PLEN5Stack Assembly Manual

PLEN Project Company

2020/2/6

Table of Contents

1. Cautions on Assembly. . 3
2. Table of Contents
    1. Common Parts. 4
    2. special kit. 5
3. About the angle of Servo horn. . 6
4. Assembly
    1. Preparation. 8
    2. Switch board assembly. 9
    3. Circuit board and battery wiring. . 11
    4. Servo motor set-up. 16
    5. Assembling the Thighs. 19
    6. Attaching leg parts. 23
    7. Shoulder parts assembly. 27
    8. Arm parts assembly. 31
    9. Servo xer attachment. 35
    10. Control board wiring. 38
    11. Head part assembly. 41
    12. Chest assembly. 46
5. Motion check
    1. Let's walk the PLEN5Stack!. 51
    2. How to adjust ServoMotor position
6. How to charge battery. . 52
7. Firmware Installation
8. Appendix
    1. PLEN5Stack servo numbering. . . . . .
    2. Control board terminal labelling

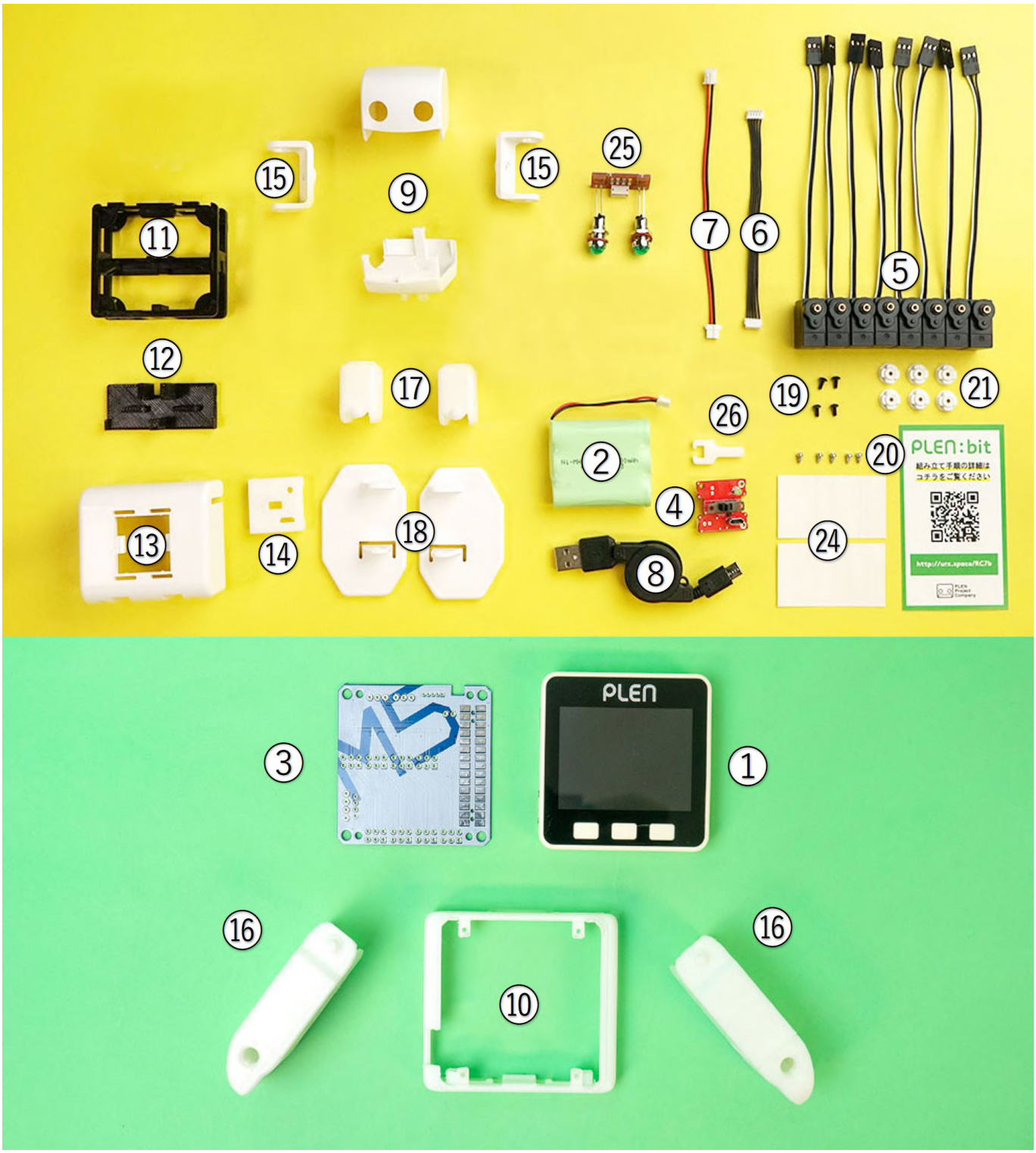
1. Cautions on Assembly

- There will be some steps where force is necessary.
  Please take the proper measures and precautions to not hurt yourself or damage the parts and follow the instructions as described.
- You will need a phillips screwdriver (+ head) for assembly.
- Please use the provided pictures as a reference during assembly.
- Please be aware that the colours and/or appearance of some parts in the provided pictures and those provided may be slightly different.
- The required program for the M5Stack has already been included.
  How to install page is [7. Firmware Installation]
  PLEN5Stack https://github.com/plenprojectcompany/PLEN5Stack
- When assembling the servo motors, the initial rotational position of the gear on the motors is important.
  The assembly instructions includes initial positioning for the motors.
  Please ensure all motors are properly set.
- When setting the servo motors, make sure you wait at least 2 seconds after turning the power switch on until the servo motors automatically set to their initial position.
  If the servo motors do not move after 2 full secods, please if check they are connected properly.

2. Contents list

2.1 Common Parts

1. M5Stack
2. Battery
3. Control Board
4. Switch Board PCB
5. Servo Motors x 8
6. Head Board Cable
7. Power Cable
8. USB Cable
9. Head Parts(top, bottom)
10. Chest Parts
11. Servo Bracket
12. Servo Fixer
13. Back Parts
14. Switch Board Holder
15. Shoulder Parts
16. Arm Parts×2
17. Thighs Parts × 2
18. Legs Parts × 2
19. Black Screw x 4
20. Silver Screw × 7
21. Servo Horn × 6
22.
23.
24. Label Sticker
25. head board
26. Connector tool

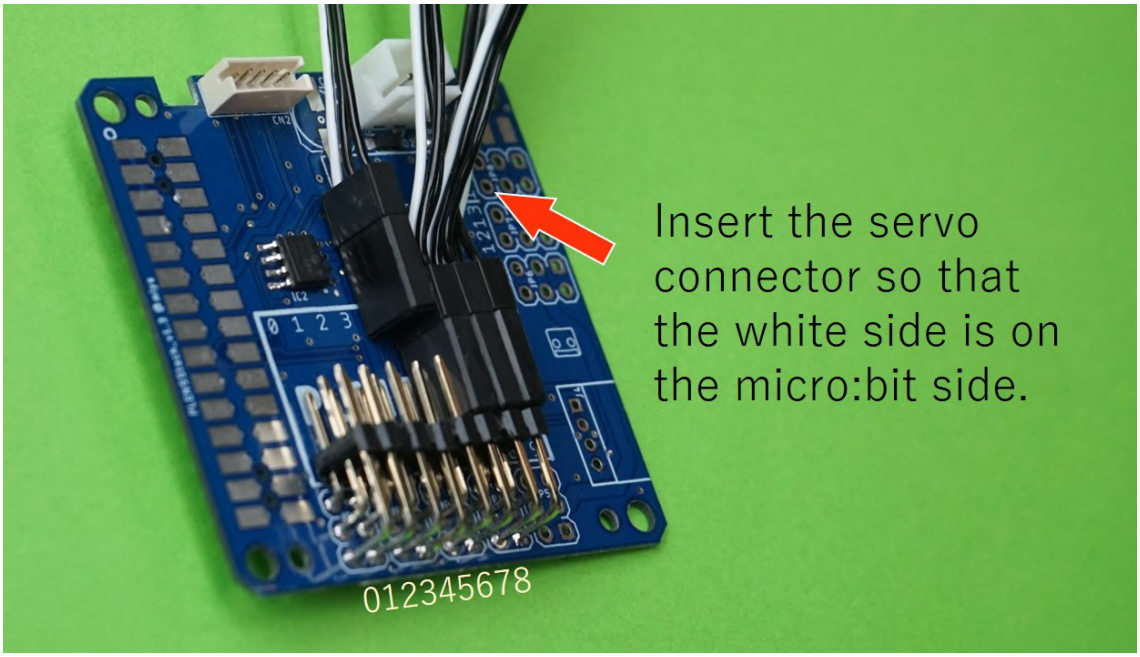


Contents list

3. About the Servo motor

3.1 Connector orientation

1. There is a direction in the connector of the servo motor. Make sure that the white cable is on the inside.



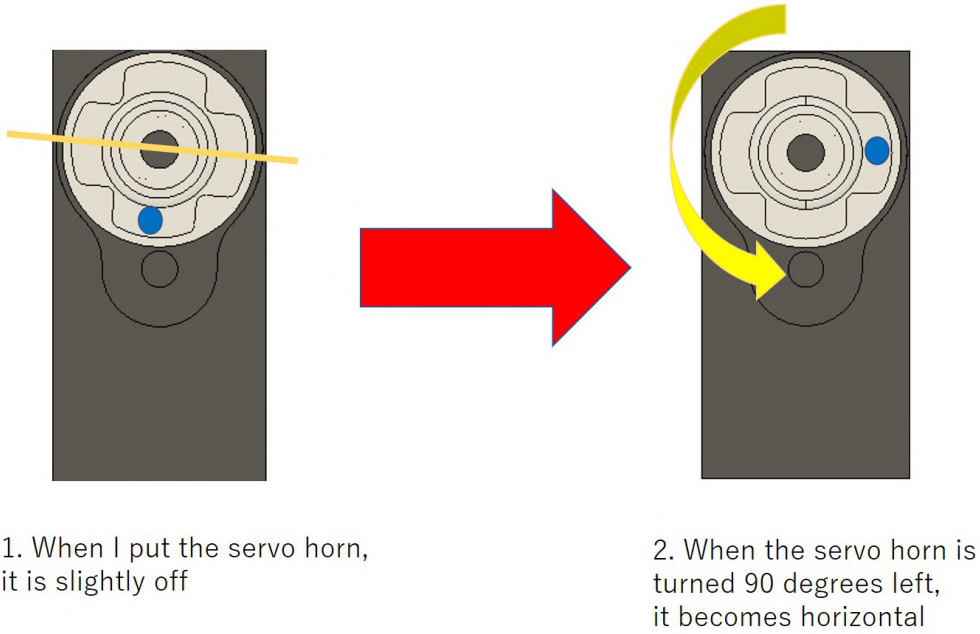
Connector orientation

3.2 About the angle of Servo horn

1. Body balance is important for biped robots. but, since servomotors have individual differences in rotation angle, it is necessary to absorb the individual differences by the servo horn attached to this.
   Therefore, the angle of the servo horn needs to be precisely adjusted. If this adjustment is not successful, you will not be able to walk or fall easily.
   Here we will explain how to make this adjustment.

2. The servo horn has a slight offset between the inner serration and the front cross.
   Therefore, when rotating the cross of the servo horn by 90 degrees, there is a point where the cross is just horizontal.
   Find this and fix the servo horn.

3. As a method other than servo horn adjustment, a method to adjust by program is also prepared. (Coming soon)
   The shoulder parts are integrated with the servo horn and can not be rotated by 90 degrees, so they need to be adjusted in the program.



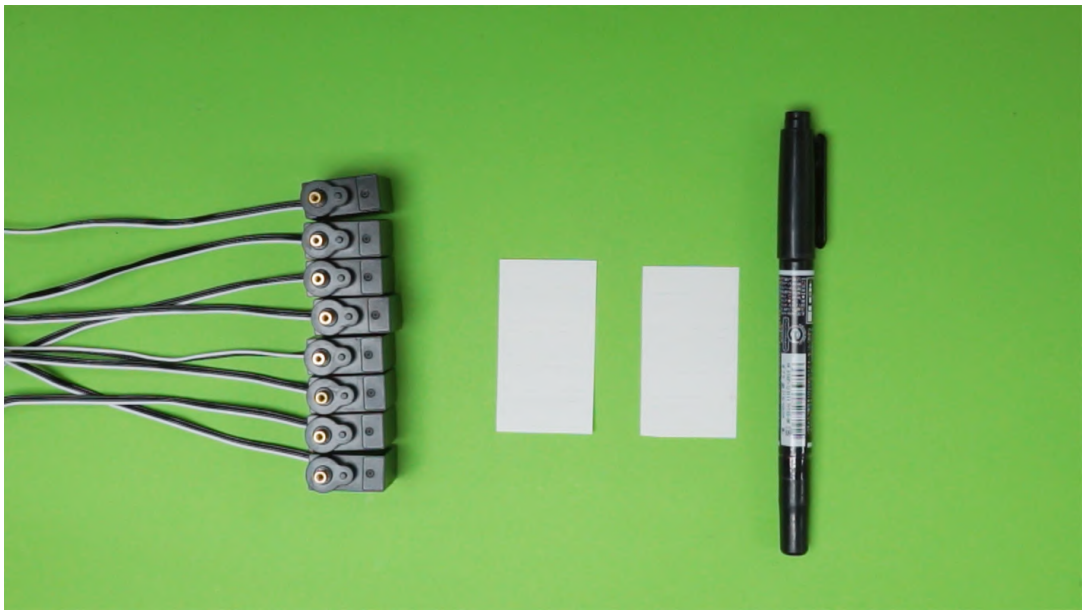
servo horn fix image

4. Assembly

4.1 Preparation

Necessary items

1. Servo Motors x8
2. Label stickers or Circular Stickers
3. Pen



Necessary items

Procedure

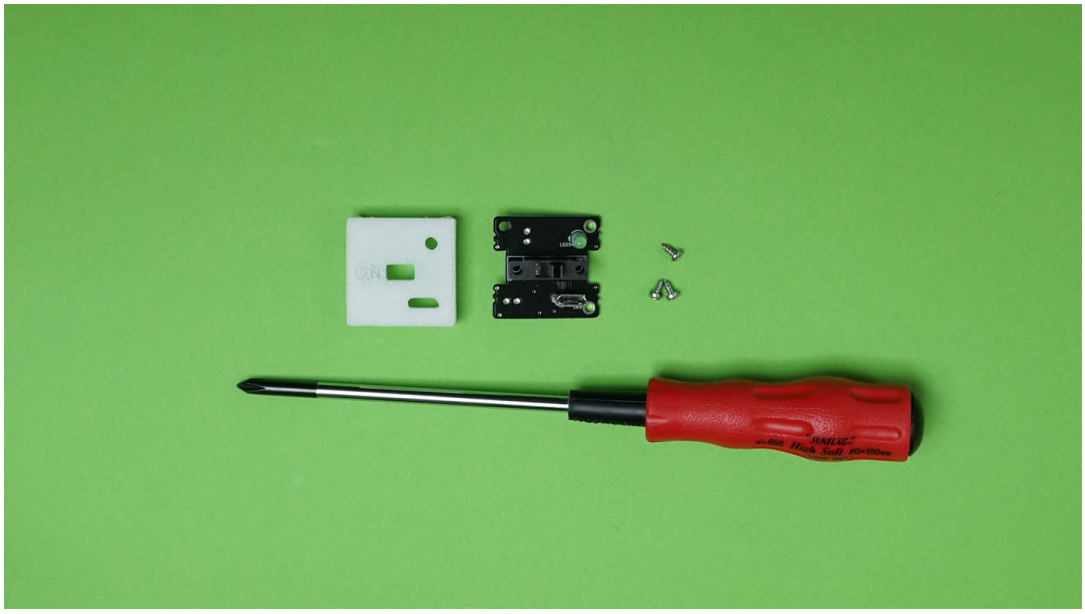
Fix the servo number stickers to each Servo motor cable.Write the numbers 0-7 on eight stickers and place them Attach the sticker in a half-folded form to the servo motor cable.

Sticker placement

4.2 Switch board assembly

Necessary items

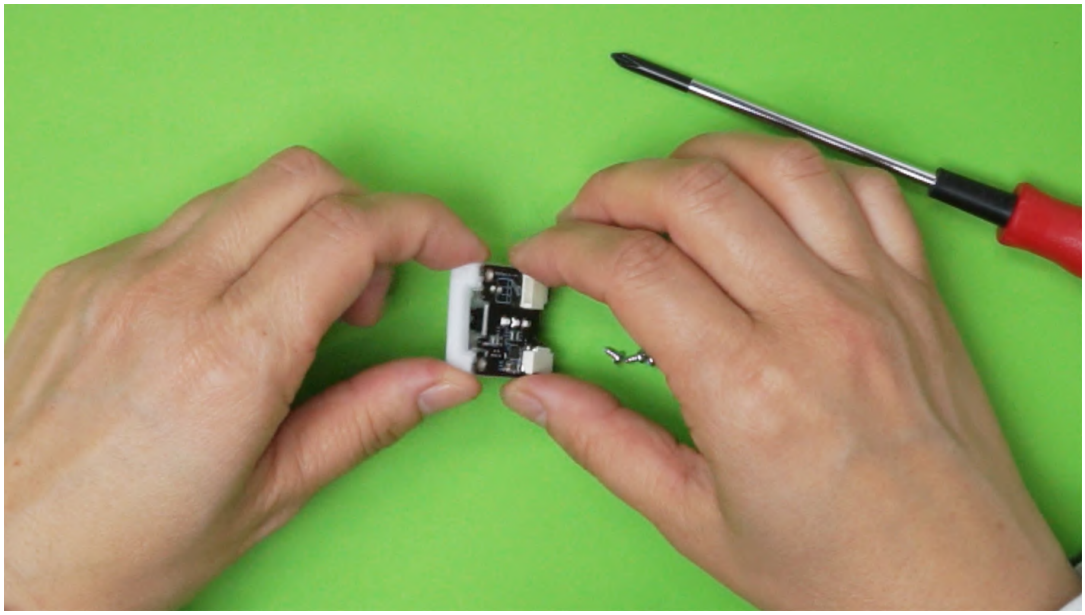
1. switch board set (switch board PCB, switch board holder, screw x2)



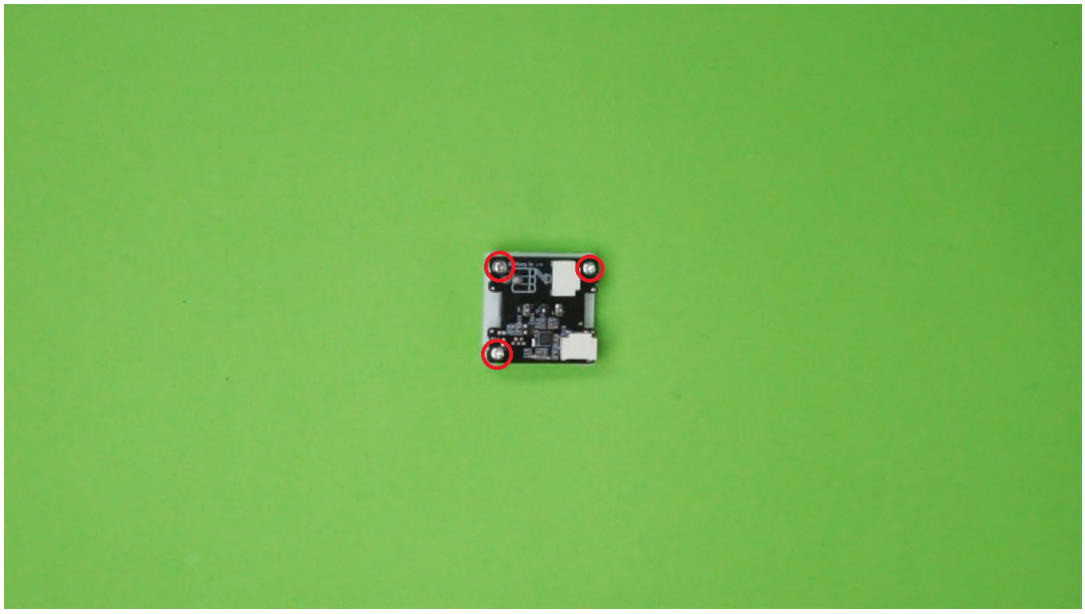
Necessary items

Procedure

1. Align the circuit board and plastic part



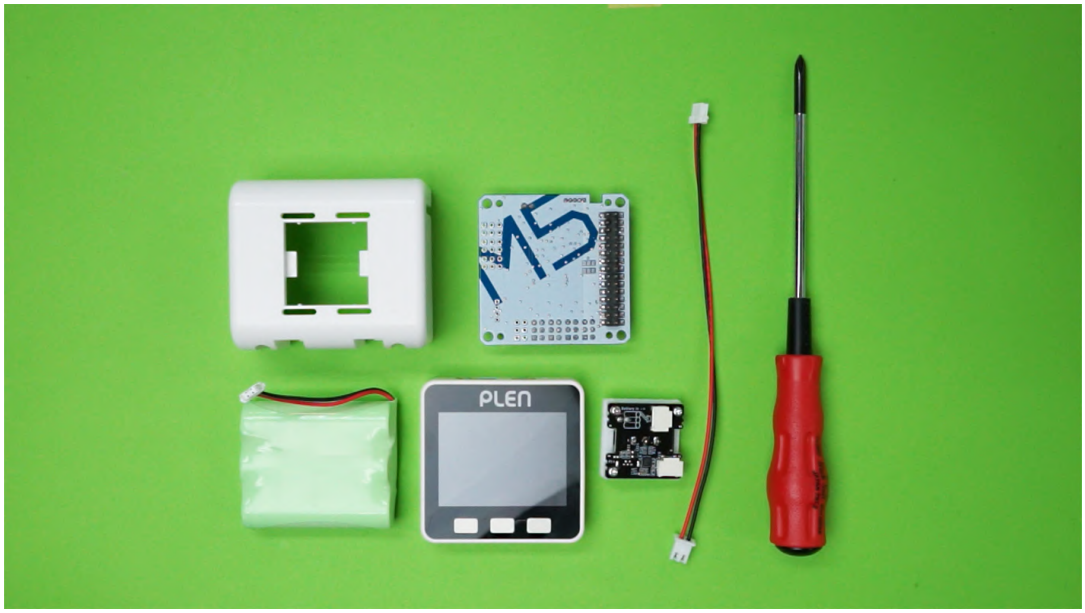
2. Screw in the circuit board using the two screws at the corners



