

uStepper - Robot Arm

Assembly instructions

Microcontroller, stepper driver and encoder in an ultra-compact design!

By ON Development IVS



Assembly notes

The parts are 3D printed, meaning that they do not have the quality and toughness as mold injection parts. Please bear this in mind while assembling and using the uStepper Robot Arm. Avoid using excessive force while assembling the Arm. When tightening bolts and screws, please take care not to overtighten, since this could cause the plastic parts to brake.

ON Development IVS can not be held responsible for damage occurring during assembly.



When the glue symbol is shown, glue could improve the assembly quality in the appropriate step. This is in general true for plastic/aluminum assembly, i.e. the rods. Care must be taken before adding glue, since the parts are permanently fixed afterwards. We recommend that the arm is first assembled and glue is added when the functionality of the arm is validated.

The design is still a Work in Progress. Files, instructions, and other stuff might change!

Attribution

The nut cover design used with the uStepper Robotic Arm is made by Gyrobot, published under a CC BY-SA license on December 24 2012. www.thingiverse.com/thing:39113

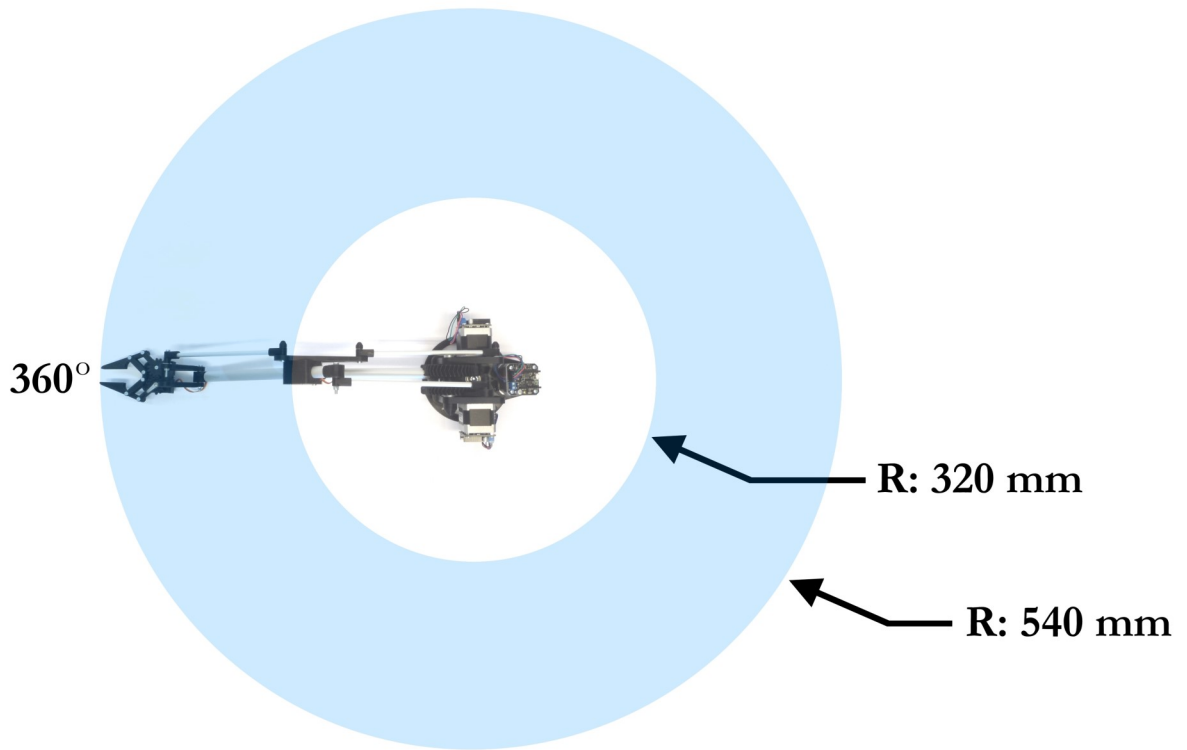
Specifications

The uStepper Robot Arm has the following specifications in its standard configuration (when using uStepper Premium kits as actuators):

Weight (including uSteppers)	1475 g
Material	PLA plastic and Aluminum (tubes)
No. of axes	3
Maximum lift (close to base / furthest from base)*	700 g / 350 g
Gear ratios	Main gear 4.09:1 Second gear 4.09:1
Stepper motor torque	0.42 Nm
Micro servo torque	0.15 Nm @ 5 V

*With 24V supply, maximum current limit setting and motor in brake mode. This rating is an absolute maximum, and continuous operation in this area should not be carried out!

Specifications — Range of Motion



Bill Of Materials



Bearings:

- 4 pcs. 608Z
- 12 pcs. 624Z

Bolts:

- 1 pc. M8 x 40 mm
- 1 pc. M8 x 70 mm
- 4 pcs. M4 x 20 mm
- 4 pcs. M4 x 35 mm
- 19 pcs. M3 x 10 mm
- 3 pcs. M3 x 16 mm
- 9 pcs. M3 x 20 mm
- 9 pcs. M3 x 25 mm

Nuts:

- 21 pcs. M3
- 7 pcs. M3 SL
- 8 pcs. M4 SL
- 2 pcs. M8 SL

Washers:

- 2 pcs. M8, OD: 15.8 mm
- 2 pcs. M4, OD: 8.8 mm

Rods:

The length of the rods can be varied to fit your needs.

