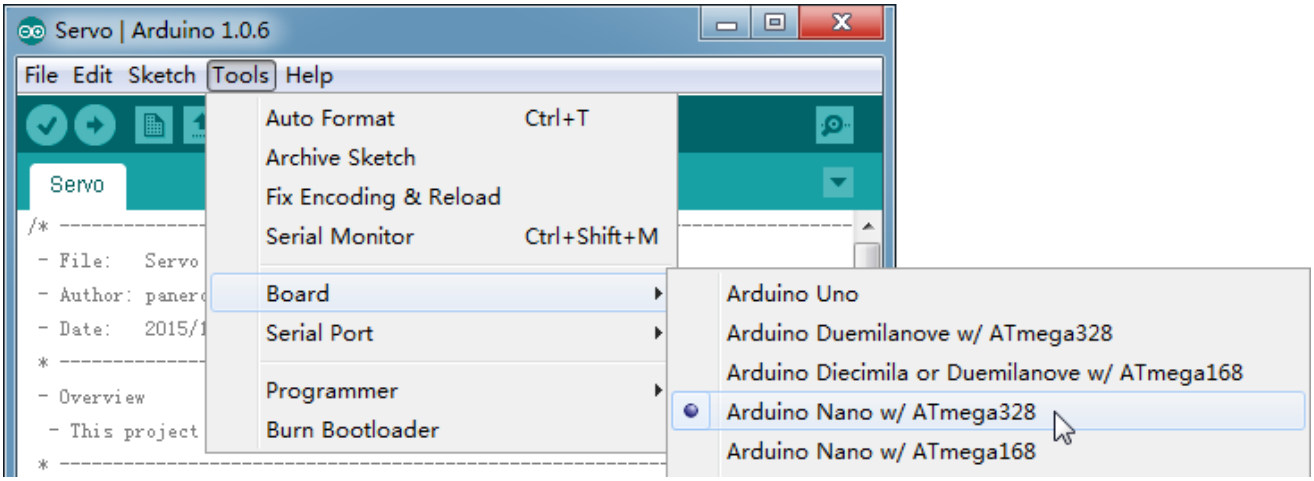


6. Open Arduino Software

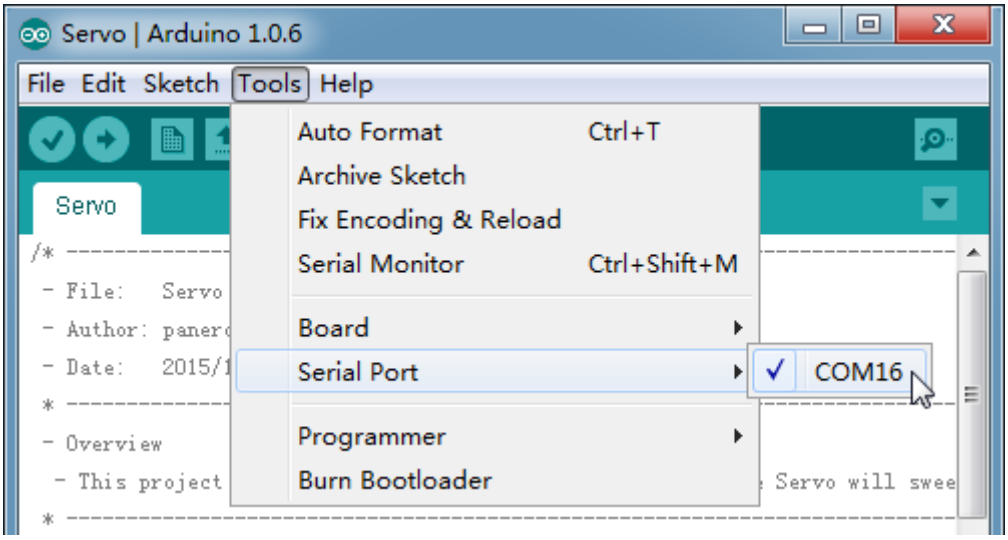
   Select **File** -> **Open**. On the pop-up window, go to the *CD\code\1.Servo\Servo* directory and find *Servo.ino*. Click it to open.



7. Select a board. Here we select **Arduino Nano w/ATmega328**.

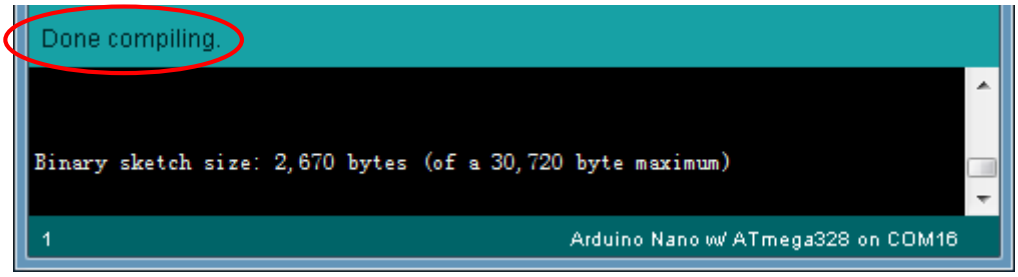


8. Go to **Tools** -> **Serial Port** to select serial port. Your sefial port may be diffirent from mine.

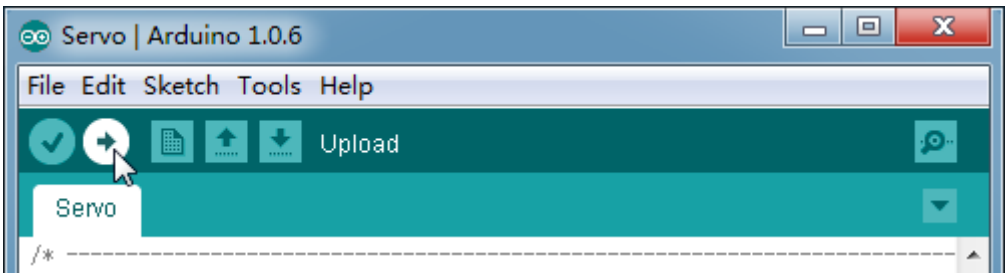


9. Click the following button to verify.

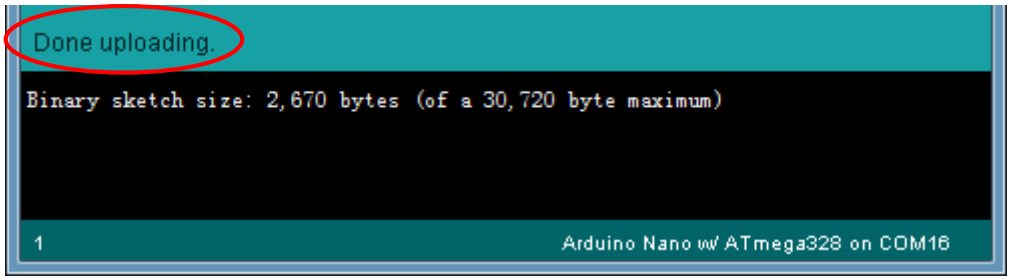
Wait for a moment until the following information appears at the bottom of the window, which indicates it is compiled successfully.



10. Click the following button to upload.



Wait for a moment until the following information appears at the bottom of the window, which indicates it is uploaded successfully.



Now, the rocker arm will sway continuously.

Remove the USB cable, switch off the power, and remove the servo cable.

nRF24l01

Description

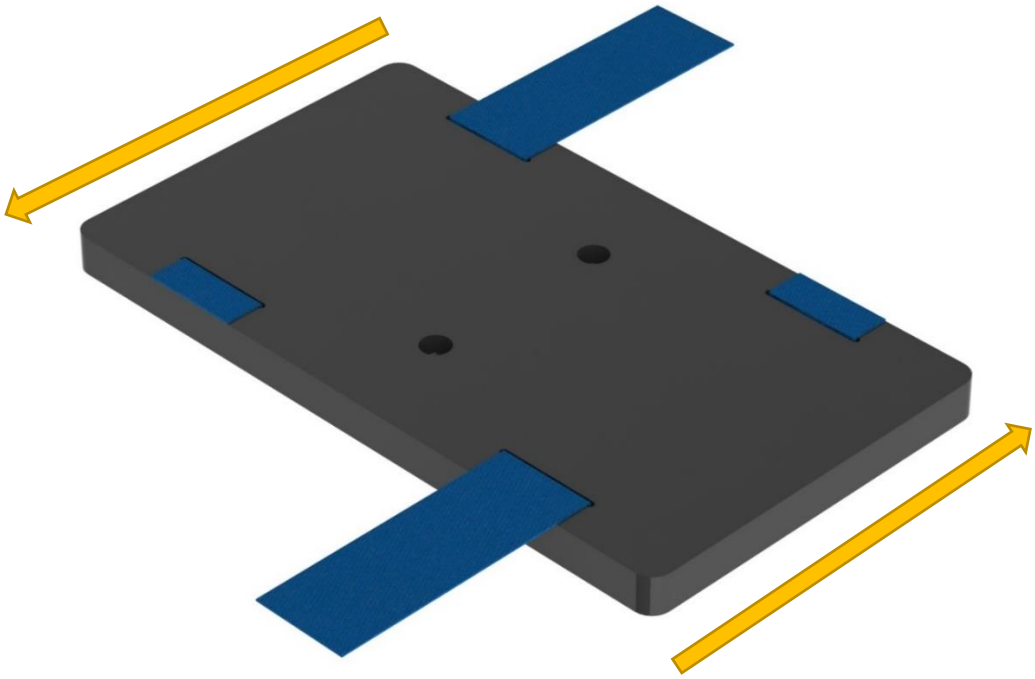
The nRF24L01 is a single-chip wireless transceiver chip, which is manufactured by NORDIC and works in the 2.4 GHz ~ 2.5 GHz ISM frequency band. The wireless transceiver includes frequency generator, enhanced ShockBurst mode controller, power amplifier, crystal oscillator, modulator and demodulator.

nRF24l01 Test

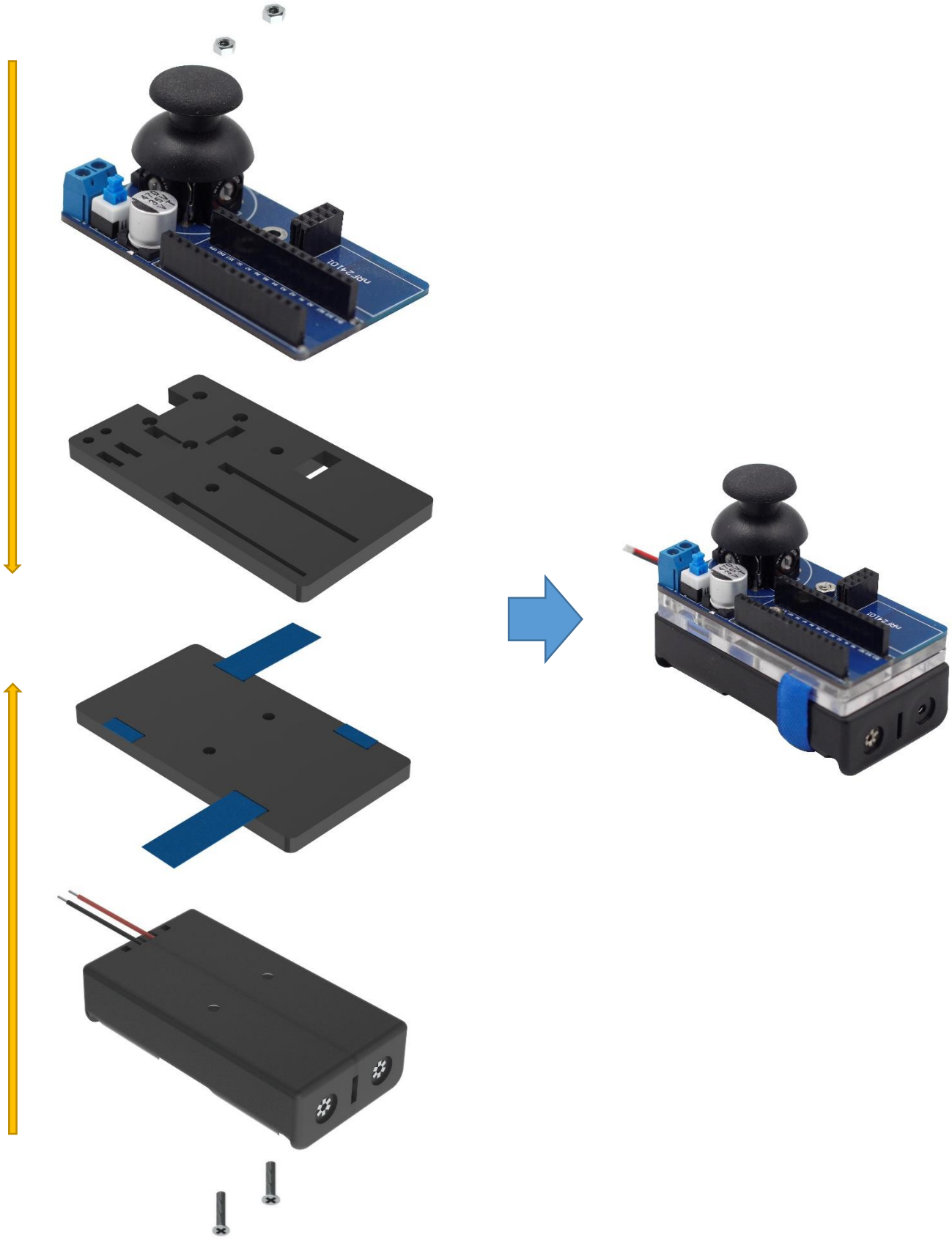
1. Cross the ribbon through the following acrylic plate.