4.3 Circuit board and battery wiring

Necessary items

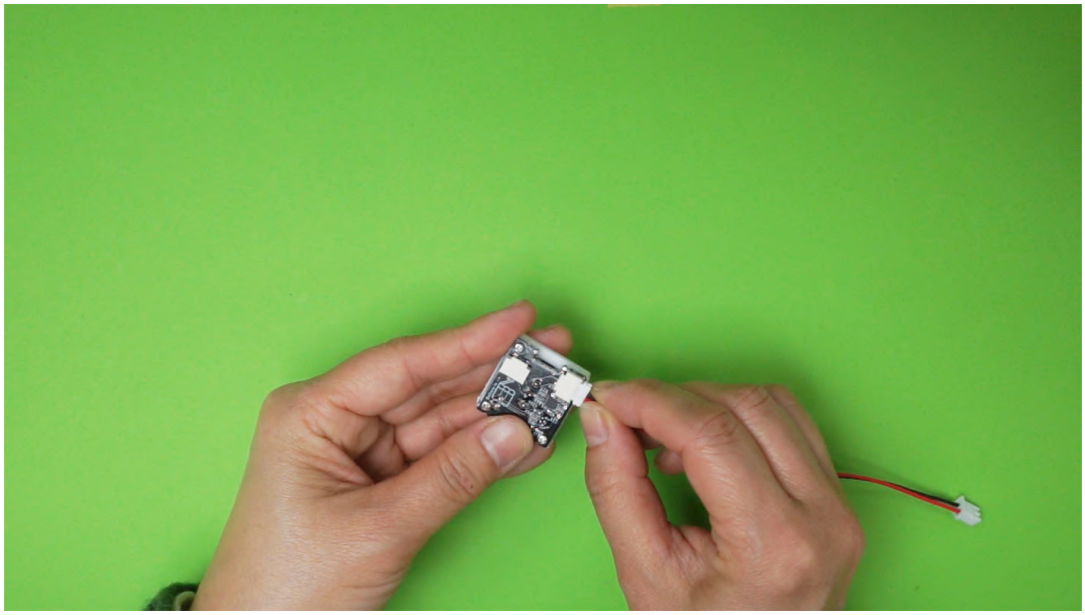
1. back part
2. switch board
3. battery
4. control board
5. M5Stack
6. power cable



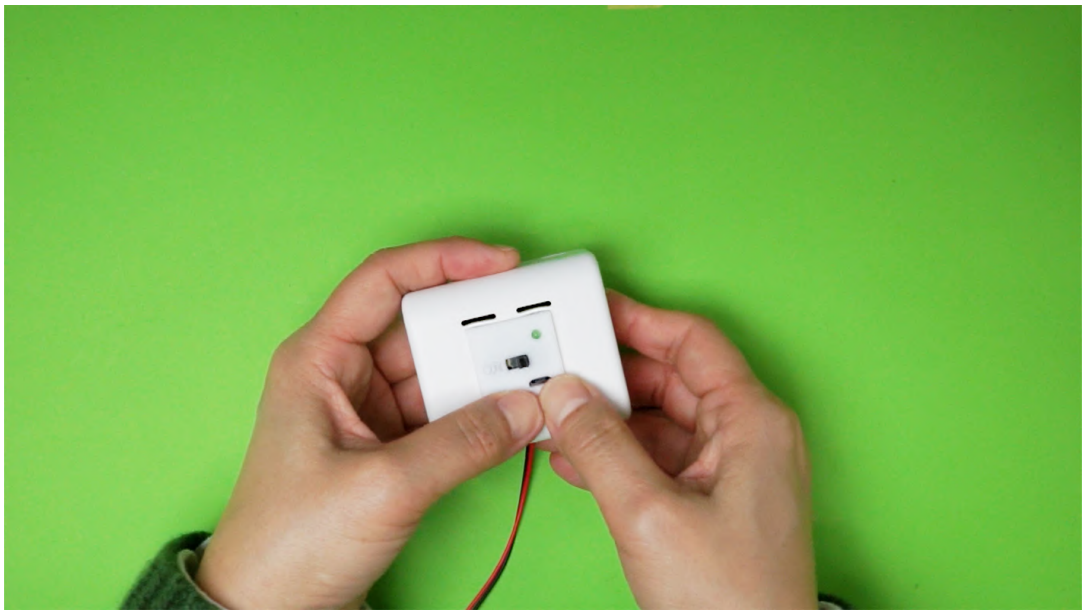
Necessary items

Procedure

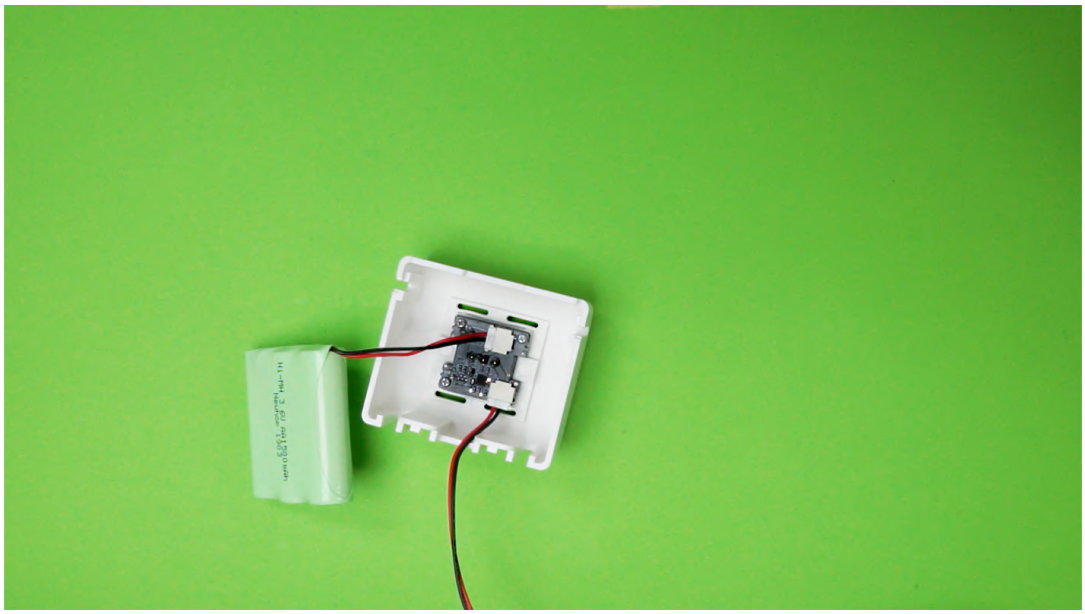
1. Connect the power cable to the switch board



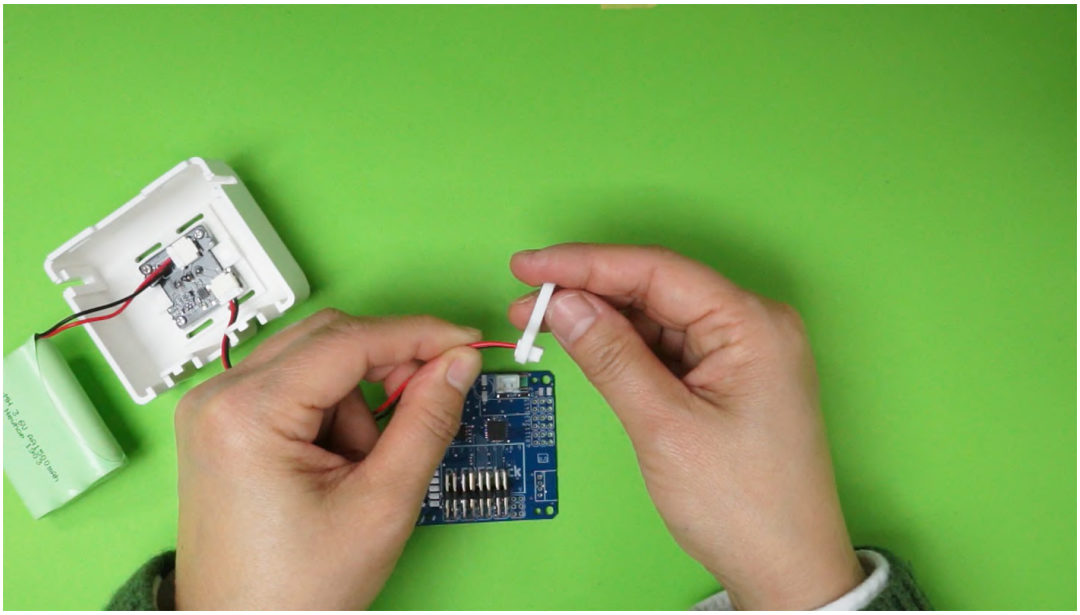
2. Insert the switch board into the back plastic part with the switch and connector going through the appropriate holes as shown in the picture.

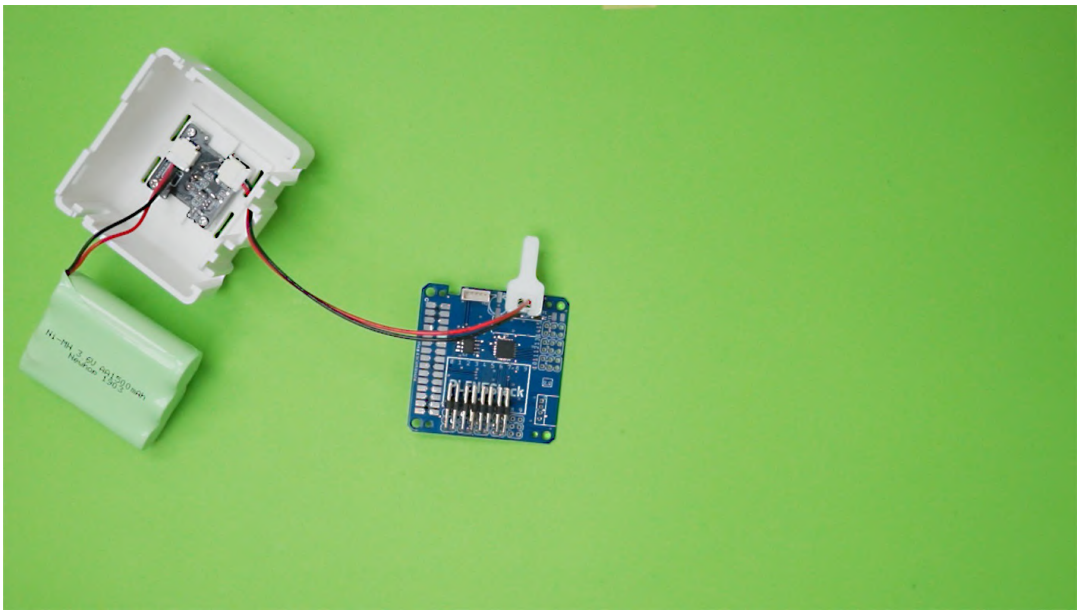


3. Connect the battery to the switch board following the below reference picture.



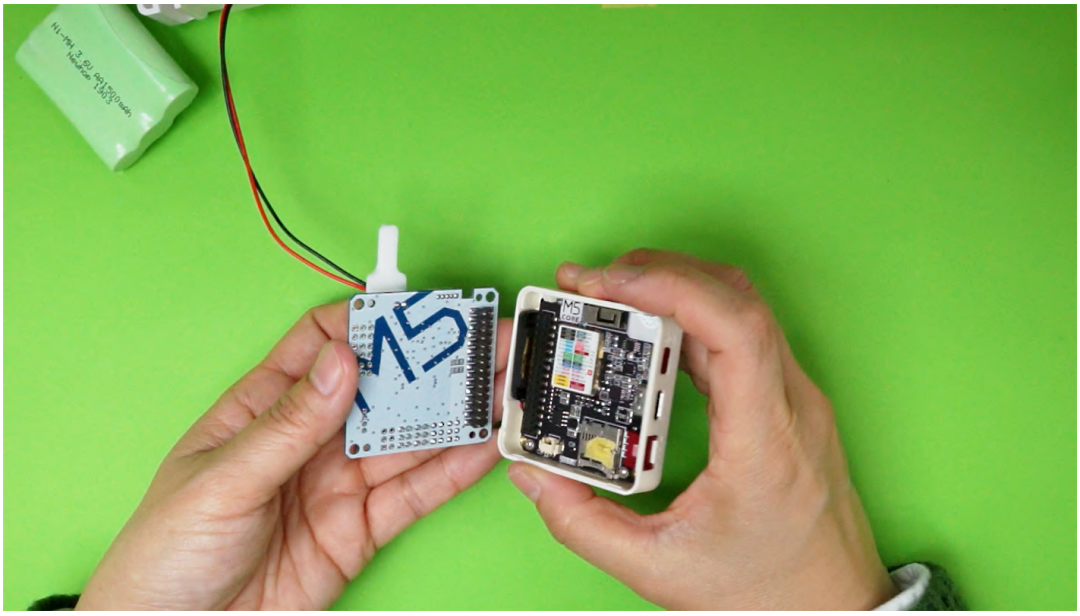
4. Connect the control board and switch using the power cable. The connectors are different so please ensure the correct connector slides smoothly into the pins.
   ※ It is necessary to remove the power cable at the time of "Control board wiring" mentioned later. In this case, since it is hard to remove the cable from the connector, for children and people with weak force, use the supplied connector tool. This is a tool to make it easy to remove by holding this tool between the power cable and the connector.



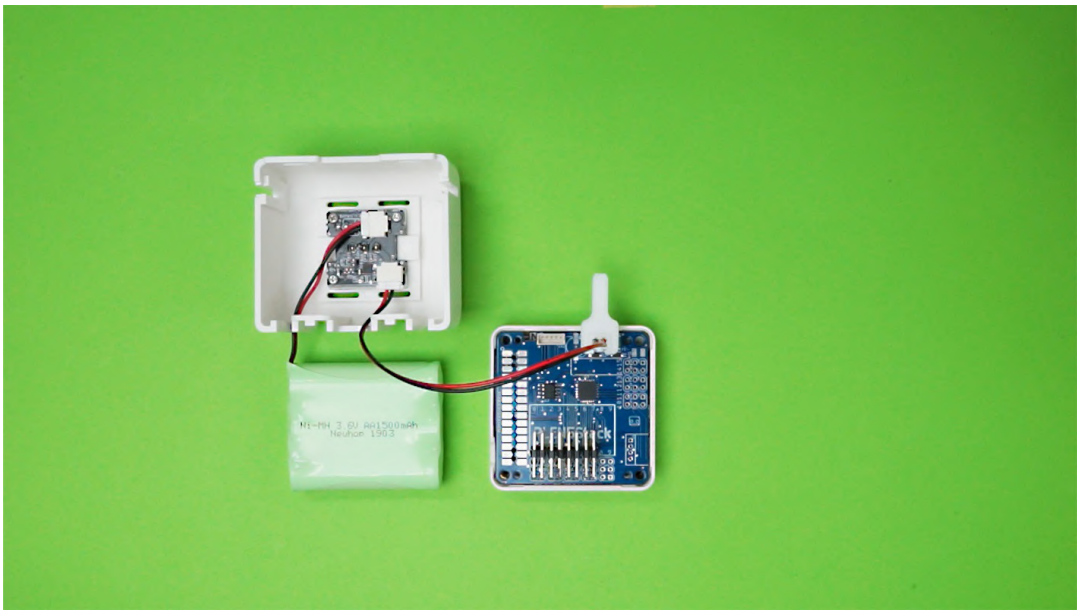


connector tool use example

5. Plug in the M5Stack to the control board.



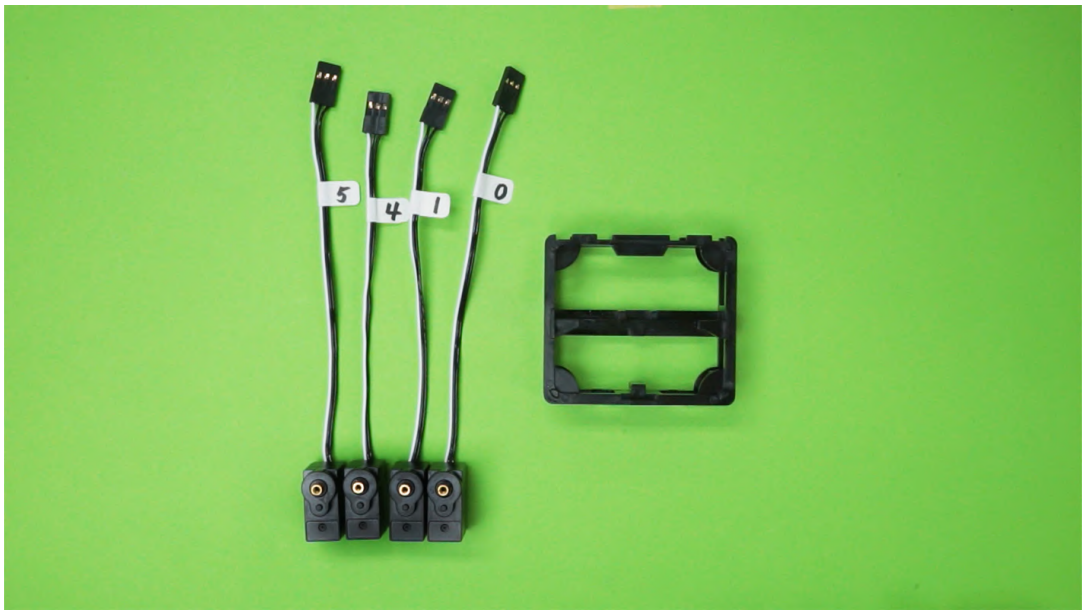
6. complete set of board assembly is seen below



4.4 Servo motor set-up

Necessary items

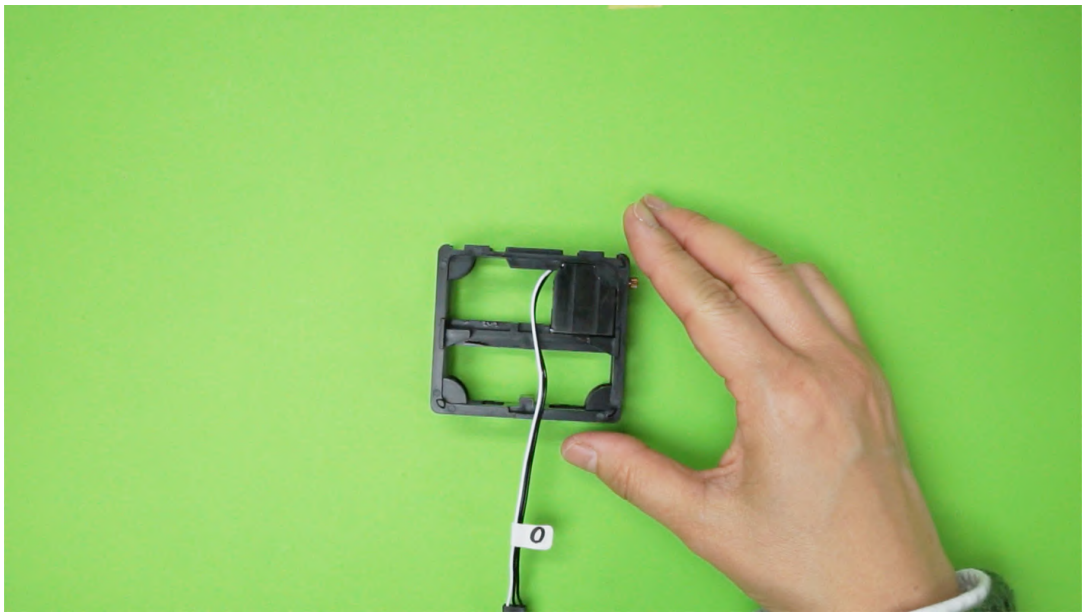
1. Servo motors ×4 (numbers 0,1,4, and 5)
2. Servo bracket