- 1 pc. 15 mm x 200 mm
- 1 pc. 15 mm x 150 mm
- 2 pcs. 6 mm x 169 mm
- 1 pc. 6 mm x 164 mm

Actuators:

- 3 pcs. uStepper premium
- 1 pc. Micro Servo

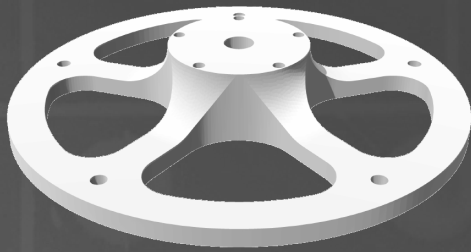
Tools:

- Adjustable wrench
- Hex Keys
- Philips screwdriver

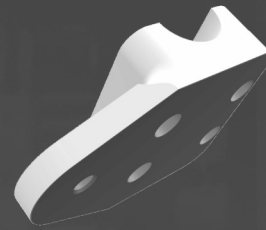
Optional:

- Super glue
- Hard stops:
 - 1 pc. M3 x 20mm
 - 1 pc. M3 x 10mm
 - 1 pc. M3 nut SL

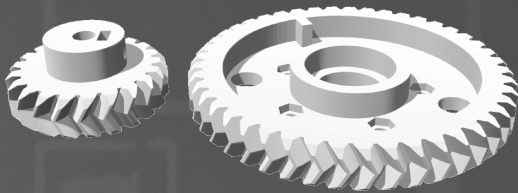
Bill Of Materials



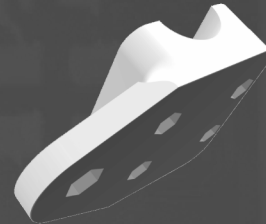
① 1 pc. Base



⑦ 1 pc. Main joint bracket left



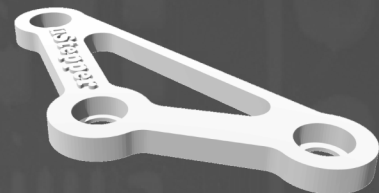
② 1 pc. Base gear



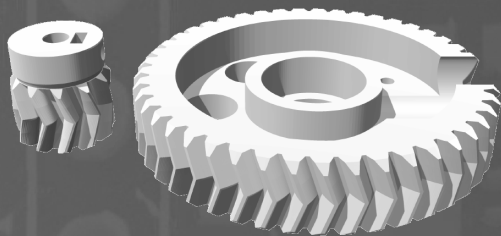
⑧ 1 pc. Main joint bracket right



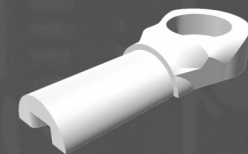
③ 1 pc. Secondary gear



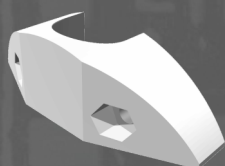
⑨ 1 pc. Triangle



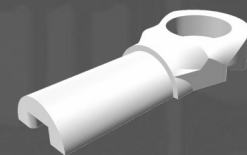
④ 1 pc. Main gear



⑩ 3 pcs. Rod end left



⑤ 1 pc. Main gear bracket



⑪ 3 pcs. Rod end right

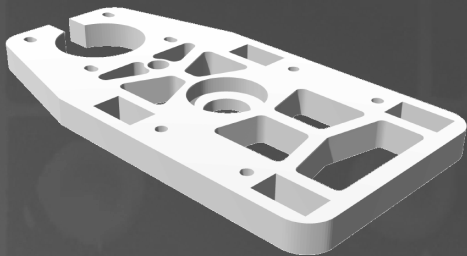


⑥ 1 pc. Secondary gear arm

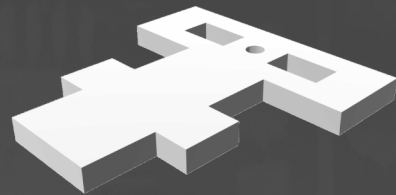


⑫ 6 pcs. Link end

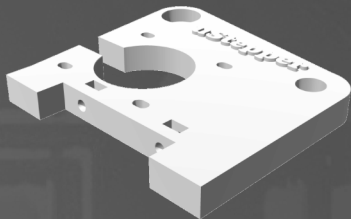
Bill Of Materials



⑬ 1 pc. Bottom plate



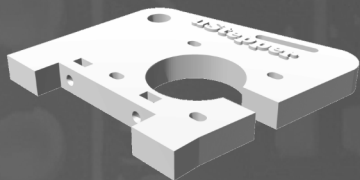
⑲ 1 pc. End bracket



⑭ 1 pc. Left side plate



⑳ 1 pc. Gripper gear



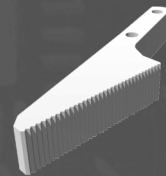
⑮ 1 pc. Right side plate



㉑ 1 pc. Gripper servo gear



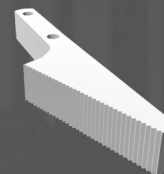
⑯ 1 pc. End triangle right



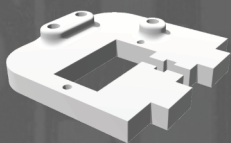
㉒ 1 pc. Gripper left



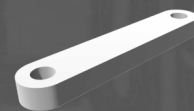
⑰ 1 pc. End triangle left



㉓ 1 pc. Gripper right

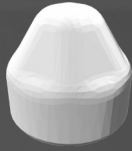


⑱ 1 pc. Gripper main brack-

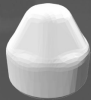


㉔ 4 pcs. Gripper link

Bill Of Materials



②⑤ 1 pc. M8 nut cover



②⑥ 4 pcs. M4 nut cover short



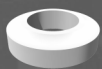
②⑦ 1 pc. M4 nut cover long



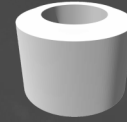
②⑧ 6 pcs. M3 nut cover



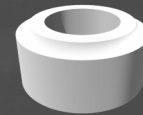
②⑨ 1 pc. M4 spacer long



③⑩ 1 pc. M4 spacer short



③① 2 pcs. M8 spacer long



③② 1 pc. M8 spacer short

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.1: Fit a 608Z bearing in the base gear (2).



Fig.2: Assemble base (1) and base gear (2) using 5 M3x25 mm bolts and 5 M3 nuts.



Fig.3: The base should look like this from above.



Fig.4: Fit a 608Z bearing in the bottom plate (13), a 624Z bearing and two M3 nuts in the side left plate (14).



Fig.5: Press the left side plate (14) into the bottom plate (13) without using excessive force. Secure it using 2 M3x10 bolts.



