ESP32 Small Robot Dog (closed)

by Gleb Devyatkin

Disclaimer

This project has been done mostly for fun about a year ago. Some libraries have been updated, so it basically does not work any more. Not every planned feature was released. No PCB is made and it creates a lot of trouble for most of you. I'm sorry to say, but I'm not going to provide any support for it any more. It's exhausting and sometimes just destroys any intentions to continue. This is not commercial project and I'm not going to do something like Donation. Maybe I'm disappointing someone. Sorry. Project closed.

ESP32 small robot dog is my attempt to make quadruped dog that become very popular after Boston Dynamics Spot. Work on the project still in progress and hardware and software can changed.

Features

- Only ESP32 required (you don't need additional PWM i2c, Bluetooth modules, etc)
- Arduino IDE
- Web based interface with telemetry, to control robot you will need just you smartphone or tablet
- CLI interface for calibration and debug
- True Inverse kinematics code
- Configurable Gait sequence and settings (just if you need it)
- Fun

Electronics

- 1 x ESP32 with 38pin
- 1 x 50x70 mm green prototyping board
- 12 x TowerPro MG90D or MD90S (cable should be out at the bottom of servo, thanks to triawan) servos (**it can be tricky to use other servos, as size may vary**, please have a look at this images of three different mg90-like servos: https://www.instagram.com/p/COoIyvzrLZt/)
- 1 x INA219 (optional)
- 1 x MPU9250 (optional, still has not been implemented, WIP)
- 3 x Mini360 (DC-DC Buck Converter Step Down Module) or similar, 2 for front/hind legs (or more), 1 for ESP32
- 1 x 18650 Battery Holder for 2 elements (try to find "18650 battery holder smt")
- 2 x 18650 Battery
- some capacitors

Other parts

- 8 x 8x12x2.5mm bearings
- 4 x small cable ties
- Super glue (cyanoacrylate) to glue all parts together

https://www.youtube.com/watch?v=jzs04zd9bQk

Step 1: Print Parts

All STLs to print can be downloaded from Thingiverse page: Robot dog, quadruped robot, 12DOF, 3DOF per leg

Some part should be mirrored to be able to print correctly. Please see attached images.

My printer have issue with first layer thickness, aka Elephant Foot. Gears should be printed as perfect as possible, so I add very tiny spacer to avoid issue, you will see that some part "flying" over surface, so please enable support for it.

I'm strongly recommend print parts with best possible quality, especially gears. As also use brim and ironing.

Full list of parts to print:

Printable parts:

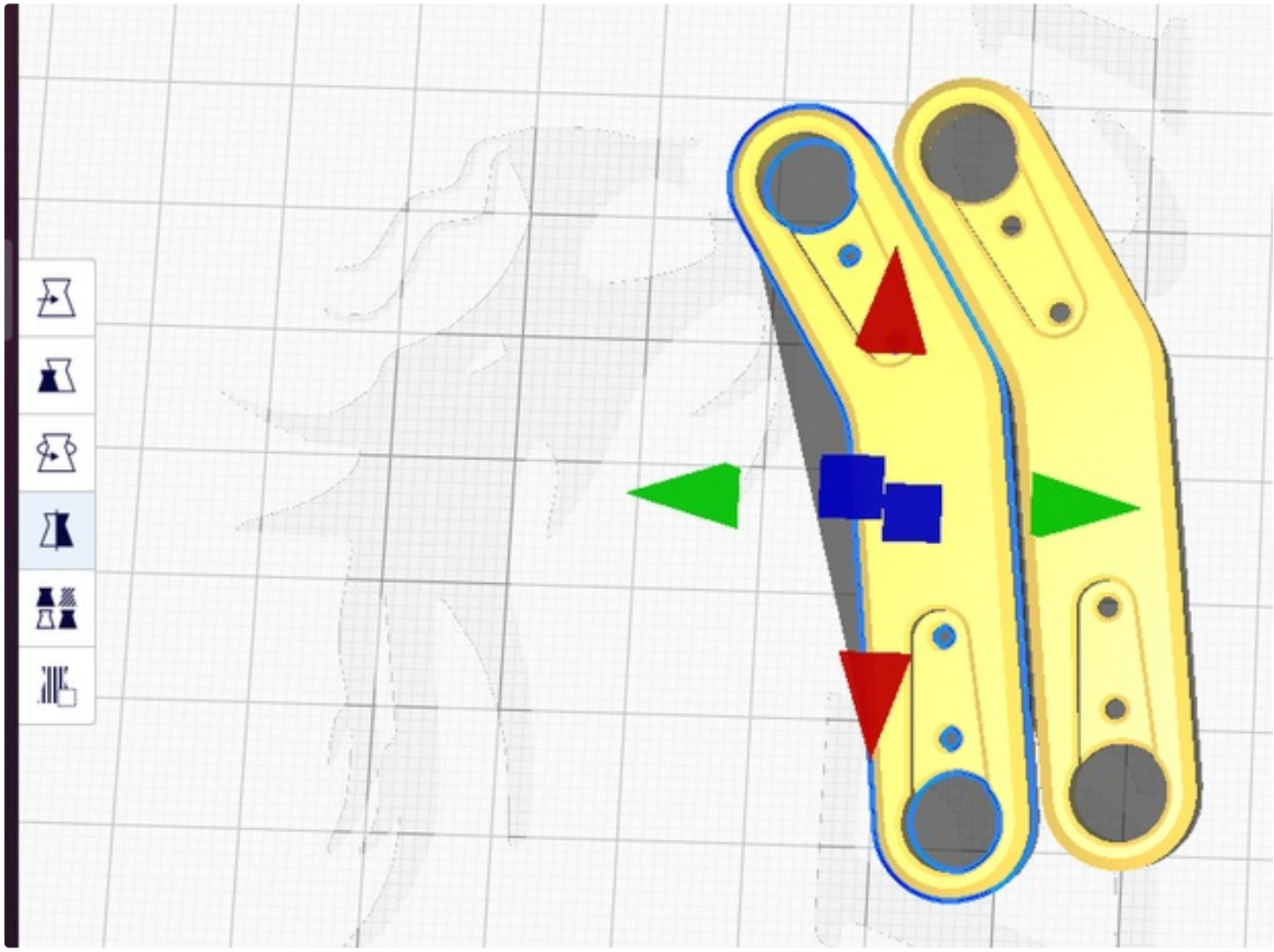
- 1 x Body

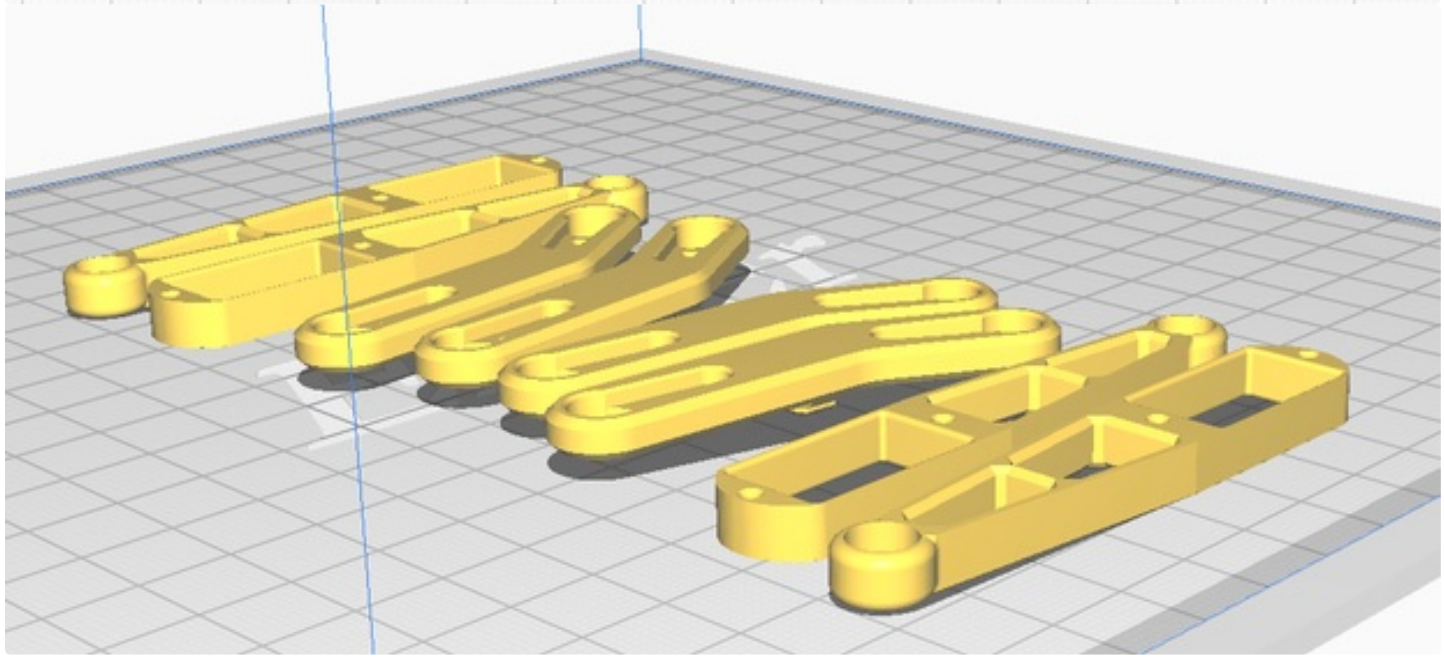
- 2 x Leg top
- 2 x Leg top (mirrored)
- 2 x Leg bottom
- 2 x Leg bottom (mirrored)
- 4 x Shoulder part1
- 4 x Shoulder part2
- 2 x Legs holder part1
- 2 x Legs holder part2
- 4 x Servo gear
- 4 x Leg shoes, print with flexible filament (not required)
- 1 x Cover
- 2 x Cover clamps

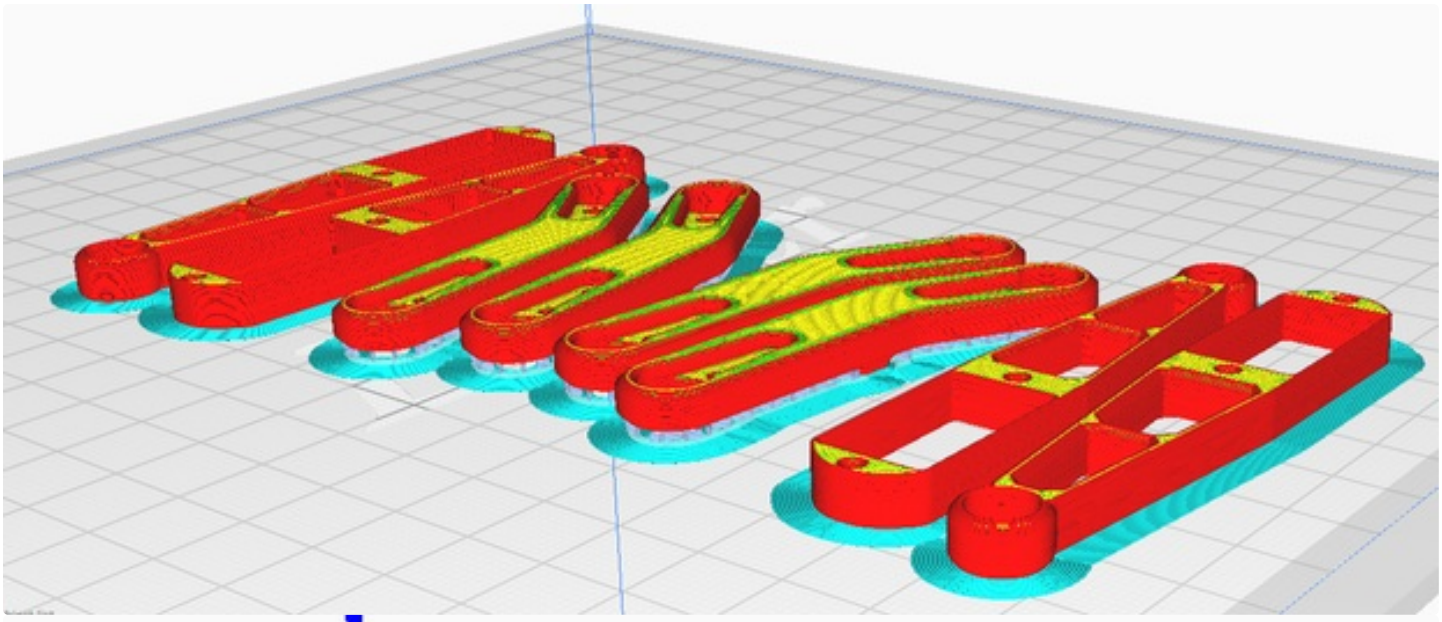
Printable helping tools (see description on GitHub):

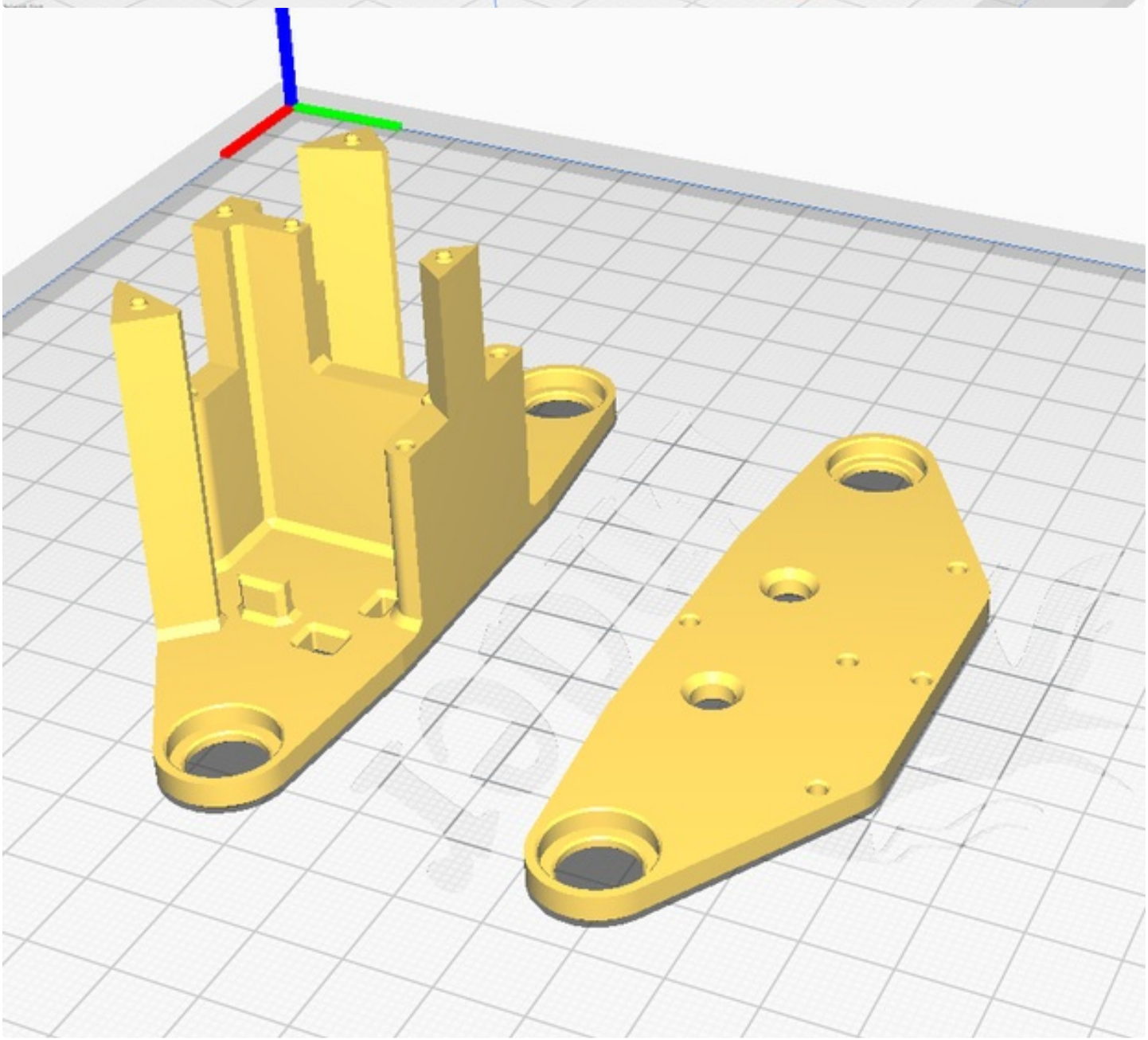
1. 1 x CALIBRATION_LEG-Beta_and_Gamma
2. 1 x CALIBRATION_LEG-Beta_and_Gamma (mirrored)
3. 1 x CALIBRATION_LEG-Alpha
4. 1 x CALIBRATION_SERVO-10deg