   The ribbon enables you to easily remove the battery. Also you can skip this step.

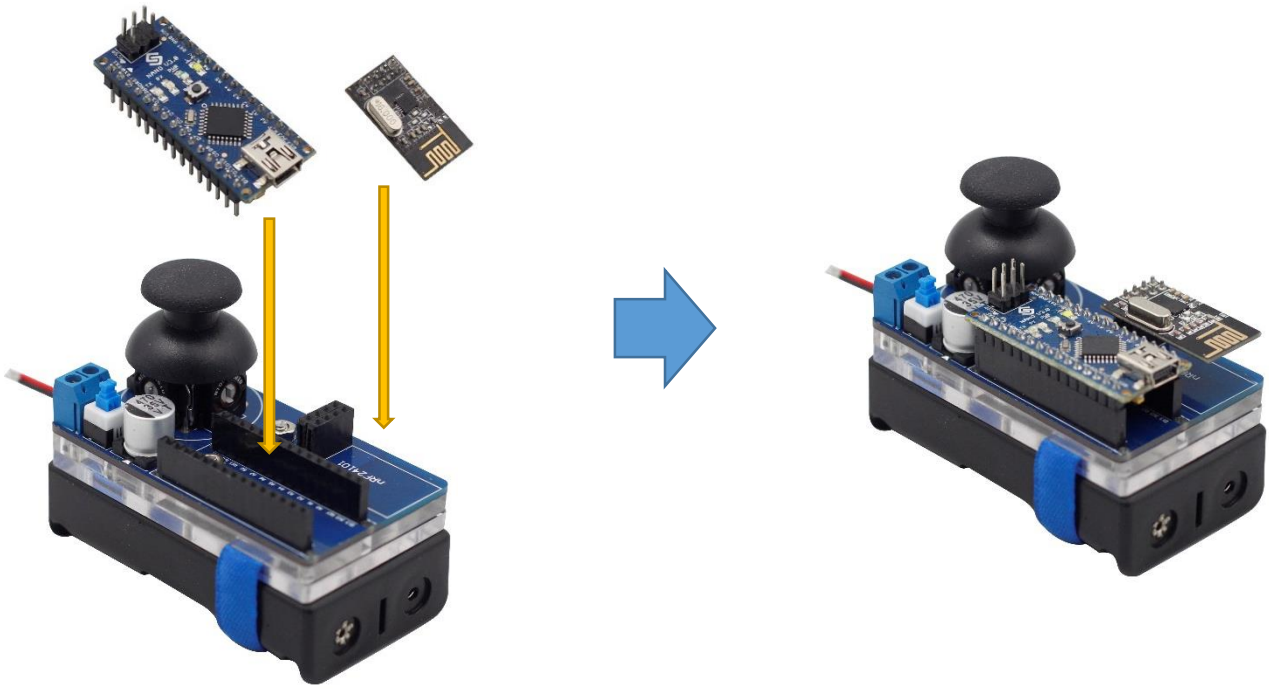
   Please note one side of the ribbon is long and the other is short and the direction is as follows.



2. Connect the following components with two M3*14 countersunk screws and two M3 nuts.



3. Plug SunFounder Nano board and nRF24l01 module into the SunFounder Mobile Robot Remote Controller board.



4. Connect with the battery holder. Make sure the power source is wired correctly and the power is kept off.

5. Mount two 18650 batteries (please pay attention not to mount it inversely).

   Check to see whether the battery holder and the battery are wired correctly. If everything looks good, switch it on. Then the blue LED on SunFounder Nano board will light up. Keep the power on.

6. Connect the SunFounder Mobile Robot Remote Controller to PC with a USB cable.

7. Upload the following code for the SunFounder Mobile Robot Remote Controller according to the method in the previous section:

   Transmit.ino under *CD\code\2.nrf24l01\Transmit* directory.

   Remove the USB cable after upload, and keep the power on.

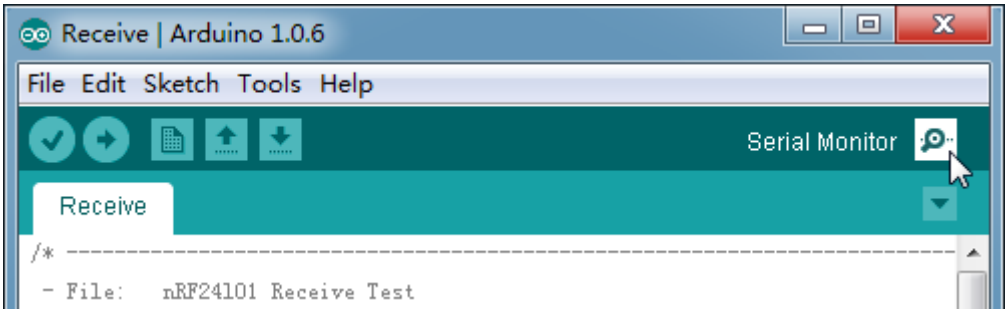
8. Connect the SunFounder Servo Control Board to your PC with a USB cable.

   The power of the controller can be off.

9. Upload the following code for the SunFounder Servo Control Board according to the method in the previous section:

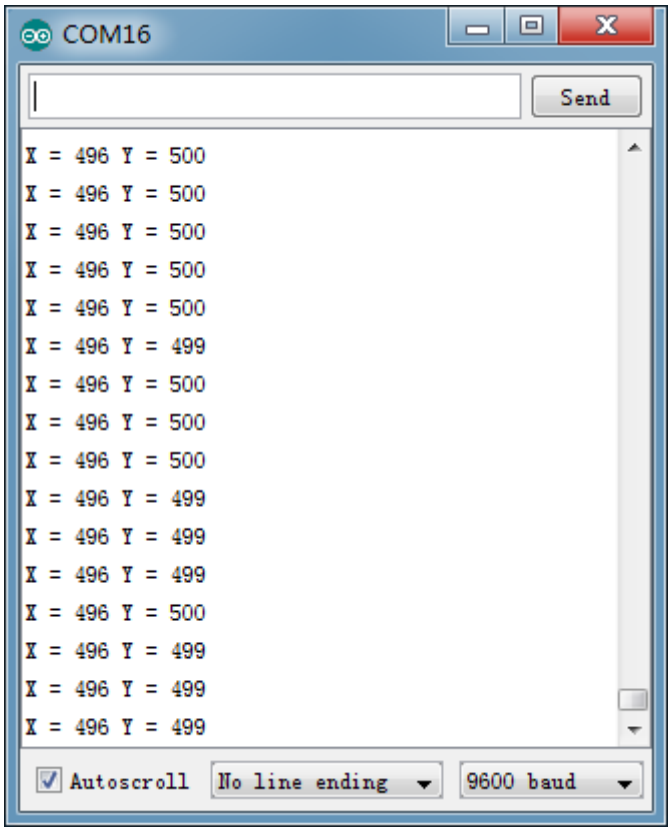
   Receive.ino under the *CD\code\2.nrf24l01\Receive* directory.

   Do not remove the USB cable after upload. Open **Serial Monitor**.



Now, you should see information received by the nFR24l01 module displayed in the Serial Monitor window.

Turn the rocker arm. The value displayed in the **Serial Monitor** window will change, which indicate wireless communication is working.

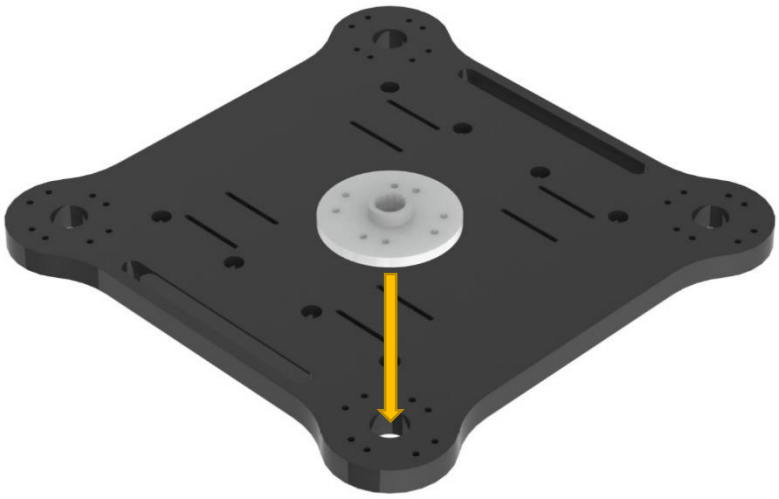


Remove the USB cable and turn off the power switch.

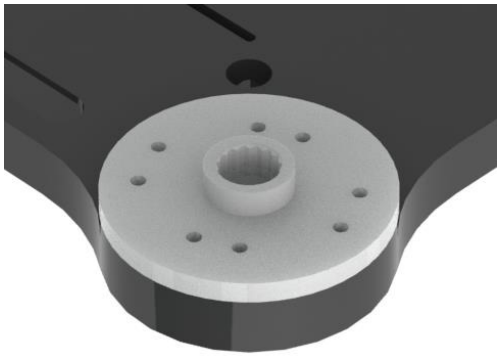
3. Assembly

Upper Plate + Rocker Arm

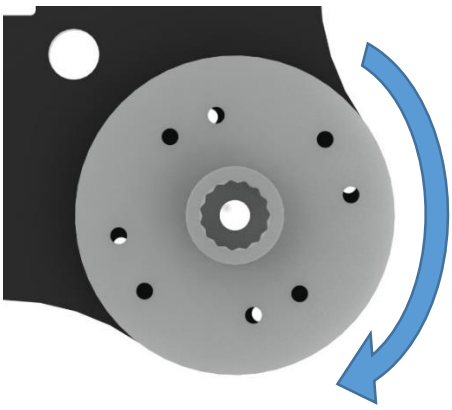
1. Assemble the rocker arm (packaged with the servo) of the servo to the following acrylic plate.