Fig.6: The bottom plate (13) and left side plate (14) assembly should look like this.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.7: Insert the M8x40 bolt in the bottom plate (13), and add a washer. Place an M8 SL nut in the base (1) (not visible here, see fig. 11)

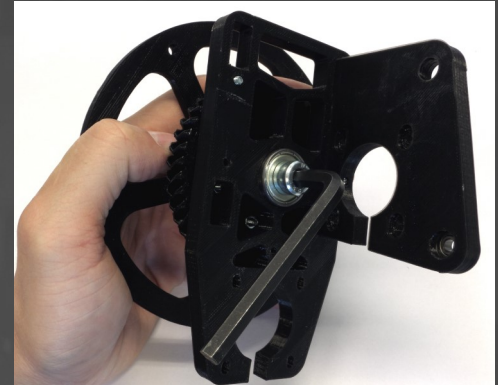


Fig.8: Tighten the bolt ensuring a smooth rotation of the bottom/base assembly.



Fig.9: The assembly should now look like this.



Fig.10: Insert an M3 nut and an M3x8 mm bolt into the base motor gear (2).



Fig.11: Mount the motor and motor gear (2). Secure the motor to the bottom plate (13) using 4 M3x10 mm bolts.

Be careful not to overtighten the motor gear bolts!

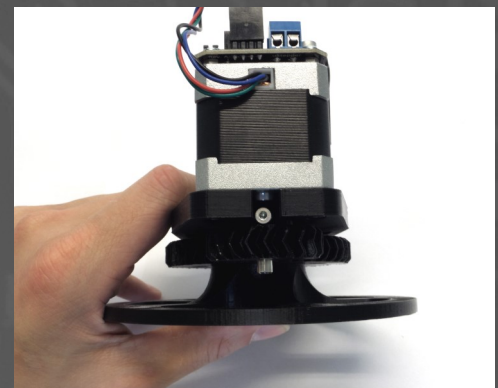


Fig.12: Tighten the M3x8 mm bolt in the motor gear (2). (Do not overtighten!)

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.13: The assembly should now look like this.

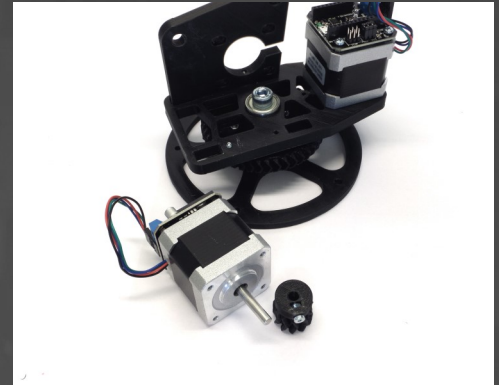


Fig.14: Insert an M3 nut and M3x8 mm bolt in the main motor gear (4).

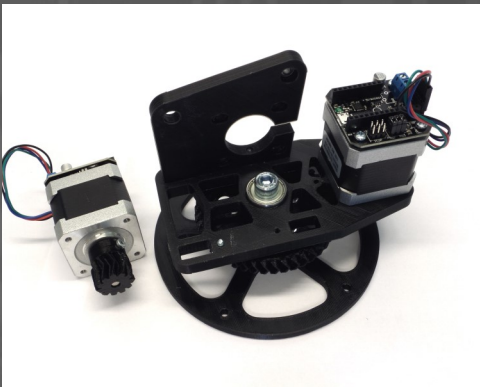


Fig.15: Mount the motor gear (4) on the motor (without tightening the bolt).



Fig.16: Insert the M8x70 mm bolt in the left side plate (14) and add the short M8 spacer (32).

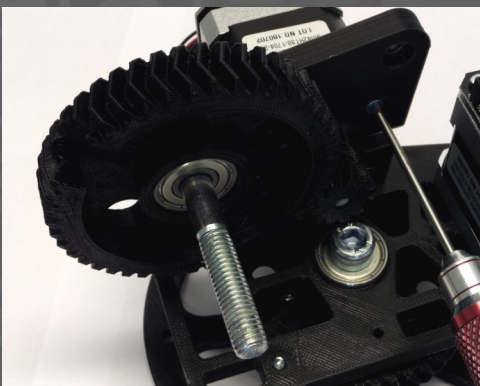


Fig.17: Fit the main gear (4) with a 608Z bearing and slide it on the M8x70 mm bolt. Insert the motor, adjust the motor gear (4) and secure the motor using 4 M3x10 mm bolts.

Be careful not to overtighten the motor gear bolts!



Fig.18: Insert nut and M3x8 mm bolt in the secondary motor gear (3).

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.19: Insert 2 M3 nuts in the right side plate (15).

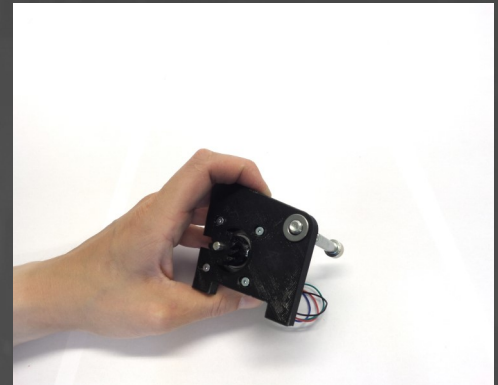


Fig.20: Mount the motor loosely (with 4 M3x10 mm) and slide in the M8x70 mm bolt (removed from the side plate Fig. 17), add a washer.



Fig.21: Fit a 624Z bearing in the second gear arm (6), and attach it to the secondary gear (3) using 2 M3x10 mm and 2 M3 nuts

Be careful not to overtighten the motor gear bolts!

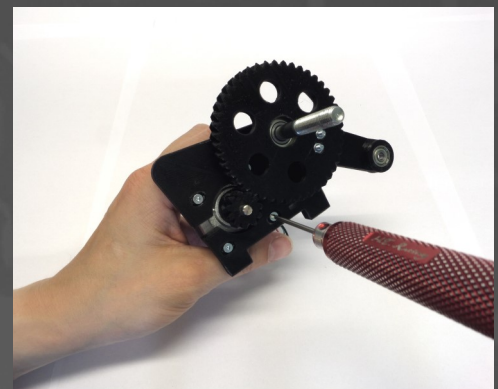


Fig.22: Slide the gear (3) onto the M8 bolt (pressing up against the washer) and align the motor gear. Tighten the motor and motor gear bolts.



Fig.23: This is how the assembly should look by now. With the gear and M8 bolt removed.