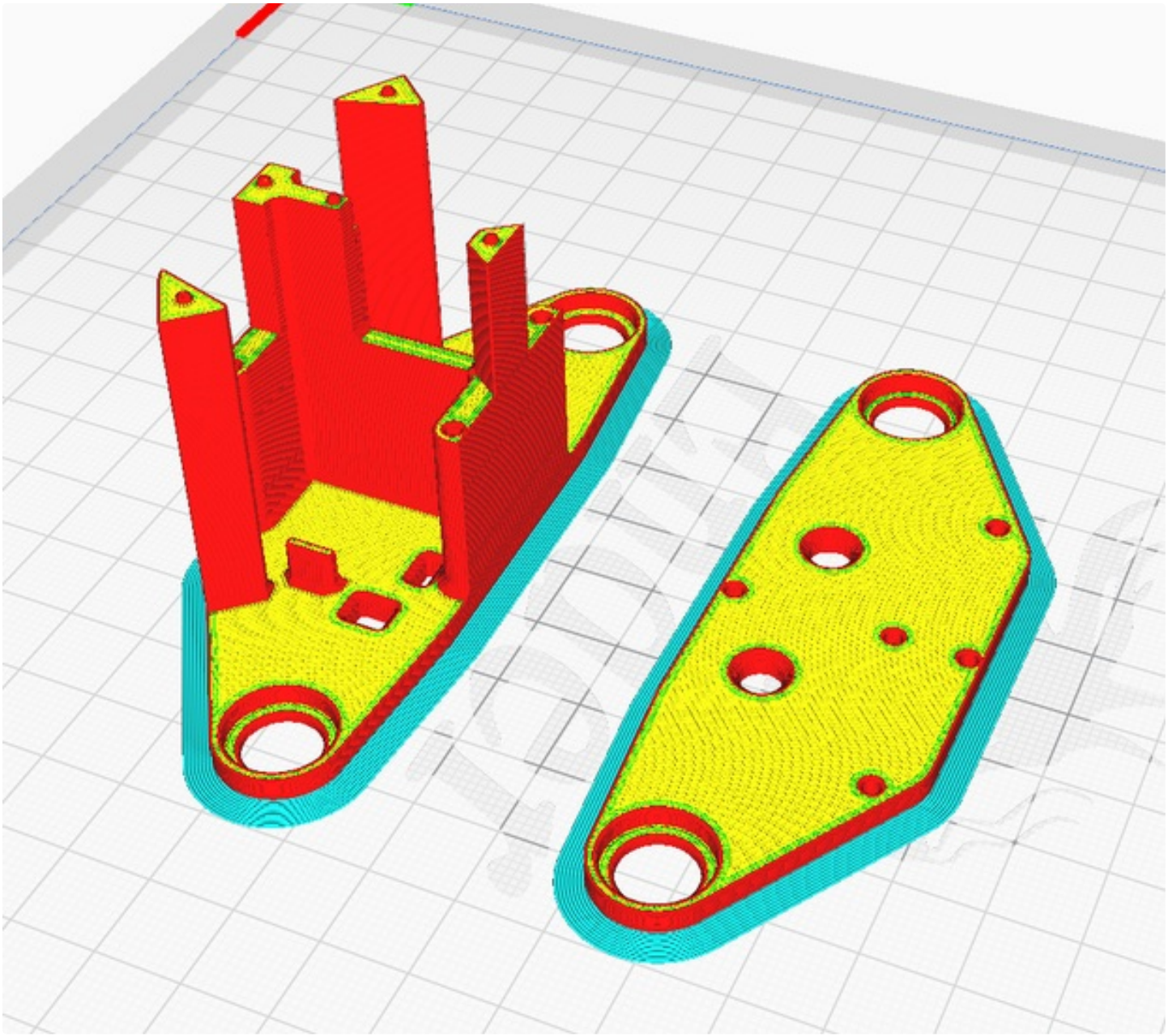
I'm using Ender 3 Pro, Cura, use Support and choose Dynamic quality. Plastic is PLA from OPY (AliExpress). For more details please visit Thingiverse page: https://www.thingiverse.com/thing:4822059