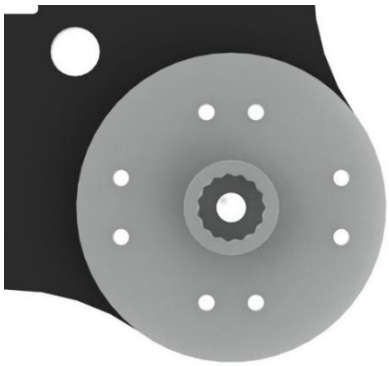
2. Fasten the rocker arm to the acrylic plate.



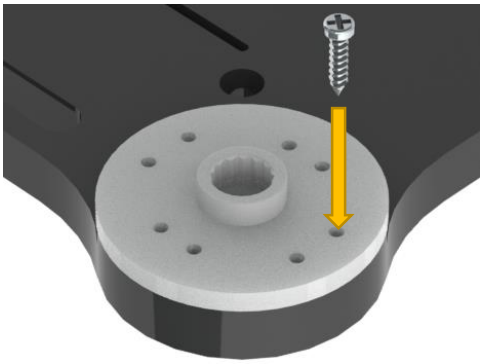
3. Rotate the rocker arm.



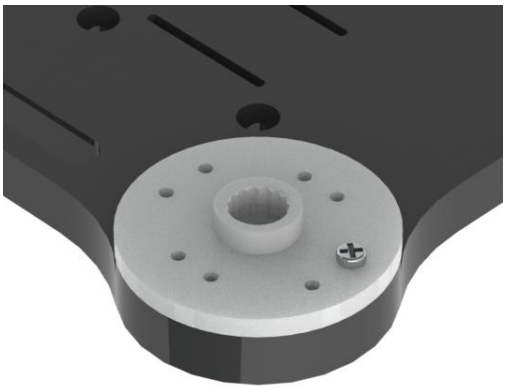
4. Align all holes of the rocker arm and the plate.



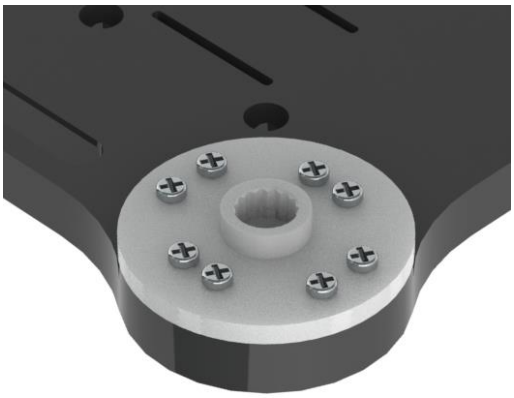
5. Connect the two components with an M1.2*5 self-tapping screw.



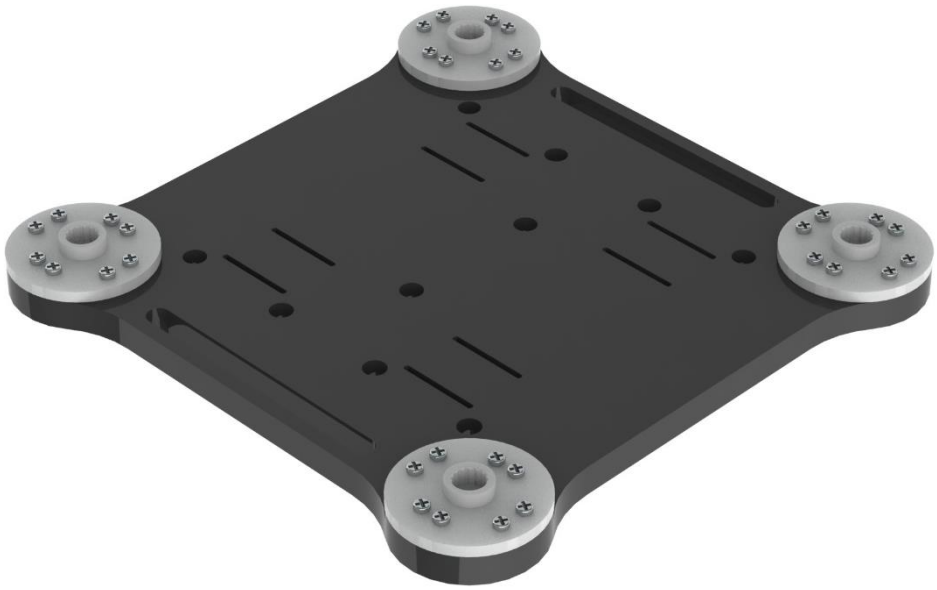
6. Tighten the screw.
   Do not over tighten it! Or the screw may be broken!



7. Tighten the other 7 screws.

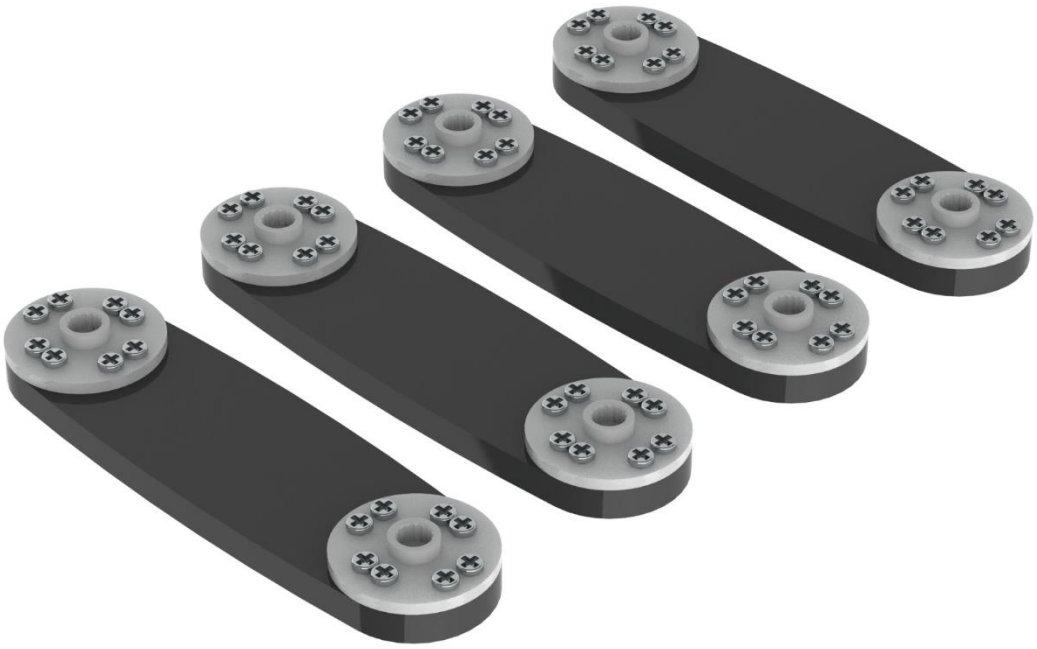


8. Assemble the other 3 rocker arms.



Thigh + Rocker Arm

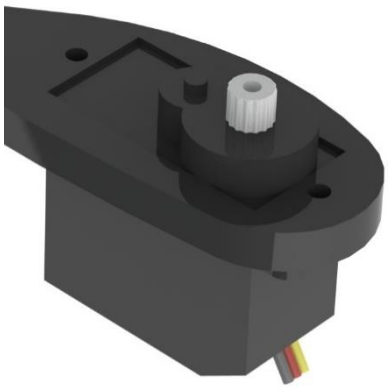
In the same way, connect the rocker arms and the thighs with M1.2*5 self-tapping screws.



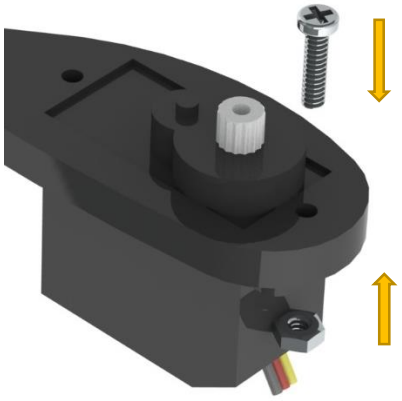
Crus + Servo

1. Assemble the servo to the crus .

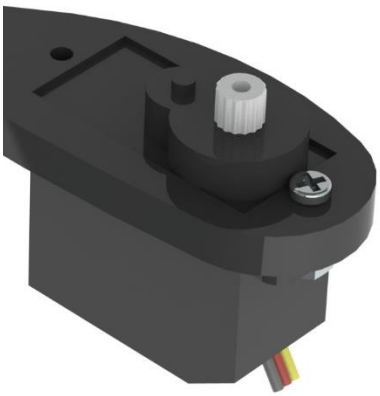
2. Fasten the servo to the crus.



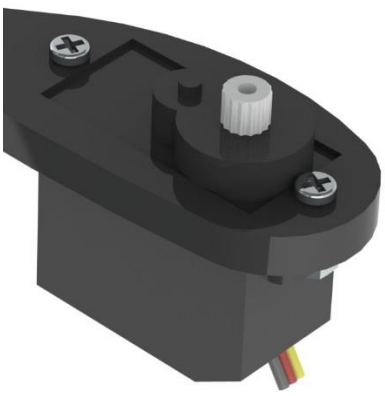
3. Connect these two components with an M2*8 screw and an M2 nut.



4. Tighten the screw.



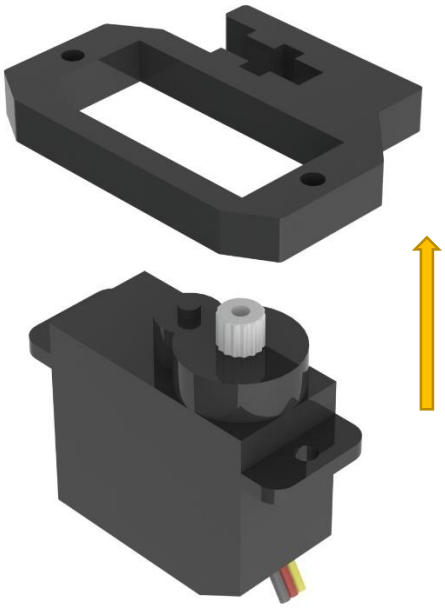
5. Tighten the other screw and nut.



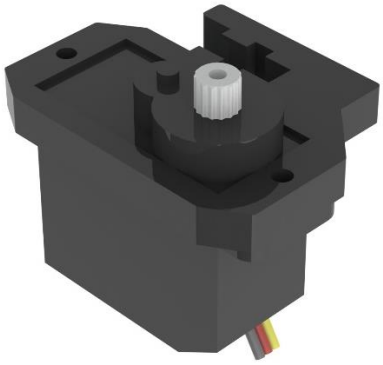
6. Assemble the other 3 servos.
   Please pay attention to the direction. They should be two opposite pairs, as shown below:

Thigh Joint 1 + Servo

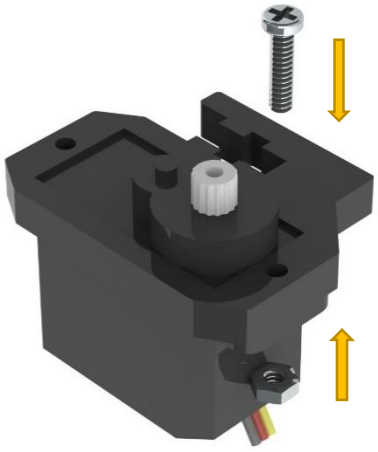
1. Assemble the servo to the following thigh joint 1.



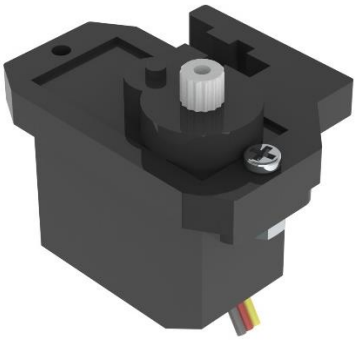
2. Fasten the servo to the thigh joint 1.