Necessary items

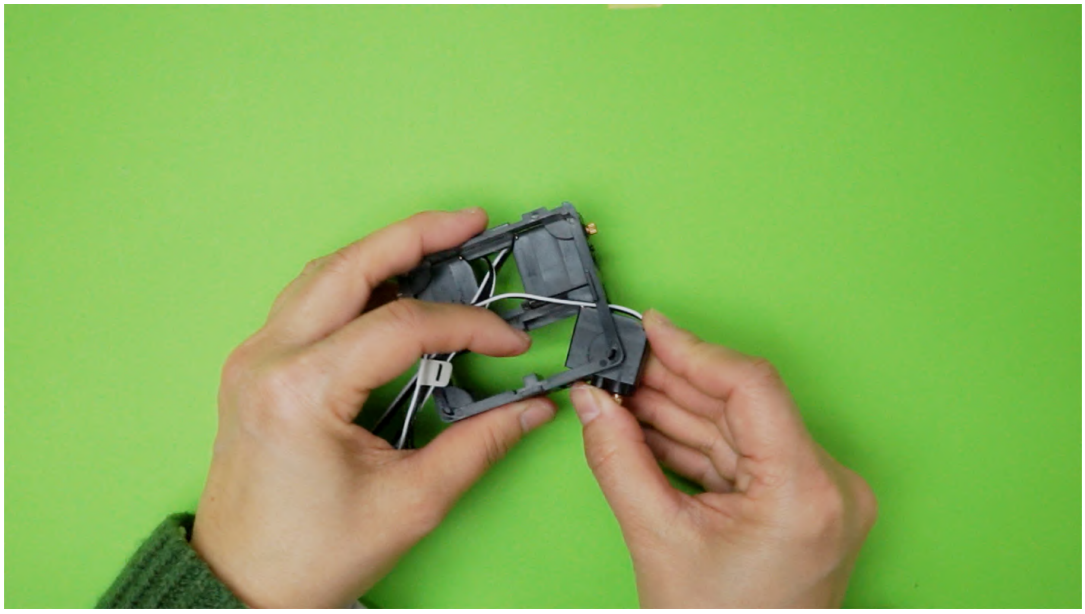
Procedure

1. Orient the servo bracket such that the long back is horizontal and towards the back when inserting the servo motors.
   The side of the bracket with this long bar in the middle is the "back" of the part and concordantly the back of the robot.
   Insert servo motor #0 into the servo bracket as shown. This will be the robot's left arm.
   Be careful not to have the cable of servo motor #0 pinched between the motor casing and plastic parts when assembling.
   Have the servo motor cable come out the "front" side of the bracket.



2. Insert servo motor #4 following the same procedure as #0 on the opposite side of the bracket.

3. Again, be careful not to have the cable of servo motor #1 pinched between the motor casing and plastic parts when assembling.

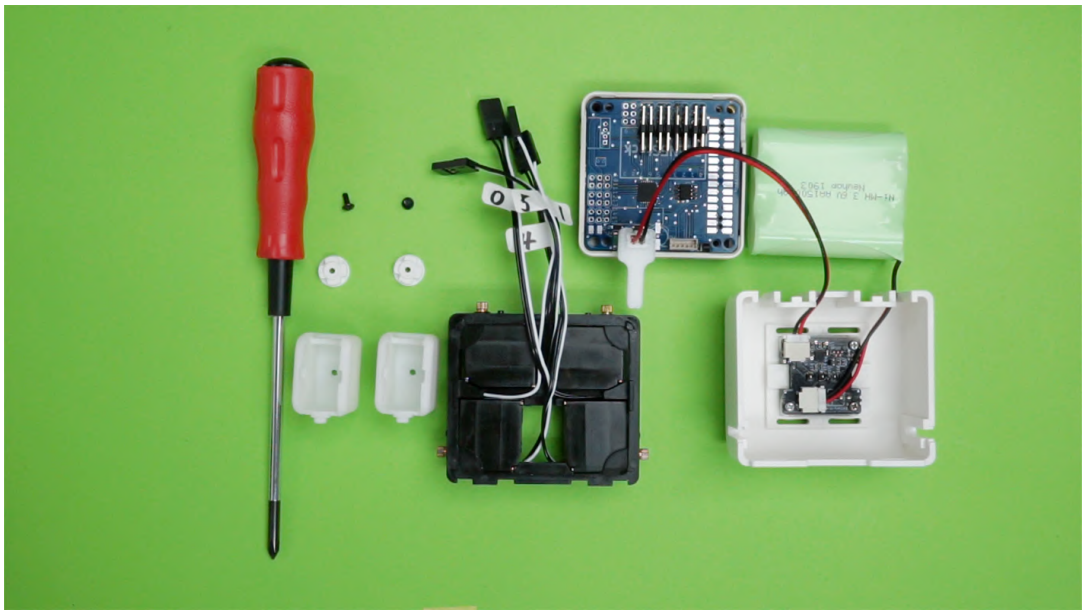


4. Insert servo motor #5 following the same procedure as #1 in the last available position in the bracket.
   Ensure all servo motor cables are coming out the "front" face of the bracket.

4.5 Assembling the Thighs

Necessary items

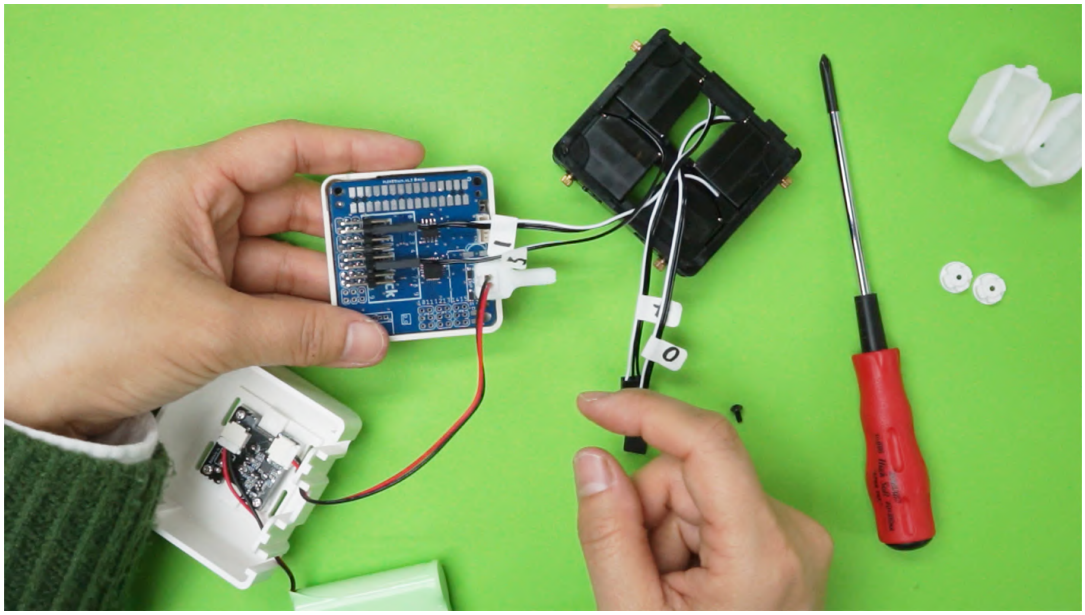
1. The previously assembled servo bracket with servo motors.
2. The previously assembled control board¥
    - battery
    - switch board
3. Thigh plastic parts ×2
4. Servo horn ×2
5. Screws ×2



Necessary items

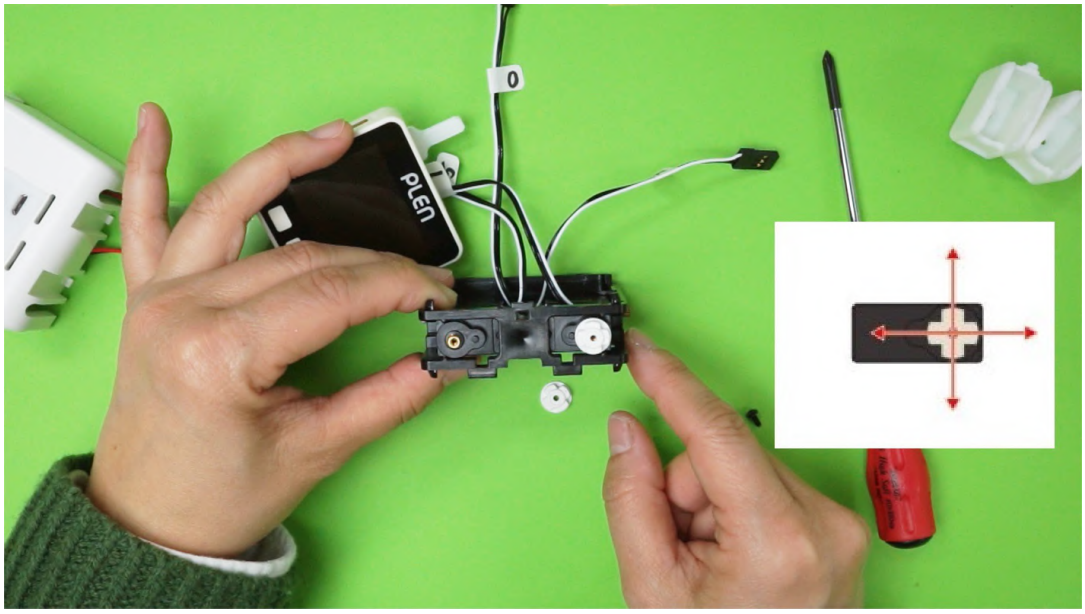
Procedure

1. Ensure the switch board switch is in the off position.
   Connect servo motors #1 and #5 to the control board pins as shown.
   The servo motor pins numbering is given in the Appendix 5.2 picture.
   When connect the motors into the pins, ensure that the black (ground) cable is towards the outside of the control board.
   Turn the switch on the switch board on.
   *if you have not installed firmware, see [7. Firmware Installation].



2. The servo motors should rotate automatically to their initial position.

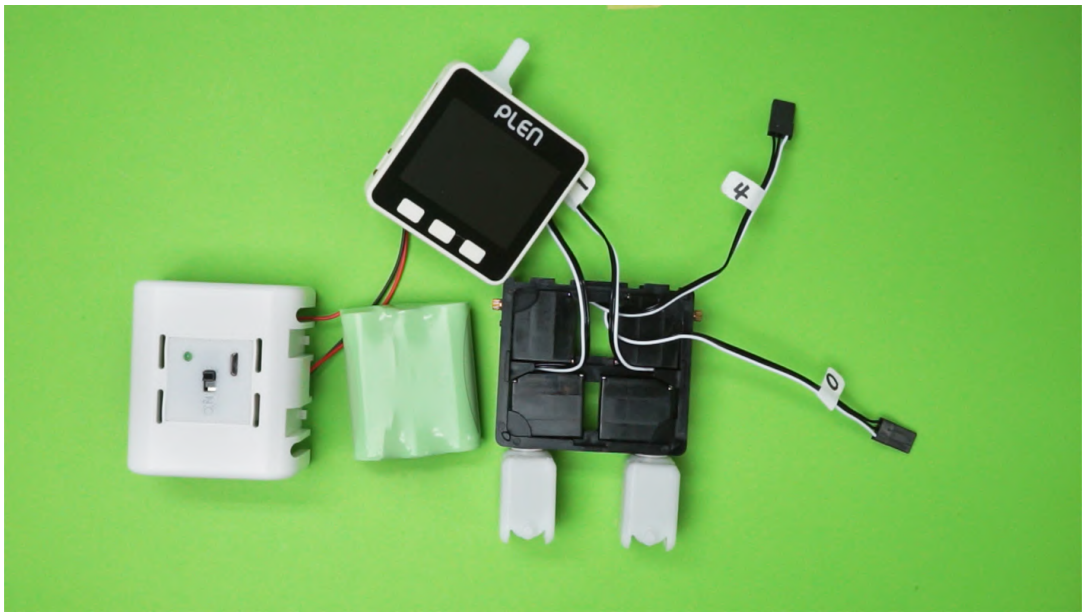
3. Attach the servo horn plastic parts to servo motors #1 and #5 as shown in the photo.
   Ensure the axis of the + on the horn is aligned with the edges of the servo motors.



4. Orient the servo bracket such that the bar across the center of the bracket is horizontal and at the back of the assembly.
   The orientation in the photo below shows the bracket such that the robot's front is being looked at and the head is on top.
   Attach the plastic thigh parts onto the servo horns as shown, such that the bump on the plastic parts are pointing in the same direction as the "front" of the servo bracket.

5. Fix the thigh parts to the horn with the screws.

6. After fully screwing in each of the thigh screws,
   remove the servo cables from the control board.



4.6 Attaching leg parts

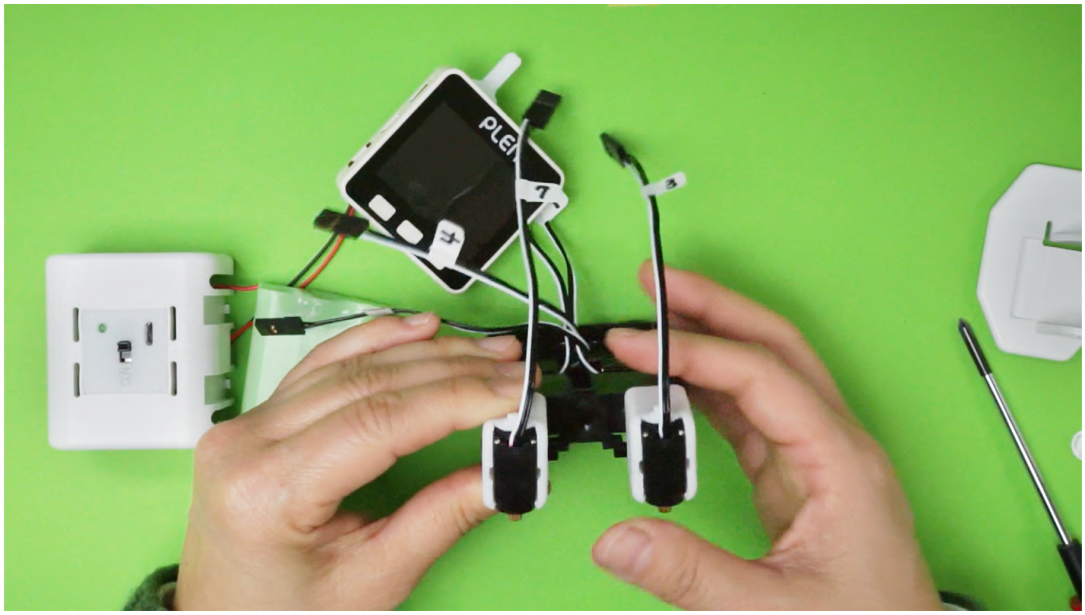
Necessary items

1. body sets
2. circuit sets
3. servo ×2 (3,7)
4. legs ×2
5. servo horn ×2

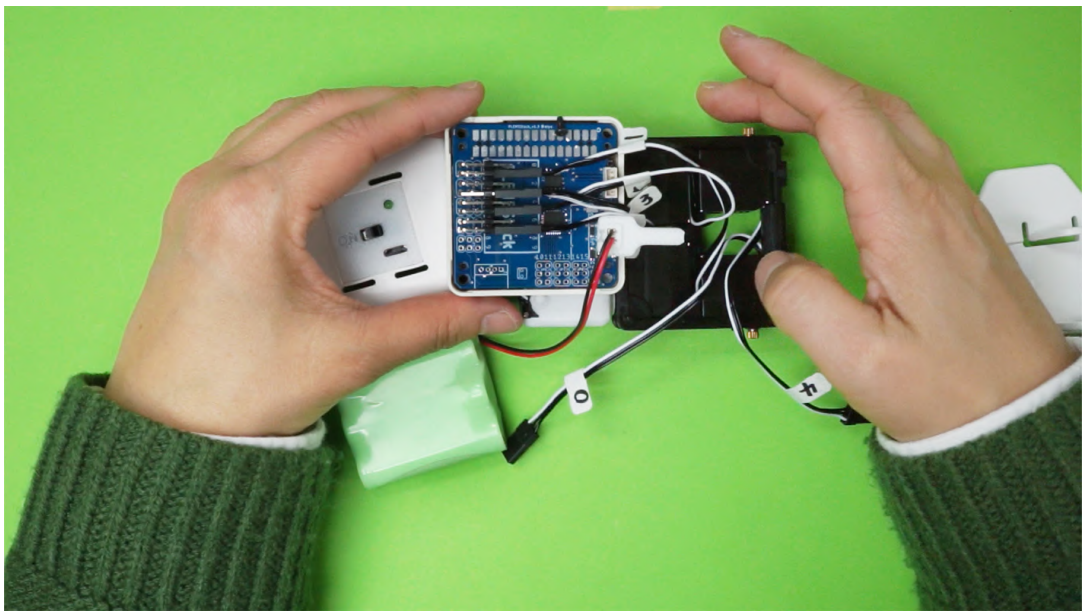
Necessary items

Procedure

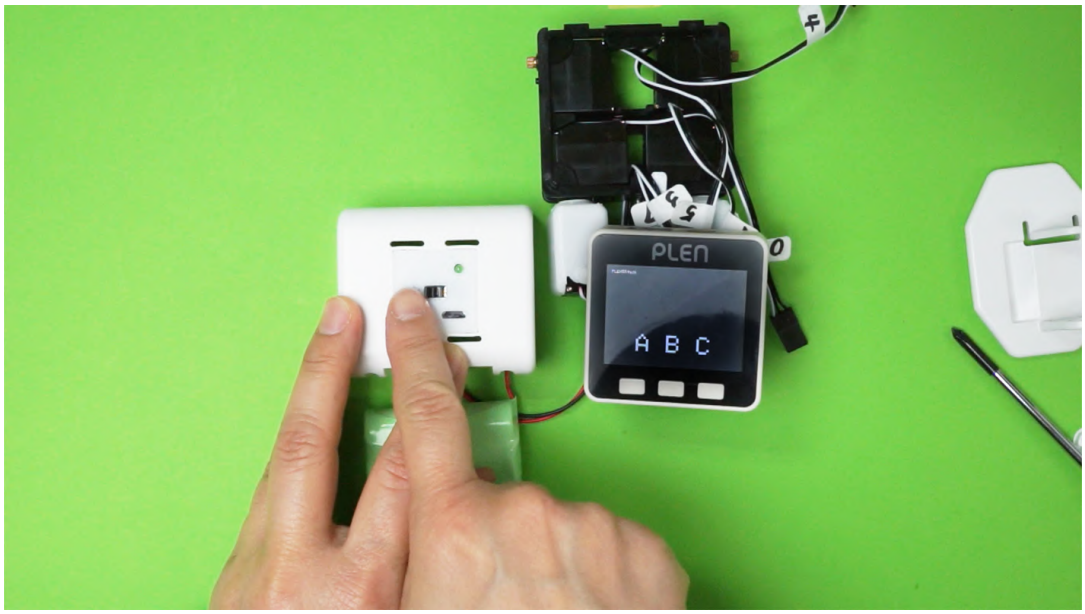
1. Insert servo motors numbers 3 and 7 into the thigh parts as shown.
   The gears of the servo motors will be pointing towards the "back" of the robot.



2. Connect the servo cables for motors 3 and 7 into the control board.
   Servo motor number 3 is to be placed as the robot's left leg.
   Motor number 3 is connected to the corresponding pin set #3 again with the black (ground) cable towards the outside of the control board.
   Repeat for motor #7. Turn the switch board back on.