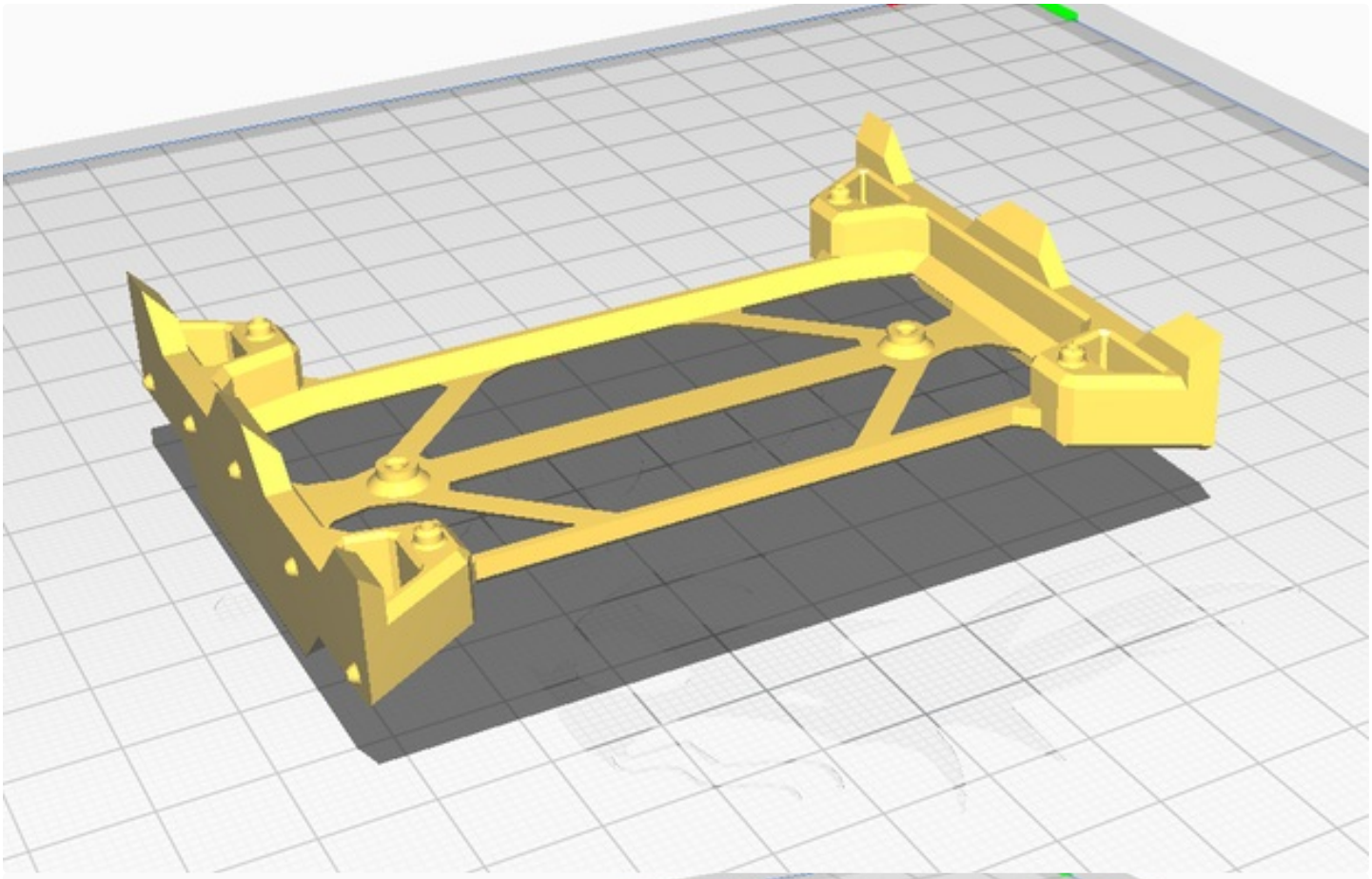


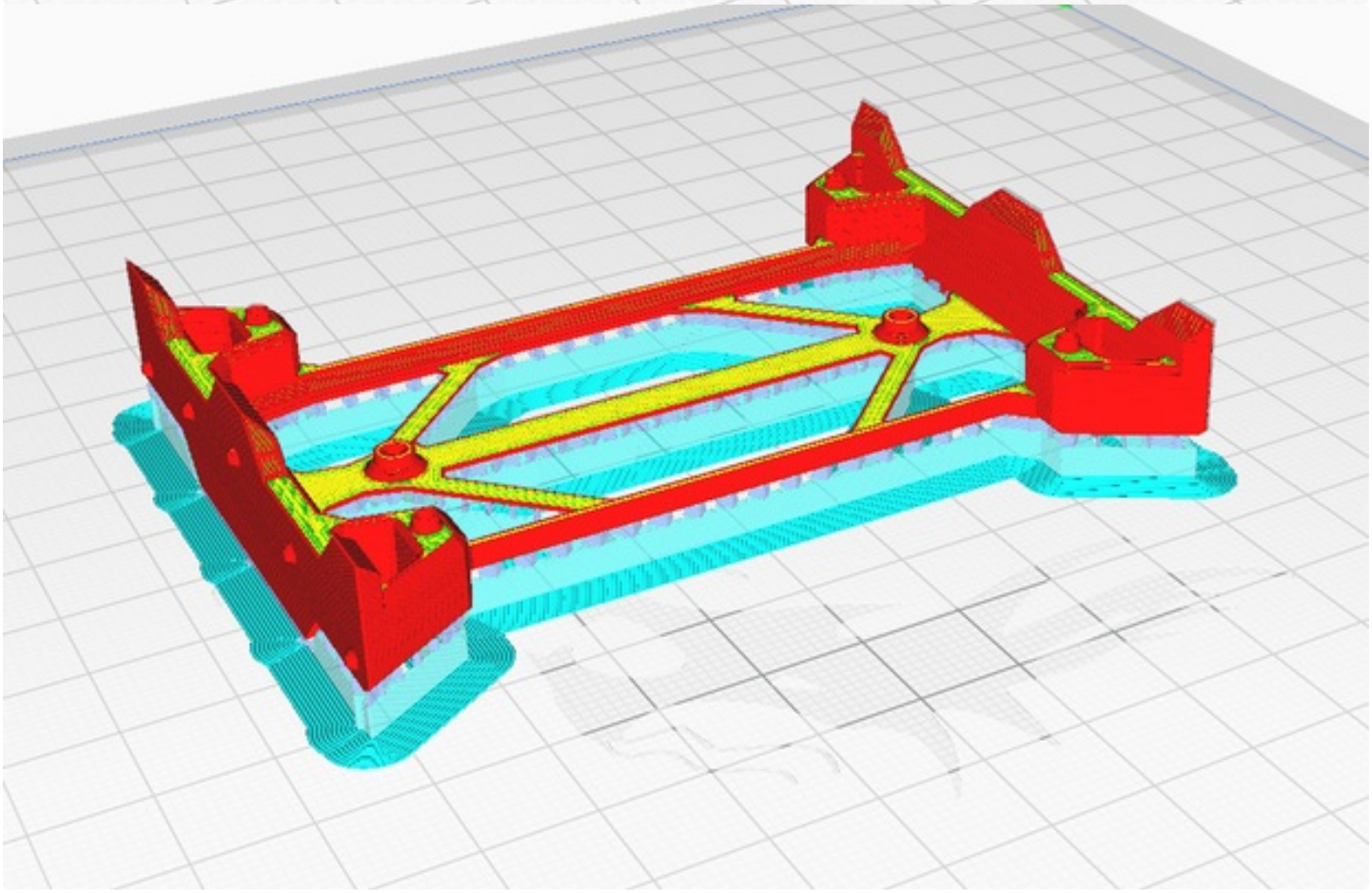


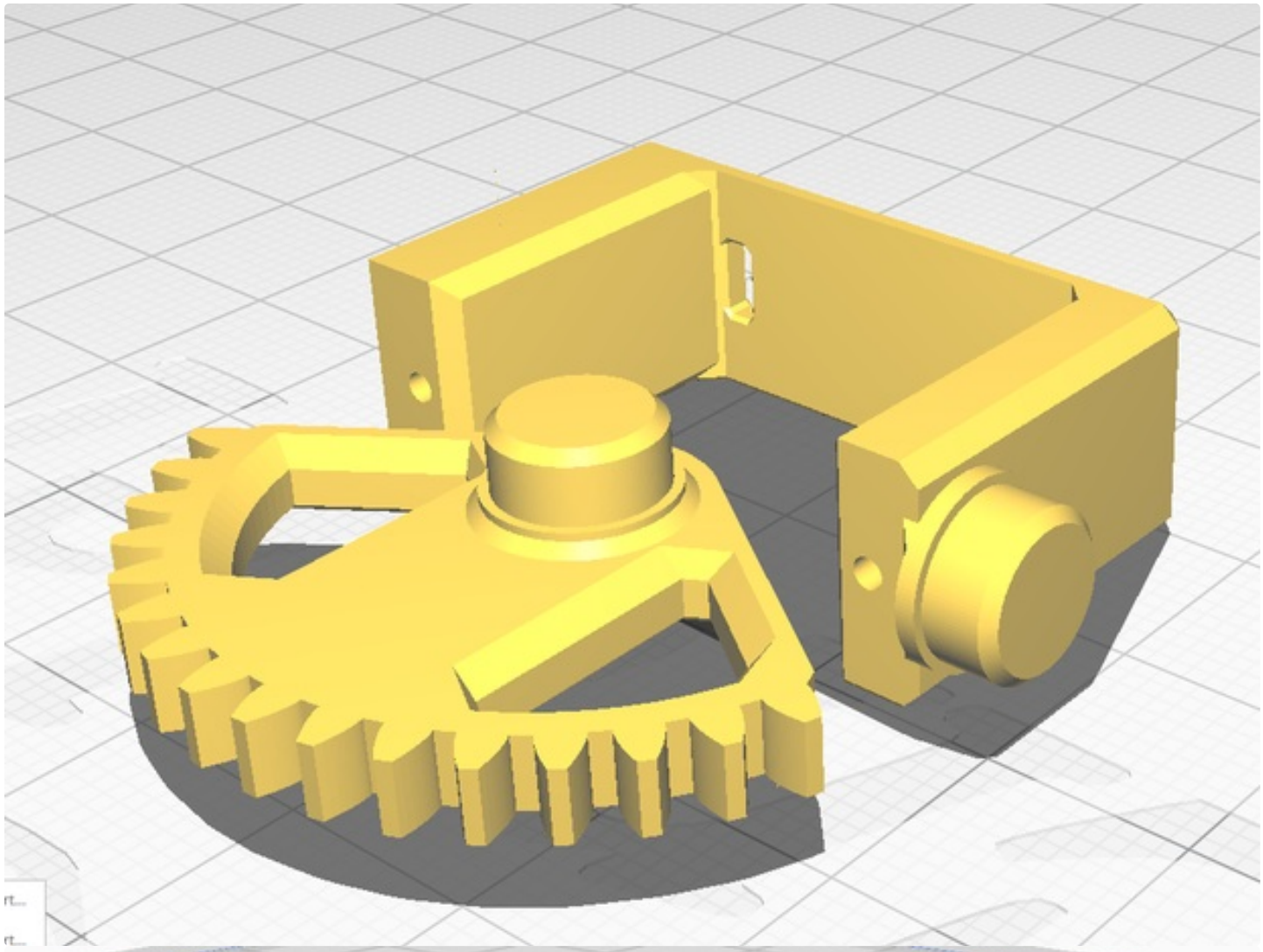


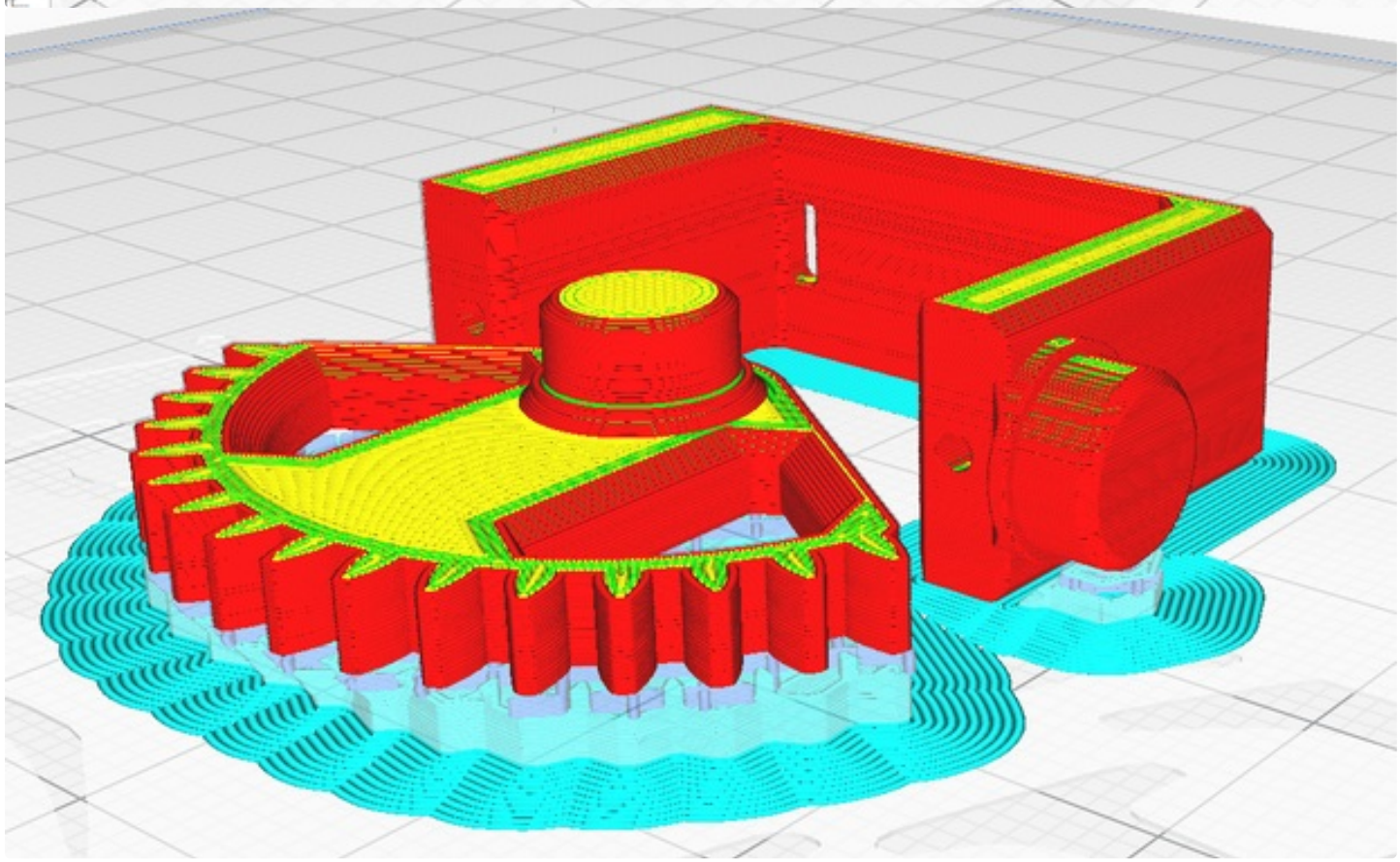


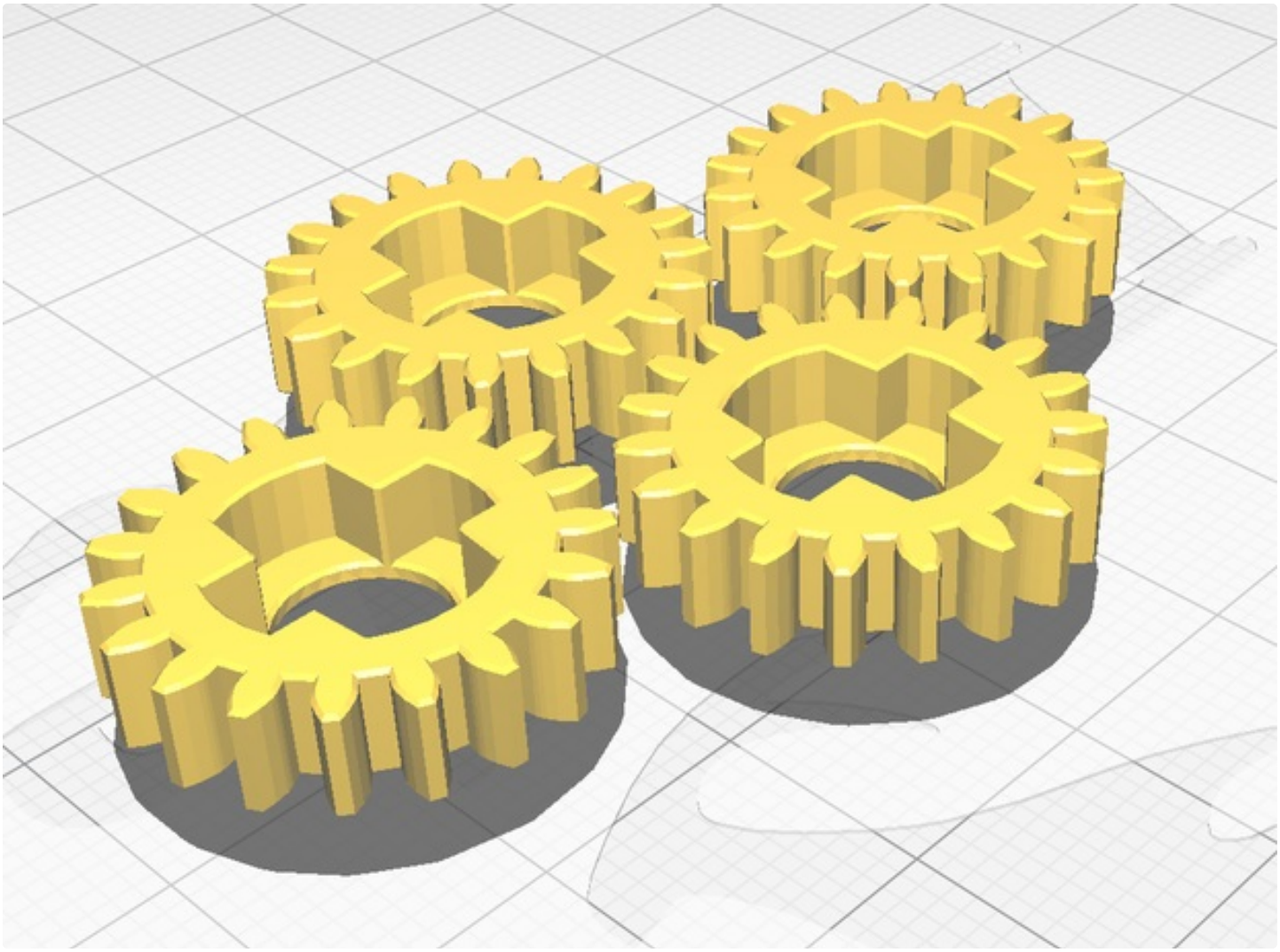


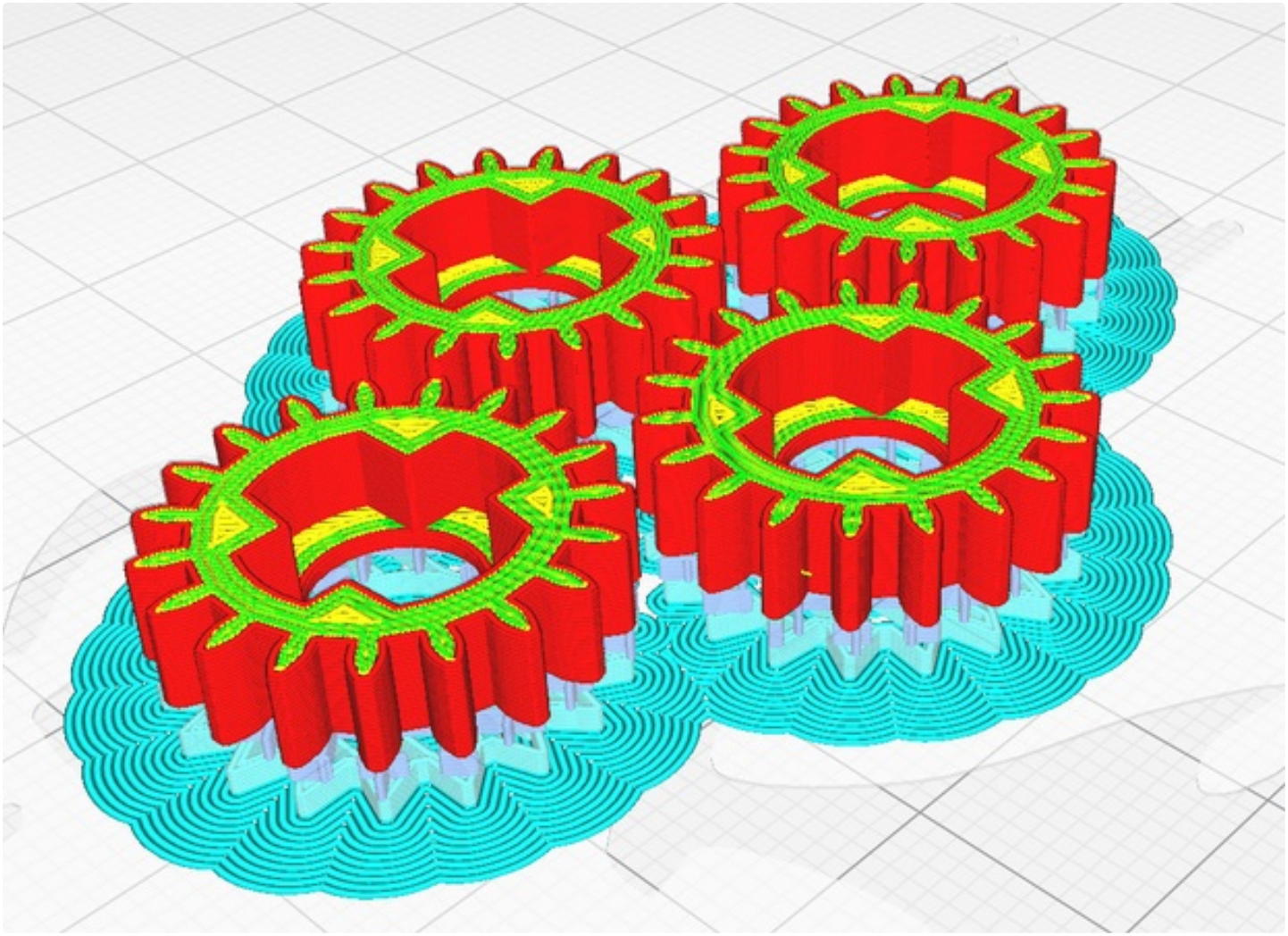


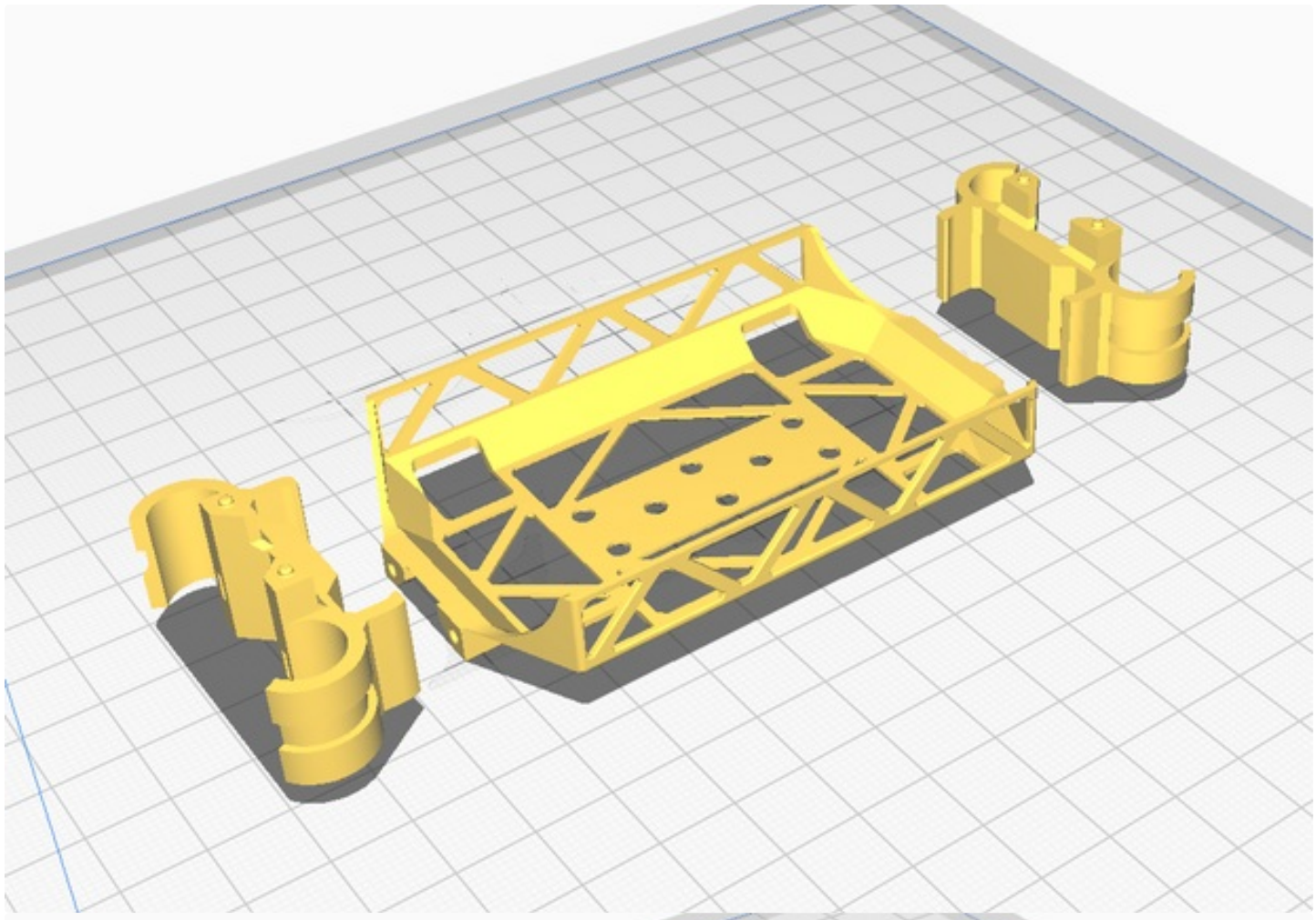


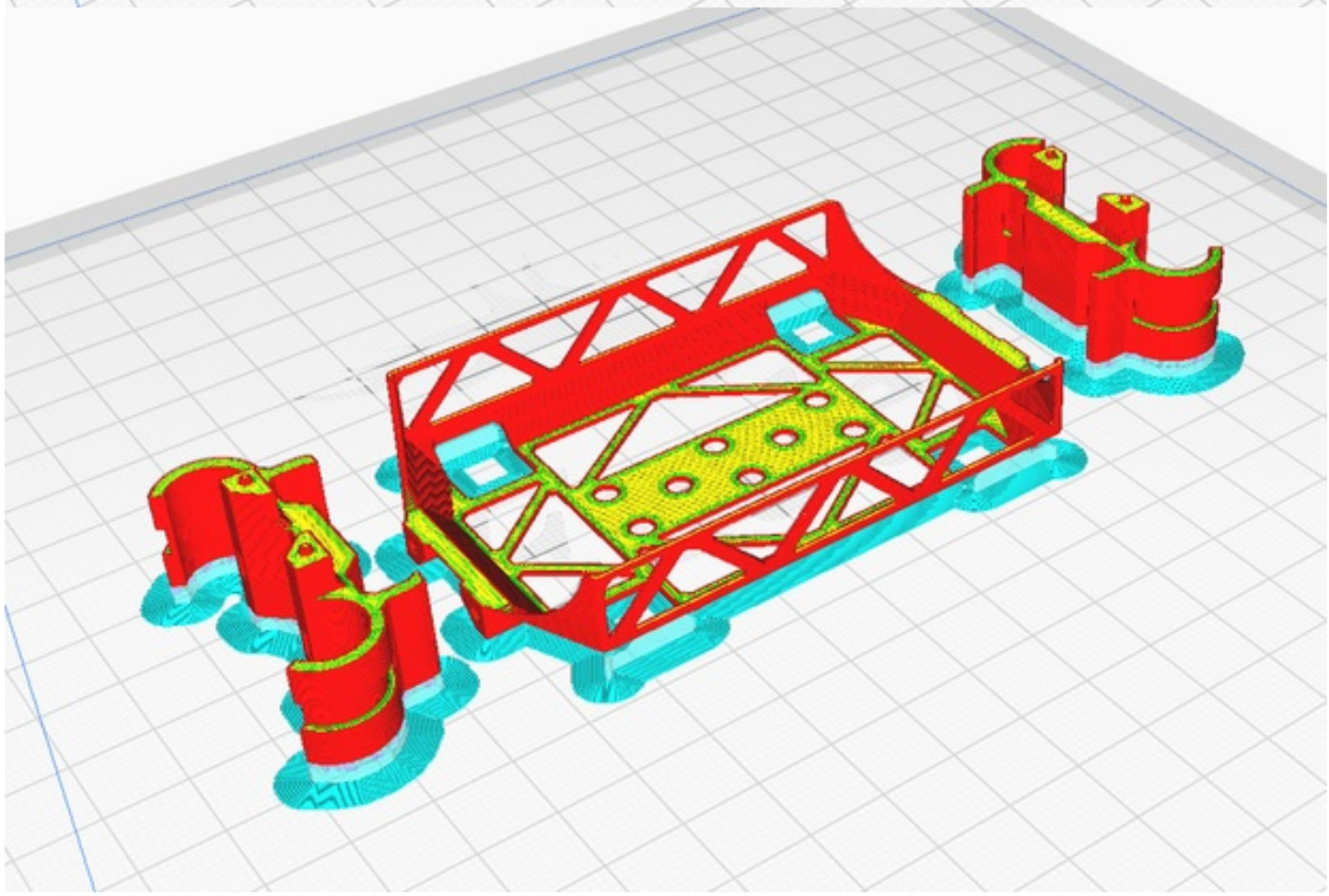












Step 2: Let's Make It Better and Glue Together

Preparation

Before we start, please check that bearings can be easy fit to body parts and over shoulder parts.

Also check that holes in Shoulder and body parts printed fine and servo **cables** (temporary disassemble servo connector) can be fit inside.