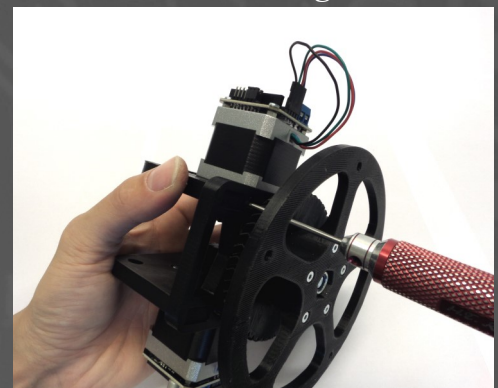


Fig.24: Now gently press the right side plate (15) into place and tighten the 2 M3x10 mm bolts.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.

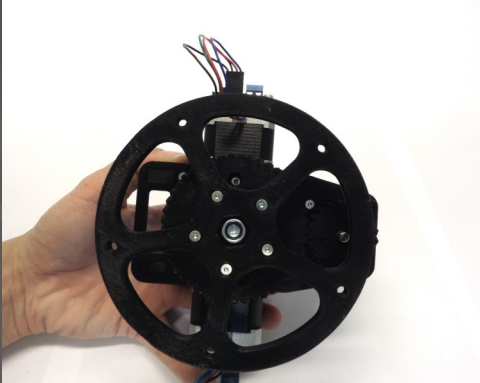


Fig.25: Bottom view showing the bolt heads, and access hole in the bottom gear (2).

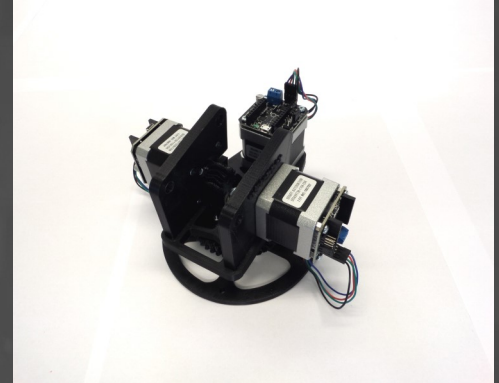


Fig.26: The Robot Arm base is now complete.



Fig.27: The 624Z bearings are pushed in the rod ends (10) and (11).

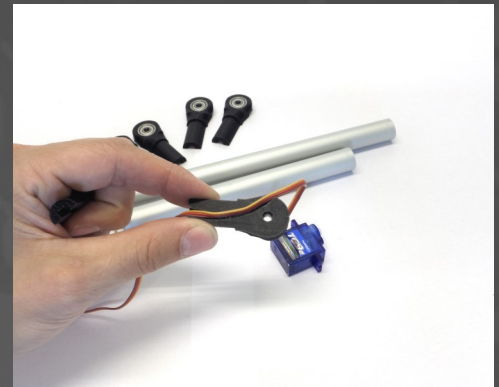


Fig.28: The rod ends (10) and (11) are equipped with a path for the servo cable.



Fig.29: Insert the servo cable prior to insertion of the rod ends (10) and (11) into the tube.

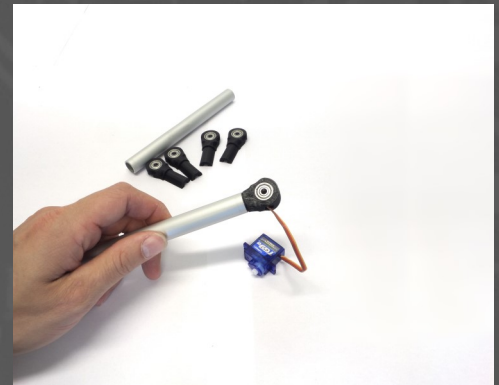


Fig.30: The rod ends (10) and (11) mounted with the servo.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.31: Assemble the rods as shown here.



Fig.32: Slide the short 15 mm tube into the main gear (4) and secure it with the bracket (5) using 2 M3x20 mm bolts and 2 M3 nuts.

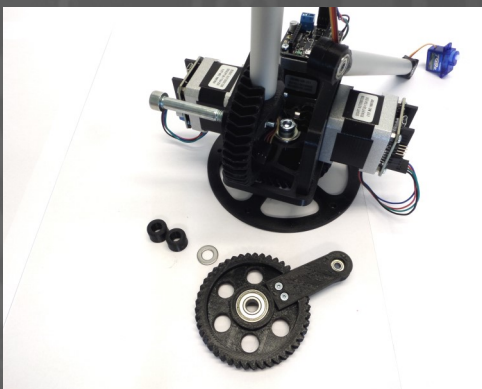


Fig.33: Slide in the M8x70 mm bolt and add the short M8 spacer (32) (see fig. 16) and main gear. Keep the servo cable accessible.

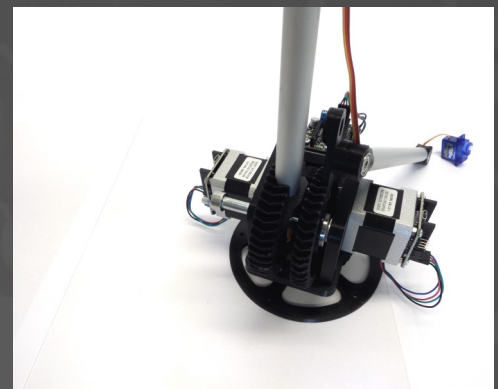


Fig.34: Slide the two long M8 spacers (31) onto the bolt with the chamfer facing the bearings. Slide the secondary gear and washer on the bolt.



Fig.35: Add an M8 SL nut on the right side and tighten the bolt. (Do not overtighten)



Fig.36: Add 4 M3 nuts and 1 M4 SL nut to the main joint bracket (7) and (8) as shown. Prepare 4 M3x25 mm bolts for assembly.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.37: Mount the main joint bracket ⑦ and ⑧ on the longer tube. The position of the tube in the bracket is adjusted in the final step.



Fig.38: Add 3 624Z bearings to the triangle ⑨, add an M4x35 mm bolt and the short M4 spacer ⑩.

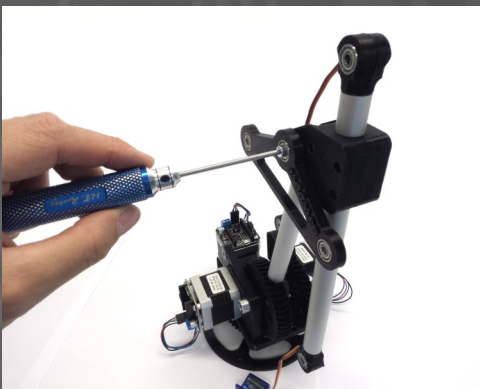


Fig.39: Tighten the M4 bolt till there is no slack but free movement of the parts.