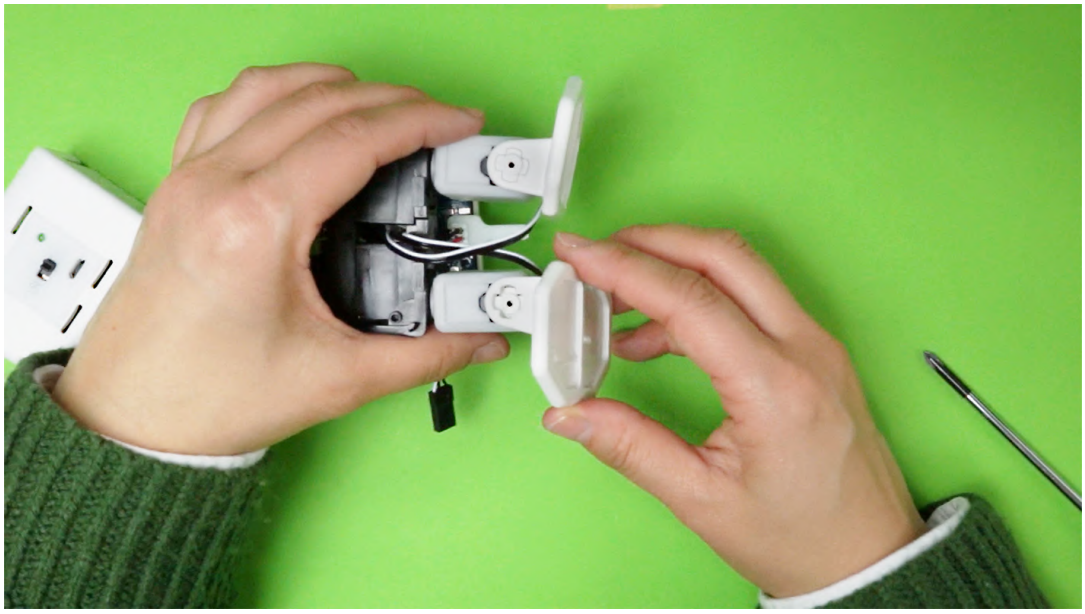


3. The servo motors should rotate automatically to their initial position.

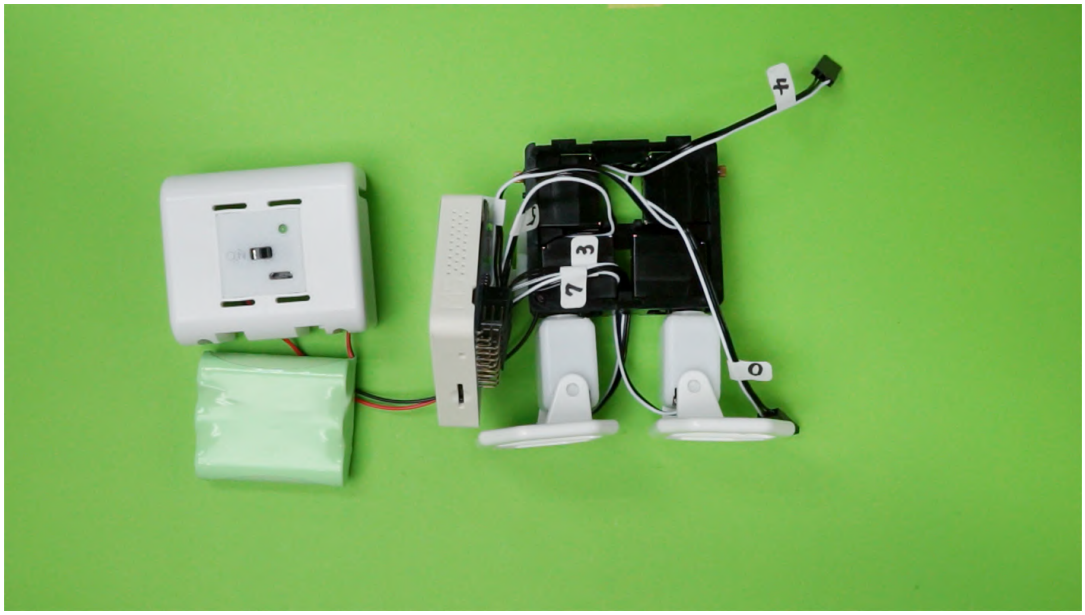


4. Similar to servo motors #1 and #5, attach the servo horns to each servo motor such that the axis of the + on the horn is aligned with the edges of the servo motors as closely as possible.

5. Attach the feet plastic parts while paying attention to ensure the wider side of the feet are towards the outside of the robot.
   Insert the + side of the foot into the servo horn and then insert the opposite side of the foot into the bump on the front side of the thigh.
   *This may take some strength.



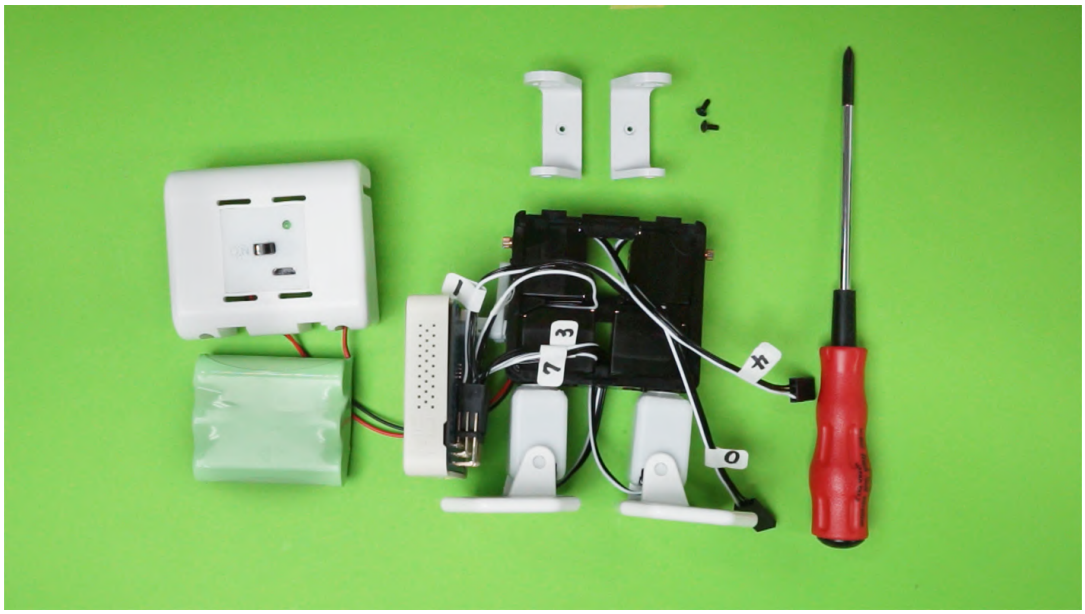
6. After fixing the feet to the servo motors,
   unplug the servo motors from the control board and turn the power switch off.



4.7 Shoulder parts assembly

Necessary items

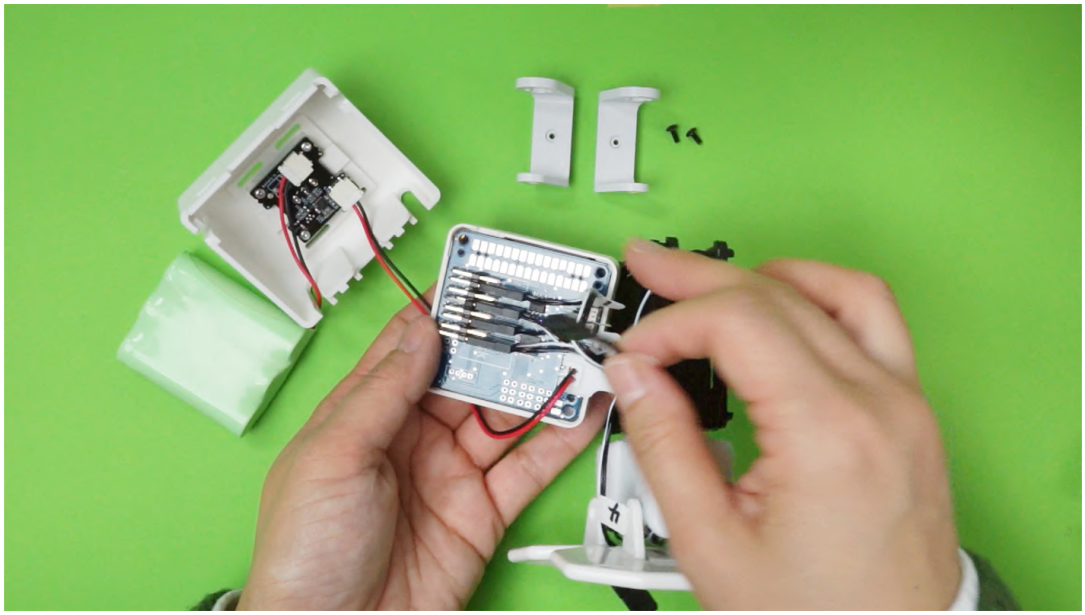
1. body sets
2. circuit sets
3. shoulder ×2
4. screw ×2



Necessary items

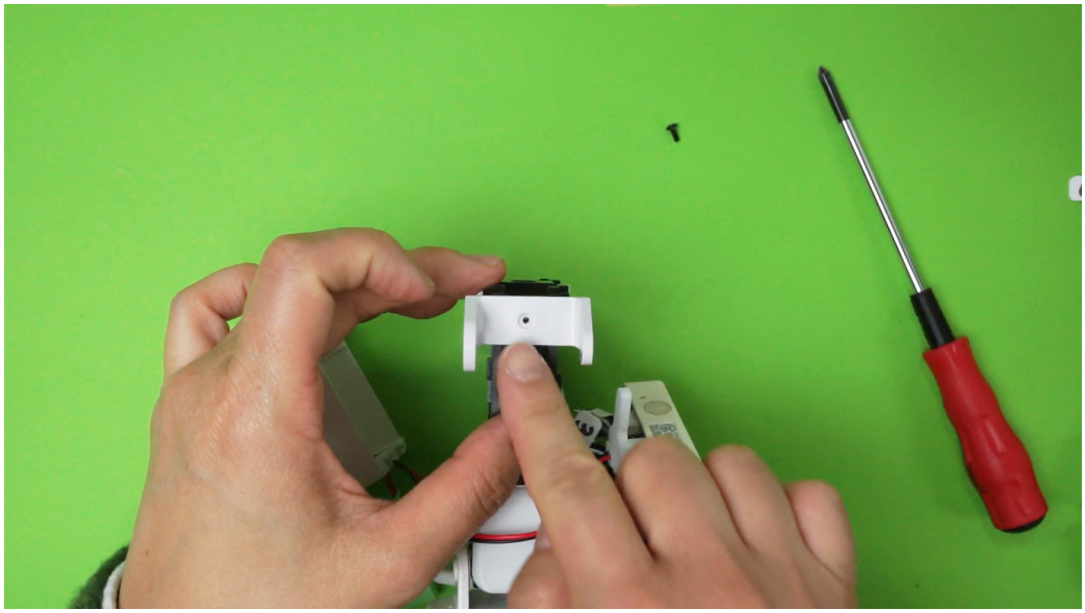
Procedure

1. Connect servo motors #0 and 4 from the servo bracket into their respective pins on the control board and turn the power switch on.

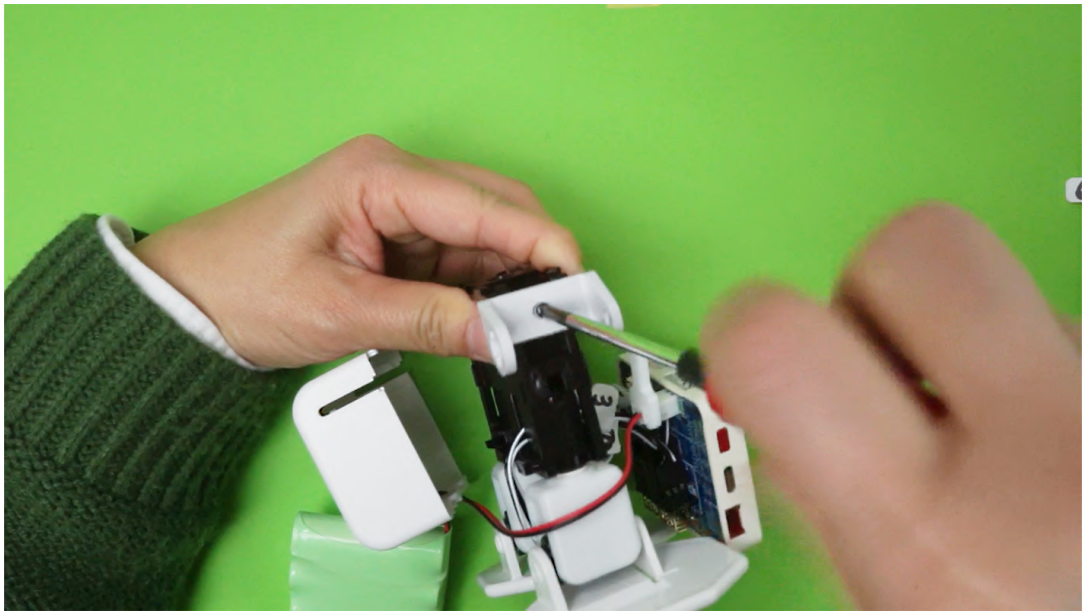


2. The servo motors should rotate automatically to their initial position.

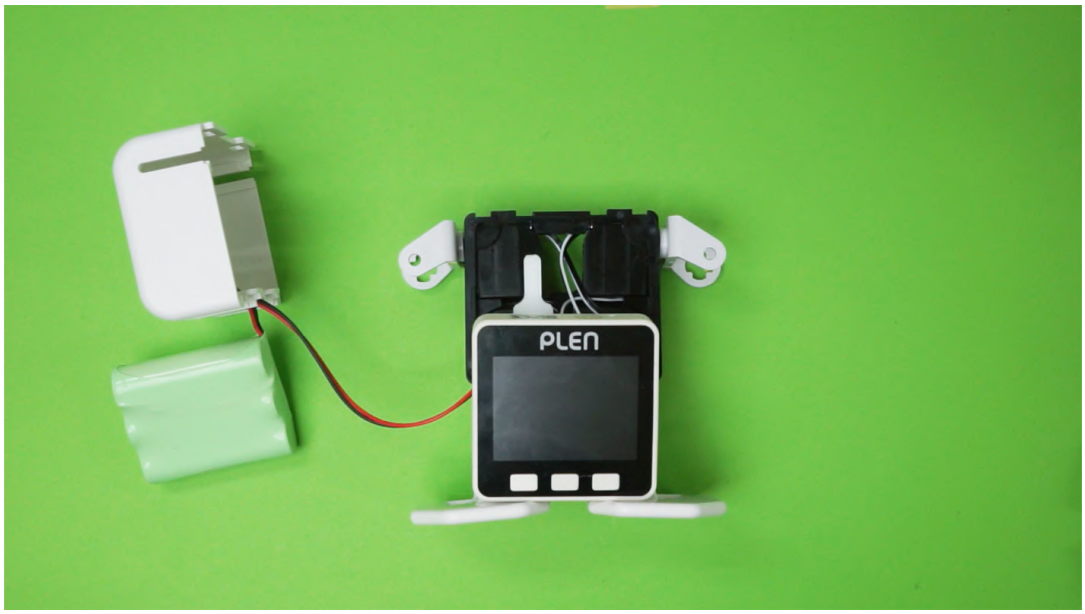
3. Insert the shoulder parts into servo motors 0 and 4 such that the flat edges are aligned with the servo motor as closely as possible.
   The wider side of the shoulder parts with the + cut should be towards the back of the robot.
   Screw in the plastic shoulder part into the servo motor.



4. Repeat the previous step for the opposite shoulder



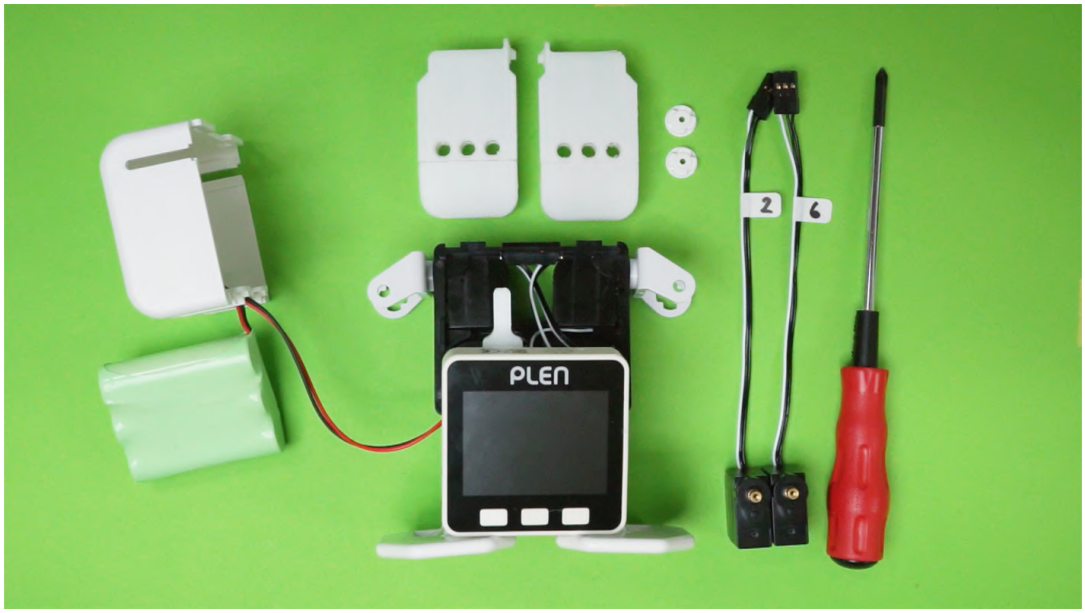
5. Unplug the servo motors from the control board and turn the power switch off.