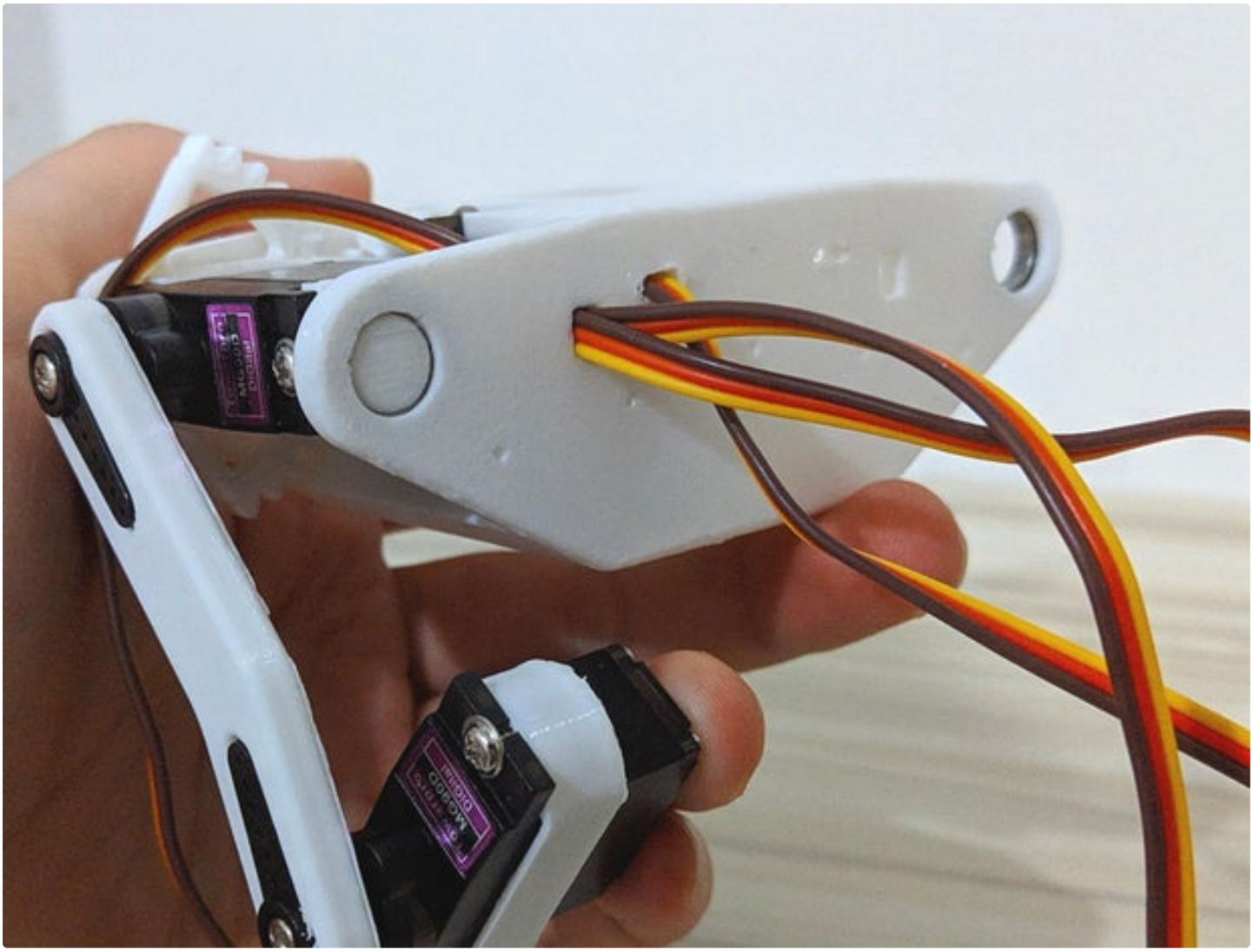
Do it

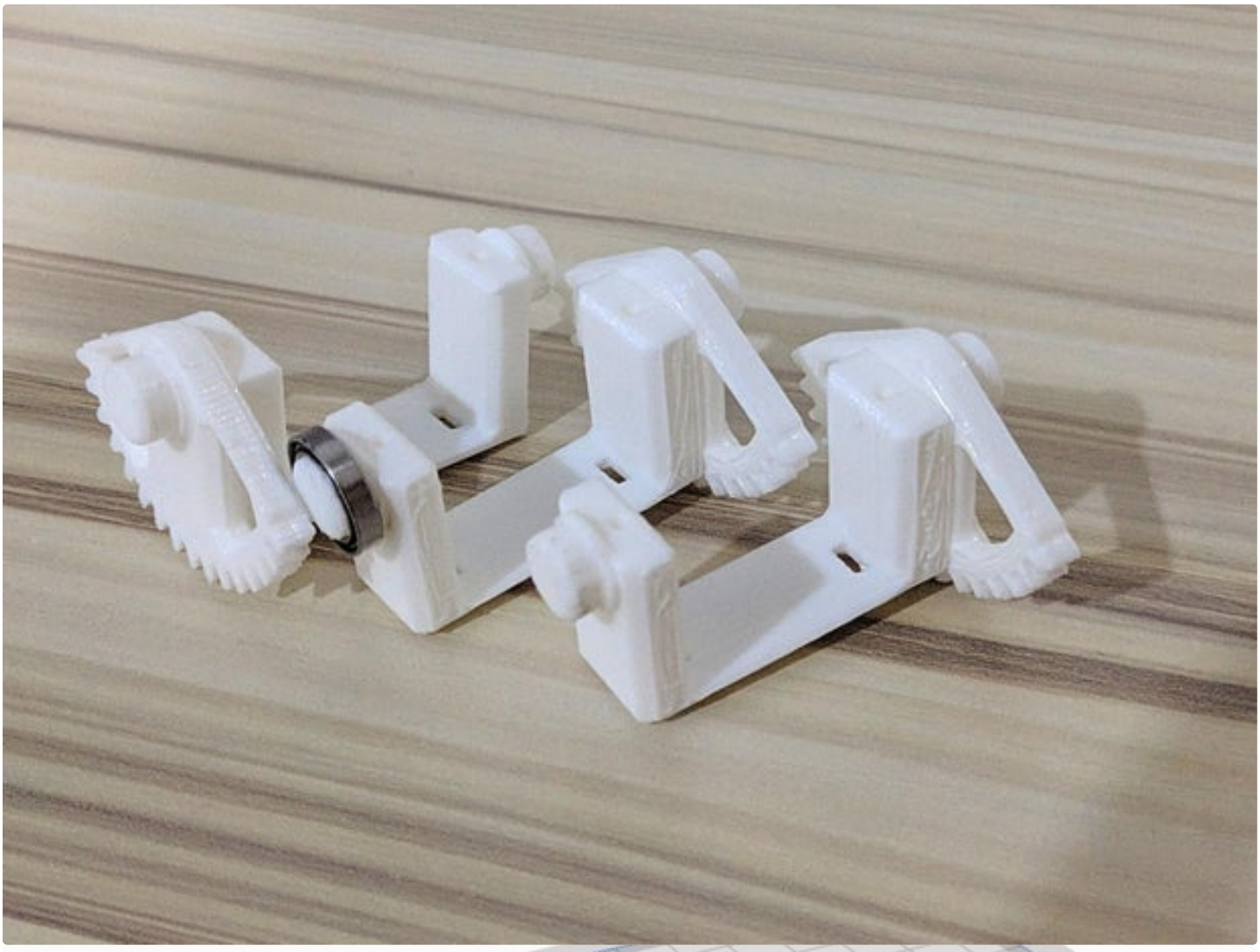
I tried to make body as light as possible, as small servos not very powerful. That is why you will need to glue some parts together. Promise it is not so hard =)

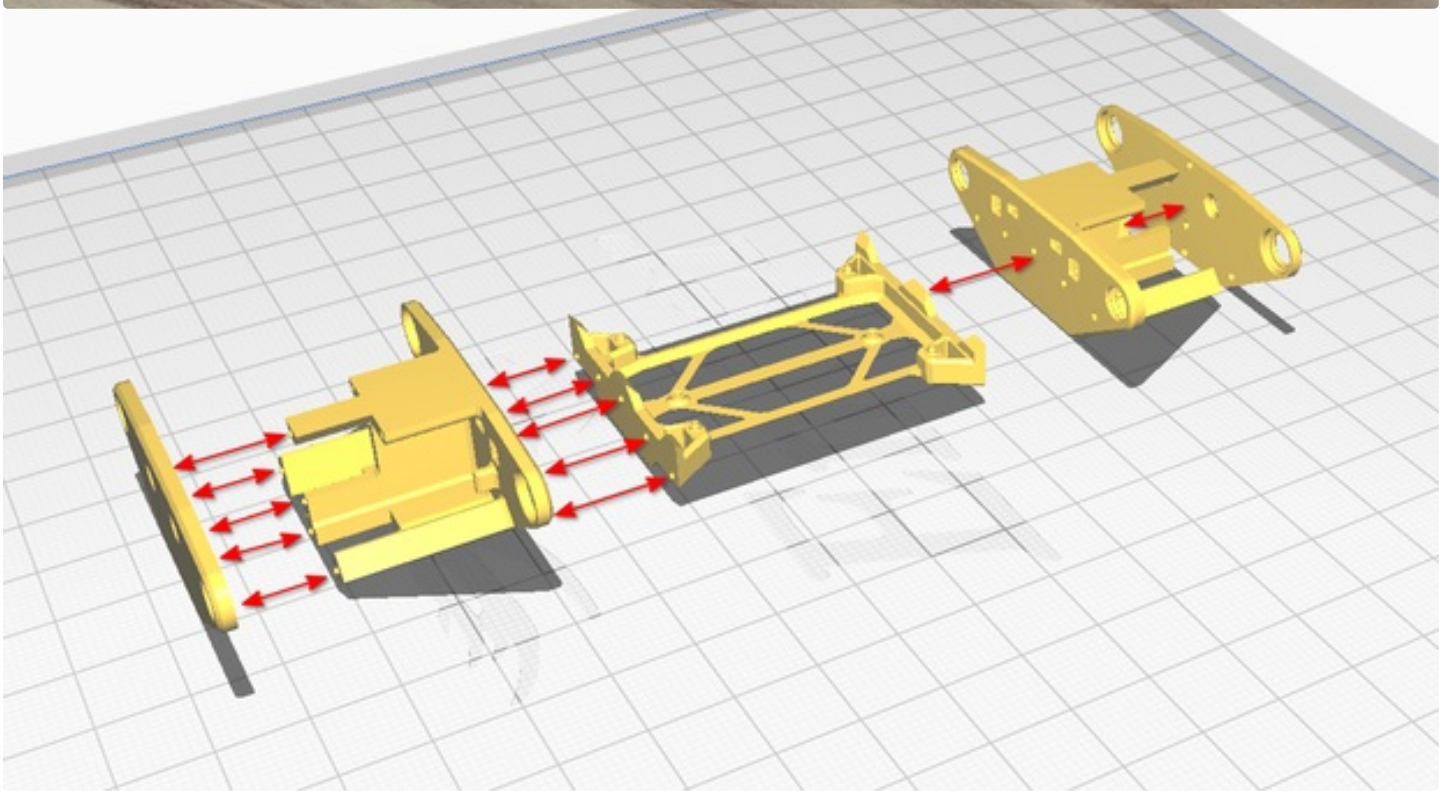
Make sure that gluing surfaces are flat, use some flat mini file and make sure parts can be connected to each other without space between. Then glue it together as shown on images.

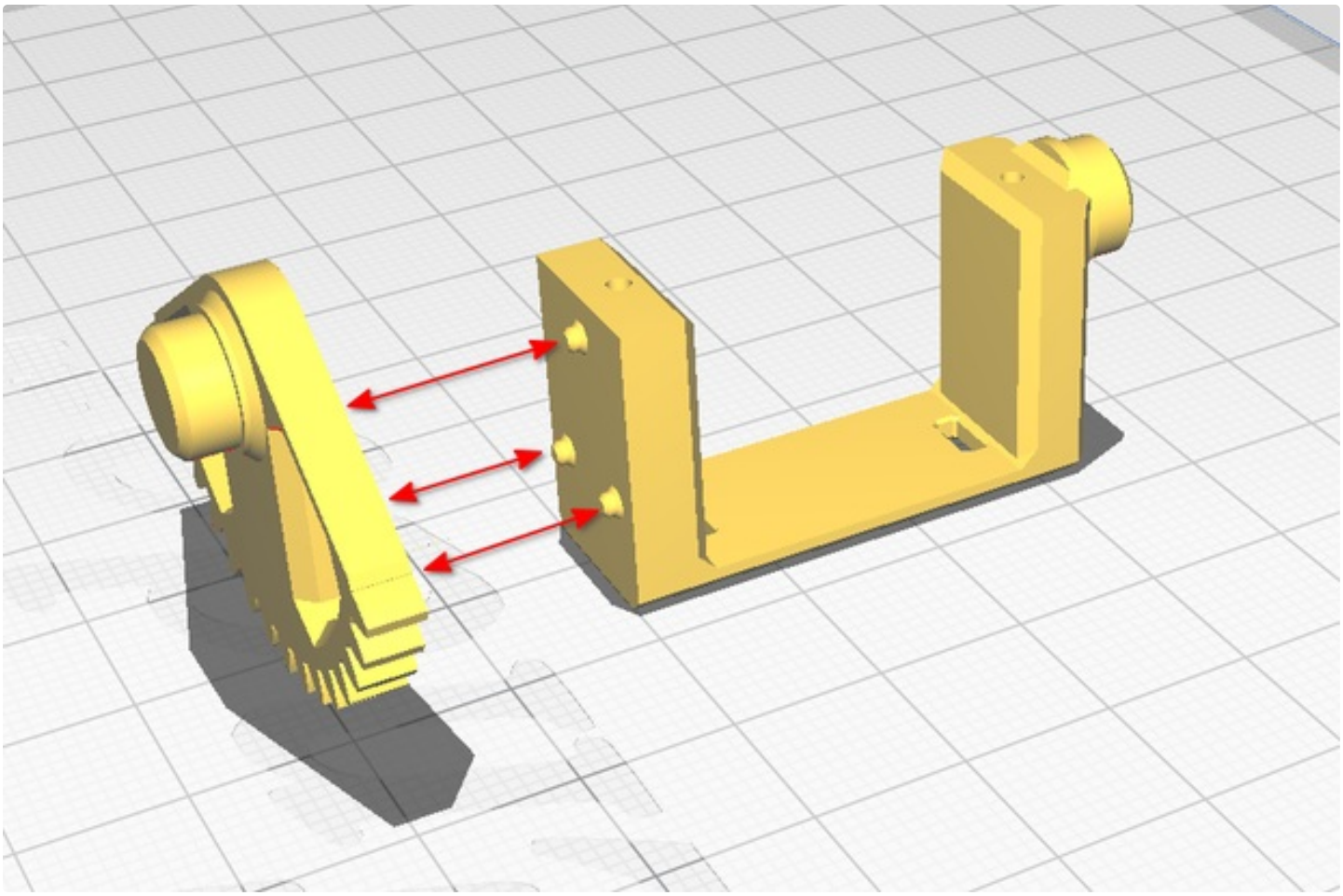
Servo gears

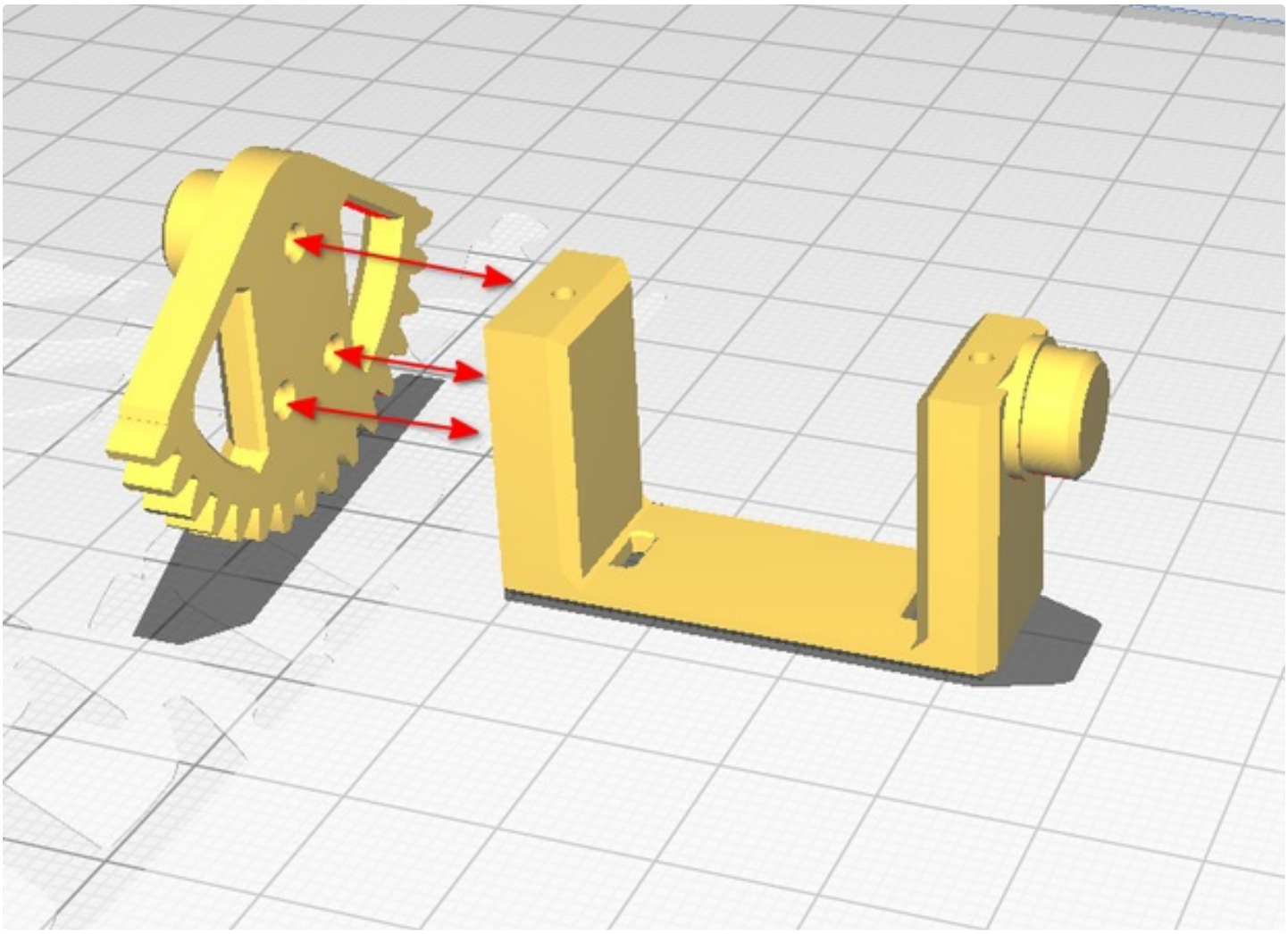
Cut servo horn (see image) to fit it inside servo gear part and glue it together.