Fig.40: The Robot Arm should look like this by now.



Fig.41: Mount the link ends ⑫ to the linkage arms.



Fig.42: Mount one of the two 169 mm arms (tube length) as shown. Requires 1 M4x20 mm and 1 M4x35 mm bolt and 2 M4 SL nuts.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.43: Mount the other 169 mm link arm from side plate to triangle and the 164 mm link arm as shown. Use 3 M4x20mm bolts and 3 M4 SL nuts.



Fig.44: The arm should look like this now.



Fig.45: Add the M8 nut cover (25) and the longer M4 nut cover (27) as shown.



Fig.46: Add the 4 M4 nut covers (26) as shown.

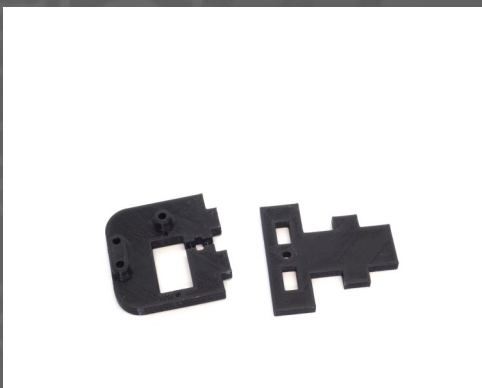


Fig.47: For the gripper assembly the gripper main bracket (18) and the end bracket (19) are needed.

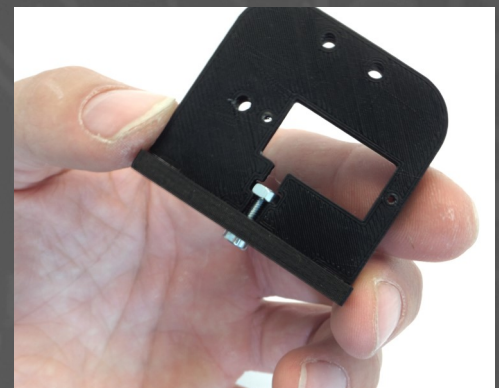


Fig.48: Press them gently together and secure with an M3x10 mm bolt and an M3 nut.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.



Fig.49: Next these parts are needed [20](#)[21](#)[22](#)[23](#)[24](#).



Fig.50: Use 4 M3x20 mm bolts and 4 M3 SL nuts to assemble the parts as shown above. (Make sure the parts move freely)



Fig.51: Mount the gear to the bracket from fig. 48 as shown, using an M3x20 mm bolt and an M3 SL nut. (Make sure the parts move freely)

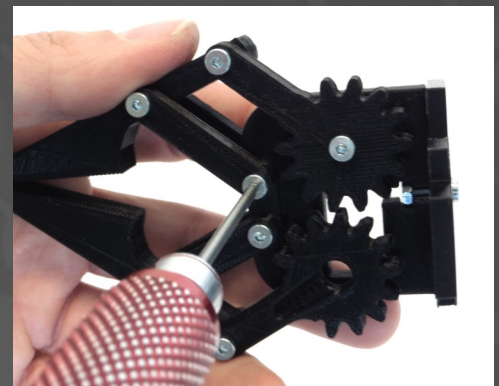


Fig.52: Use 2 M3x20 mm bolts and 2 M3 SL nuts for the assembly shown here. (Make sure the parts move freely)



Fig.53: The gripper should look like this by now.



Fig.54: Add M3 nut covers [28](#) to all nuts but the one holding the gear, as shown here.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.

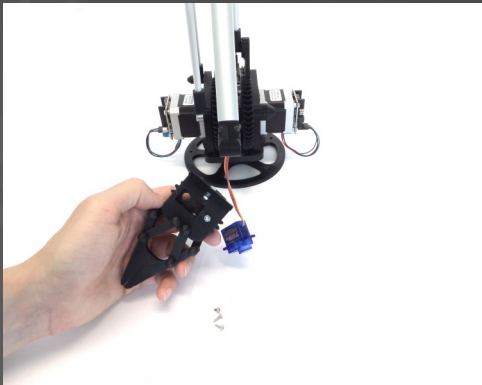


Fig.55: The gripper is now ready for mount of the micro servo.



Fig.56: Use the two longer screws from the servo accessories bag to mount the servo.

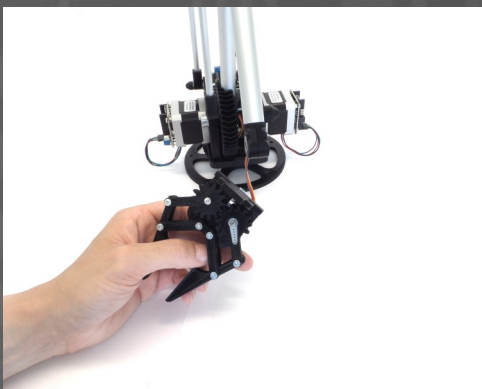


Fig.57: Insert the servo horn as shown and tighten the small center screw carefully.

Note:

You should power on the servo to move it to neutral prior to installing the servo horn.



Fig.58: Add a 624Z bearing to the left end triangle (17) and an M4 SL nut to the right (16).

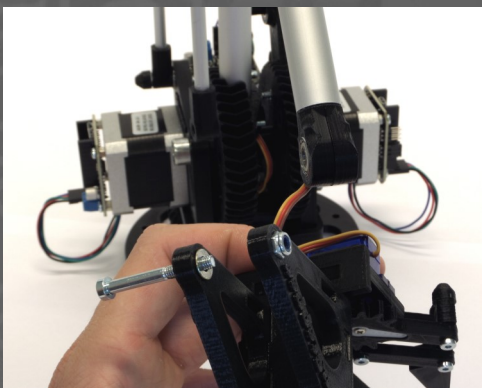


Fig.59: Press the gripper assembly and the end triangles (16) and (17) together. Insert the M4x35 mm bolt and add a M4 washer as shown.