4.8 Arm parts assembly

Necessary items

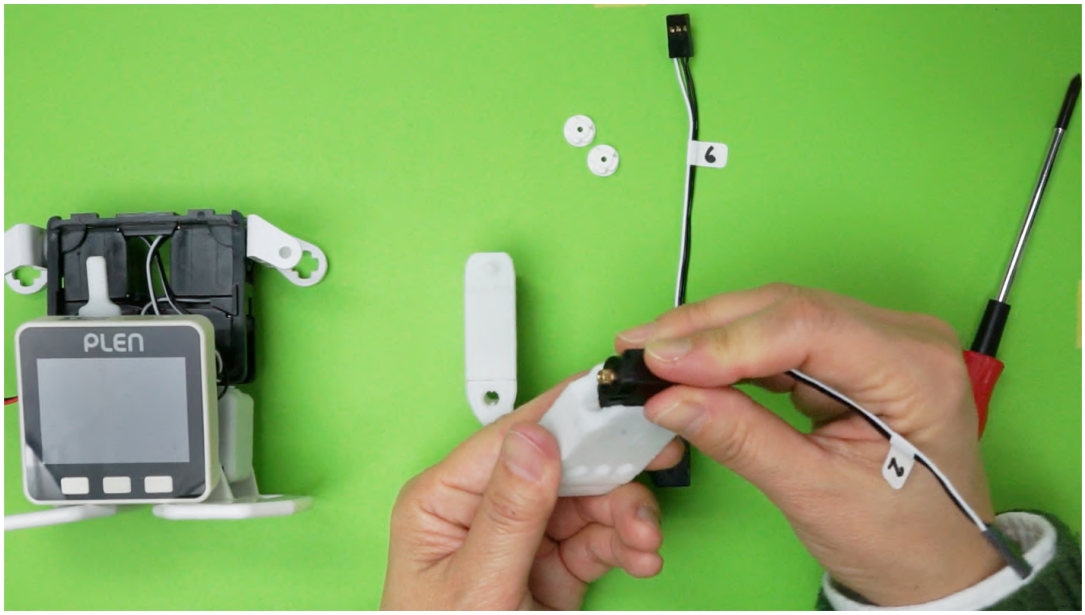
1. body sets
2. circuit sets
3. arm ×2
4. servo ×2 (2,6)
5. servo horn ×2



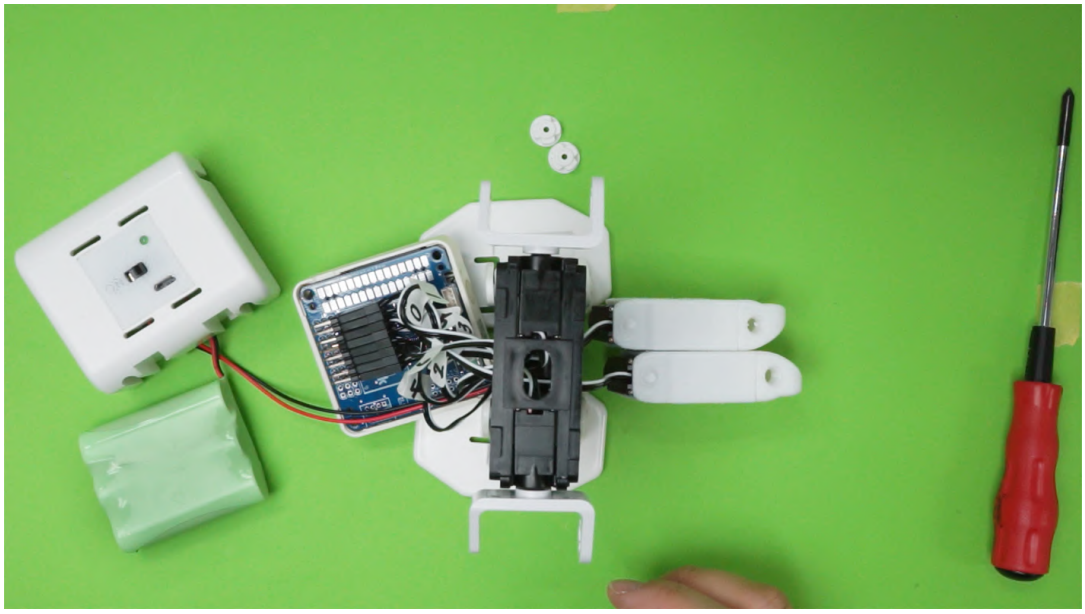
Necessary items

Procedure

1. Place the servo motors #2 and 6 into the plastic arm parts such that motor #2 is the robot's left arm.

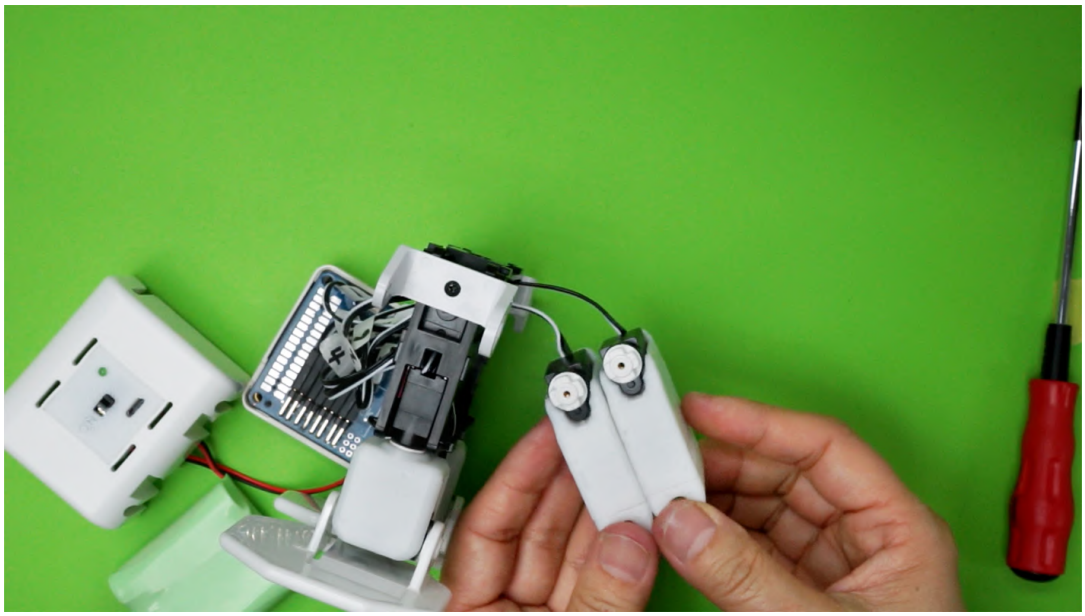


2. Directly connect servo motors #2 and 6 into their respective pins on the control board and turn the power switch on.



3. The servo motors should rotate automatically to their initial position.

4. Attach the servo horns to each servo motor such that the axis of the + on the horn is aligned with the edges of the servo motors as closely as possible.



5. Insert the left and right arms into the shoulder pieces lining up the servo horn with the cut + shape on each shoulder.
   *Ensure the
   arms are inserted pointing down.

6. After fixing the arms to the shoulder parts,
   unplug the servo motors from the control board and turn the power switch off.

4.9 Servo fixer attachment

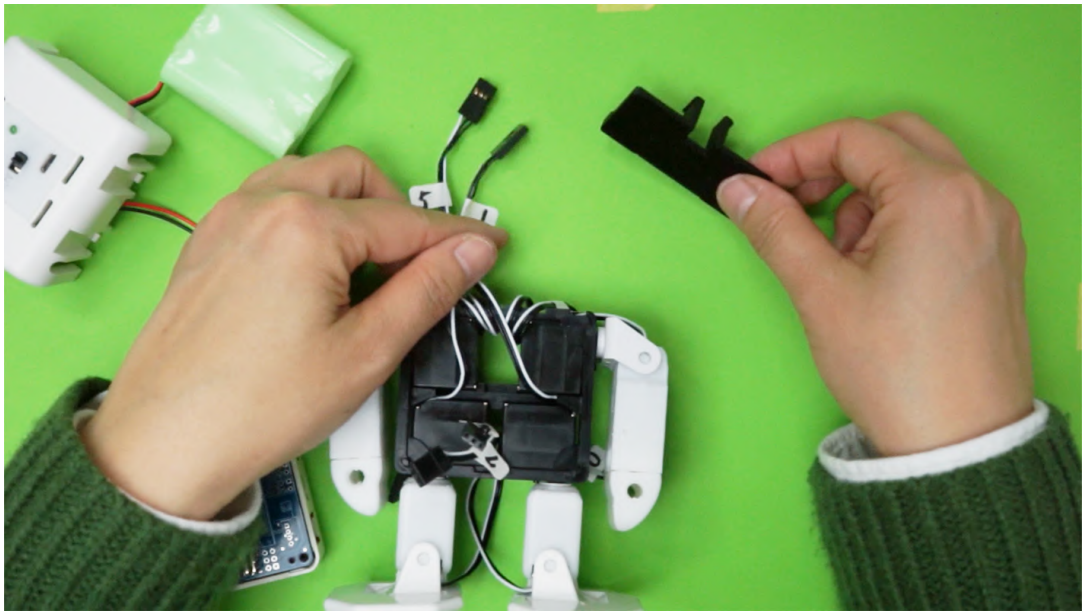
Necessary items

1. Body assembly set
2. Servo fixer part

Necessary items

Procedure

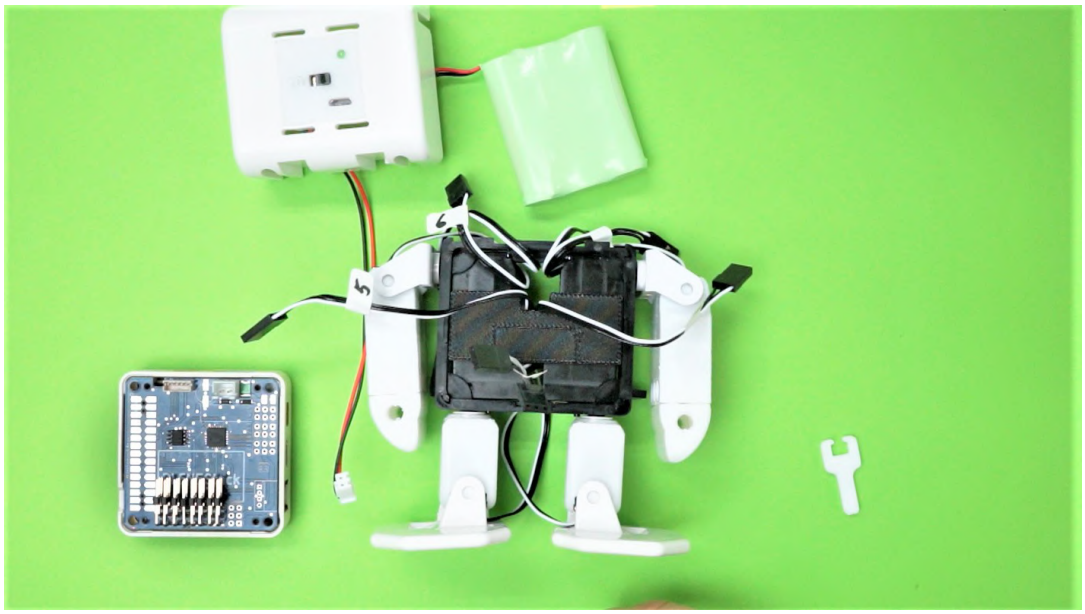
1. Pass the cables of the eight servo motors through the servo bracket and through front as shown.



2. The cables of motors #3 and 7 are passed through the lower hole of the bracket, and left there for later.

3. Servo motors #1 and 5 are passed between the opening in the servo fixer,
while the remaining cables are temporarily wrapped up around the top ofthe body to keep them out of the way.

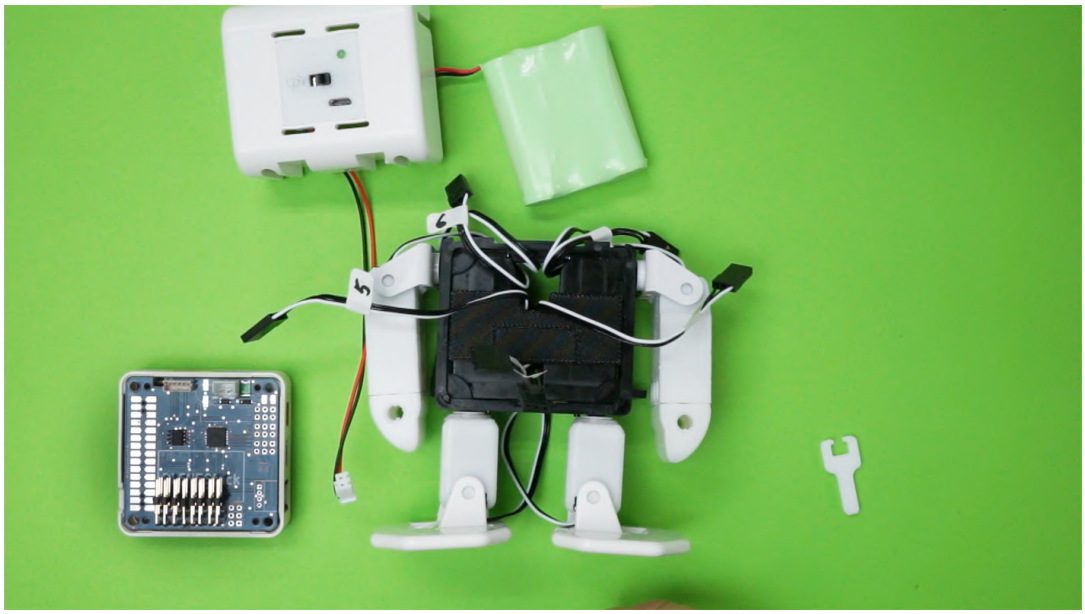
4. Attach the servo fixer part so as to not catch and pinch any of the other servo motor cables.



4.10 Control board wiring

Necessary items

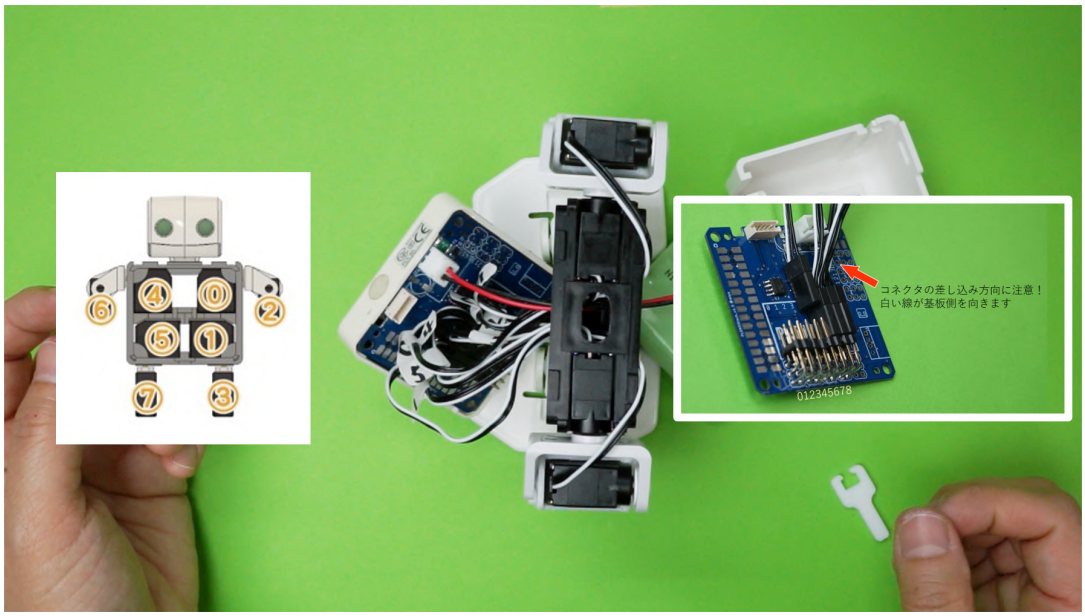
1. Battery assembly
2. Control board assembly



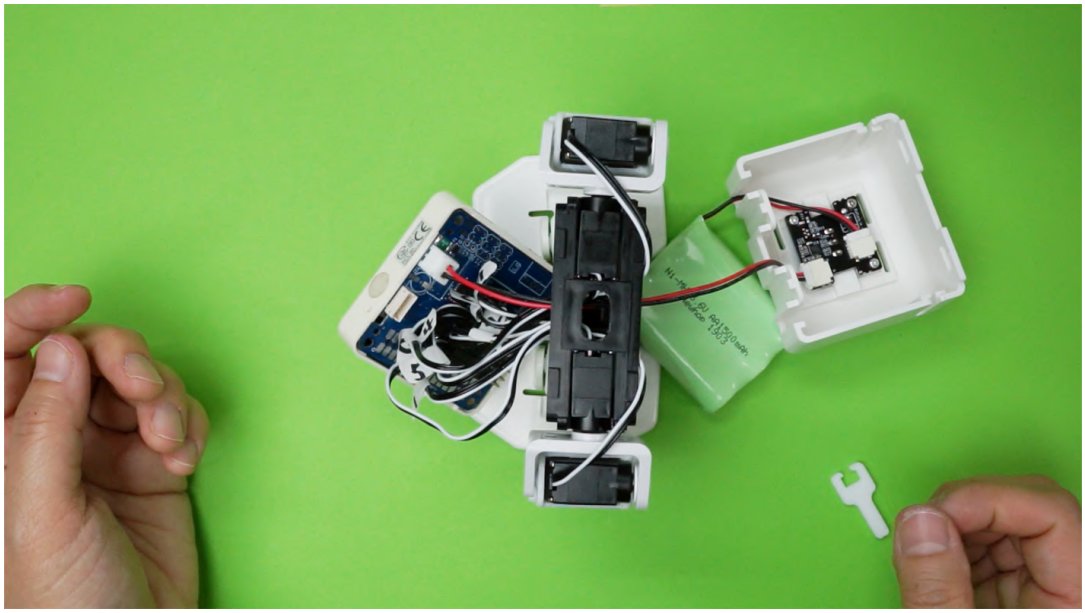
Necessary items

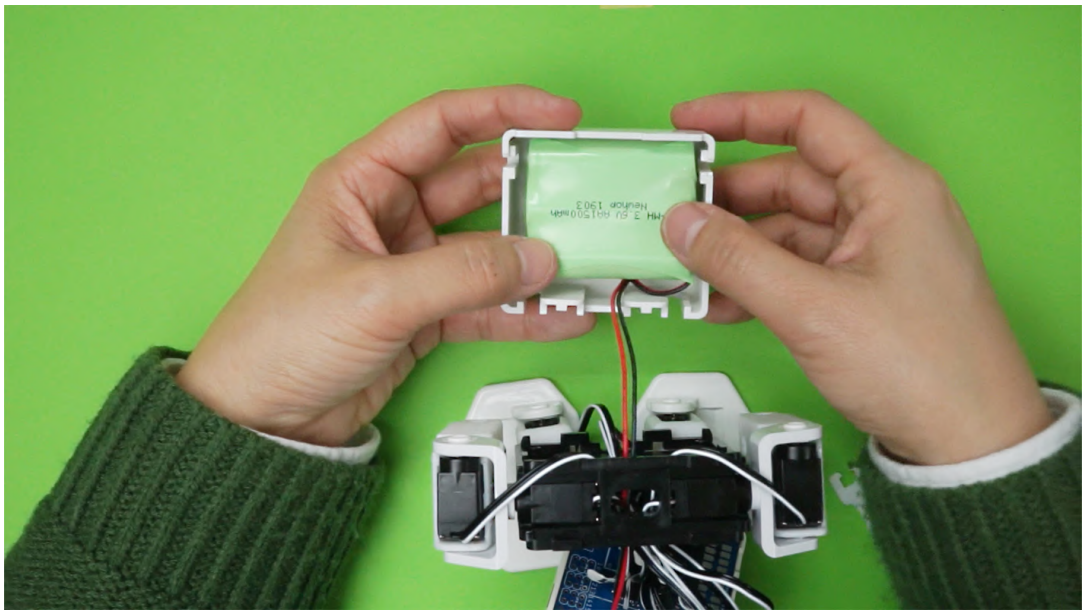
Procedure

1. Remove the M5Stack and the power cable from the control board.
   Pass the power cable along with the servo motor cables from the back side through the front hole in the body and reconnect the power cable to the control board again.

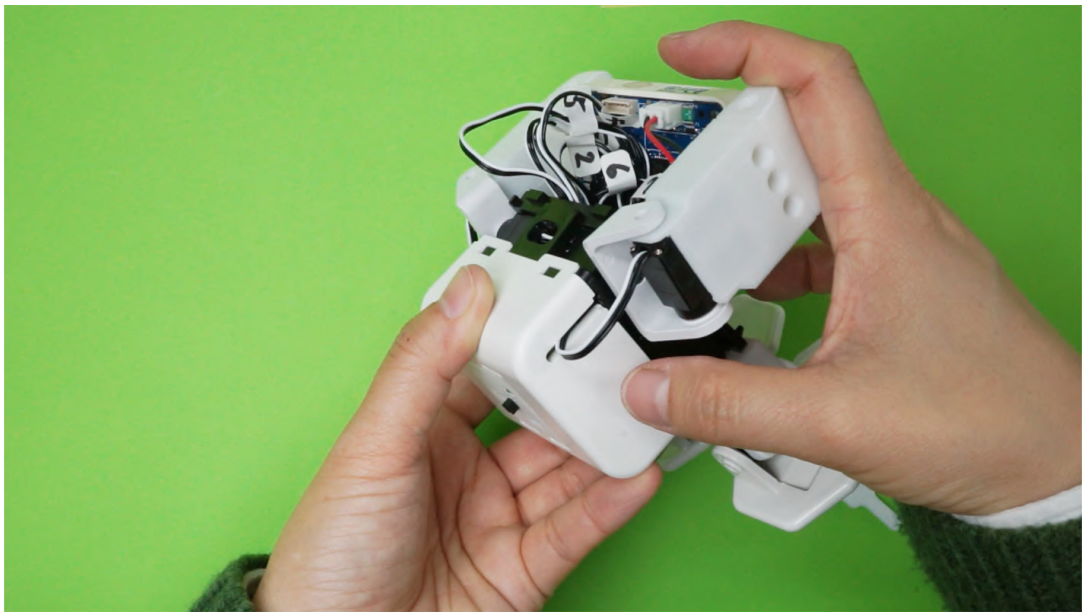


2. Put the battery into the back plastic part on top of the switch board and keep the battery cable underneath the battery.
   Attach the back plastic part to the back of the servo bracket.





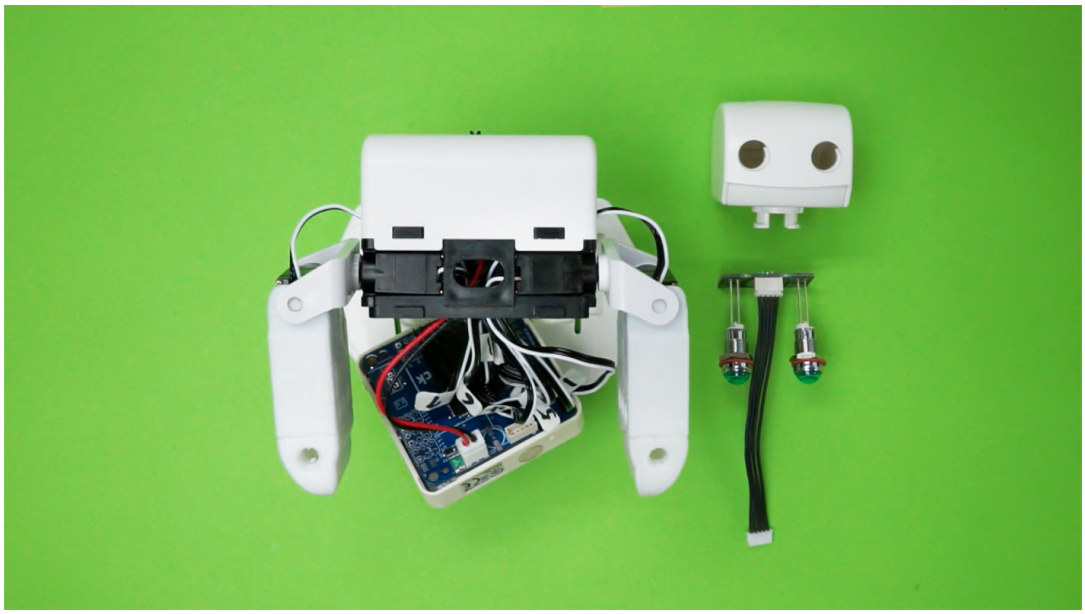
3. Connect all servo motor cables following the appropriate order with servo motor number matching pin number.