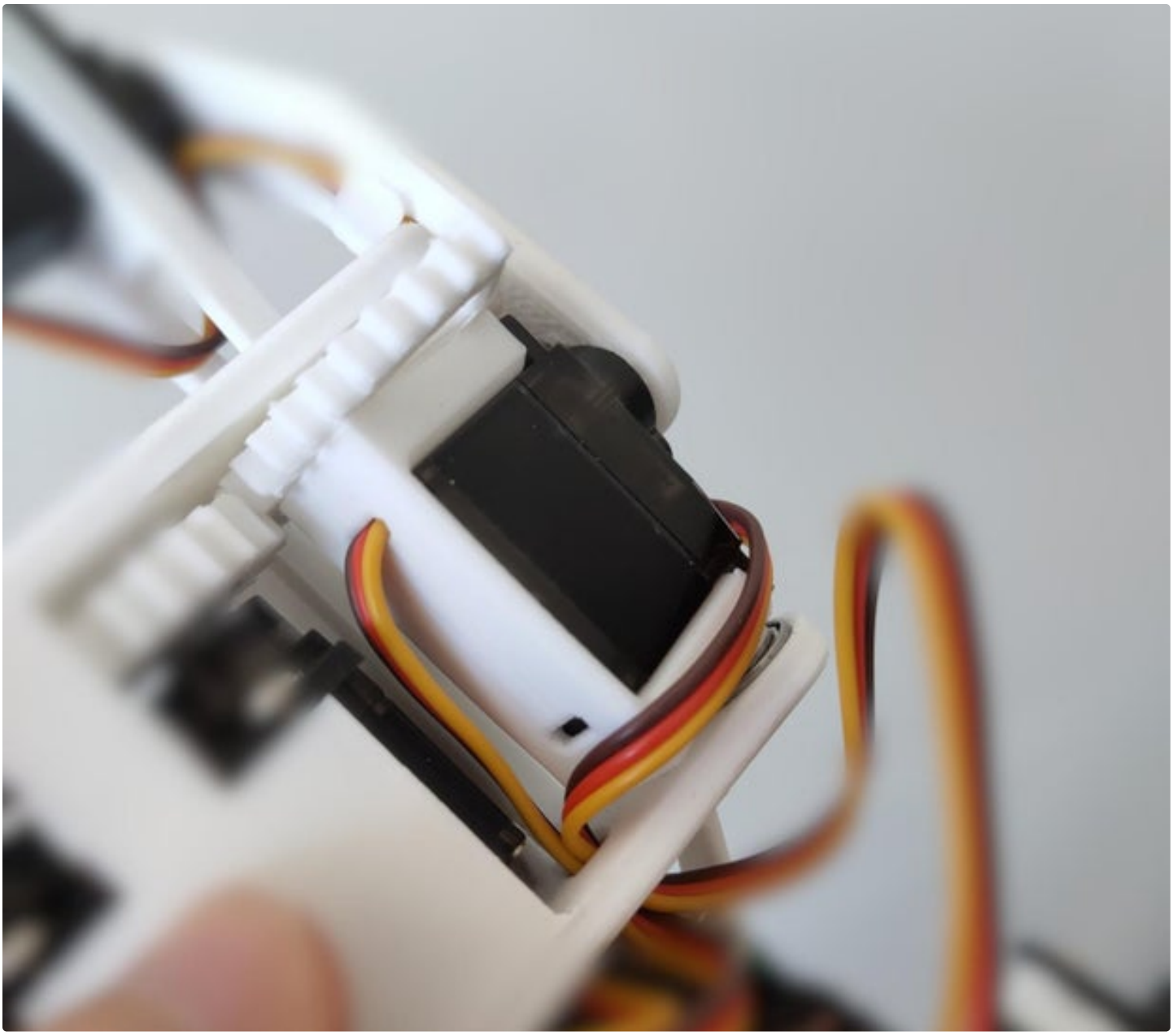
Step 3: Legs

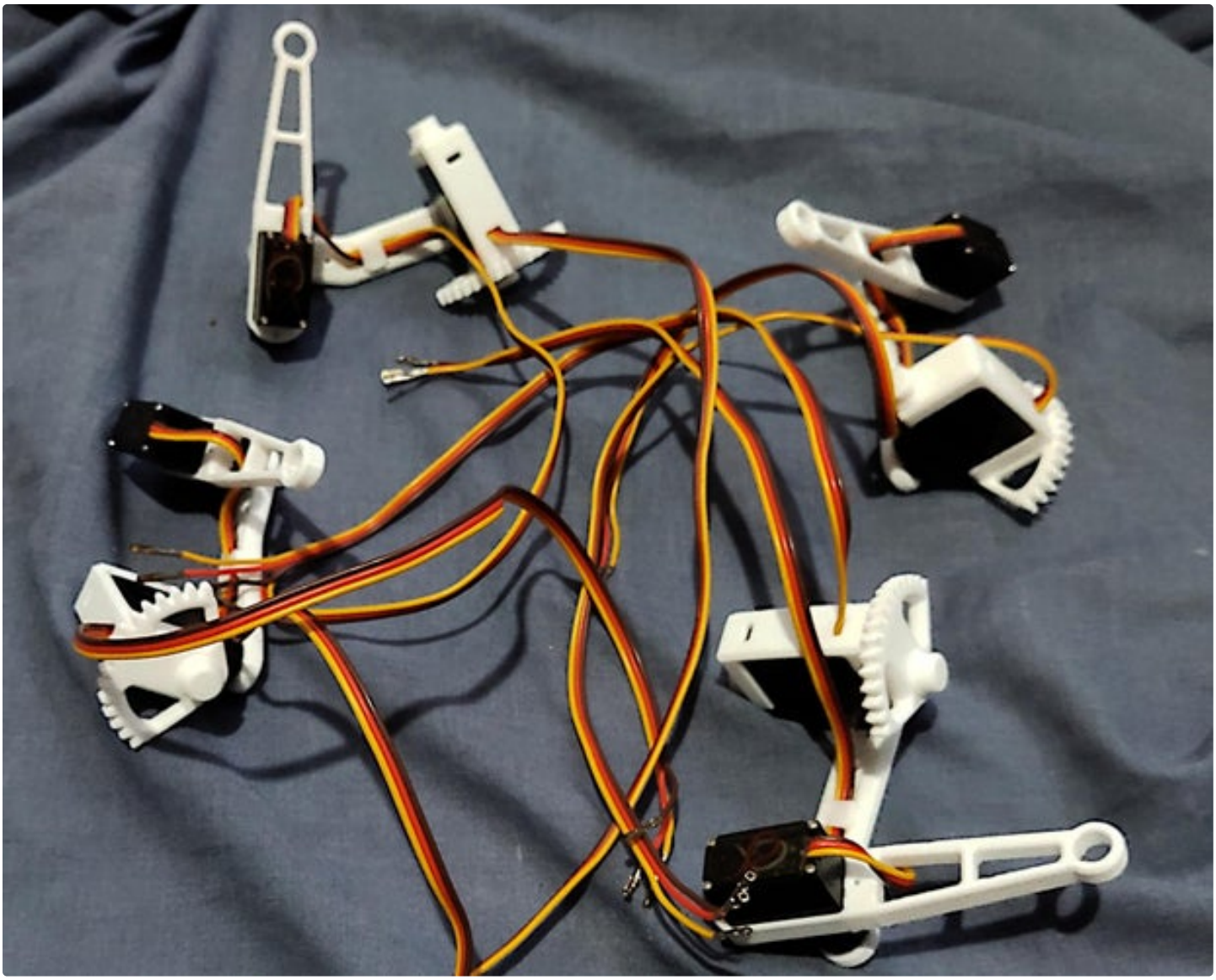
Glue short servo horns into "leg top" parts.

Insert servo into "leg bottom part" and insert cable as shown on image.

Pull another servo cable through one of the hole on the "shoulder" part.

Repeat with other legs.





Step 4: Assemble Body and Legs Together

As was shown on previous pictures, pull all cables through legs and body holes.

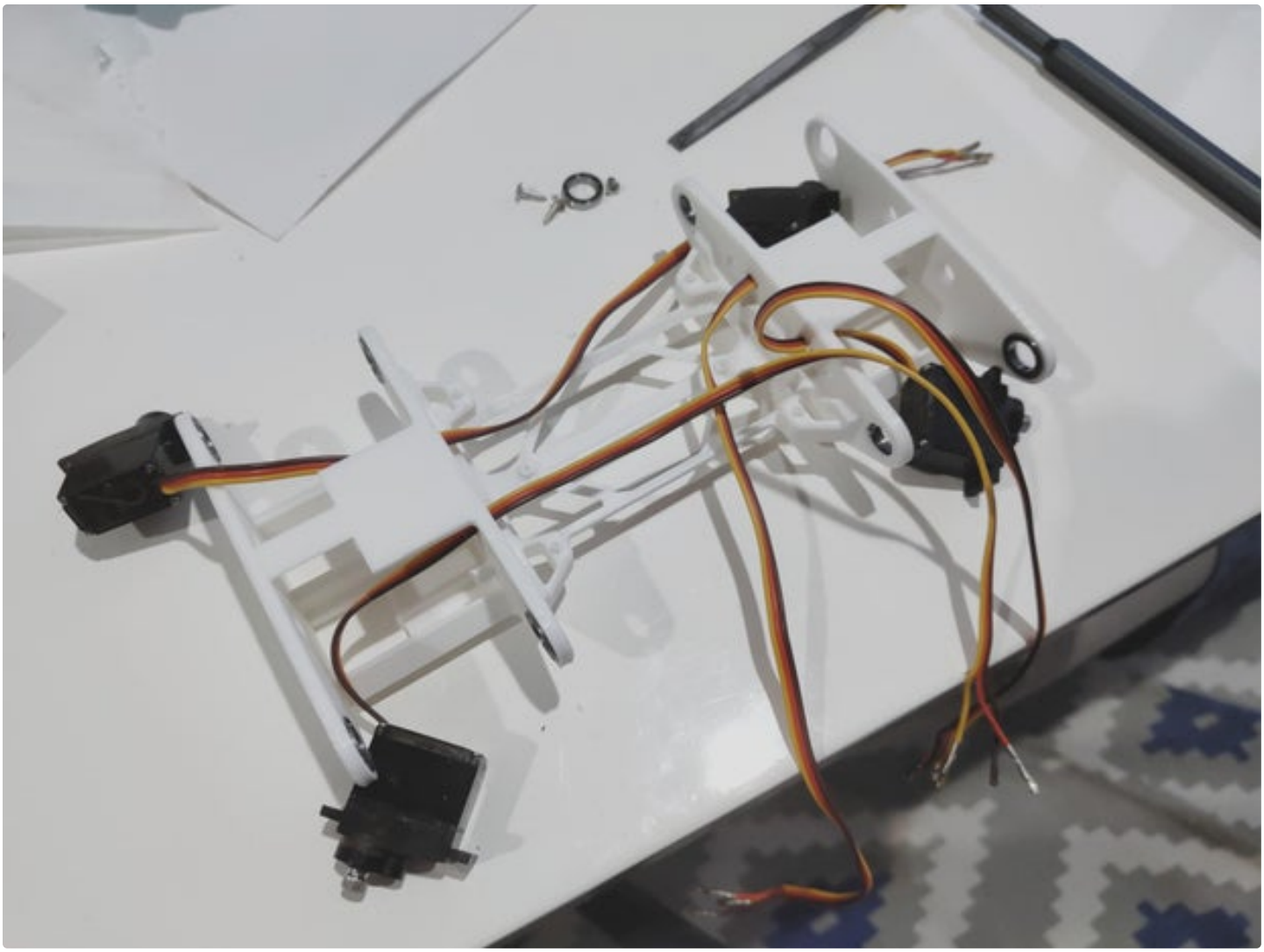
Set all servos to middle using Arduino/ESP32 or servo tester.

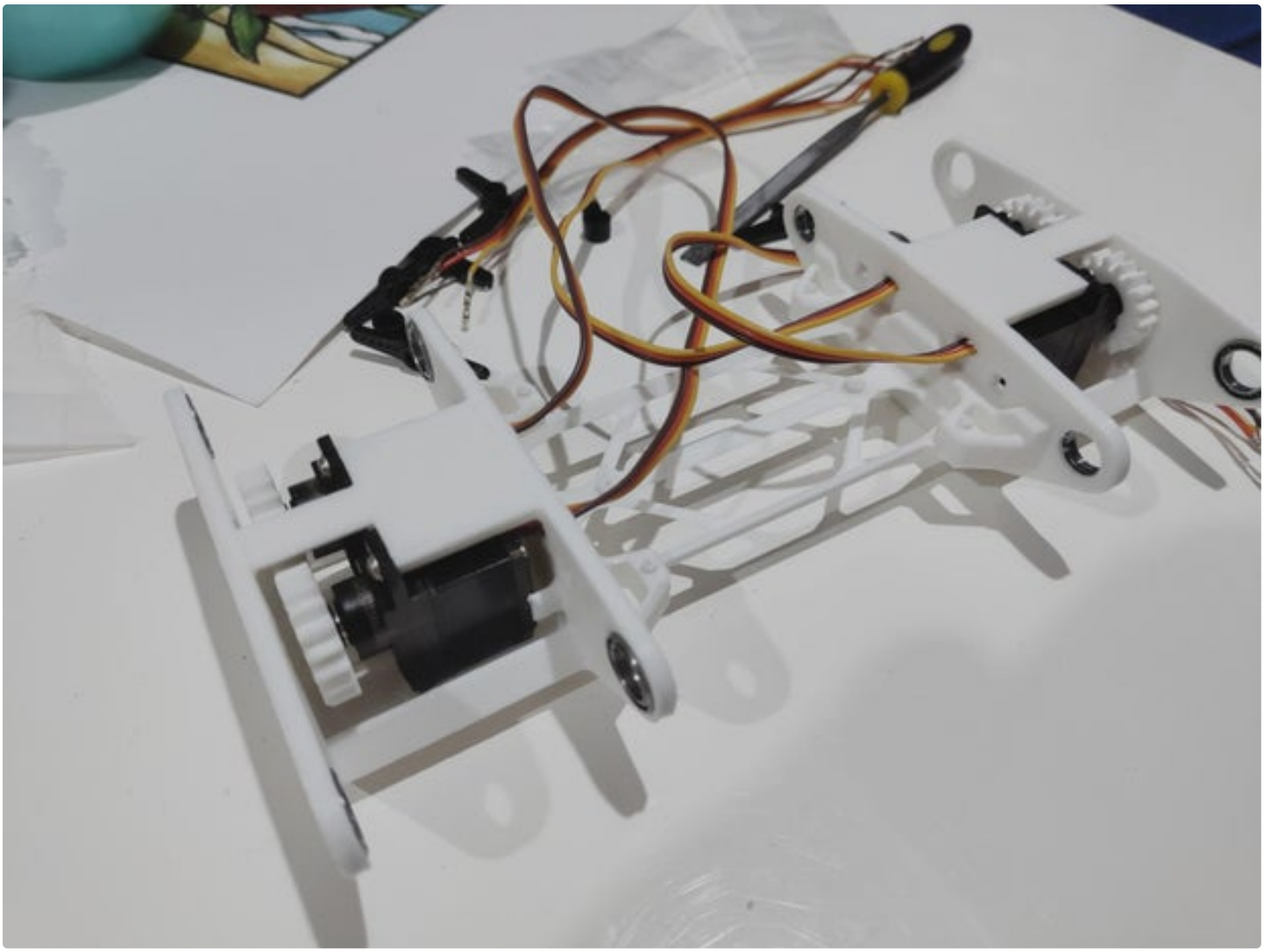
Cut servo horn to make it fit inside "servo gear", glue it and install on the servo as usual. Insert servos into body. Screwing it can be challenging.