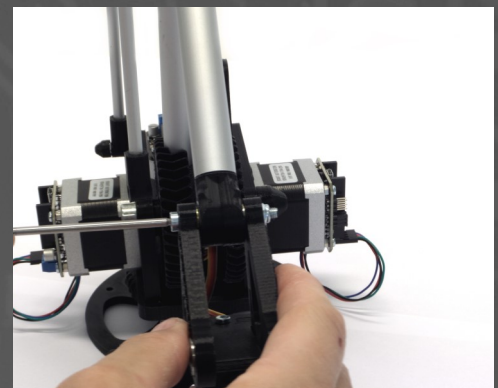


Fig.60: Add a washer to the right side also, and tighten the bolt while ensuring that there is free movement of the parts.

Assembly

Follow the steps below to assemble the uStepper Robot Arm.

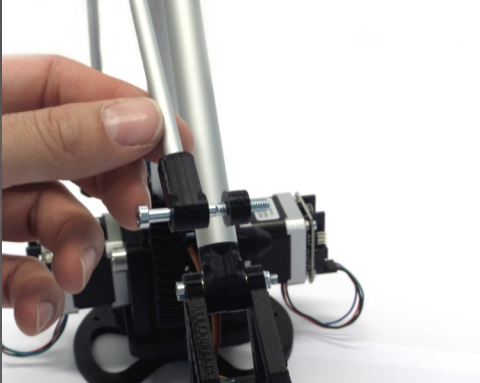


Fig.61: Insert an M4x35 mm bolt into the link end (12) and add the long M4 spacer (29) as shown.

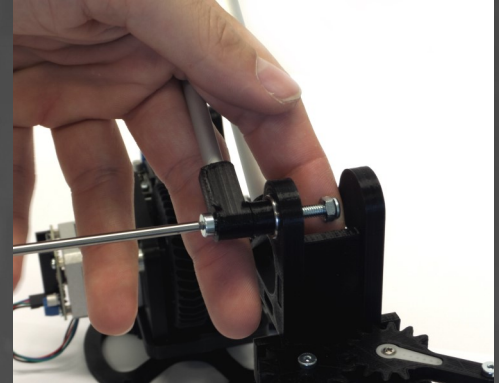


Fig.62: Connect the link to the end triangle (17) as shown, and tighten the bolt. An M4 SL nut is used here.



Fig.63: The assembly of the end effector should look like this.



Fig.64: Adjust the position of the tube as mentioned in fig. 37 so that the gripper is level with the base.

Finished Robot Arm

You have now assembled the uStepper Robot Arm, and your result should be similar to what is shown on the following two pictures.



Optional hard stops

The uStepper Robot Arm design allows the mounting of hard stops on both the rotating axis and the secondary arm.

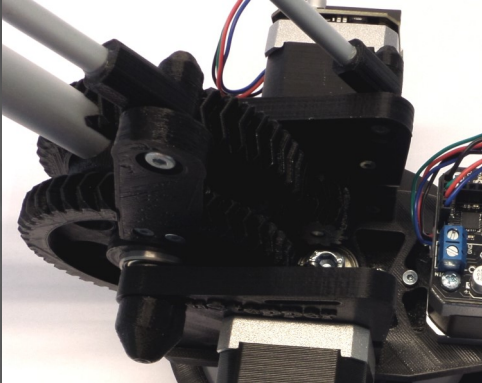


Fig.64: An M3x10 mm bolt is inserted in the bottom plate (13) as seen here (close to the stepper motor on the right in the picture).

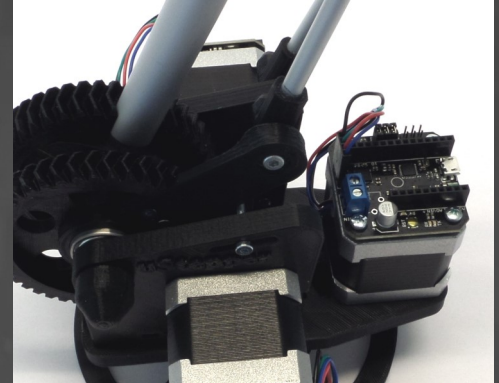


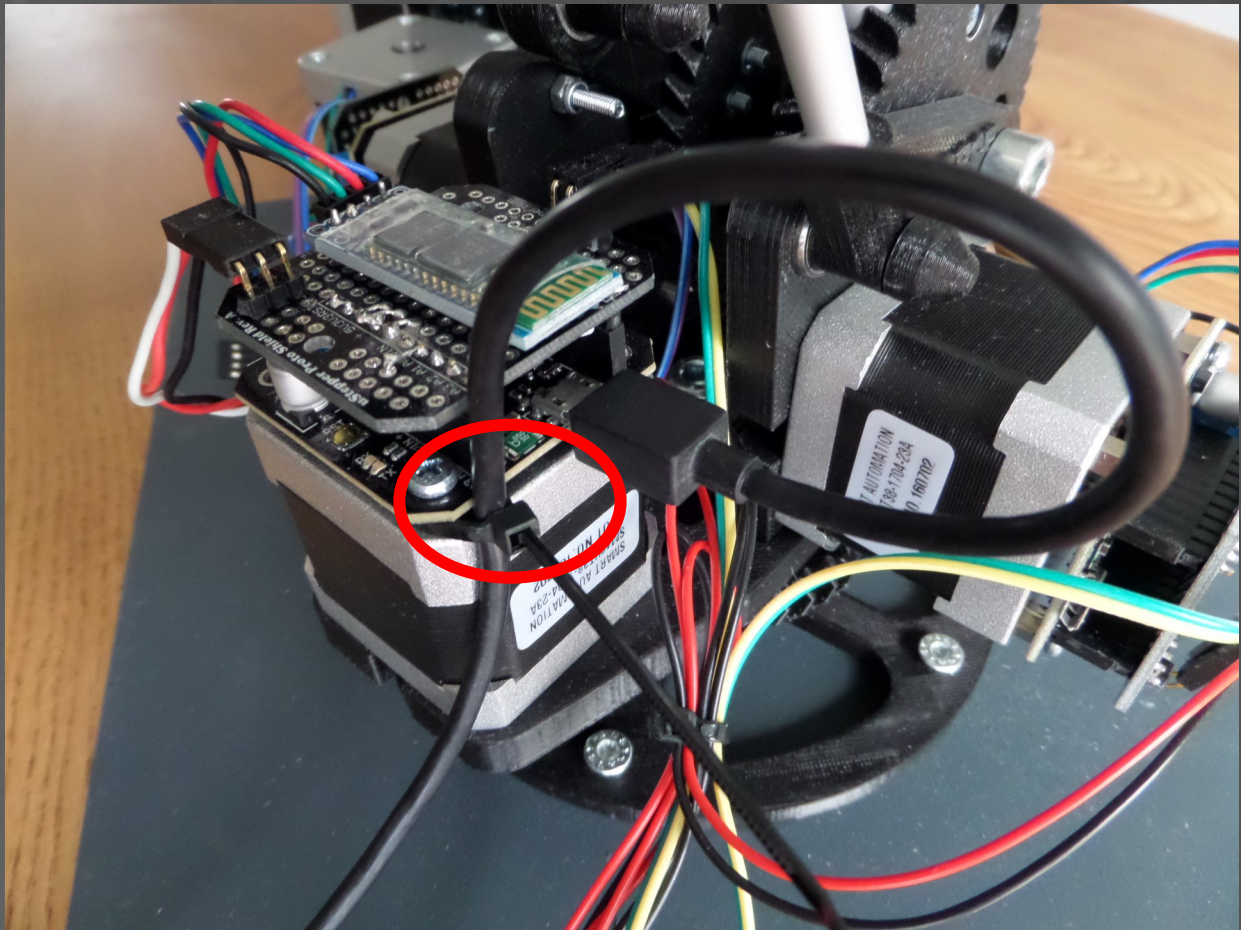
Fig.65: An M3x20 mm bolt and an M3 SL nut is inserted in the right side plate (15). The position of the bolt can be adjusted as required.