4.11 Head part assembly

Necessary items

1. body sets
2. head parts(top, bottom)
3. head board
4. head board cable



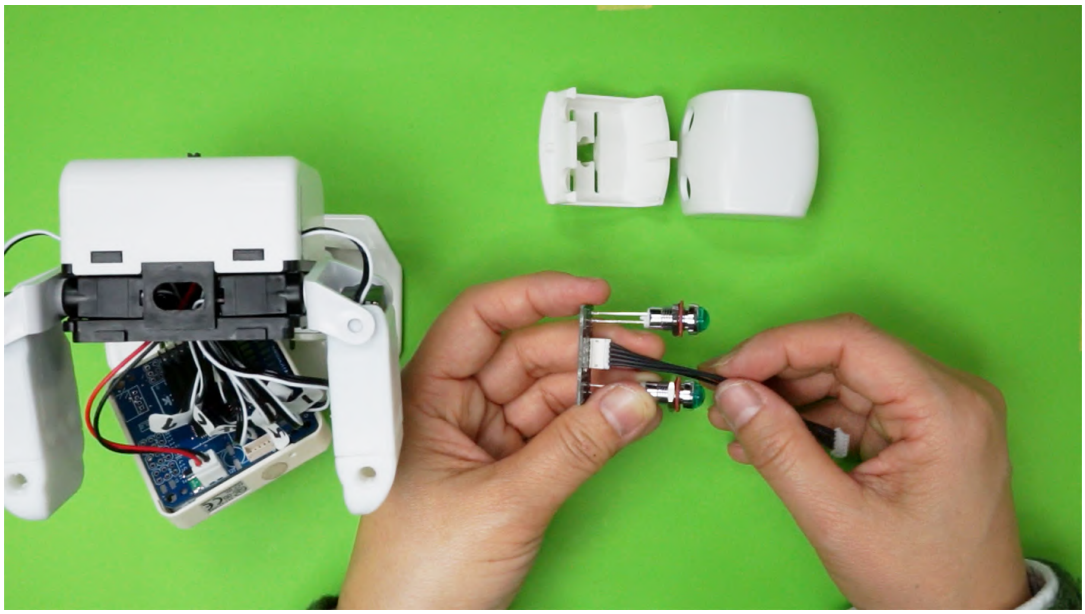
Necessary items

Procedure

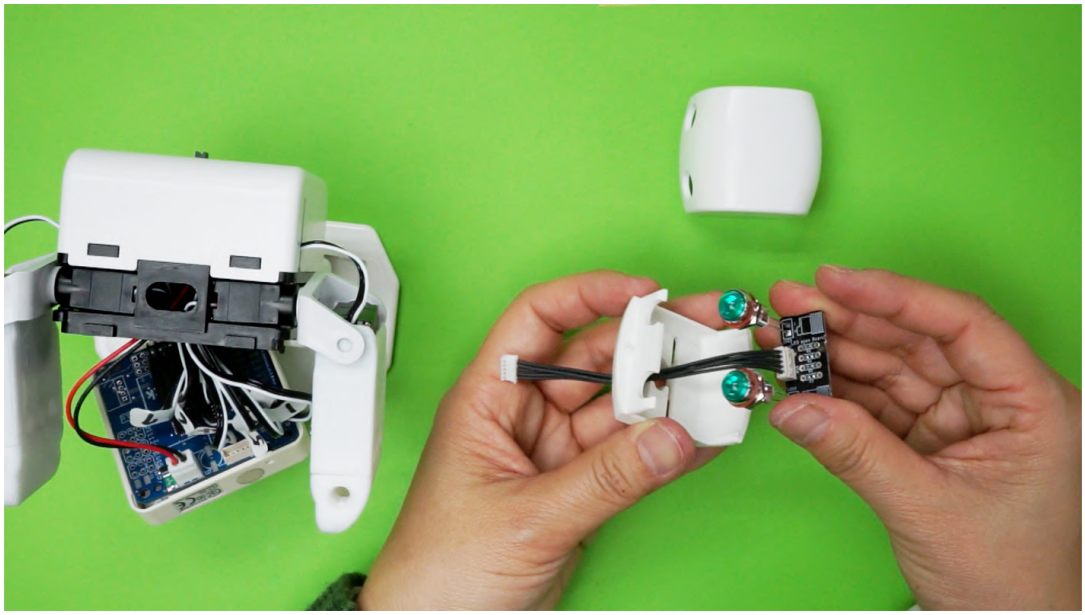
1. Take apart the top and bottom plastic parts of the head

2. Connect the final head-board control cable to the head-board

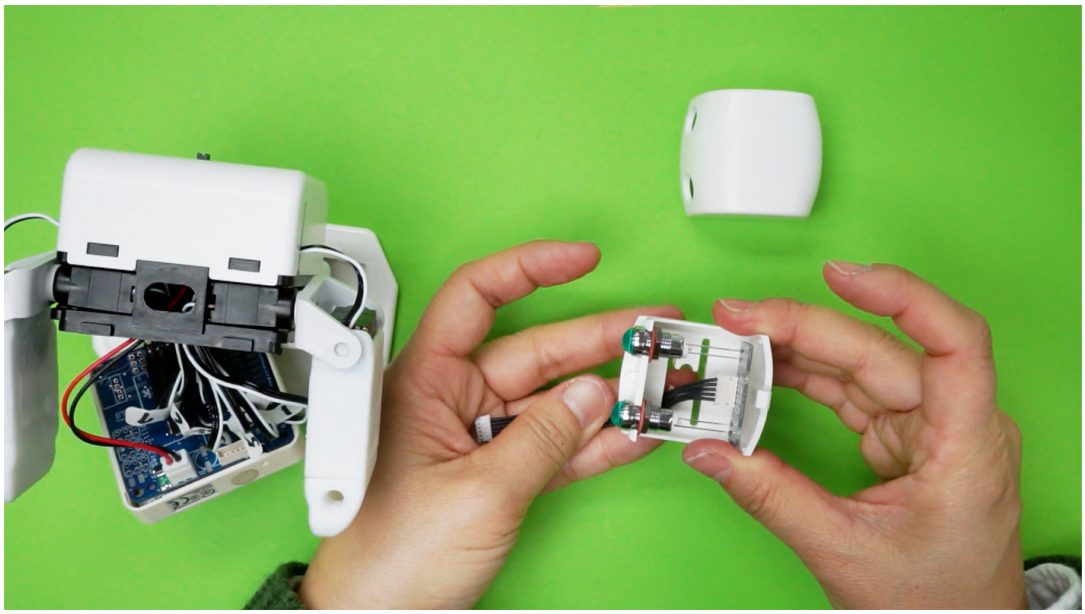
3. Unscrew the nuts on each LED down about 3mm.



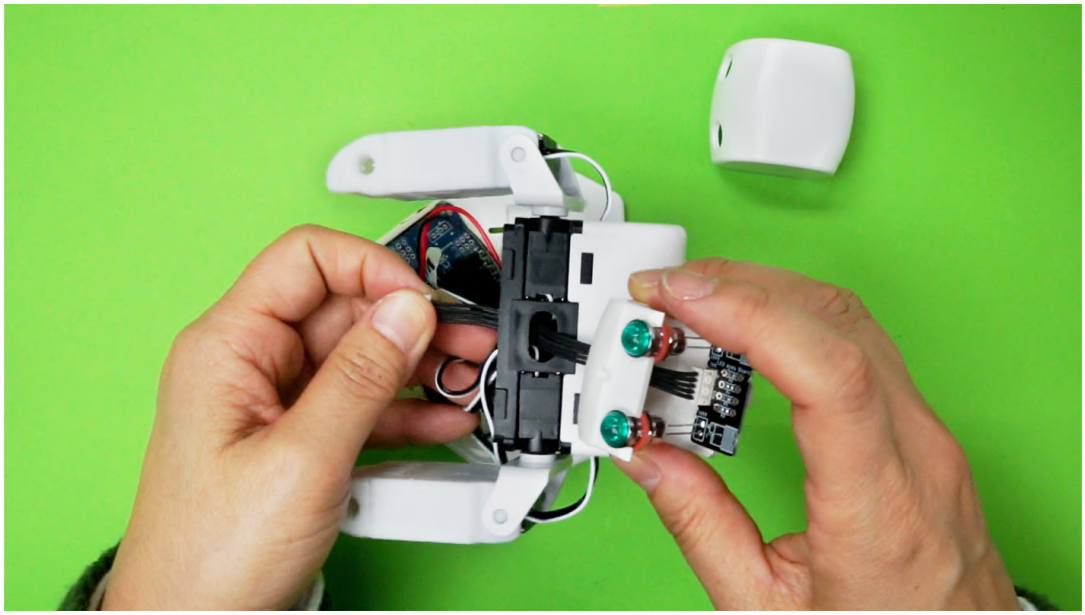
4. Pass the head-board cable through the hole in the bottom side of the head plastic part.



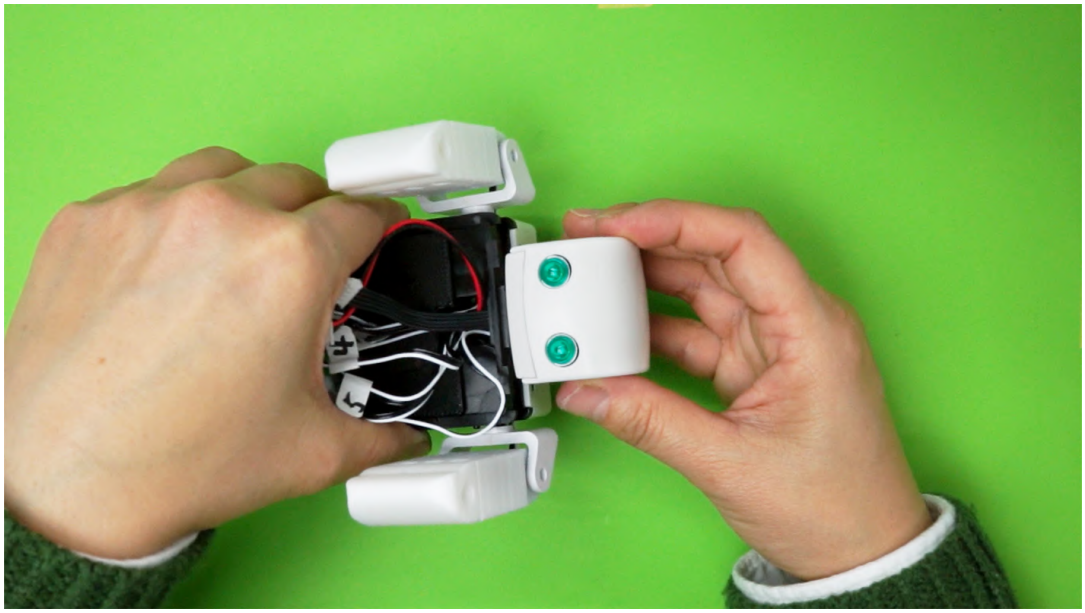
5. Bend the LED legs 90 degrees such that the head-board is rotated up,
   and insert both LEDs into the semi-circular grooves in the bottom plastic heat part such that the nuts on each LED are on the inside of the head.



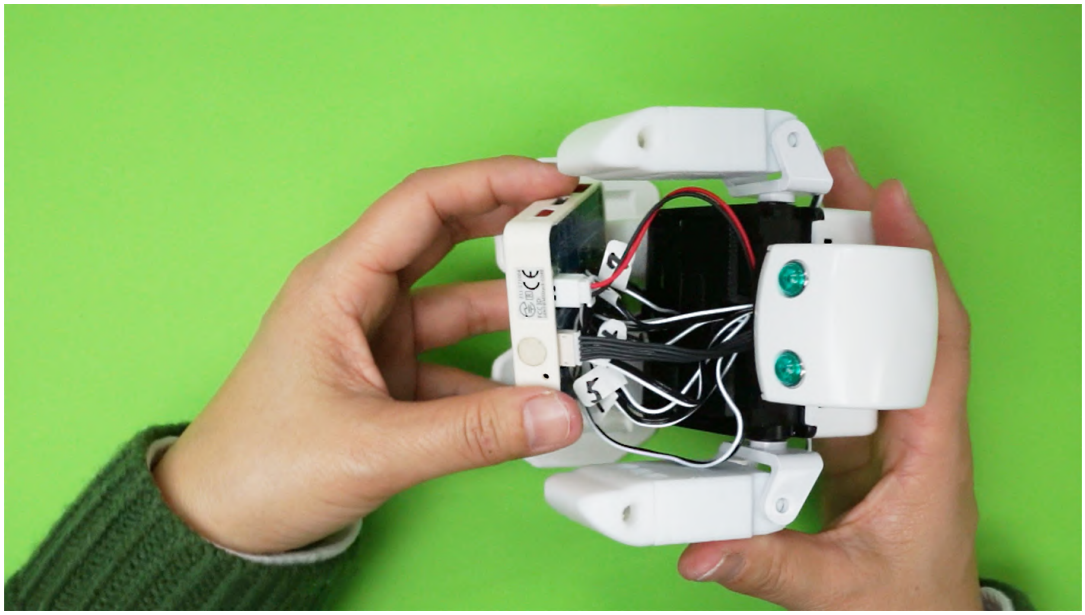
6. Align and place the top plastic head part onto the bottom part by first passing the LED bulbs through the top heat eye holes.



7. Insert the head-board cable through the top hole in the servo bracket and pass through the front side of the body.
   Insert the assembled head into the same hole to fix the head to the servo bracket.



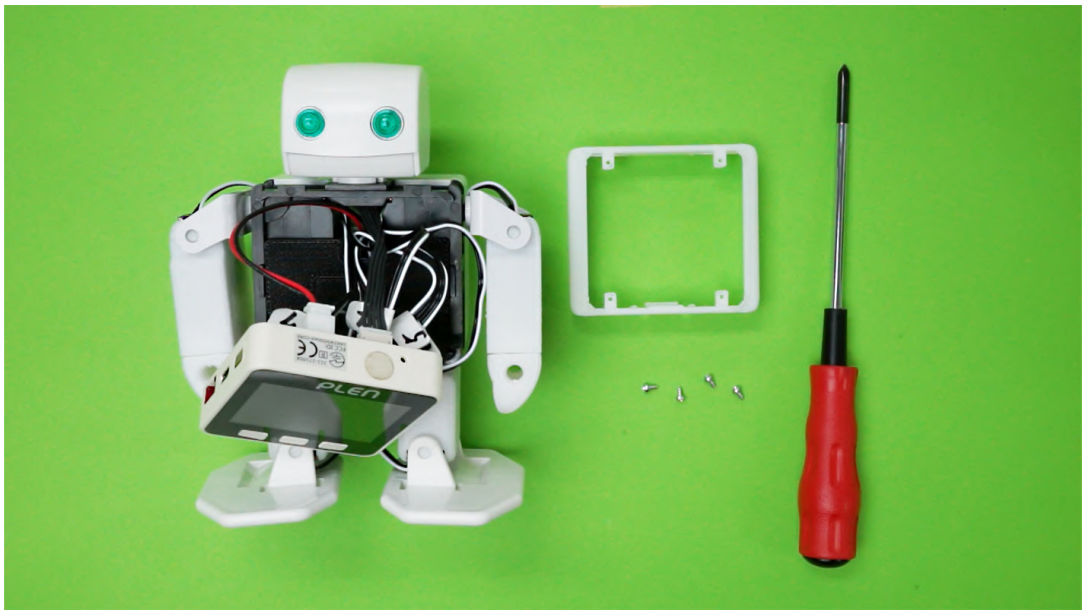
8. Connect the head-board cable into the control board.



4.12 Chest assembly

Necessary items

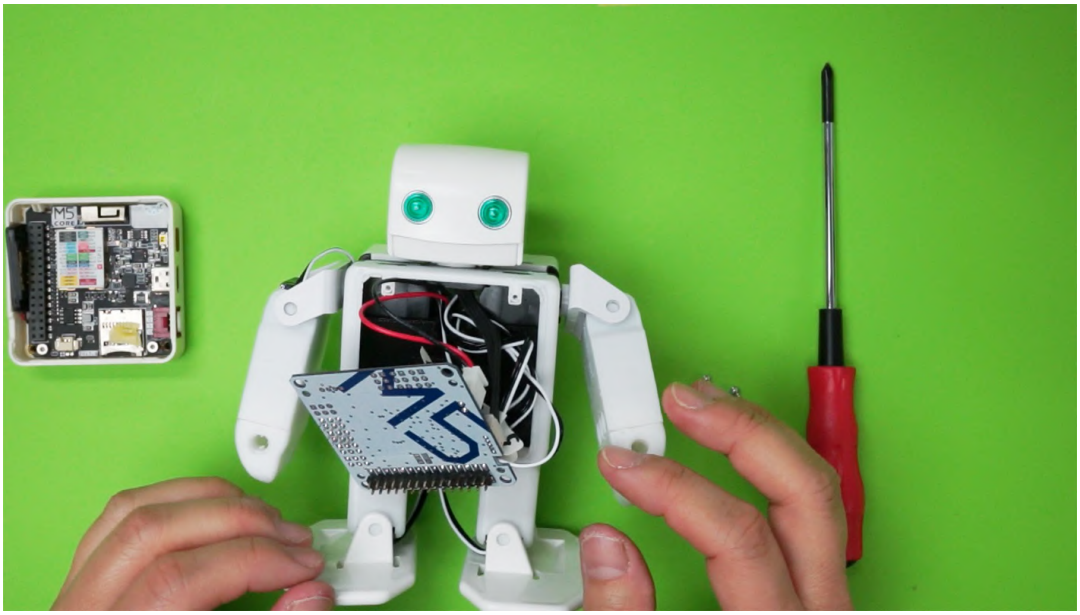
1. body sets
2. chest
3. M5Stack
4. screw × 2



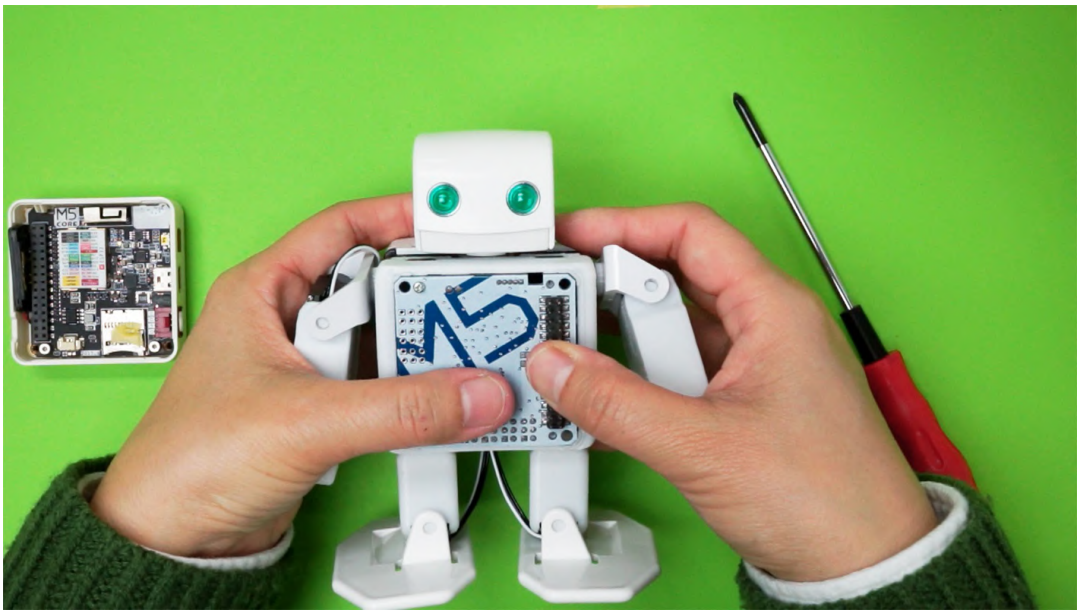
Necessary items

Procedure

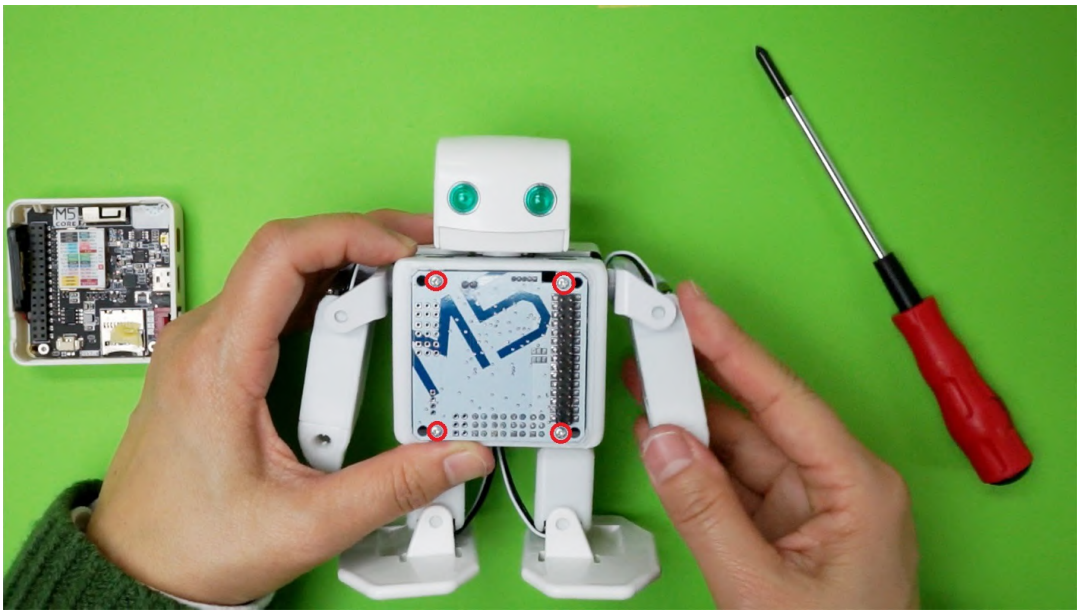
1. Remove M5Stack from control board.
   Pass the control board through the body part and bring it out to the front.



