MyOrthotics 2.0 Workshop

MyOrthotics 2.0 is a new version of the Fab Academy final project (MyOrthotics), developed by Adriana Cabrera in 2016 for cases of semi paralysis.

This version is based on cutting and its purpose is to explore rapid construction for orthotics for first aid cases or temporary use.
The first version of this orthotic workshop was realized in the Fab Lab Kamp-Lintfort Hochschule Rhein Waal for the course of Biomechanics and Biomaterial and for the class of Prof. William Megill.

The changes of the microcontroller board were designed for the workshop *Hands on assistive devices (MyOrthotics 2.0) realized in the international Fab Lab Conference in Santiago de Chile.*

In the repository you can find the template of the splint for men and women to introduction of the topic.. For optimal fitting, 3D scanning the patient's arm and hand is recommended.

1. 3D Scanning
    a. Repairing Mesh Remake
    b. 360 Fusion
    c. Exact Flat
    d. Folding patterns
2. Cutting
    a. Illustrator, Rhinoceros, preparing the file
    b. Belt test measurements on your body
3. Electronic
    a. Introduction to soldering
    b. MyOrthotics SKu Board
    c. Arduino Nano
    d. Voltage regulator
    e. MyOWare Sensor

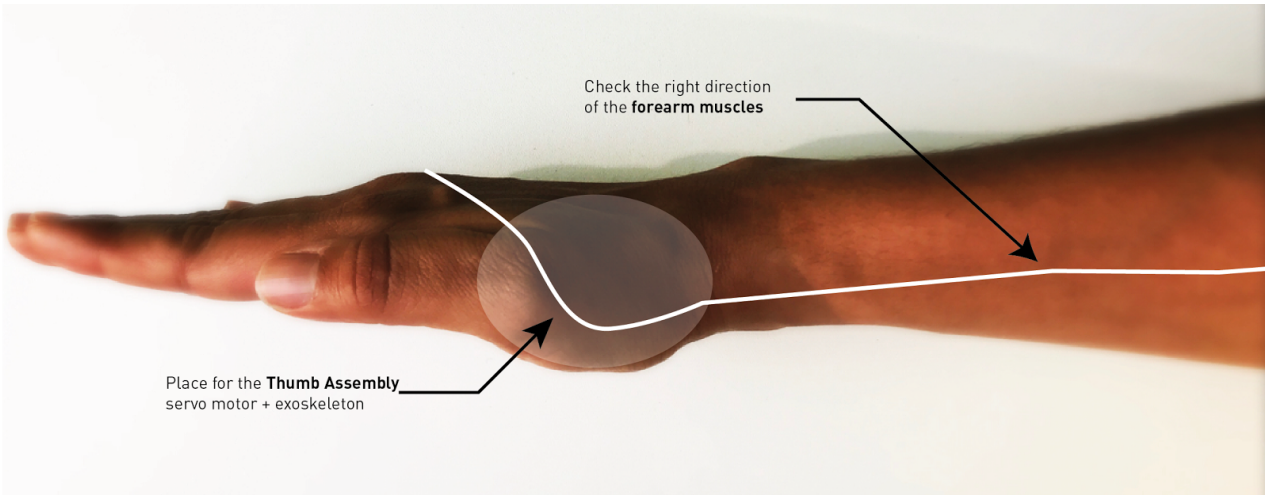
4. 3D printing on the surface

5. Assembly
    a. Motors
    b. Exoskeleton
    c. Phalanges
6. Wiring

3D Scanning

Please refer to the iSense scanner in the following website:
https://www.3dsystems.com/shop/support/isense/videos

Or look in the documentation of the repository:
http://archive.fabacademy.org/archives/2016/fablabkamplintfort/students/124/



IMPORTANT CONSIDERATIONS FOR MAKING THE SCANNER:

Position of the hand

- Remember to have the hand relaxed in order to have the muscles in the right position, try to stay still during the scanning time.
- The thumb has to stay parallel to the hand in order to use this part for the attachment of the thumb motor mechanism.