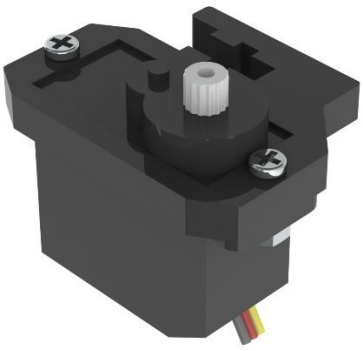
3. Connect the two components with an M2*8 screw and an M2 nut.



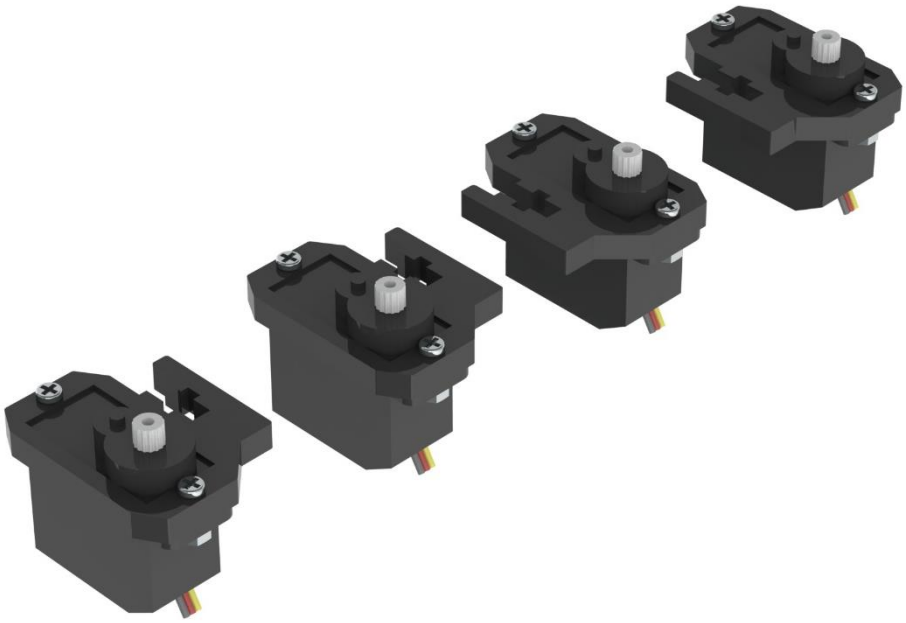
4. Tighten the screw.



5. Tighten the other screw and nut.

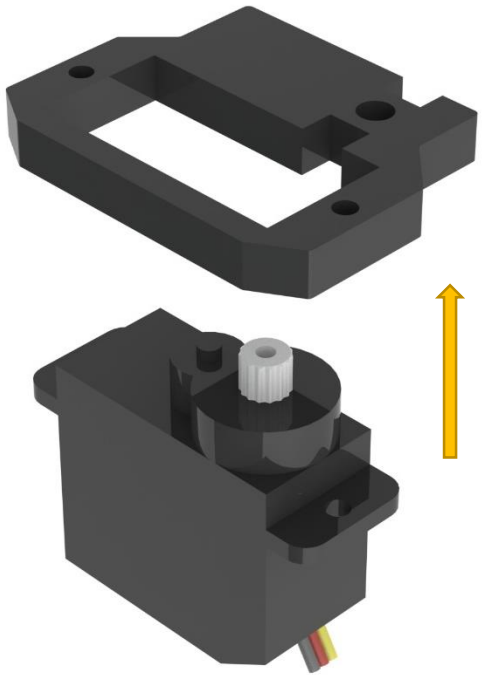


6. Assemble the other 3 servos.
   Please pay attention to the direction. They should be two opposite pairs, as shown below:

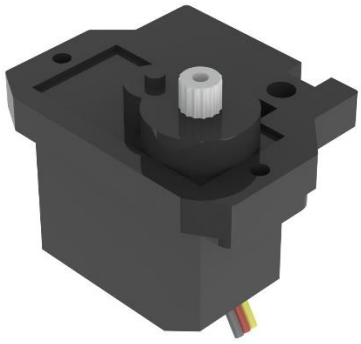


Thigh Joint 2 + Servo

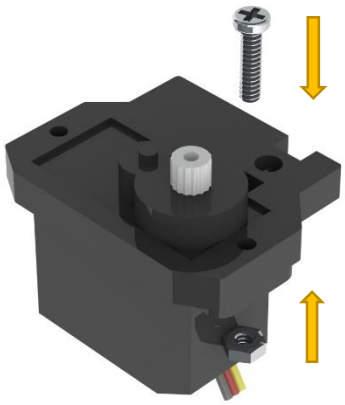
1. Assemble the servo to the following thigh joint 2.



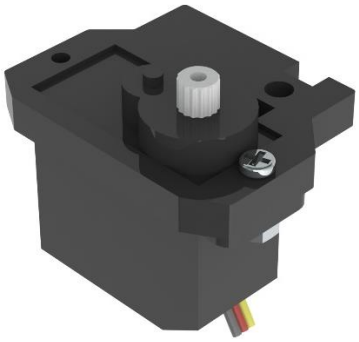
2. Fasten the servo to the thigh joint.



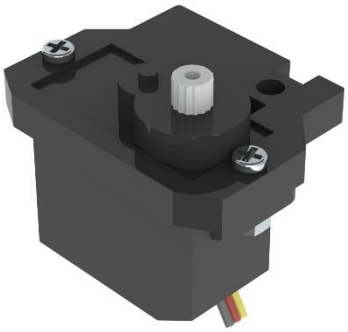
3. Connect the two components with an M2*8 screw and an M2 nut.



4. Tighten the screw.



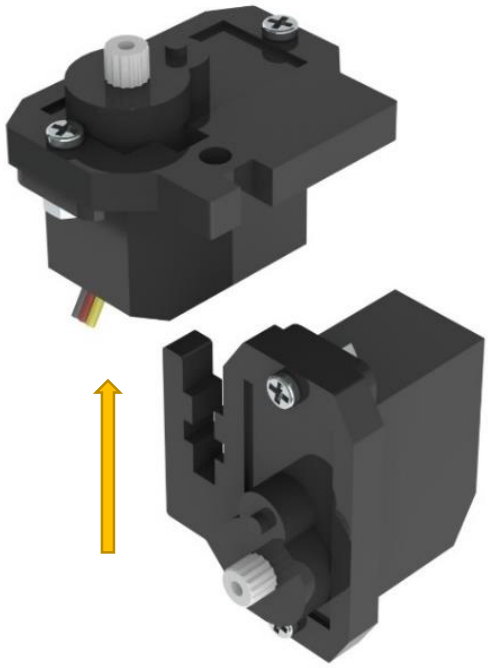
5. Tighten the other screw and nut.



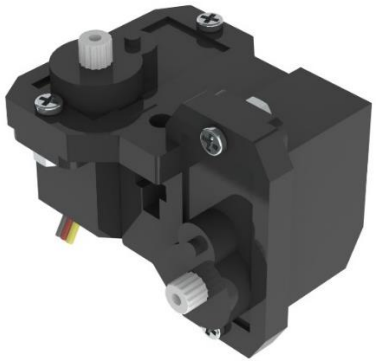
6. Assemble the other 3 servos.
   Please pay attention to the direction. They should be two opposite pairs, as shown below:

Thigh Joint 1 + Thigh Joint 2

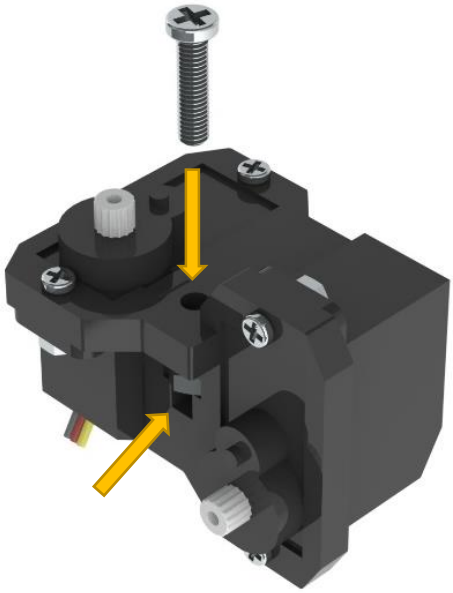
1. Assemble the following two components.



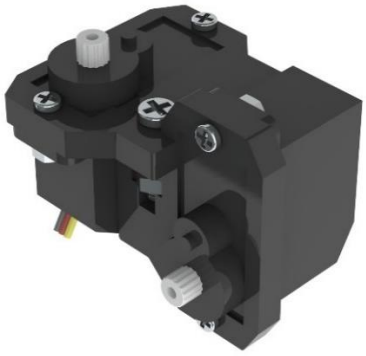
2. Stuck the two components tightly.



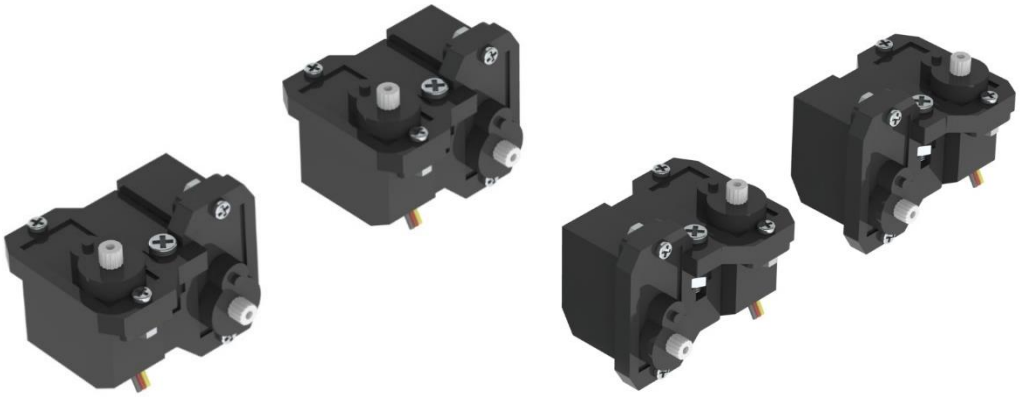
3. Fasten the two components with an M3*12 screw and an M3 nut.