2. Attach the chest parts to the servo bracket body.



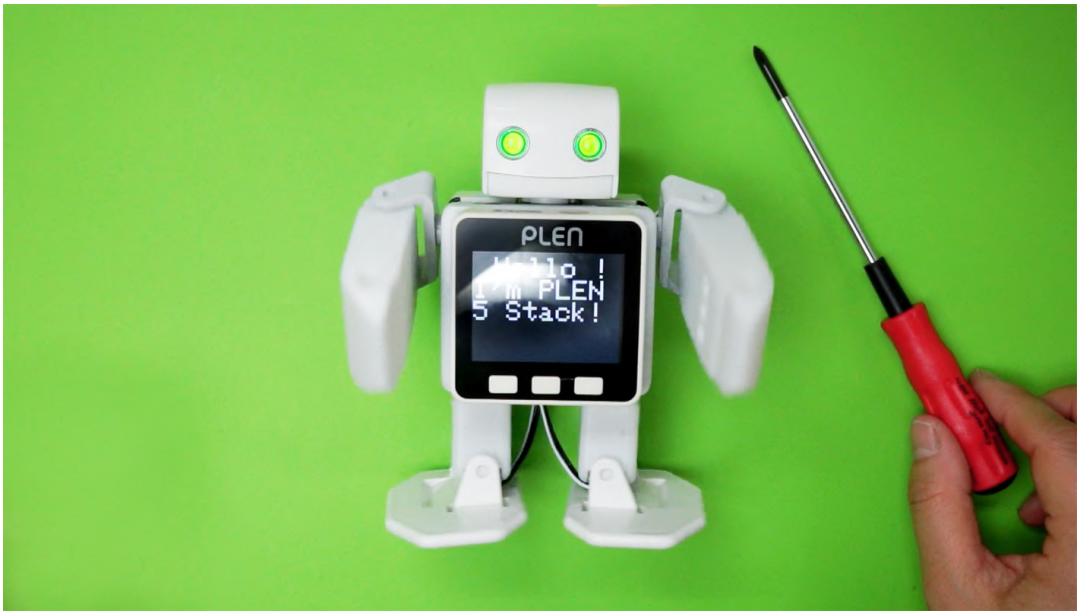
3. Screw the control board to the chest part



4. Insert the M5Stack.

5. Switch the robot on and confirm if all servo motors have rotated and initialized.

6. Press the M5Stack A and B buttons to check that the limbs work. C button is blink the EYE LED.



5. Motion check

5.1 Let's walk the PLEN5Stack!

1. Press A Button to check if PLEN5Stack walks.

2. Enjoy PLEN5Stack!

6. How to charge battery

1. Connect PLEN5Stack (back Switch Board) and PC (or USB charger) with cable.
2. Charging : LED ON
3. Full charge : LED OFF

7. Firmware Installation

How to Install

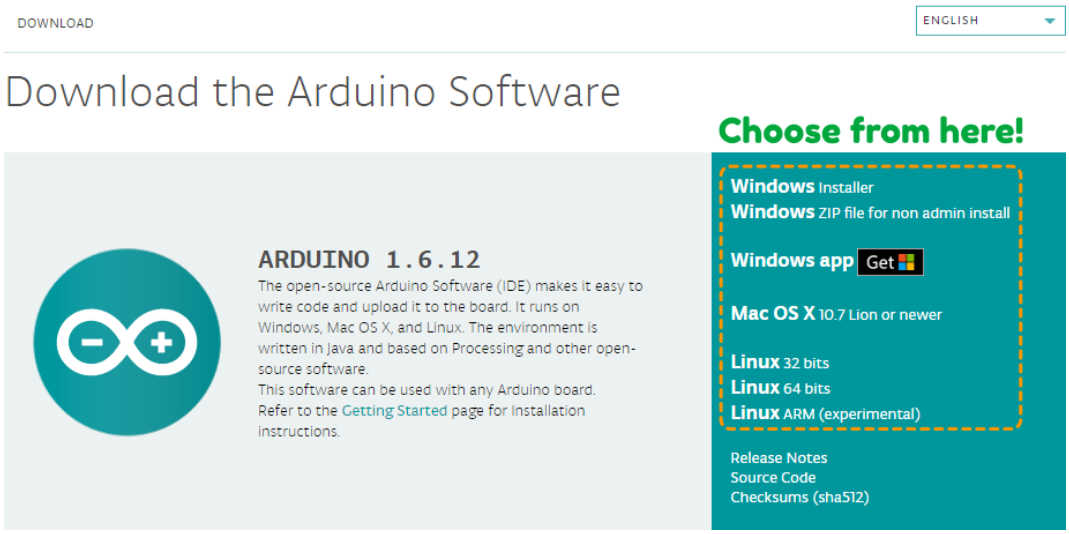
1. Download (and install) Arduino IDE from arduino.cc website. (Choose your environment, then click "JUST DOWNLOAD" button.)
2. Add board manager URL: https://dl.espressif.com/dl/package_esp32_index.json
3. Add esp32 board
4. Add M5Stack library
5. Download this repository from here.
6. Open the firmware.ino using the Arduino IDE.
7. Click the upload button (that is like a right arrow).

Preliminary Arrangements

To write PLEN5Stack's firmware requires Arduino IDE ver.1.8.0 or above. Please download and install it before to do continued steps.

How to Download the Arduino IDE

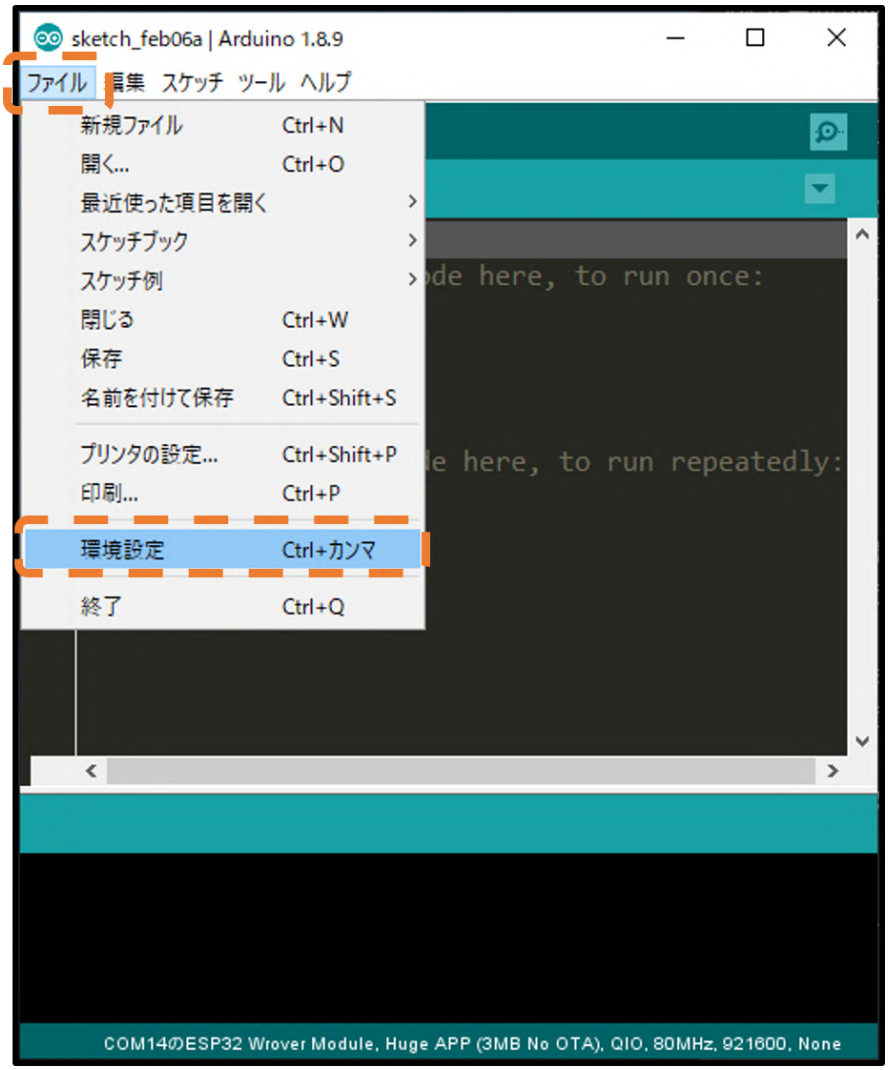
Access the Arduino IDE download page, and then choose your environment.

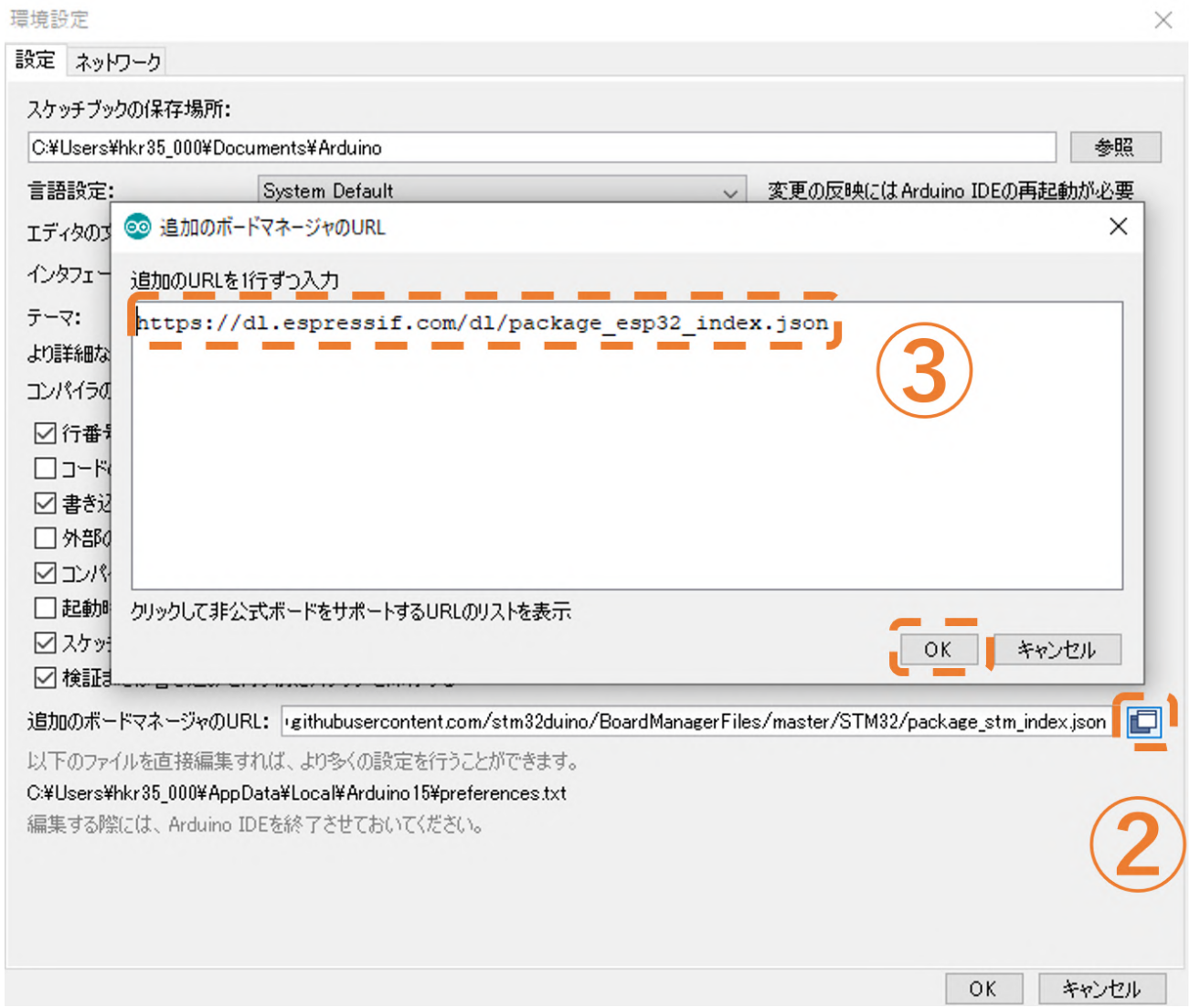


Click “JUST DOWNLOAD” button. (You do not need to select donation menu.)

Setting the Arduino IDE

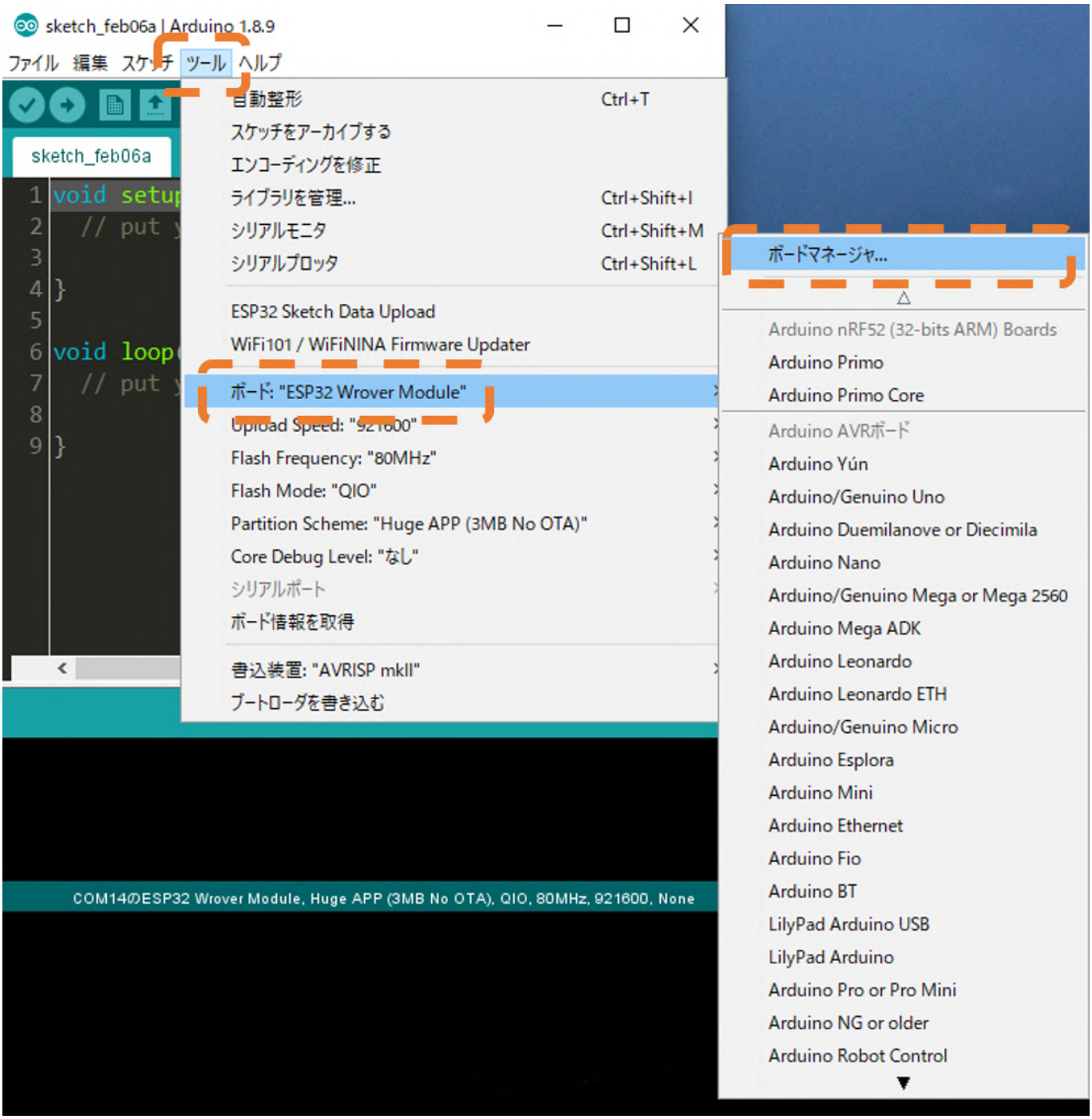
1. [File] -> [Preferences]
2. Right button for Additonal Boards Manager URLs
3. Inpust the URL: https://dl.espressif.com/dl/package_esp32_index.json

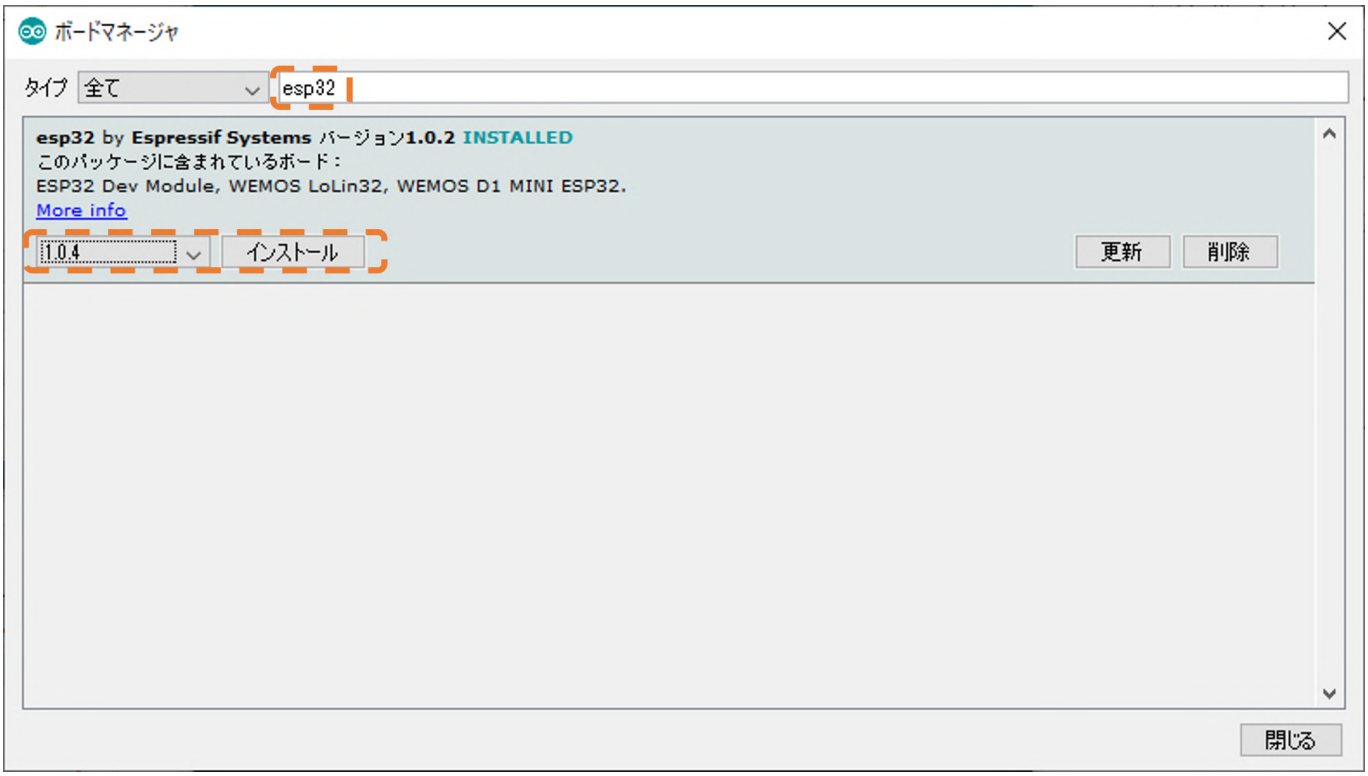



環境設定
設定
ネットワーク
スケッチブックの保存場所:
C:¥Users¥hkr35_000¥Documents¥Arduino
参照
言語設定:
System Default
変更の反映にはArduino IDEの再起動が必要
追加のボードマネージャのURL
追加のURLを1行ずつ入力
https://dl.espressif.com/dl/package_esp32_index.json
3
クリックして非公式ボードをサポートするURLのリストを表示
OK
キャンセル
テーマ:
追加のボードマネージャのURL:
githubusercontent.com/stm32duino/BoardManagerFiles/master/STM32/package_stm_index.json
以下のファイルを直接編集すれば、より多くの設定を行うことができます。
C:¥Users¥hkr35_000¥AppData¥Local¥Arduino15¥preferences.txt
編集する際には、Arduino IDEを終了させておいてください。
2
OK
キャンセル