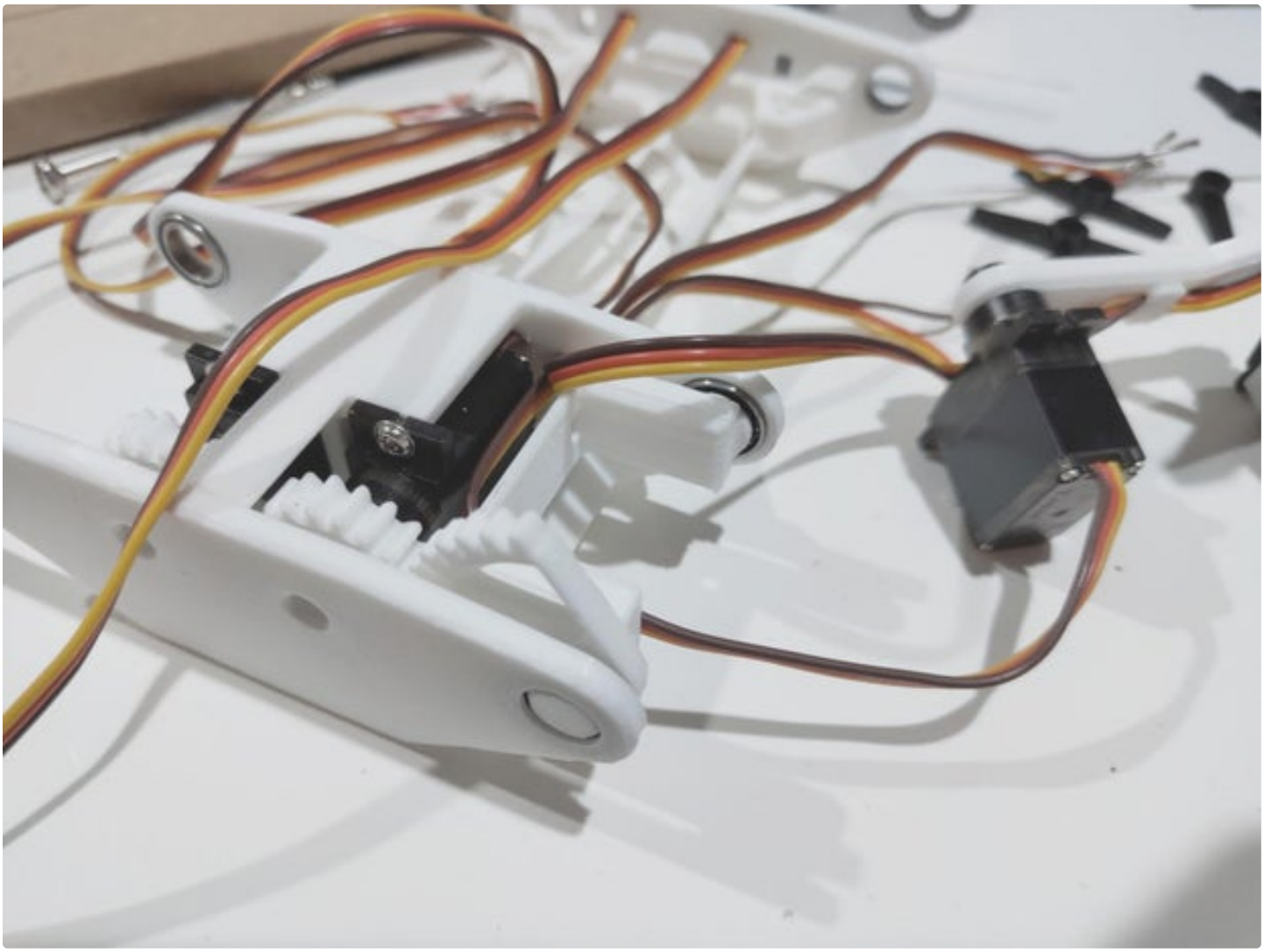
Squeeze "shoulder" part without servo (but with cable in place) and insert it between bearings.

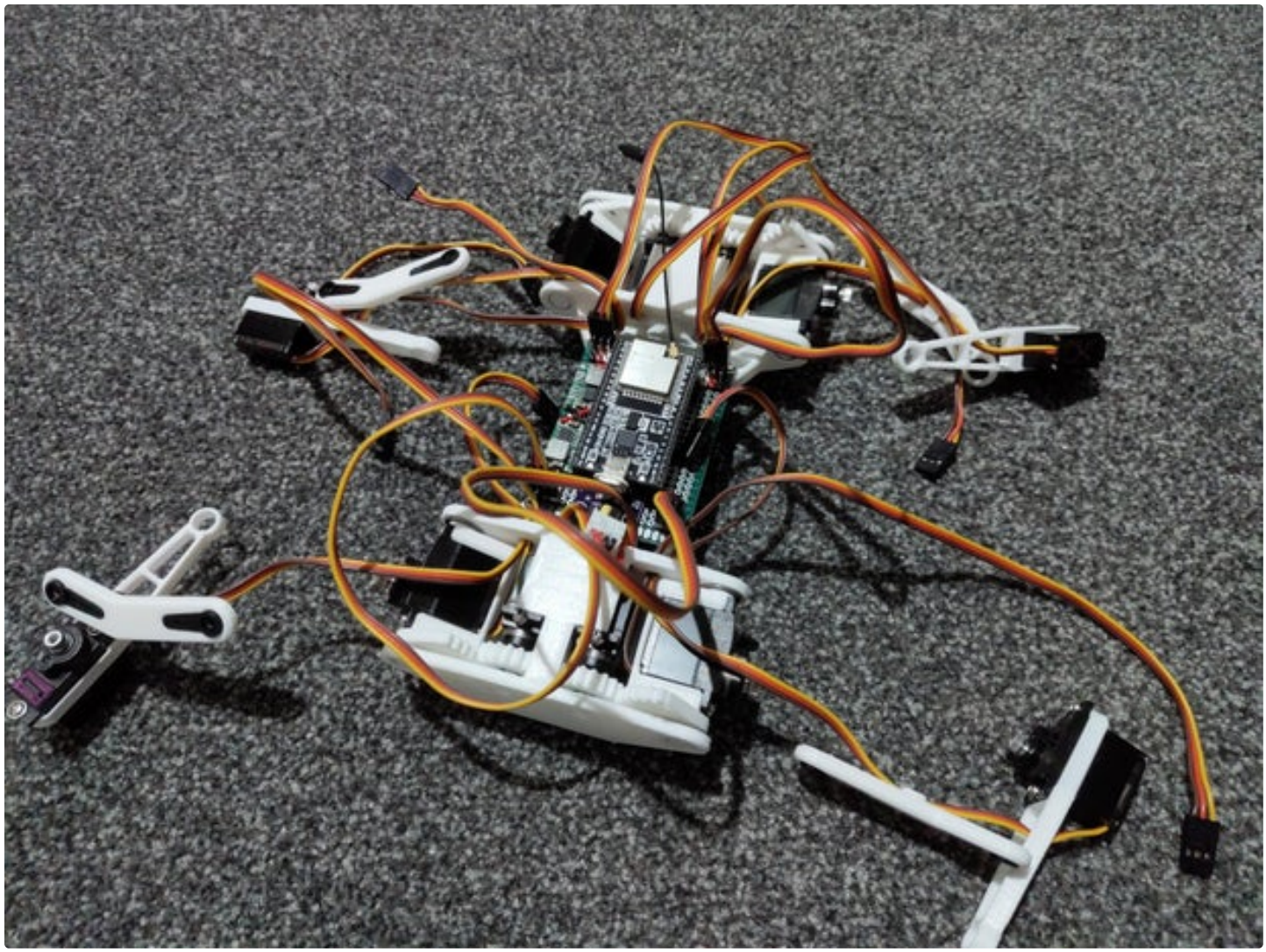
Repeat with other servos and parts.

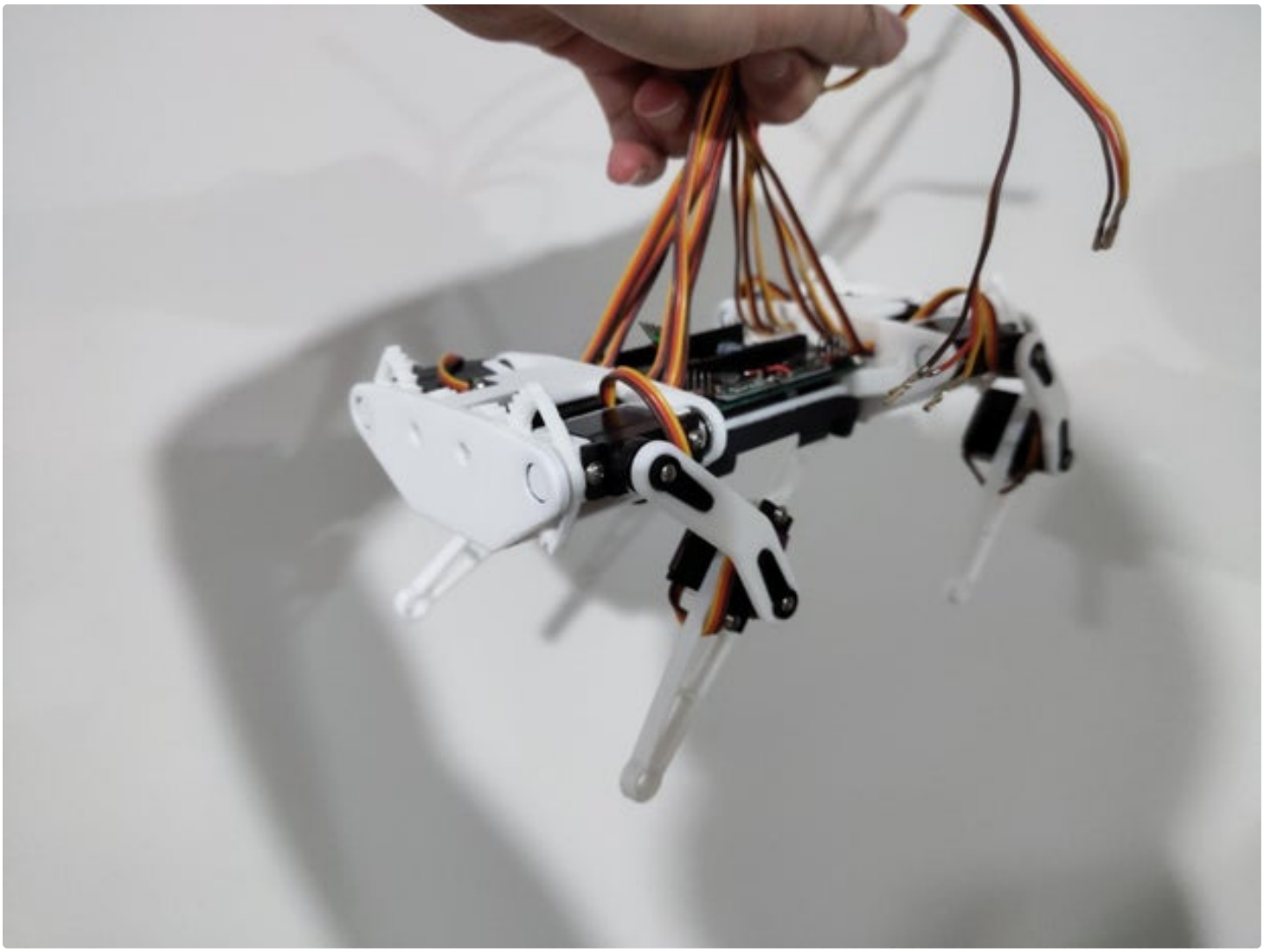
You don't need to fix legs with bolts at that moment, later you will need to calibrate legs following instruction in my GitHub repository: https://github.com/SovGVD/esp32-robot-dog-code

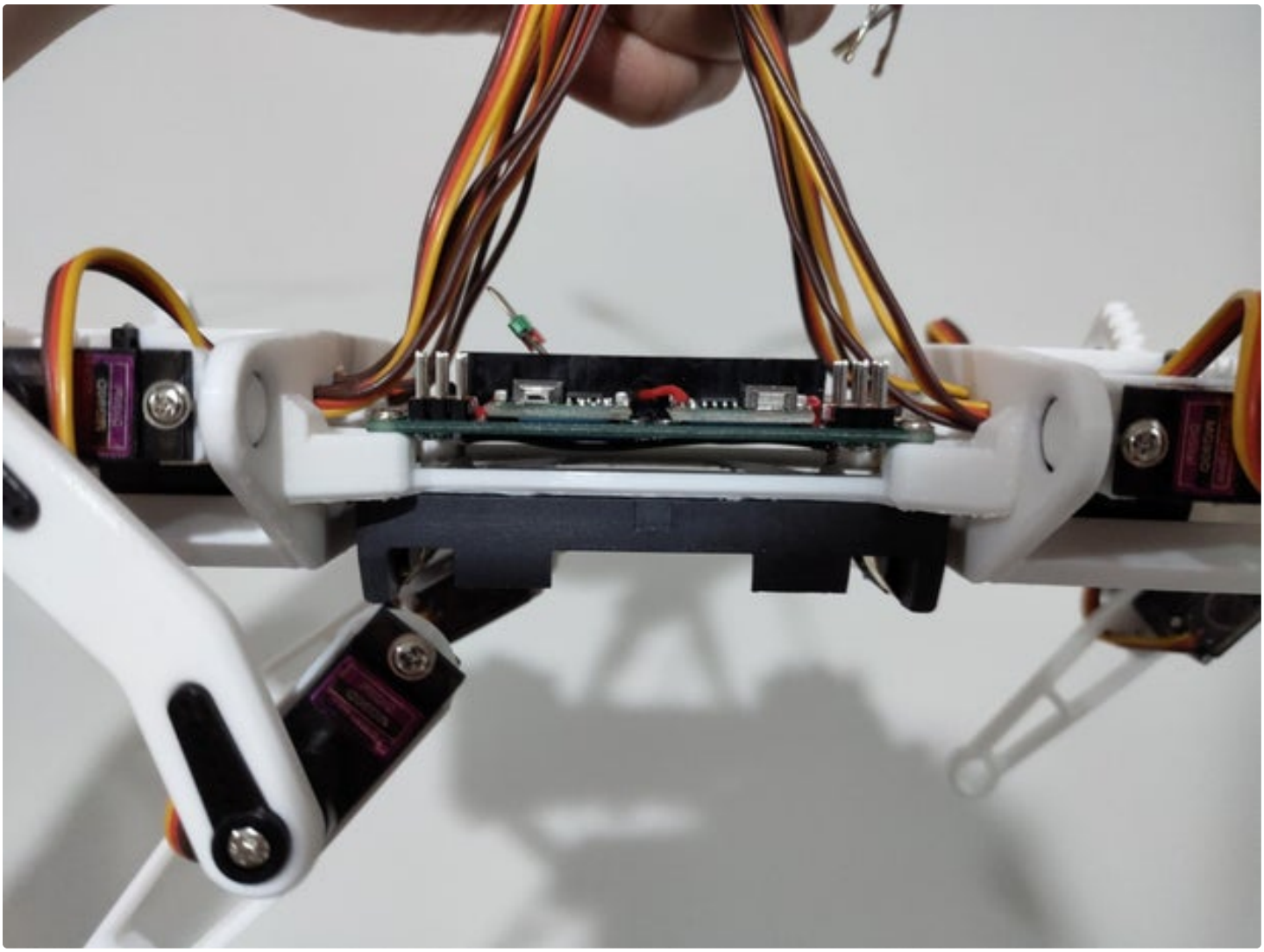












Step 5: PCB

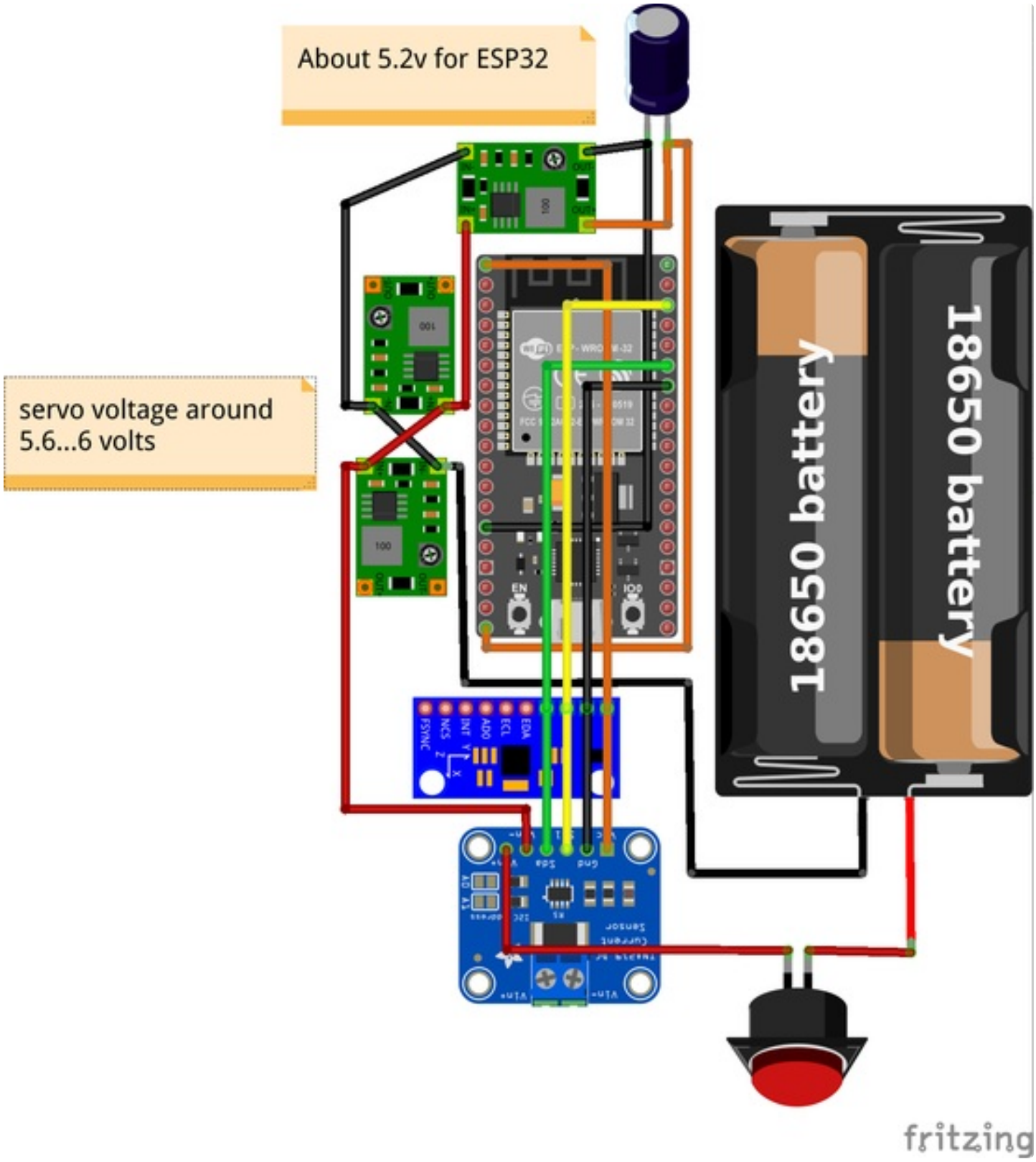
PCB configuration is up to you. I can only show what I did.