4. Tighten the screw.

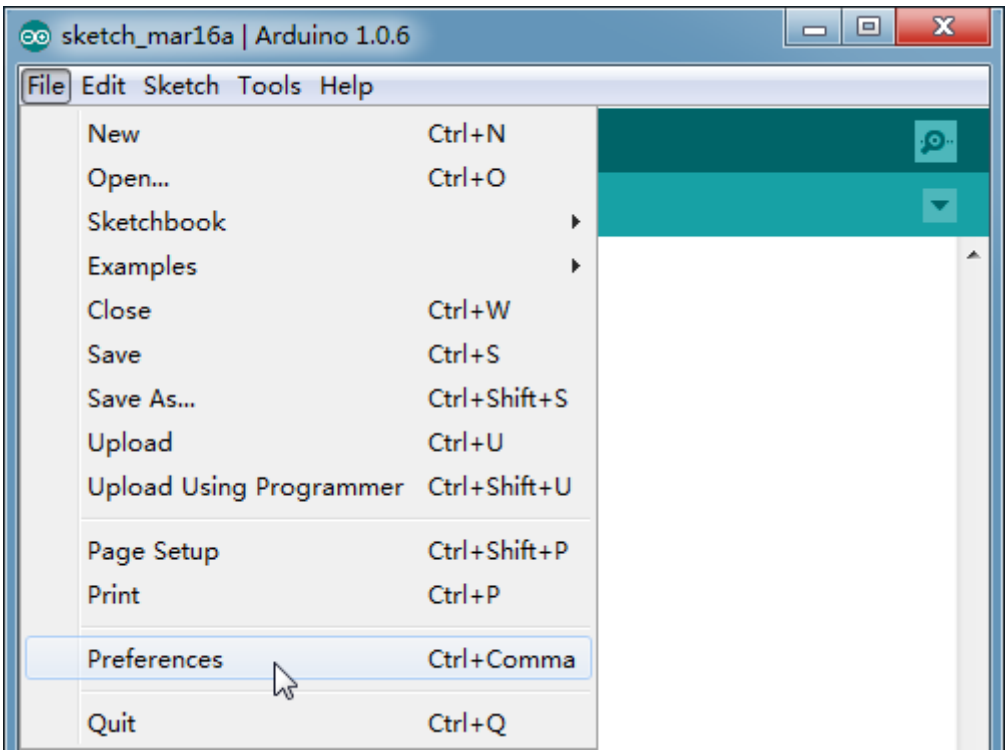


5. Assemble the other 3 pairs similarly.
   Please pay attention to the direction. The two combined pairs should be of opposite directions, as shown below:

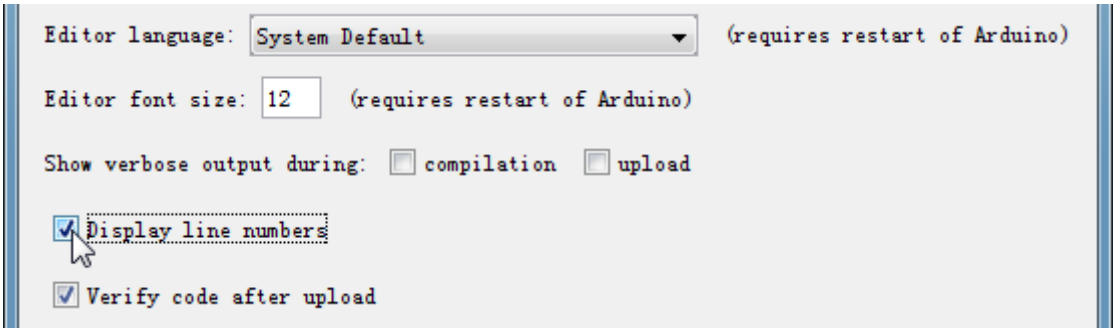


Uploading Assembly Program

Open Arduino Software, and then select **File** -> **Preferences**.



Check **Display line numbers**.



Open *Crawler.ino* under *CD\code\3.Crawl\Crawler* directory.

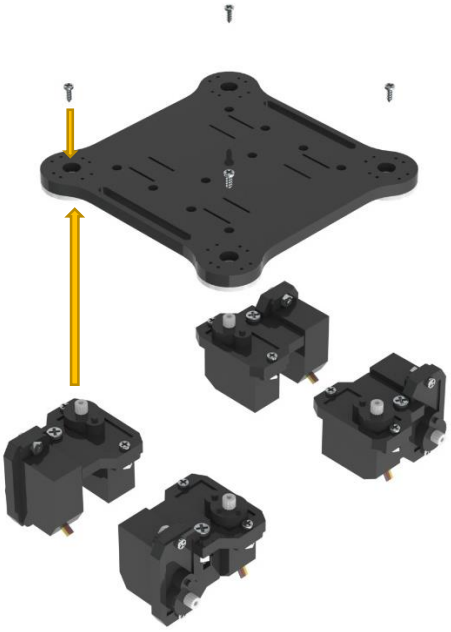
Modify code lines 32-34 as follows, compile the code, upload it to the SunFounder Servo Control Board, and then remove the USB cable.

```
31  /* Installation and Adjustment ----------------------------------------
32  #define INSTALL //uncomment only this to install the robot
33  //#define ADJUST        //uncomment only this to adjust the servos
34  //#define VERIFY        //uncomment only this to verify the adjustment
```

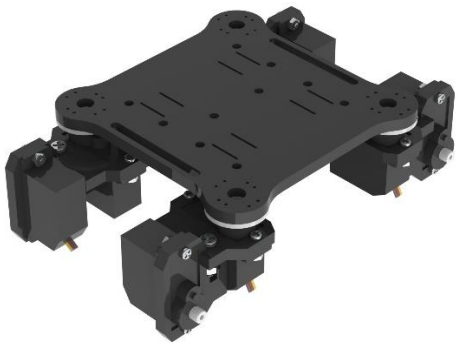
Connect all the 12 servos to the SunFounder Servo Control Board, and then turn on the power switch. Now all the servos will rotate and then stay in a certain position. Keep the power on and the servos connected until you turn it off.

Upper Plate + Thigh Joint

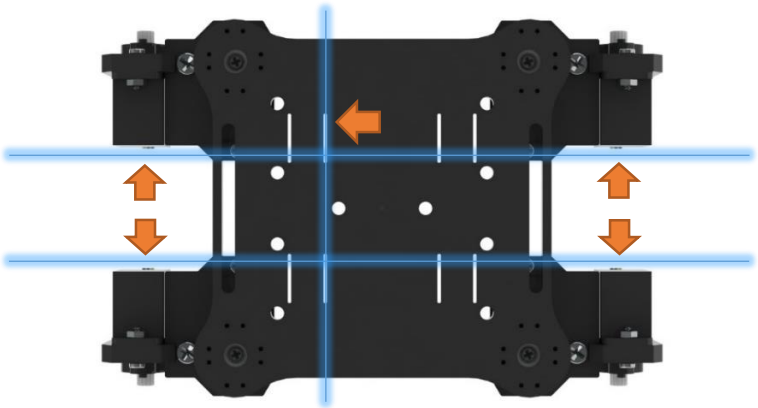
1. Connect the servo rocker arm and the servo with servo screws.
   (Packaged with the servo, the servo screws are within the smaller two of five screws.)
   The directions of all components must be exactly the same with the following picture:



2. Tighten the screw.

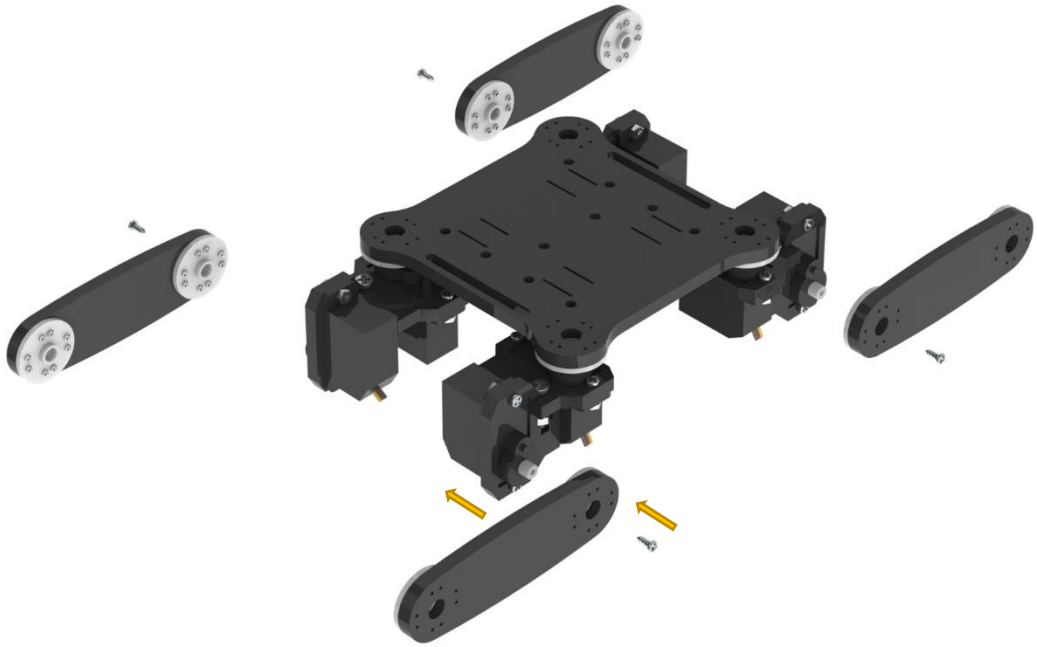


After connection, the plan view is as follows. Please pay attention to the direction of these components. Try your best to make it close to the following picture. But if there is some deviation, that's OK.

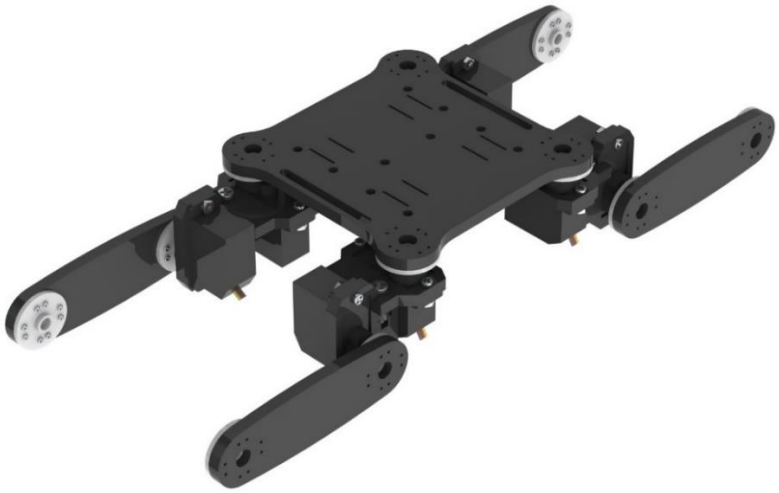


Thigh Joint + Thigh

1. Connect the servo rocker arm and the servo with servo screws.
   (Packaged with the servo, the servo screws are within the smaller two of five screws.)
   The directions of all components must be exactly the same with the following picture:



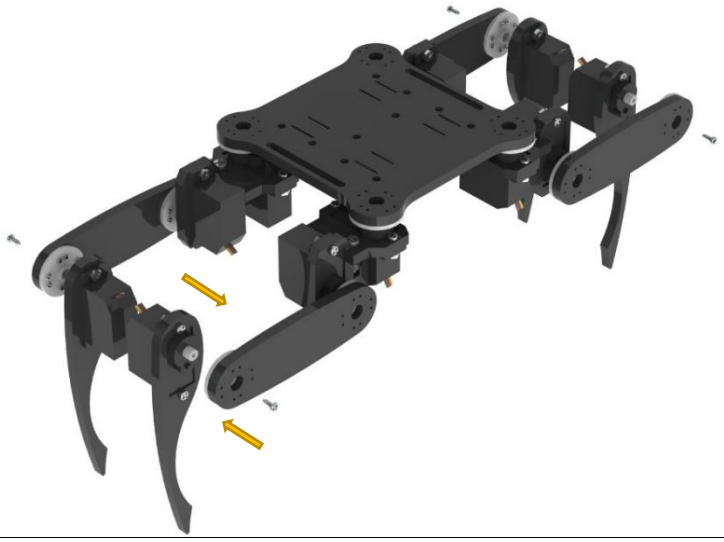
2. Tighten the screw.



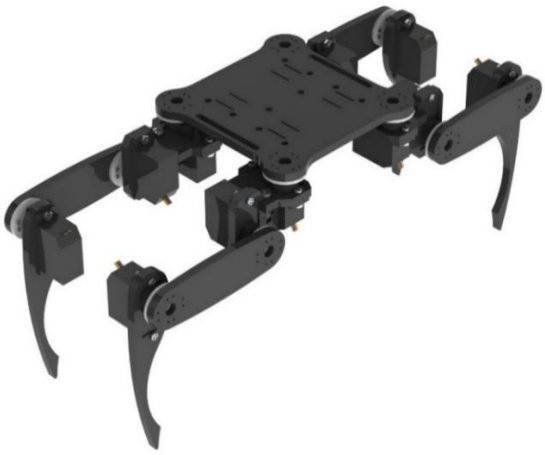
After connection, the front view is as follows. Please pay attention to the direction of these components, it should be horizontal.
Try your best to make it close to the following picture, but if there is some deviation, that's OK.