Install board

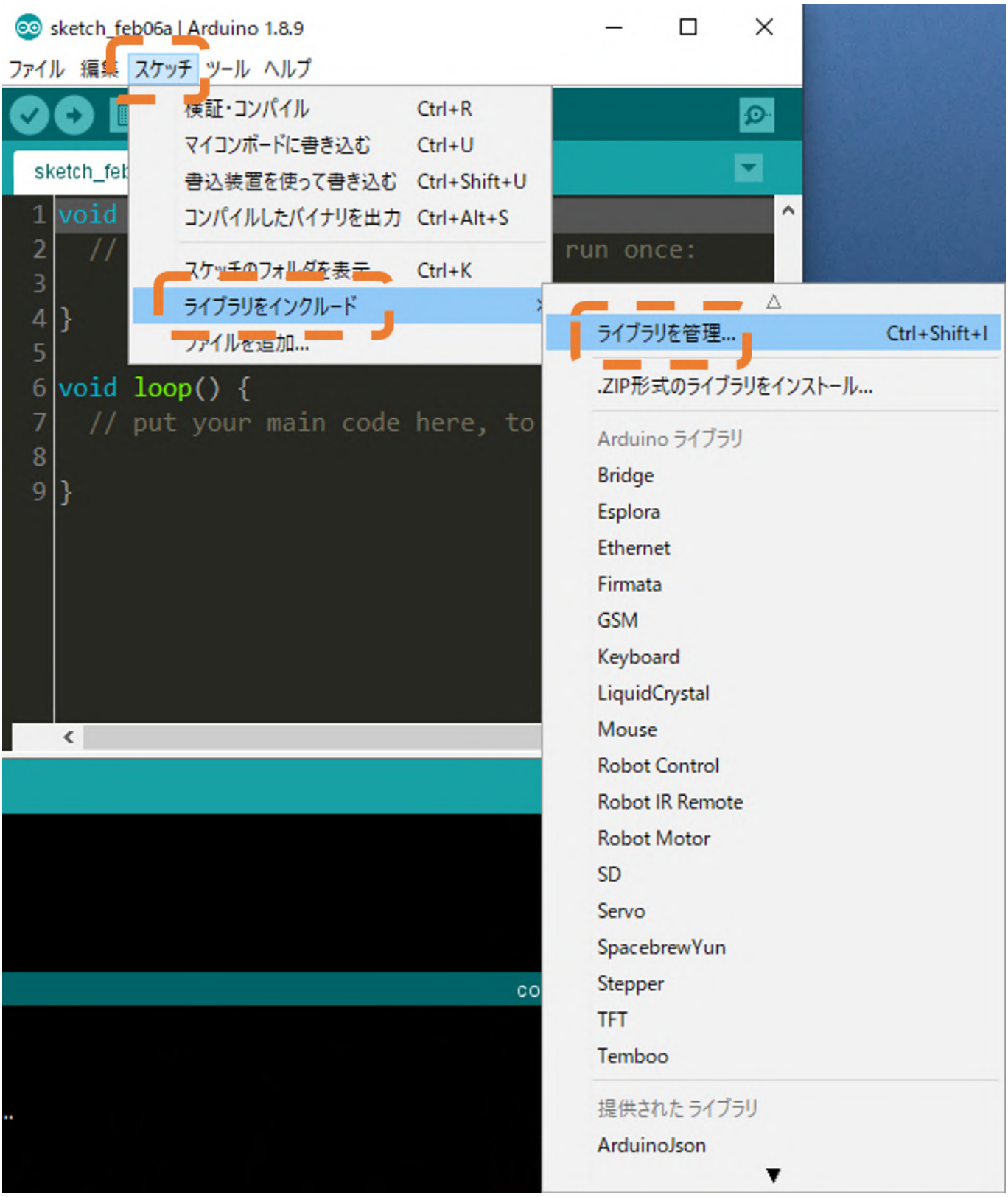
1. [Tools] -> [Boards:...] -> [Boards Managers...]
2. Input the [esp32] for Boards Managers
3. Instal the esp32

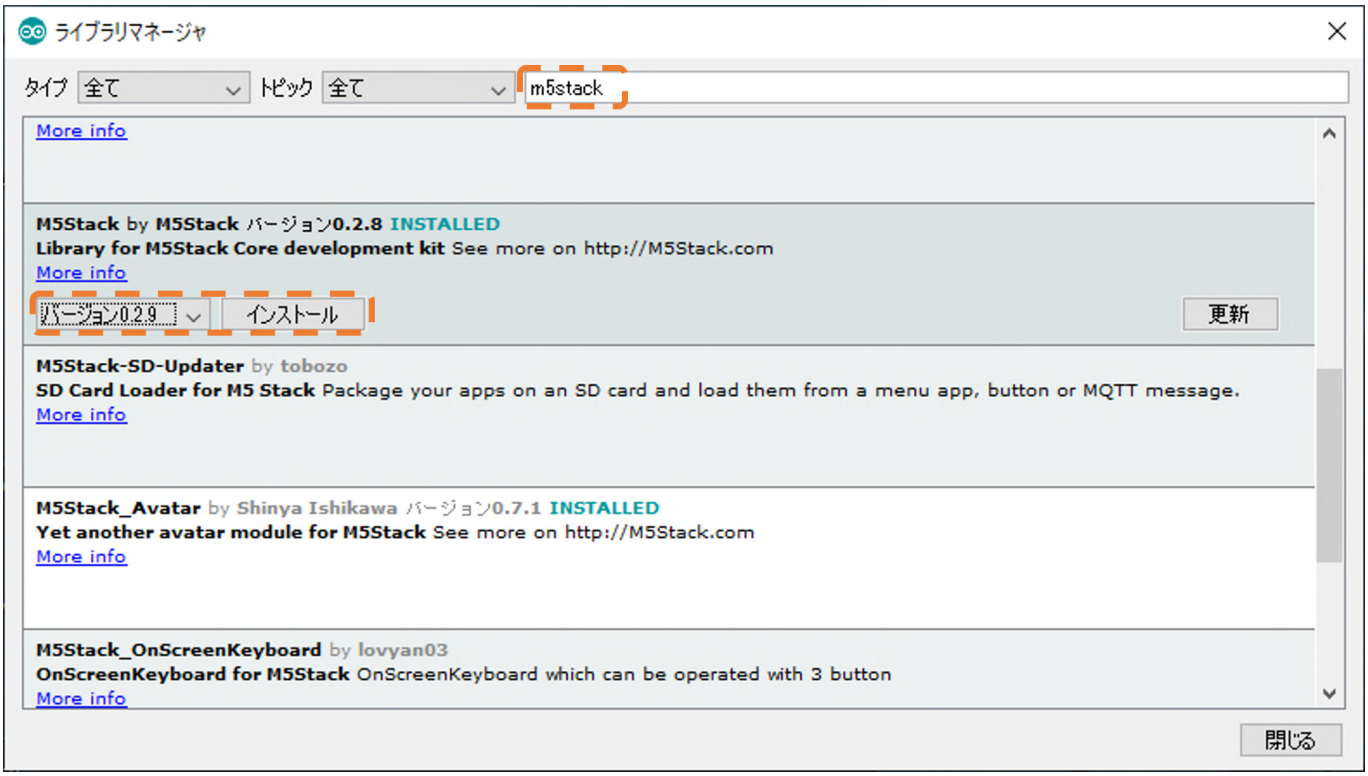



ボードマネージャ
タイプ
全て
esp32
esp32 by Espressif Systems バージョン1.0.2 INSTALLED
このパッケージに含まれているボード：
ESP32 Dev Module, WEMOS LoLin32, WEMOS D1 MINI ESP32.
More info
1.0.4
インストール
更新
削除
閉じる

Install libraly

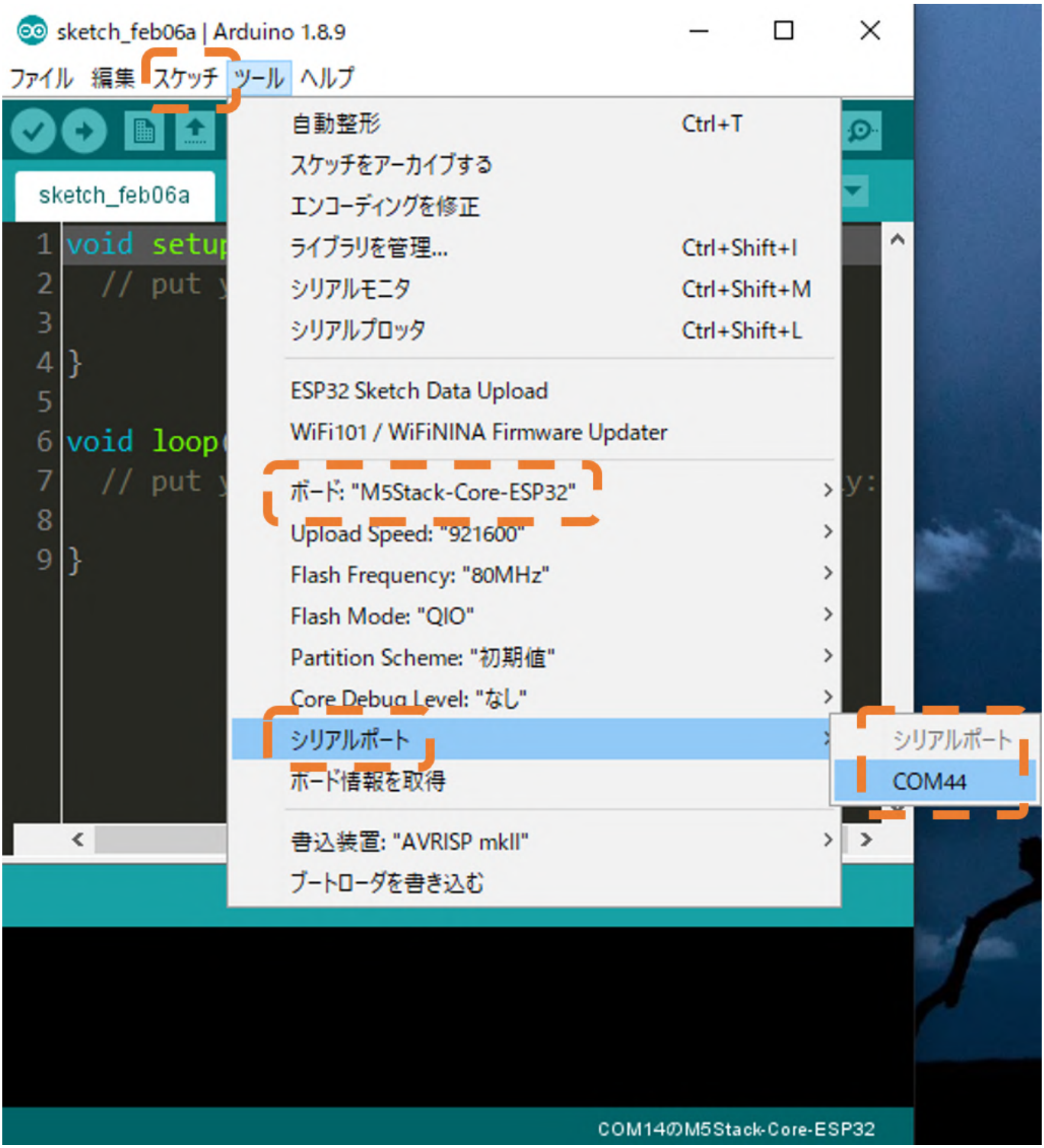
1. [Skecth] -> [Include Library] -> [Manage Libraries...]
2. Input the [m5stack] for Library Manaber
3. Install the [M5Stack]




ライブラリマネージャ
タイプ 全て
トピック 全て
m5stack
More info
M5Stack by M5Stack バージョン0.2.8 INSTALLED
Library for M5Stack Core development kit See more on http://M5Stack.com
More info
バージョン0.2.9
インストール
更新
M5Stack-SD-Updater by tobozo
SD Card Loader for M5 Stack Package your apps on an SD card and load them from a menu app, button or MQTT message.
More info
M5Stack_Avatar by Shinya Ishikawa バージョン0.7.1 INSTALLED
Yet another avatar module for M5Stack See more on http://M5Stack.com
More info
M5Stack_OnScreenKeyboard by lovyan03
OnScreenKeyboard for M5Stack OnScreenKeyboard which can be operated with 3 button
More info
閉じる

board select

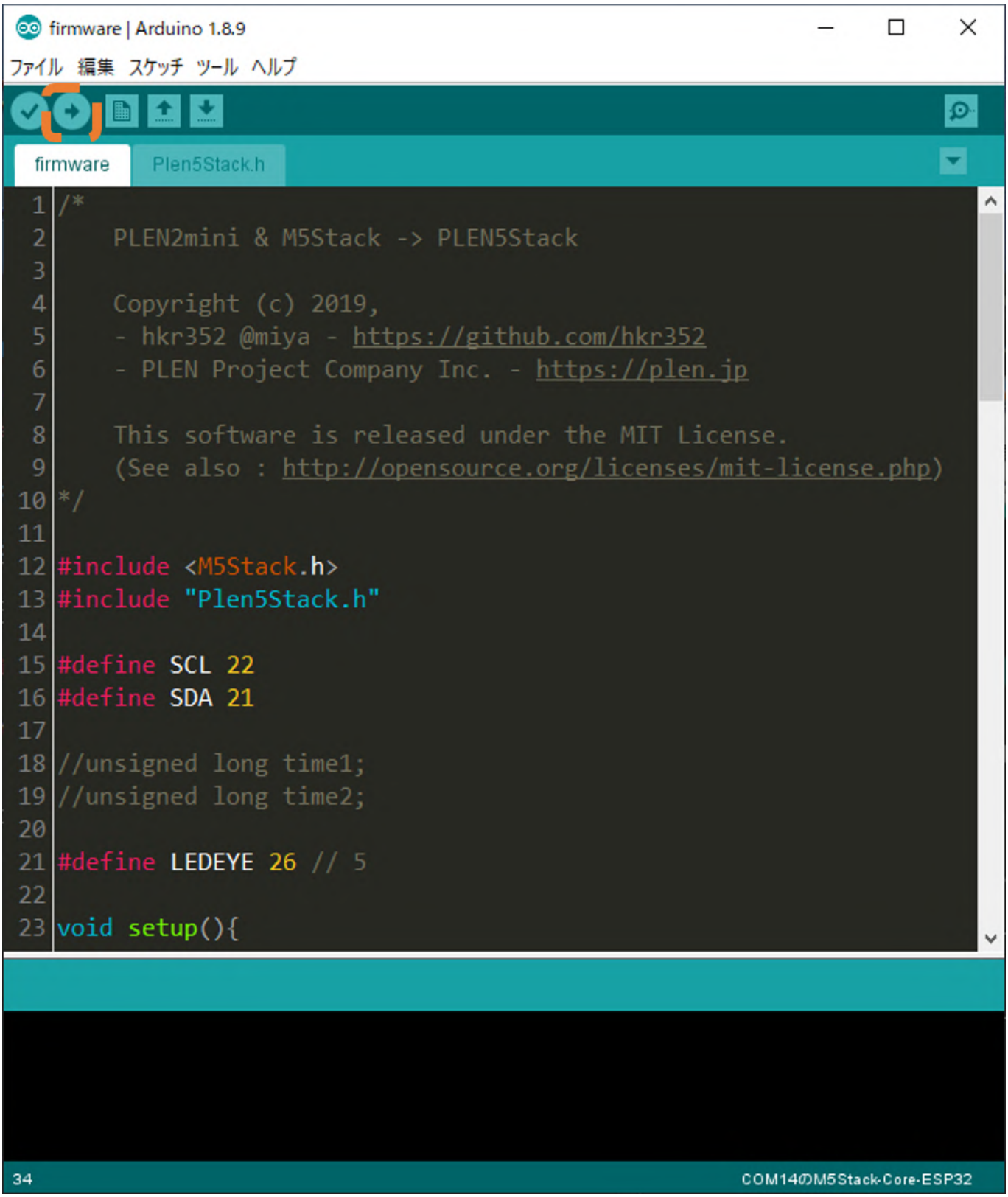
1. [Tools] -> [Board:...] -> [M5Stack-Core-ESP32]
2. [Tools] -> [Port] -> Select the your Serial Ports (Port name is different in each environments.)



Installation Procedure

Download [PLEN5Stack] repository

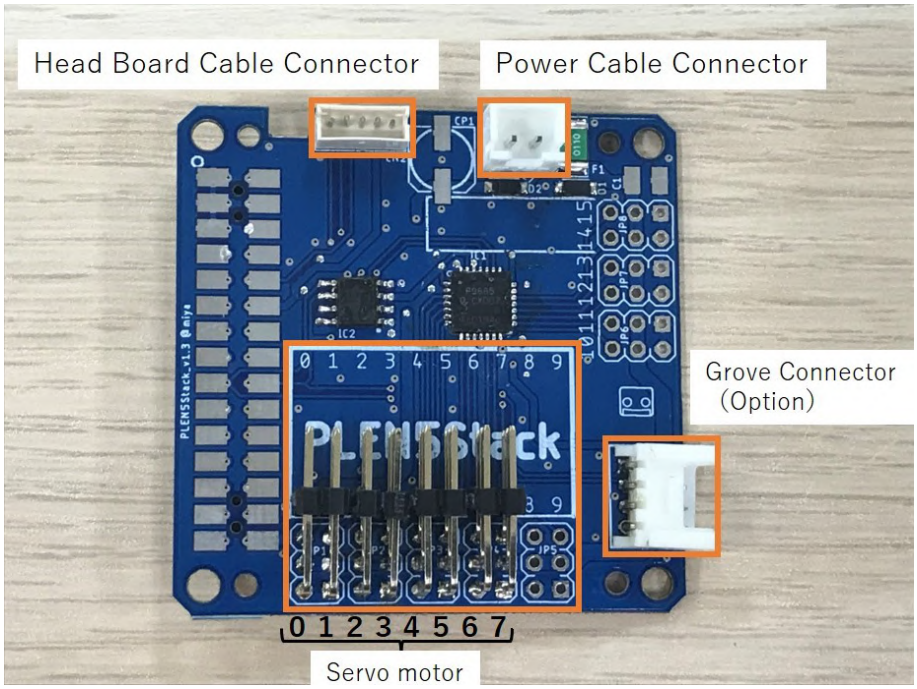
1. Open “firmware.ino” (This is placed “firmware/” directory) with Arduino IDE.
2. Connect M5Stack to PC with USBTypeC cable.
3. Click the Upload[->] button.



Appendix

PLEN5Stack servo numbering

Control board terminal labelling



PLEN5Stack Support

If you have any questions, please contact one of the following

- PLEN5Stack Slack community : http://u0u0.net/YJzp
- PLEN Support : https://plen.jp/wp/contact/