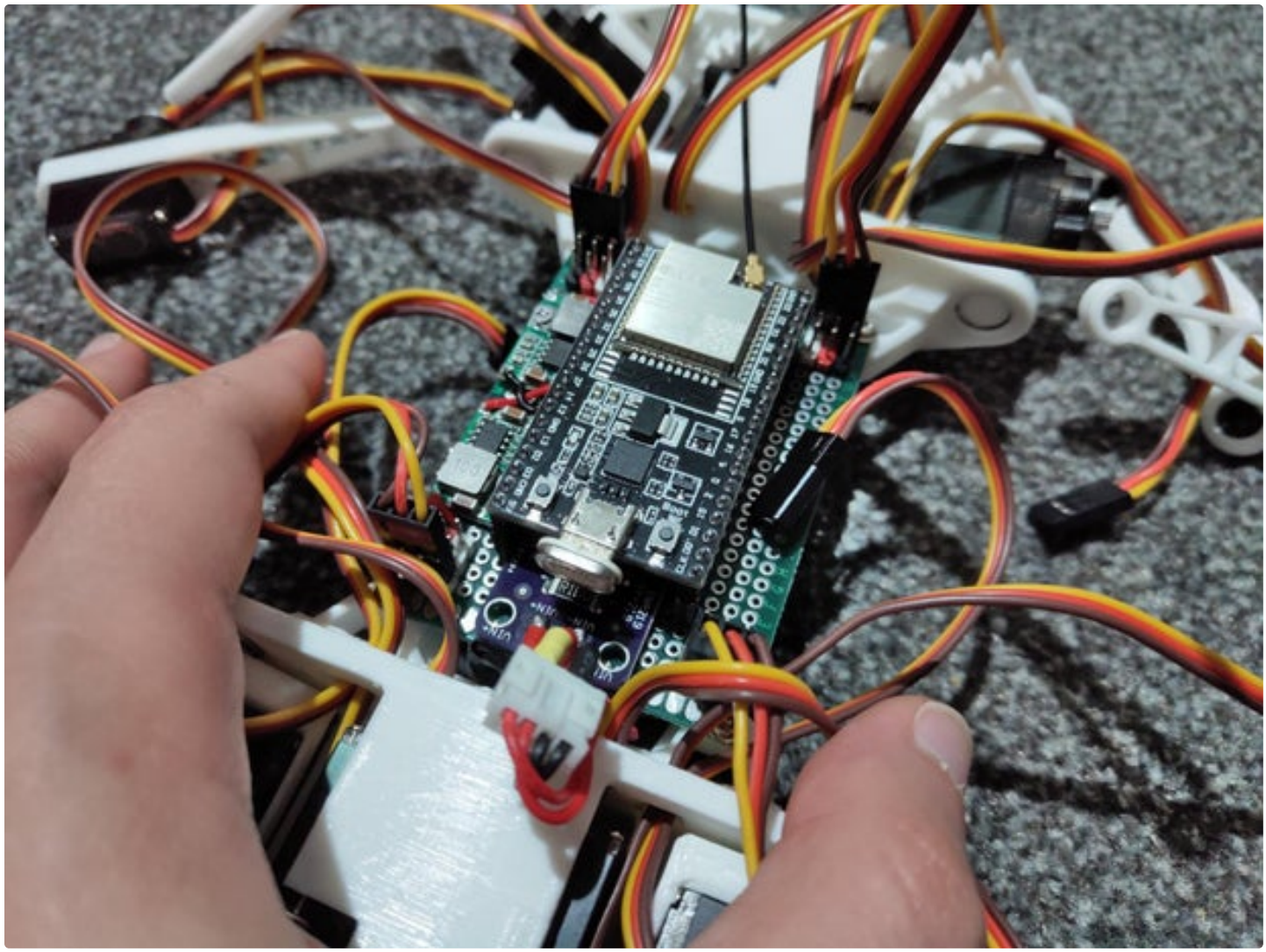
Sensors connected to default I2C bus of ESP32 (GPIO 21 and 22).

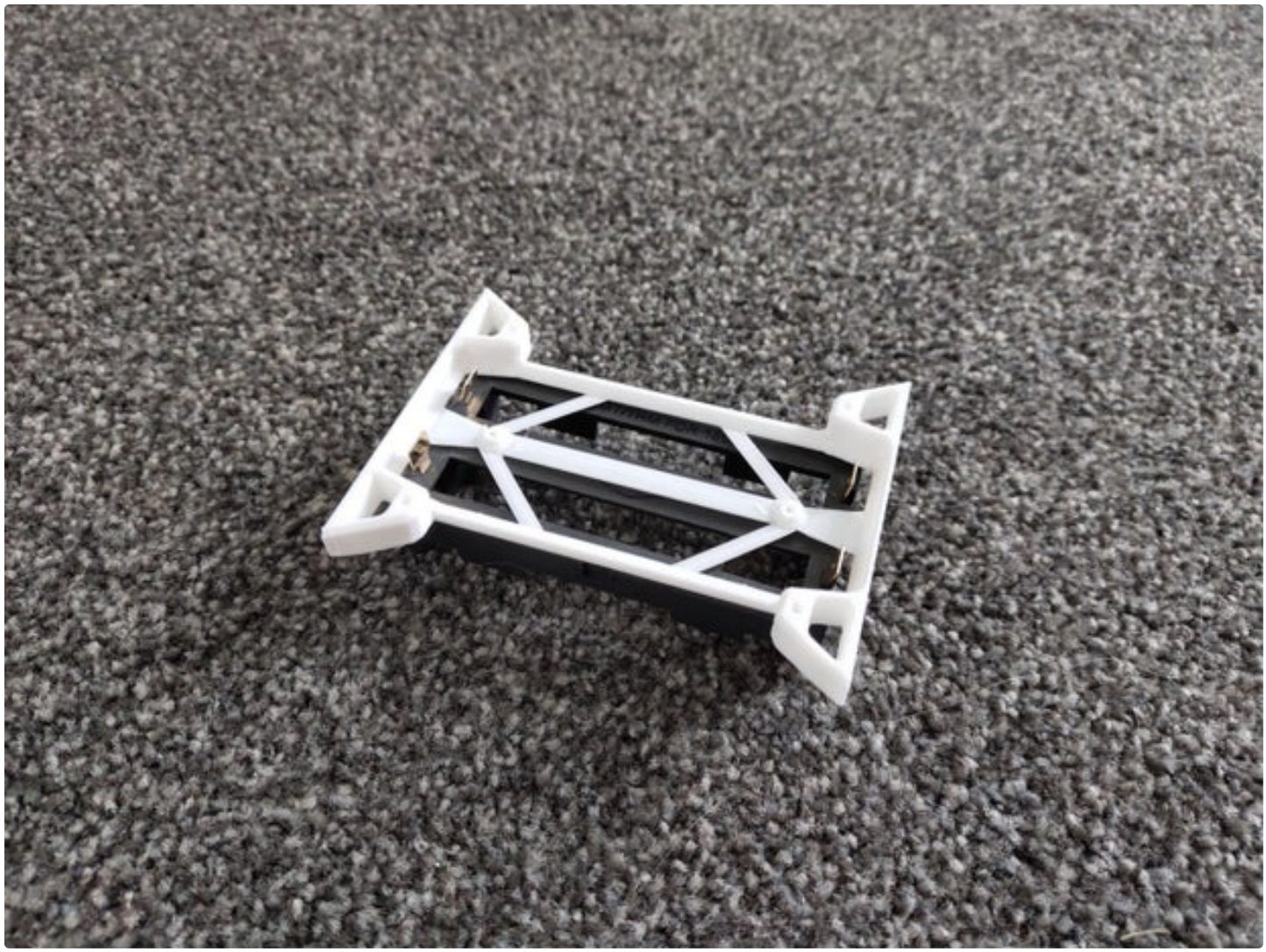
Servos connected to:

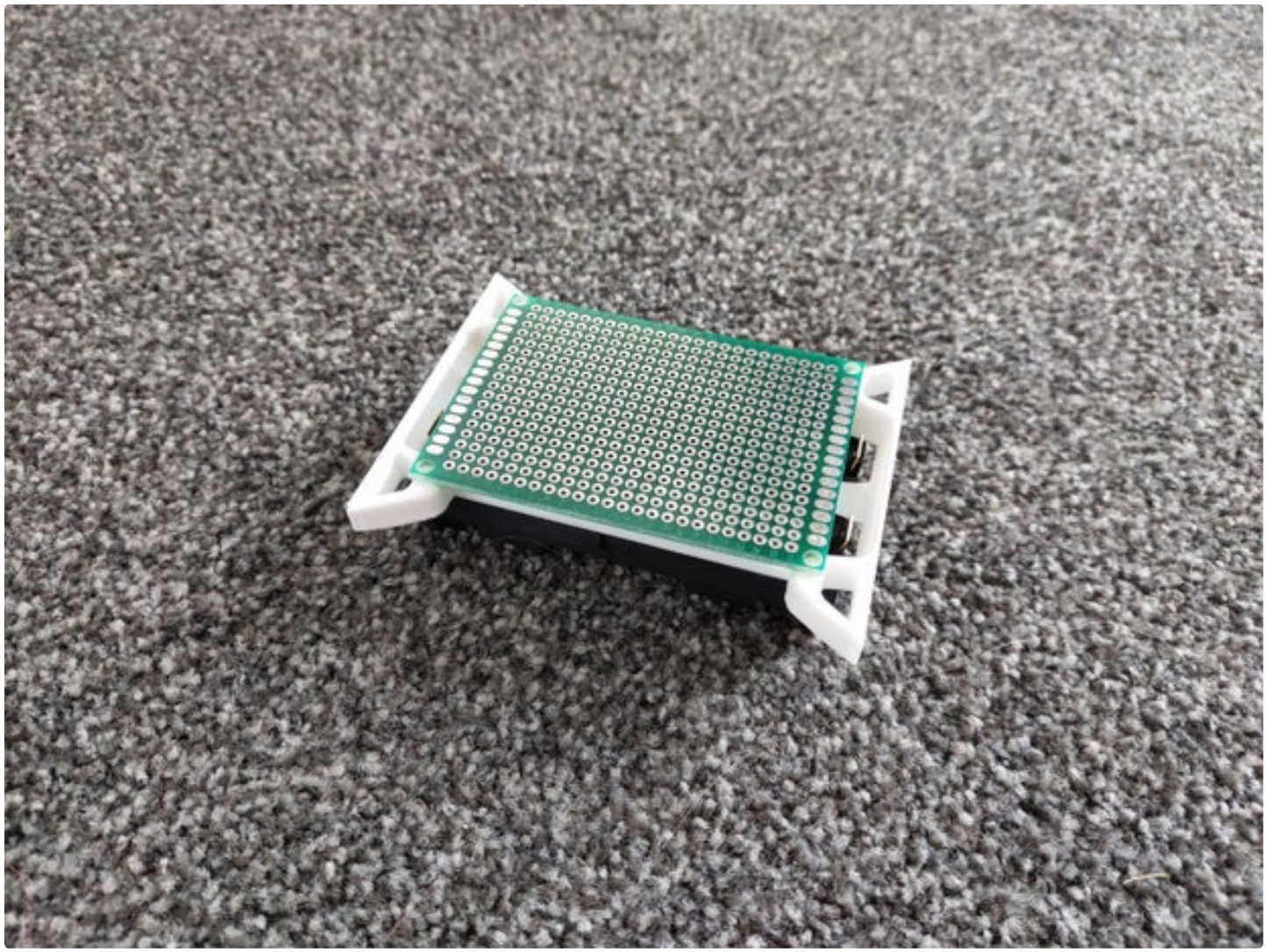
- Left front: 25 (body servo, servo gear, alpha), 26 (body to leg servo, shoulder, beta), 27 (leg servo,gamma)
- Right front: 16, 18, 17
- Left hind (back): 13, 12, 14
- Right hind (back): 4, 2, 15

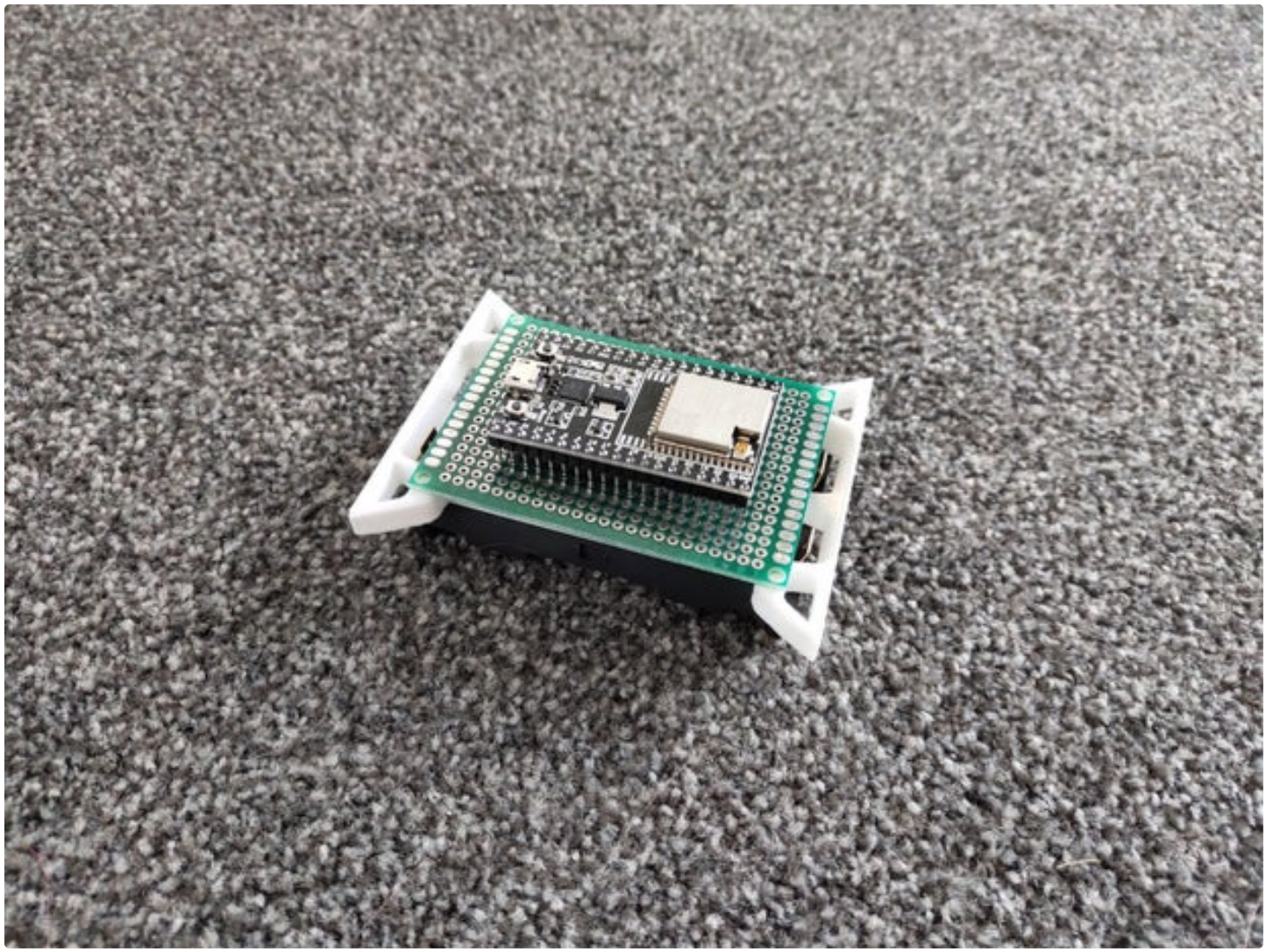
You can reconfigure it in the code, but make sure that ESP32 ISR Servo library support it.