Thigh + Crus

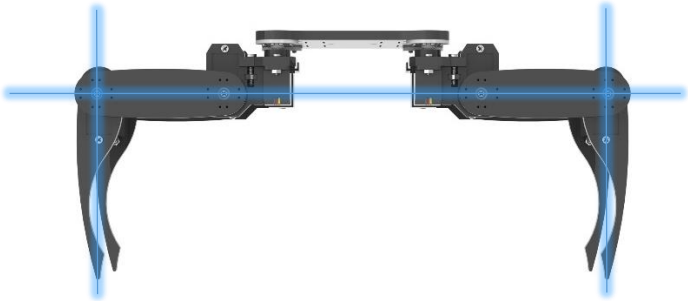
1. Connect the servo rocker arm and the servo with servo screws.
   (Packaged with the servo, the servo screws are within the smaller two of five screws.)
   The directions of all components must be exactly the same with the following picture:



2. Tighten the screw.



After connection, the front view is as follows. Please pay attention to the direction of these components, it should be vertical.
Try your best to make it close to the following picture, but if there is some deviation, that's OK.



Switch off the SunFounder Servo Control Board. Remove the batteries first, then the battery holder, and finally all the servo wires. Now you can rotate any joints of the robot.

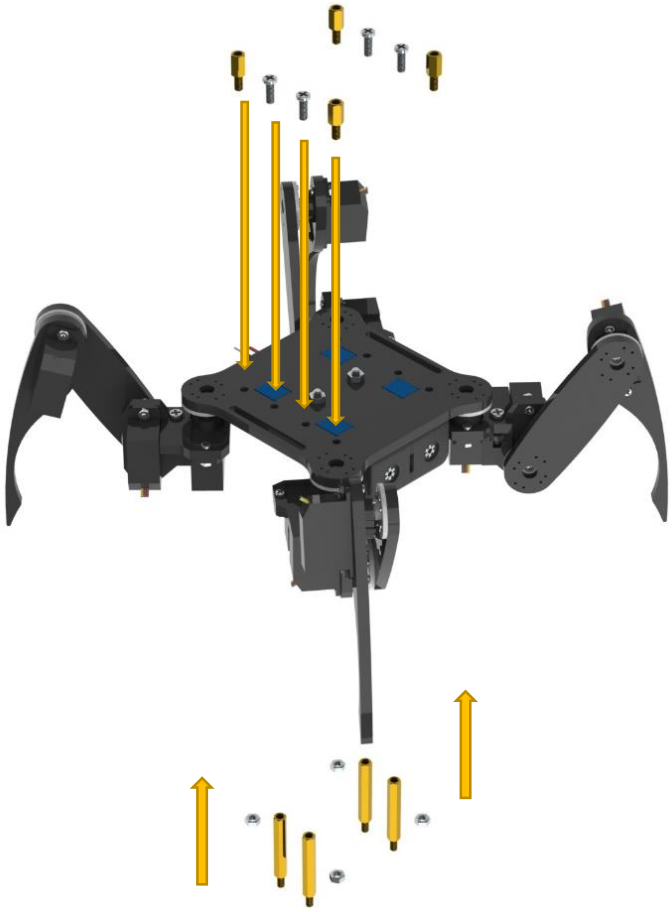
Battery Holder

Cross the ribbon through the plate, and connect the following components with the M3*10 countersunk screws and M3 nuts.

It is shown as follows after connection.

Upper Plate + Copper Standoffs

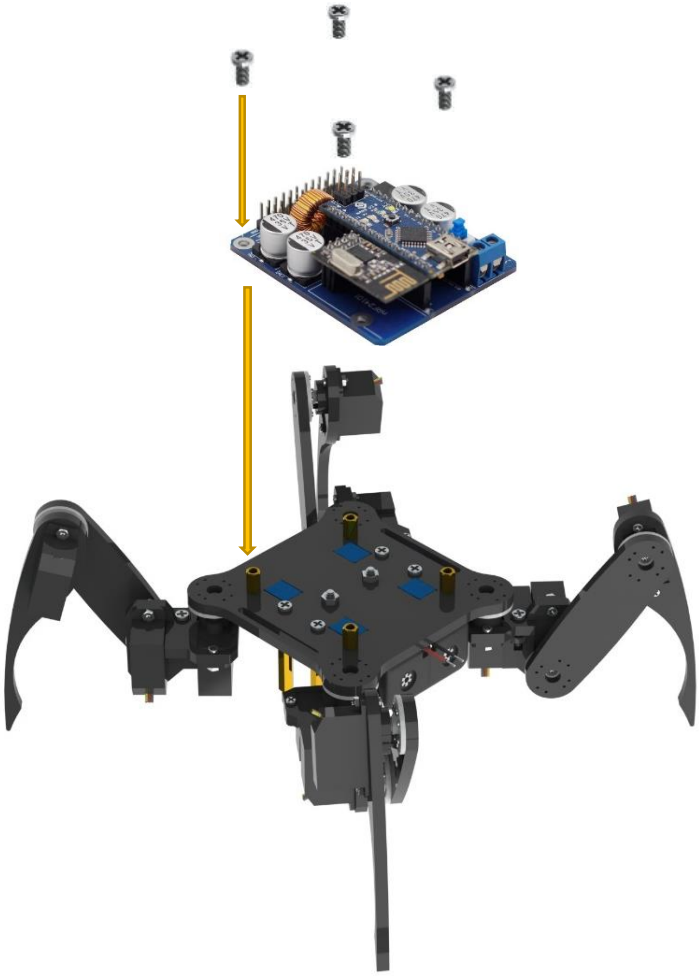
Fasten the M3*30 copper standoffs, M3*8 copper standoffs, M3*8 screws, and M3 nuts into the following plate.



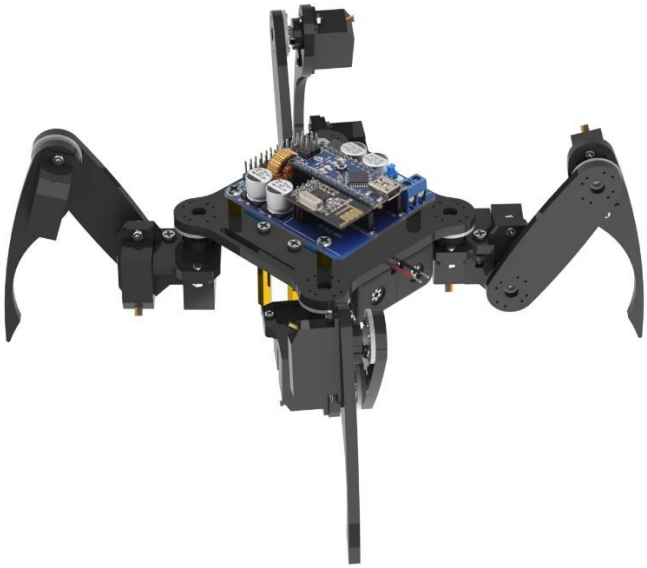
It is shown as follows after connection.

SunFounder Servo Control Board

Connect the SunFounder Servo Control Board to the following plate with M3*6 screws.

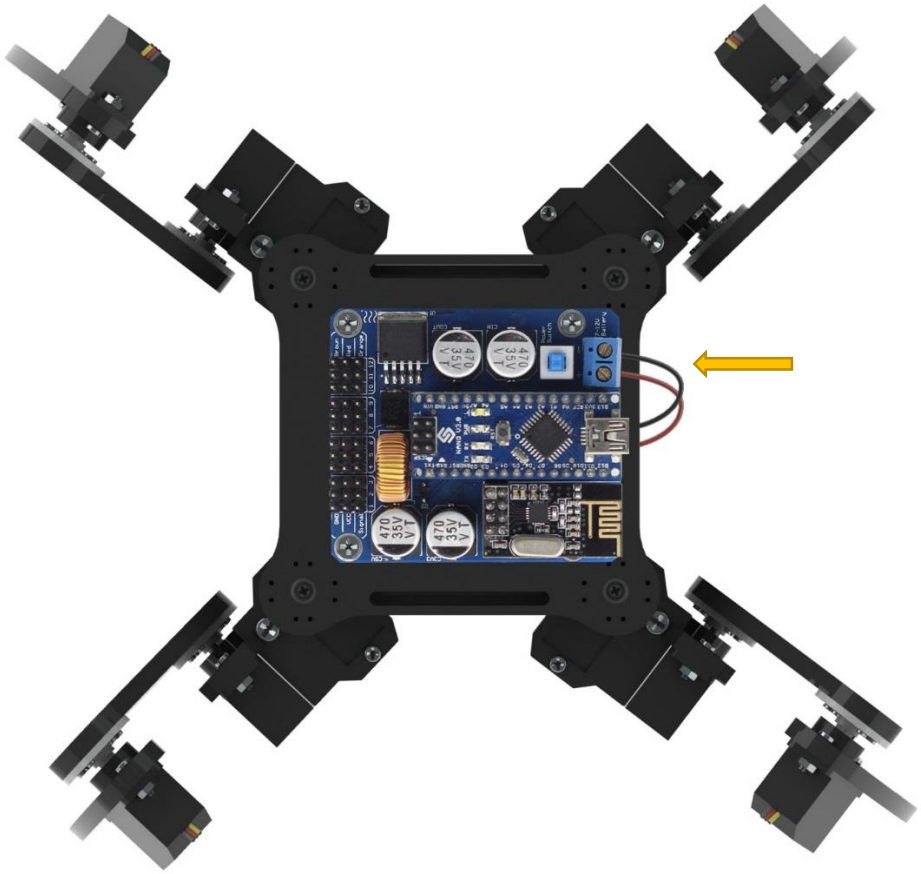


It is shown as follows after connection.



Lower Plate

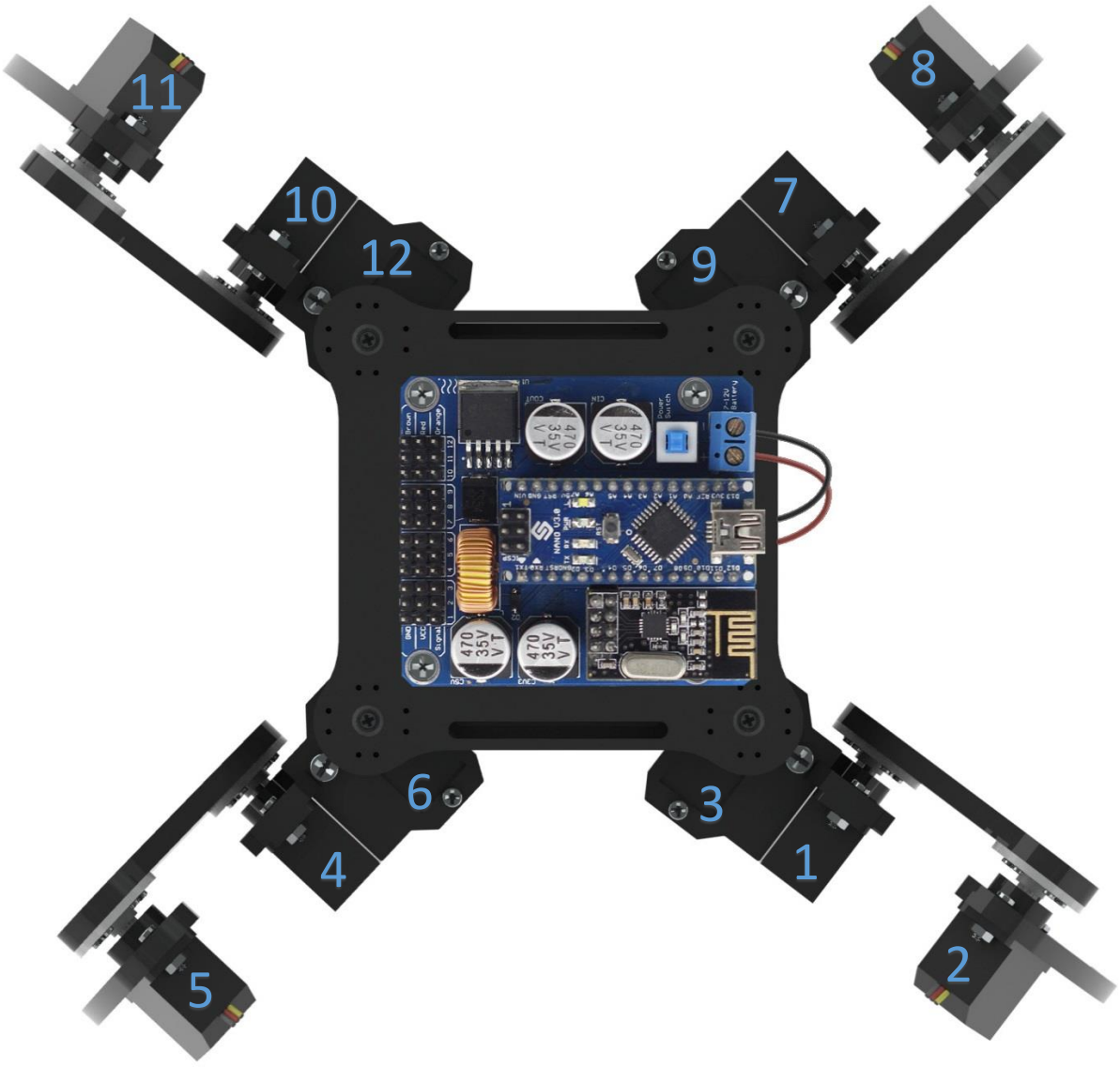
1. Keep the power off and connect the battery holder. Pay attention not to connect the power inversely.