If mounting hard stops, please make sure that your software takes this into account. If this is not considered you might risk damaging the uStepper Robot Arm.

Connections for Demo code

The uStepper Robot Arm demo code on GitHub is tailored for a specific set of pin connections. These are shown on the following page.

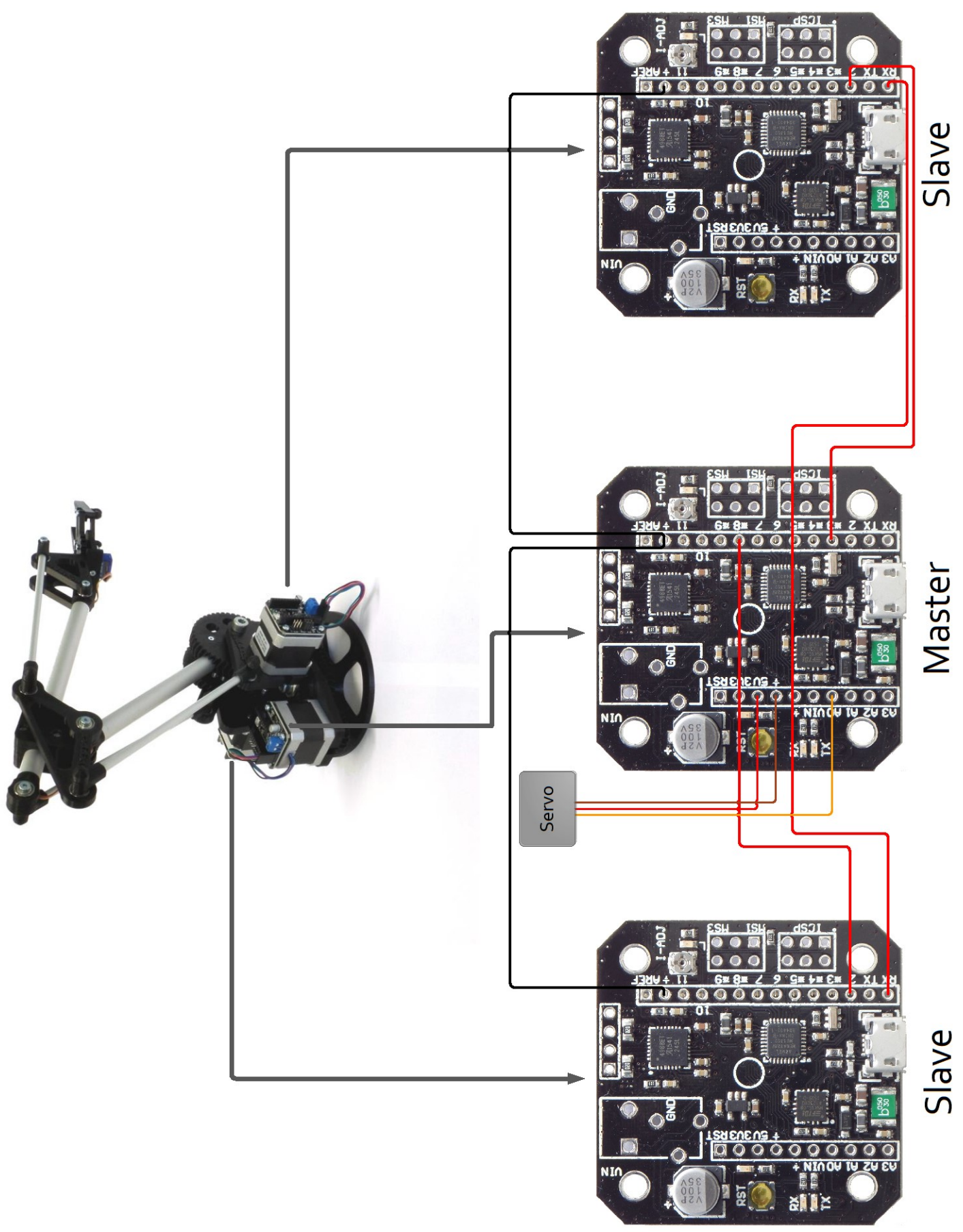
To communicate with the Robot Arm a Serial connection to the master is established. If doing this using the USB port, secure the USB cable so that it doesn't break the USB port of the uStepper. Alternatively a Bluetooth module can be used for wireless communication. A demo video of the Robot Arm can be found on www.ustepper.com or our YouTube channel.



**If using USB cable
for communication**

SECURE IT!