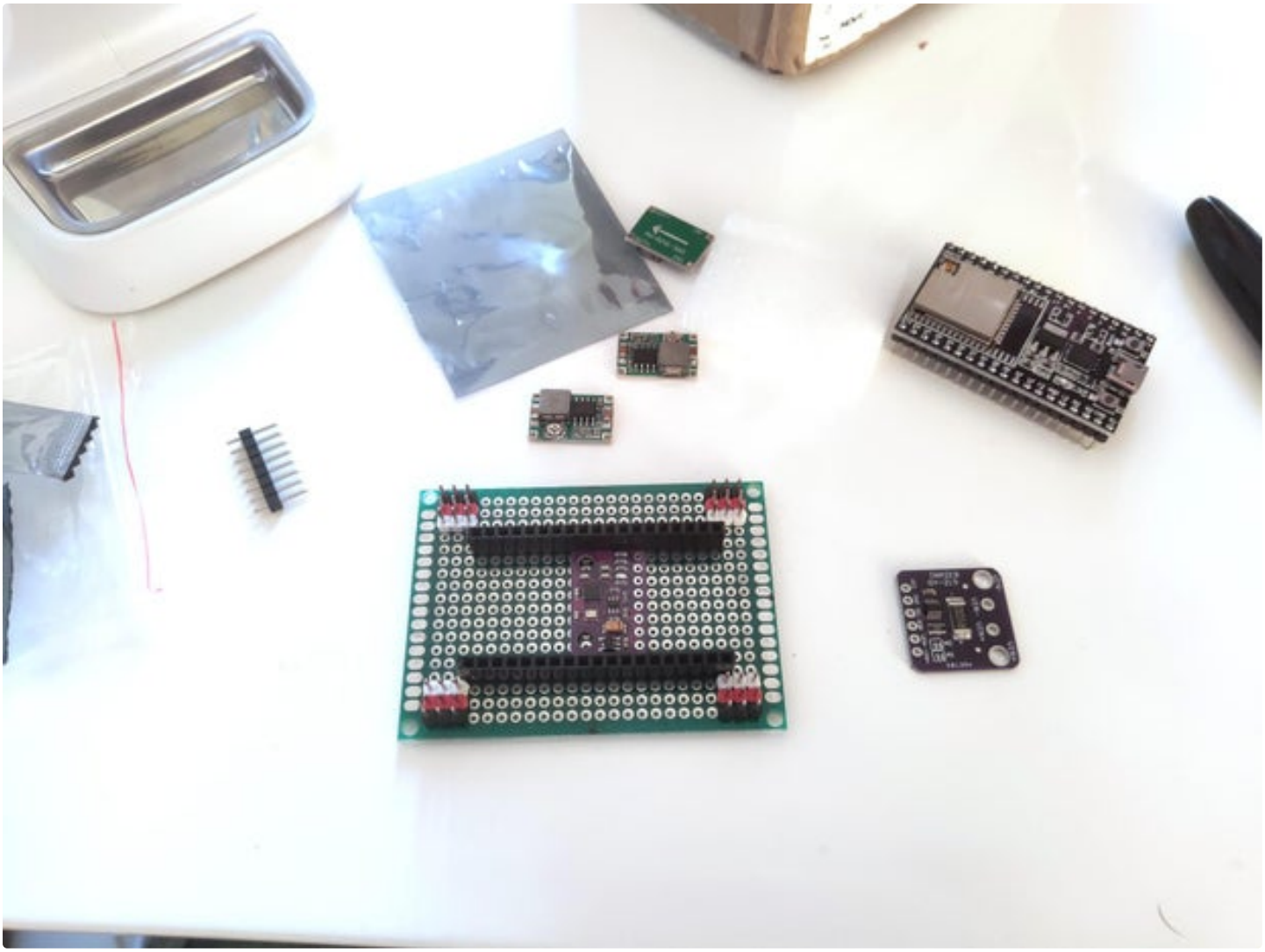

About 5.2v for ESP32
servo voltage around
5.6...6 volts
18650 battery
18650 battery
fritzing

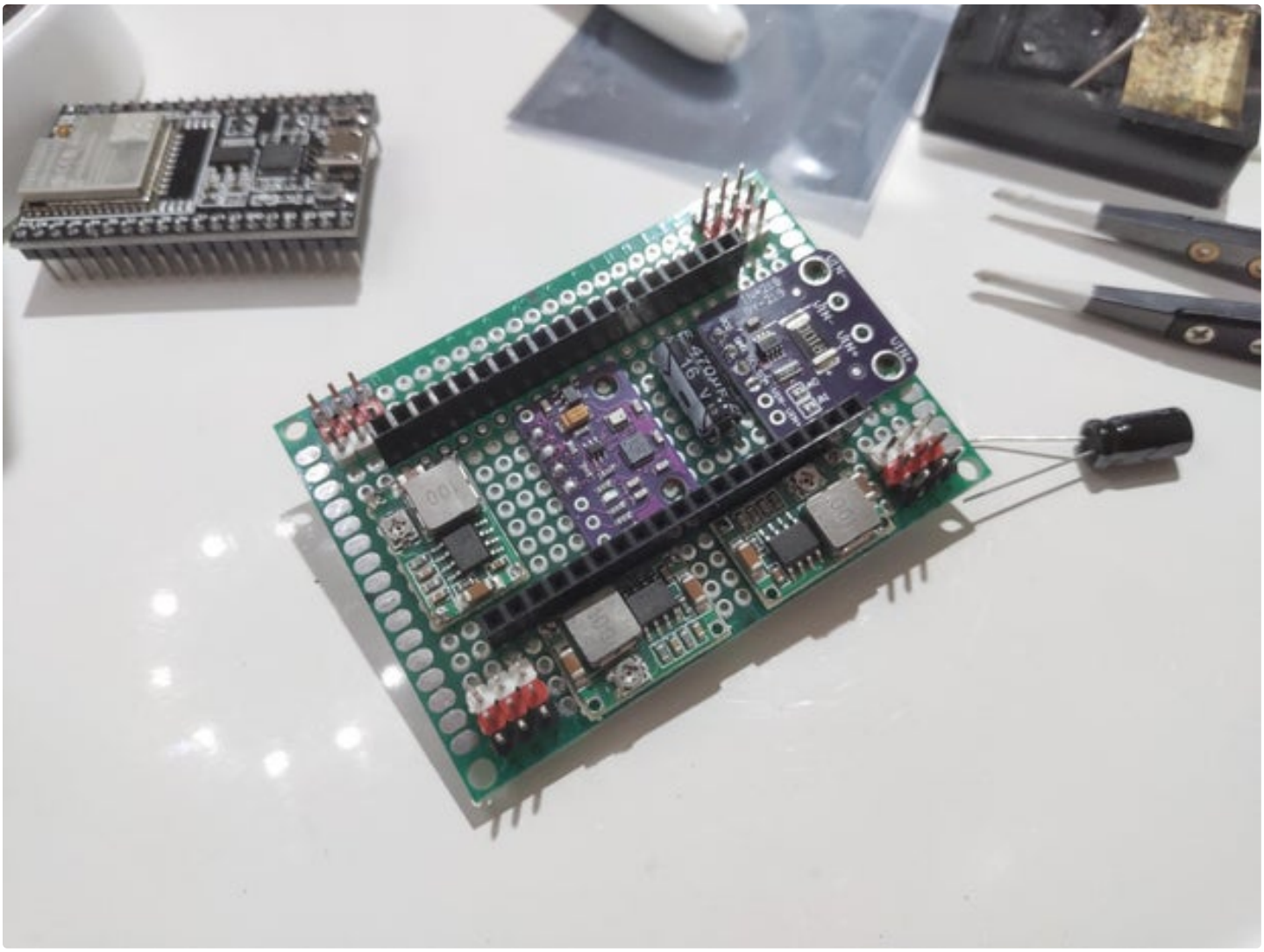


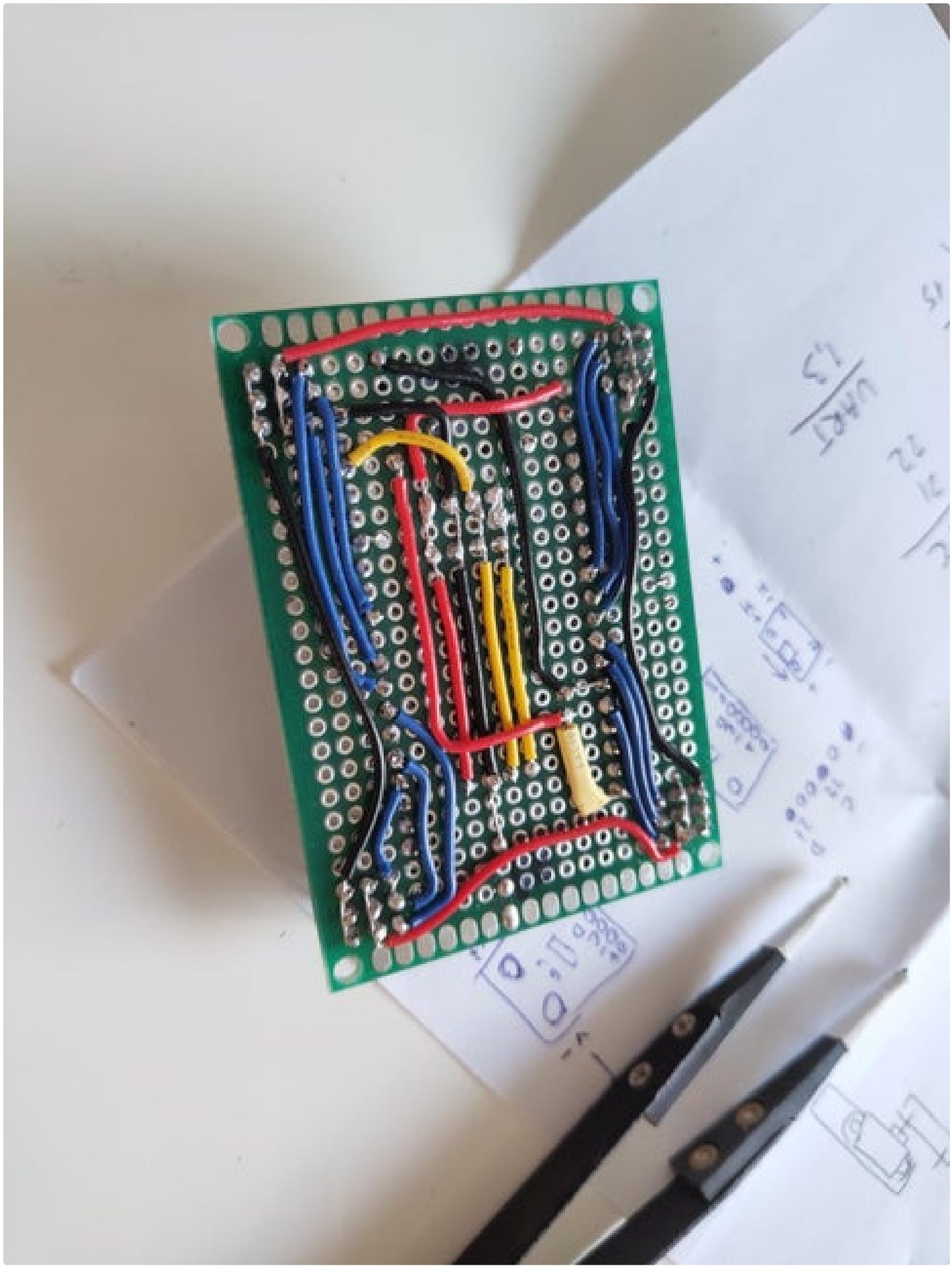












Step 6: Code

Setup Arduino IDE to work with ESP32 but don't use esp32 version 2 and higher. There were some strange changes related to WiFi, so one of the core just freezing in v2.x.x

Install addition libraries (most of them could be installed in Arduino IDE "Sketch" menu -> "Include Library" -> "Manage Libraries...", **please use only specified version**):

- ESP Async Web Server with Async TCP
- ESP32 ISR Servo version 1.1.0
- MPU9250_WE version 1.1.3
- INA219_WE

Setup WiFi Access point credentials.

1. Rename config_wifi.example.h to config_wifi.h
2. Change APssid to any name of your robot, e.g. SmallRobotDog
3. Change APpass to password (8 or more chars), e.g. MySup3rPassw0rd
4. After code upload to ESP32 you should be able to find SmallRobotDog WiFi with your phone or tablet.

Open browser and input URL http://192.168.4.1/ and you will see two virtual joystick to control robot dog.

Step 7: Good Luck!

Hope you like that project. More code and instruction updates on the go and hopefully will be release soon.

https://www.youtube.com/watch?v=aZ13q9g28yg

https://www.youtube.com/watch?v=cCIKNy16uMQ

Thank you for all the effort you put into this. I built it but I did have problems soldering up the board, as others did apparently, so I decided to create a pcb instead. If you reboot this project and would like me to upload my gerber files let me know.

I would definitely appreciate some PCB files being posted- I tried soldering one up but my parts aren't exactly the same as his so the arrangement is different, so my pcb is a mess of wires and is extremely difficult to troubleshoot. Thanks in advance!

I also had a heck of time wiring up the circuit. I thought it was me but apparently others have also found it quite challenging. After two failed attempts at laying out and soldering up the board I decided to try creating a pcb using Fritzing. I did it and sent it out to Aisler to be printed. The board looks good but I haven't tried to use it so I can't say if it actually works or not. Unfortunately it seems I'm not allowed to updoad zip files or the gerber file types so I've uploaded my Fritzing circuit file and a pdf of it. Good luck!

Thanks! I ended up designing my own PCB based on the schematic since I wanted to use the IMU, but I appreciate the help. Fritzing's autoroute feature really is a lifesaver.

Perfect!

I try to compile the code you give but at the end is Hal_PWM is error the arduine IDE wont finish its compile before insert code to Esp32. Any idea how to solve it?

Hi. I just tried this code with newest version of all libraries and found that everything broken =(
I've update instruction with versions that at least should compile without errors:
- ESP32 ISR Servo version 1.1.0
- MPU9250_WE version 1.1.3
Version of the library could be chosen in Arduino IDE Library manager in dropdown menu near Install button.
I will try to update code and test it with latest version of library some times later (with the new walking robot). Sorry, just have no time at the moment for that project and did not see anyone going to help with it.

That Library is Good to go. If you want help from me i can help you but I dont know how to start with, im newbie. Now I'm going to build the circuit board. In time I try to connect with My Computer browser it does show up 2 button to control the robot but when I try to using My phone its show the button but can't shake it. I don't know why?

Try another browser. I'm using Android phone with Google Chrome.

goggle browser is now work, the button can move but after Wifi connect to robot when i try to move the button nothing happen. what should i do next?

Did you assemble robot, connect all servos and provide power to it?

Yes I already assemble it.
and power it. All servo had rotation.

I think its lack in my Component, i don't use MPU and INA219 I only power it straight to Esp and servo. Maybe that the reason why it can't move. (The article above is Optional)

MPU and INA should not be the problem. Sorry but I can't test my setup without that sensors. As also can't check code at the moment. Maybe this weekend I will find time for it.

Dear Mr. Gleb
Sorry to bore you, i think I will use Ina and Mpu next. but I already Solve it, it seem my Esp32 Core is corrupted so I Re-Install the library, its work like charm. But when I turn on the Robot all Servo move like crazy, its seems the Servo Pin is not correct, like Pin 16 in Esp32 I cant find the Pin.
I would know all Pin did you use for Servo?

Dear Mr. Gleb
I already figure out about ServoPin, now the robot can move correctly but when I turn on the esp and servo with power, all servo move clockwise and temporary i build 2 switch, 1 for esp and 2 for servo. it seems when power up esp and servo together esp had low voltage and reset the positioning servo but after a few second servo go back to original position. how do you solve this problem?
I too put some capasitor but it does nothing, by the way I use 330uf,
what capacitor did you use?
well another problem to solve

Best Rigard

Hi. You are not the first who have that problem and I can't reproduce it to understand and fix. I'm using mg90d servos.

I will check the Mg90d servo although i use Mg90s,
i think the problem is on trimmer setting on first boot, it say :
0 leg trim (0,0,0)

1 leg trim (0,0,0)
2 leg trim
3 leg trim
but when we find place where to adjust, the problem will solve.
need time to learn,

Hi, great design, thanks! One question about the servos, you say MG90D or MG90S, will the MG90S fit properly? Someone on Instagram said it didn't fit.

its Fit for Mg90s Servo. I try it already.
if not in 3D setting or Printer type the tolerrance is big.

Hi i saw in photos that you connect something to vin+ and vin- but you didnt show in pcb layout

Hi, ina219 module have 2 pairs of vin+ and vin-. On scheme it is connected to pins near i2c data pins.

To ina 219

İf you cant find ESP Async Web Server in arduino libraries
you should download this libraries to arduino
https://github.com/me-no-dev/ESPAsyncTCP
https://github.com/me-no-dev/ESPAsyncWebServer
these two libraries literally solve my problems. Thanks to Gleb Devyatkin

Yes, that two, sorry for delay with reply. I add links to libraries.

hello sir

Hello

how did you connect the inner servos to the gears? i dont see that in your instructions. Please assist. Thank you

Updated. You need to cut one of the servo horns to make it fit inside printed gear. Use glue.

Thanks thats what I thought but just wanted to be certain.

Am I missing the PCB layout? Please post it too or a link on how to put all the electronics togeter.

In step 5 you can find scheme of connection for most of parts, as also list of pins for servos. It is not properly made PCB, just connections.

What is the spec for the capacitor and what is it for?

I think it's not required for that project. I used to use a couple of capacitors in another project, where start of DC motor take too much power for a very short period of time, so capacitor save controller from poweroff at the start.

well, its in your photos and on the drawing. therefore I was asking.

Looks cool. Can it already walk too?

It can walk.

This looks amazing! How much is the estimated cost of parts? Except the 3D printer of course.

Sorry, I did not count the final cost. And it will be very different depends on shops with electronic parts or delivery price. Everything (including fillament for 3D printer) bought on Aliexpress.

Well this looks totally amazing, well done. I hope you continue developing it. I'm amazed how good it is with standard small servos. Maybe next one will be bigger and use stepper motors now you've proved the concept.

Thank you. New features in progress. I made this small robot dog to easy test code and algorithms for the bigger version (also servo based): https://www.instagram.com/p/CDX-HhODbw4/

amazing!

Awesome!

Very nice work! :)