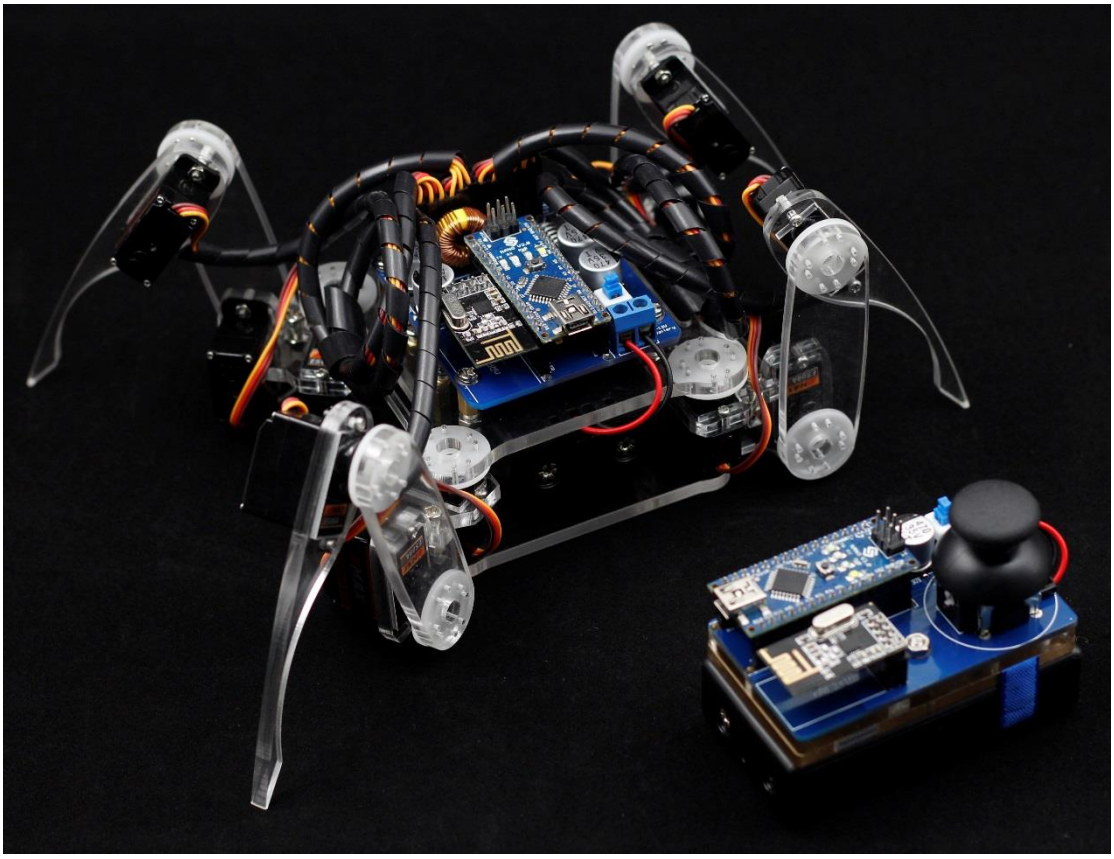
2. Mount the batteries to the lower plate. Fix the lower plate with M3 nuts.

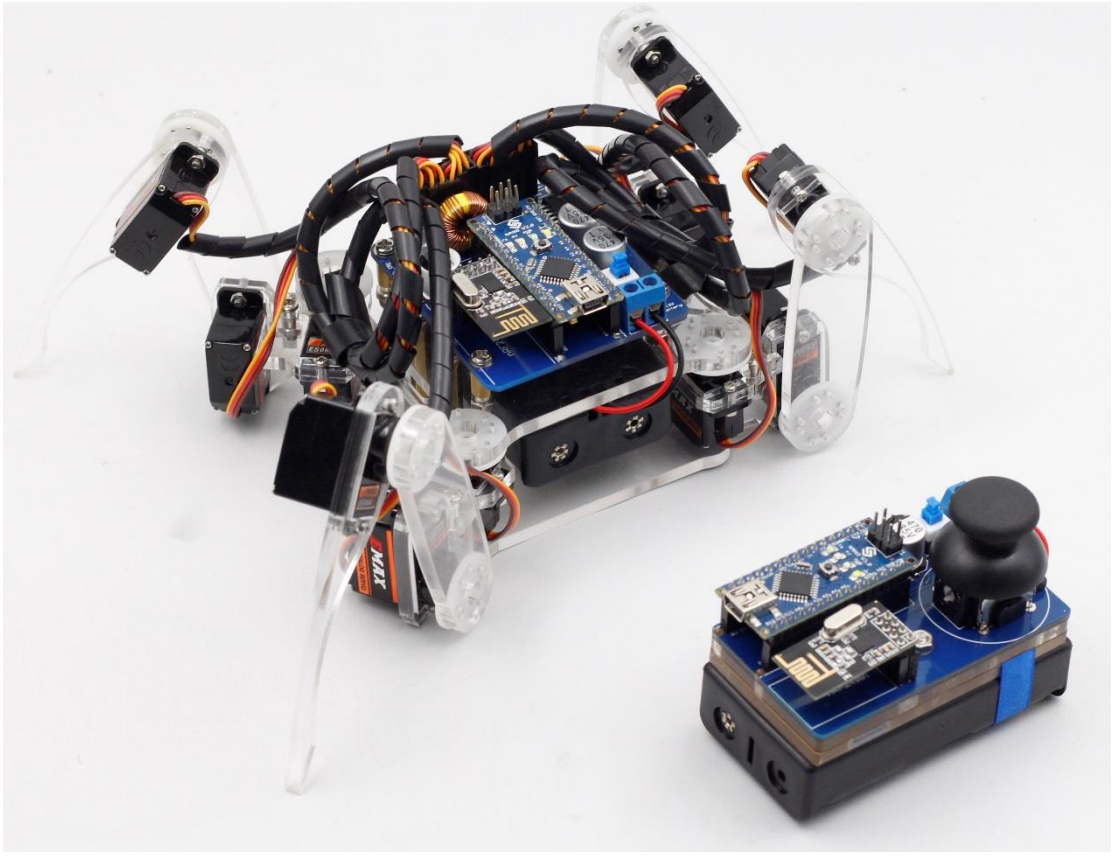
Servo

Wire the servos to the SunFounder Servo Control Board according to the following servo number. The numbers are corresponding to the pin number on the control board.



Organize the wires of the servo with wire harness tube. Now the crawling quadruped robot has been fully assembled.





4. Calibrating

During the installation, there may be errors in mechanical connection. So you need to calibrate the robot to make sure the accuracy.

Uploading Code for Calibration

Open *Crawler.ino* under *CD\code\3.Crawl\Crawler* directory

Modify code lines 32-34 as follows, compile the code, upload it to the SunFounder Servo Control Board, and then remove the USB cable.

```
31  /* Installation and Adjustment ----------------------------------------
32  //#define INSTALL       //uncomment only this to install the robot
33  #define ADJUST  //uncomment only this to adjust the servos
34  //#define VERIFY        //uncomment only this to verify the adjustment
```

Switch on SunFounder Servo Control Board. At this point, the crawling robot will keep the calibration poses.

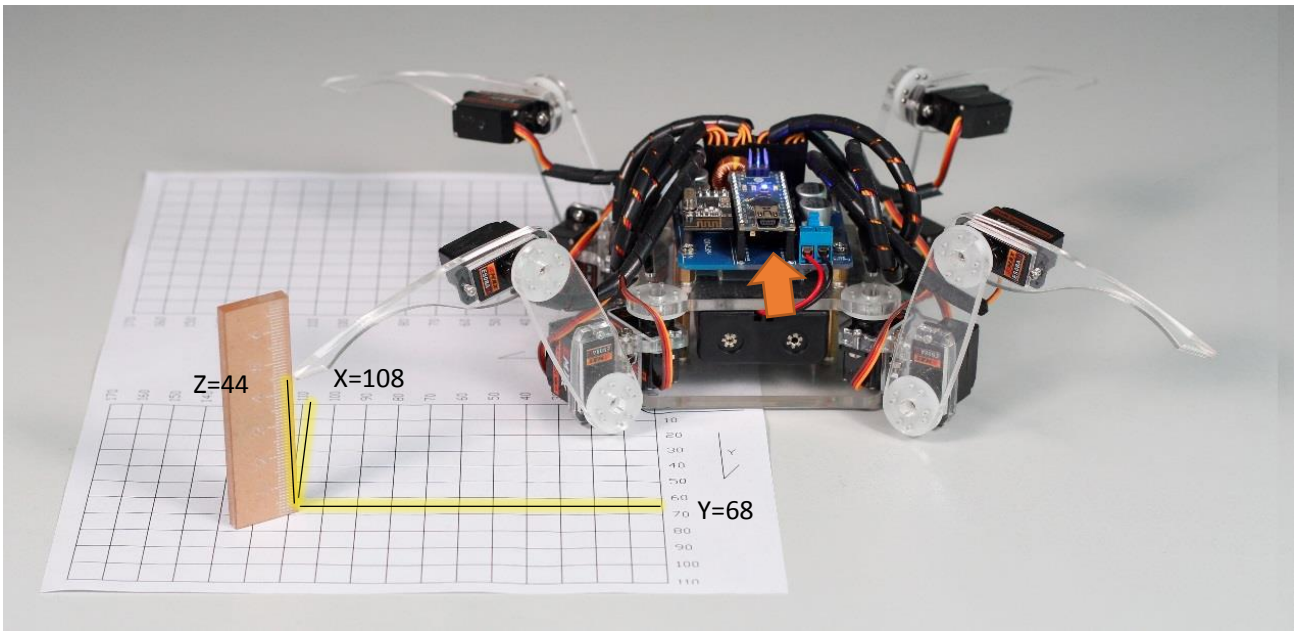
Calibrating

Measure the 3D (x, y, z) coordinates of the end of the four legs, put them in the array real_site[4][3] at line 36 to calibrate the error during the installation.