Connections for Demo code

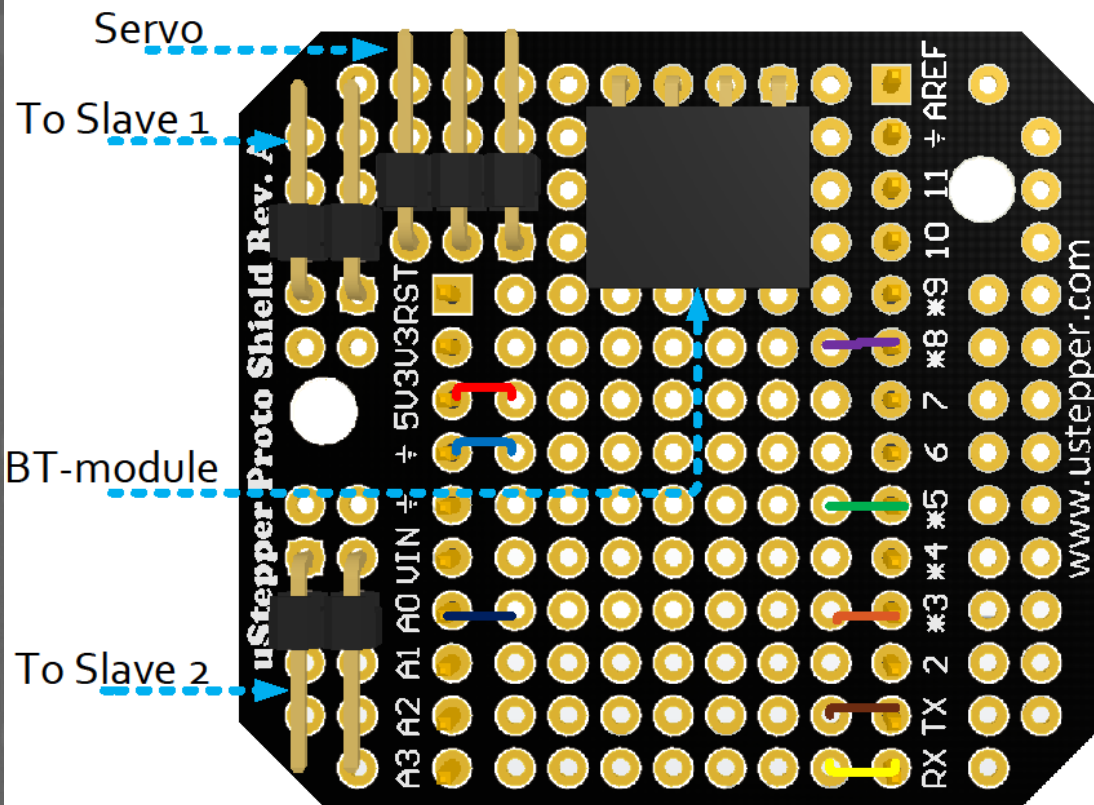
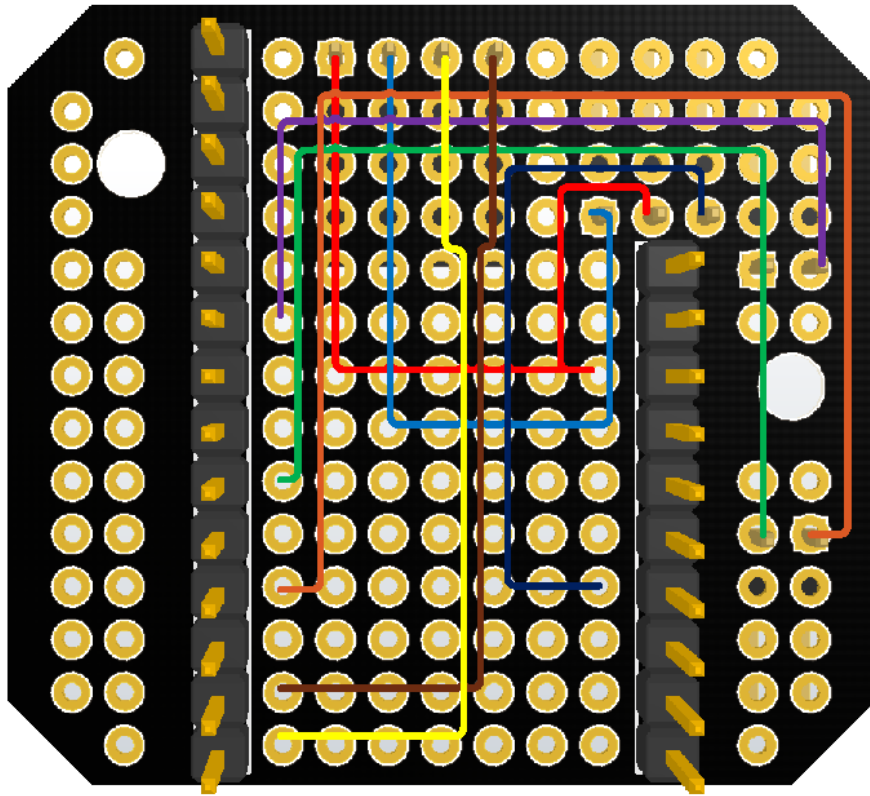


Optional Master Shield

It is recommended not to use USB connection for communication, but instead a Bluetooth module. On the following page a suggestion on how to solder up a shield for the master uStepper is shown. This uStepper will carry the BT-module, drive the gripper servo and communicate with the two slaves. The different connections are shown with individually colored wires for easier identification. The wiring is the same as presented on the prior page, with the addition of a BT-module of course.

Optional Master Shield

Bottom side



Top side

Disclaimer

ON Development IVS can not be held responsible for any damage inflicted upon mounting or interfacing with the uStepper board or the uStepper Robot Arm. This also includes damage to stepper motor (both electrical and mechanical), any other 3rd party hardware connected to uStepper or physical damage to its surroundings. Most stepper motor cases are made of aluminum, and care must be taken when preparing the mountings for uStepper.

By using the uStepper products you acknowledge that ON Development IVS can not be held responsible for any injuries and/or damage to any 3rd party hardware that may occur when using the uStepper products.

Detailed description, design files and examples can be found on www.uStepper.com

Contact

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