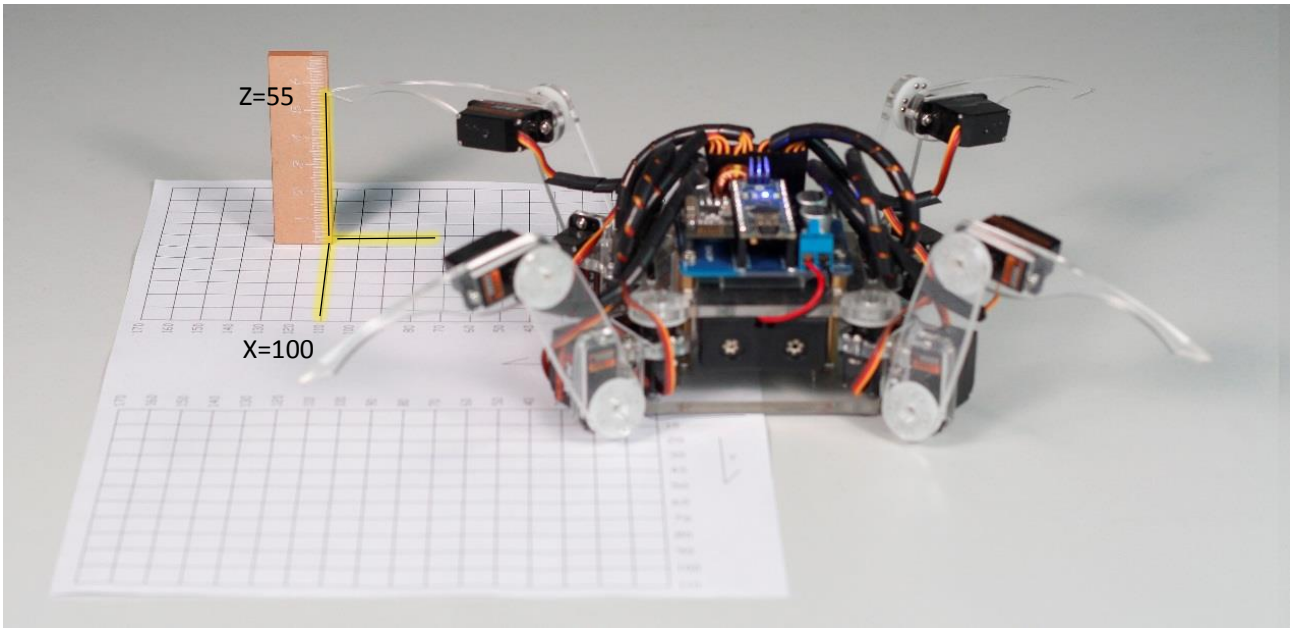
```
34  //#define VERIFY        //uncomment only this to verify the adjustment
35  const float adjust_site[3] = { 100,  80,  42 };
36  const float real_site[4][3] = { { 100,  80,  42 },  { 100,  80,  42 },
37                                  { 100,  80,  42 },  { 100,  80,  42 } };
```

a. Place the robot as shown in the following picture. Measure the coordinates (x, y, z) of leg 1 with a ruler. Here it is (108, 68, 44).

   Please pay attention to the direction of the robot and refer to the orange arrow below.

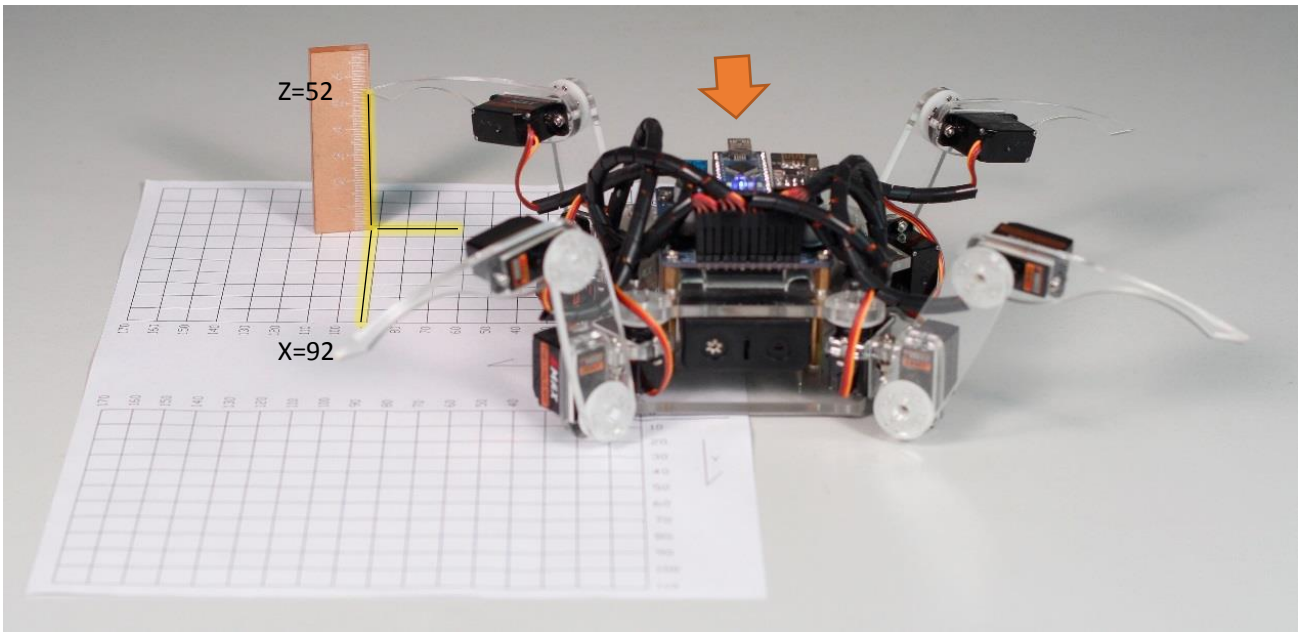


b. Measure the coordinate (x, y, z) of leg 2. Here it is (100, 65, 55).

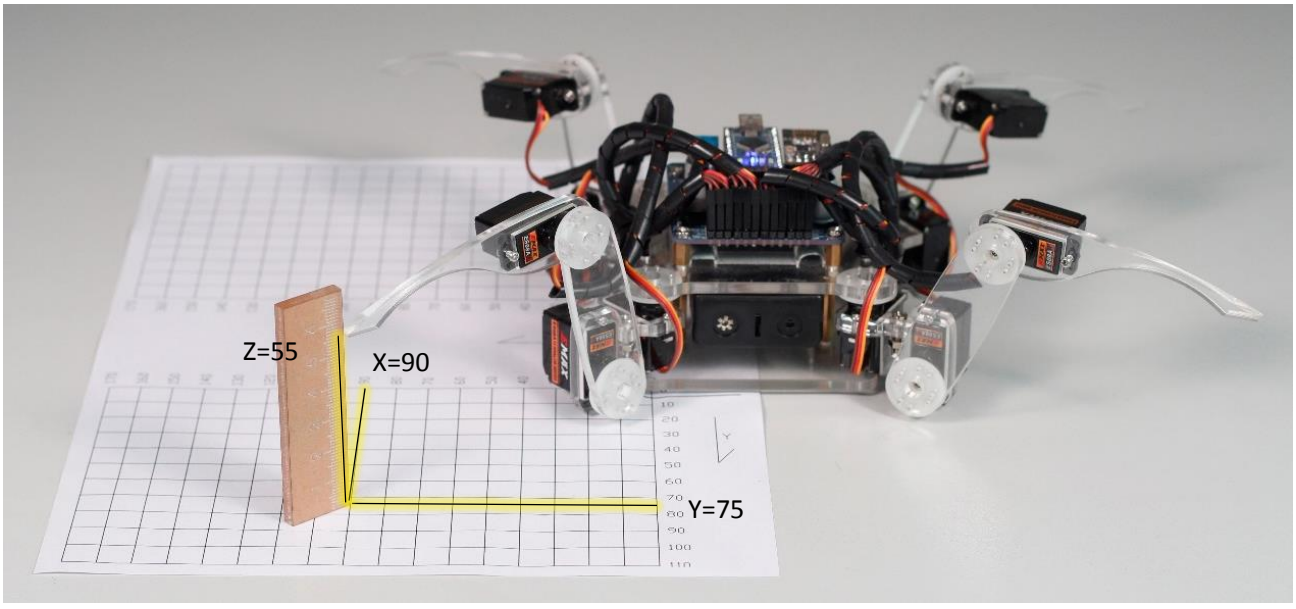


c. Rotate the robot as shown in the following figure, and measure the coordinates (x, y, z) of leg 3. Here it is (92, 72, 52).

   Please pay attention to the direction of the robot and refer to the orange arrow below.



d. Measure the coordinate (x, y, z) of leg 4. Here it is (90, 75, 55).



So, the coordinates filled in the array are (108,68,44), (100,65,55), (92,72,52), and (90,75,55), as shown below:

```
31  /* Installation and Adjustment ----------------------------------------
32  //#define INSTALL       //uncomment only this to install the robot
33  #define ADJUST  //uncomment only this to adjust the servos
34  //#define VERIFY        //uncomment only this to verify the adjustment
35  const float adjust_site[3] = { 100, 80, 42 };
36  const float real_site[4][3] = { { 108, 68, 44 }, { 100, 65, 55 },
37                                  { 92, 72, 52 }, { 90, 75, 55 } };
```

Fill in the values according to your actual measurements to calibrate the robot correctly.

Uploading Code for Verification

Modify code lines 32-34 as follows, compile the code, upload it to the SunFounder Servo Control Board, and then remove the USB cable.

```
31  /* Installation and Adjustment ----------------------------------------
32  //#define INSTALL       //uncomment only this to install the robot
33  //#define ADJUST        //uncomment only this to adjust the servos
34  #define VERIFY  //uncomment only this to verify the adjustment
35  const float adjust_site[3] = { 100, 80, 42 };
36  const float real_site[4][3] = { { 108, 68, 44 }, { 100, 65, 55 },
37                                  { 92, 72, 52 }, { 90, 75, 55 } };
```

Switch on SunFounder Servo Control Board. At this point, the crawling robot will keep the verification poses.

Verifying

Place the crawling robot on the calibration chart, and then measure the 3D coordinates (x, y, z) with a ruler. If it is close to the calibration coordinates (100, 80, 42) set in *adjust_site[3]* and the error of each axis is less than 10mm, it means calibration is successful. Otherwise, recalibrate it until it succeeds.

5. Movement

Crawling

Uploading Code for SunFounder Mobile Robot Remote Controller

Open *Remoter.ino* under the *CD\code\3.Crawl\Remoter* directory.

Compile the code, upload it to SunFounder Mobile Robot Remote Controller, and then remove the USB cable. Switch on the remote controller.

Uploading Code for SunFounder Servo Control Board

Open *Crawler.ino* under the *CD\code\3.Crawl\Crawler* directory.

Modify code lines 32-34 as follows, compile the code, upload it to the SunFounder Servo Control Board, and then remove the USB cable.

```
31  /* Installation and Adjustment ----------------------------------------
32  //#define INSTALL       //uncomment only this to install the robot
33  //#define ADJUST        //uncomment only this to adjust the servos
34  //#define VERIFY        //uncomment only this to verify the adjustment
```

Switch on SunFounder Servo Control Board. Now you can control the robot crawling with the remote controller.

Dancing

Uploading Code for SunFounder Mobile Robot Remote Controller

The SunFounder Mobile Robot Remote Controller uses the above code, and you don't need to upload it again.

Uploading Code for SunFounder Servo Control Board

Open *Dance.ino* under the *CD\code\4.Dance\Dance* directory.

Compile the code, upload the code to SunFounder Servo Control Board, and then remove the USB cable.

Switch on SunFounder Servo Control Board. The robot will dance for a while.

When the robot stops, switch on SunFounder Mobile Robot Remote Controller. Now, you can use it to make the robot dancing.

That's all for the SunFounder crawling quadruped robot. You can start your trial now and have lots of fun in it!

If you have any suggestions or ideas, please send emails to support@sunfounder.com or leave us messages on our official forum. We will reply ASAP.

Thank you.