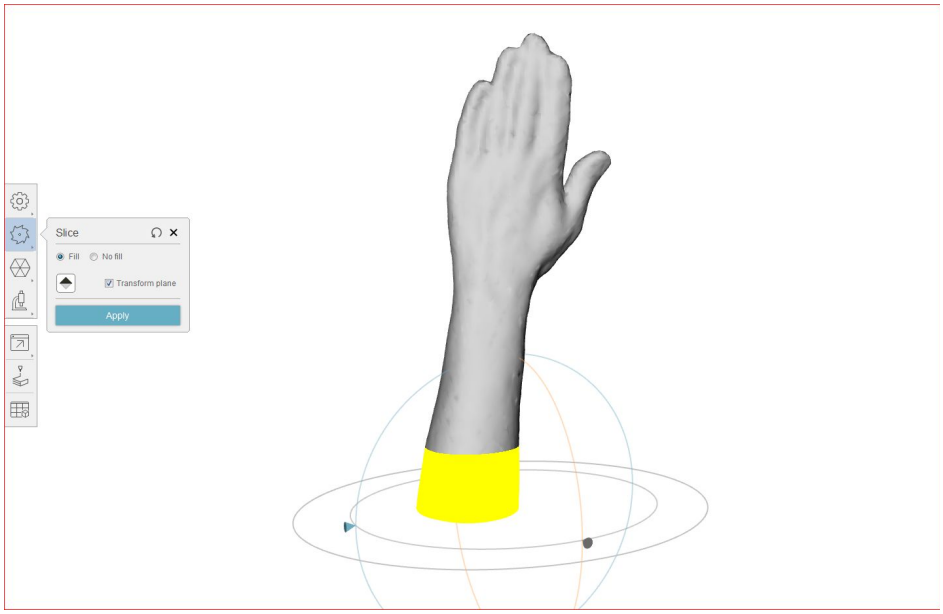
Edition of the mesh:

Scale of the hand

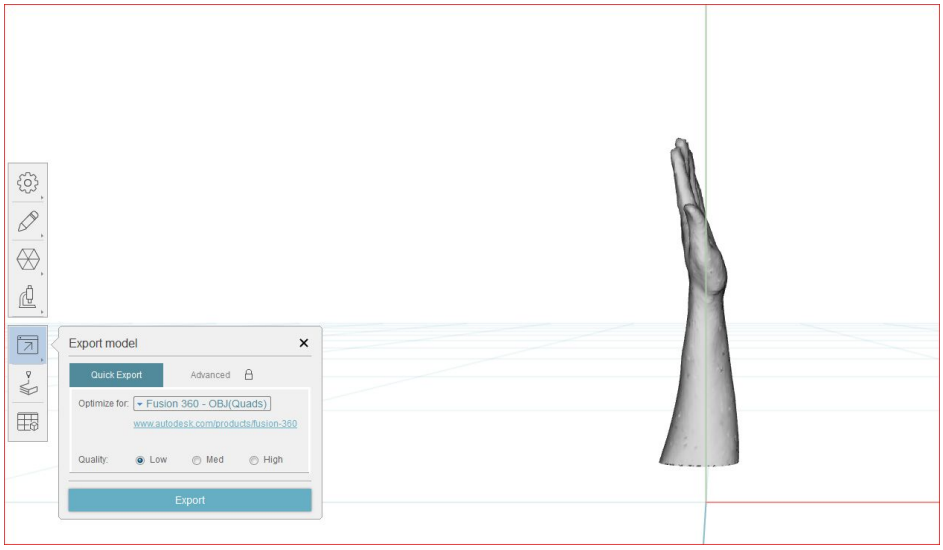
Depending on the 3D Scan you might notice that the measurements are not corresponding to the original model. In this case, edit it in the mesh editor in order to have a better workflow in the next steps.

In order to work in the next steps with 360 Fusion and to level the draft analysis in the curvatures of the hand we will use the program ReMake. This program enables the conversion from a triangular mesh to a OBJ Quads mesh.

-> Open the model
-> Scale the model if it has a wrong scale
-> Cut the parts that you don't need



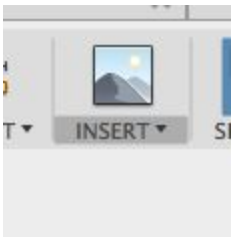
-> Smooth the model and close the holes

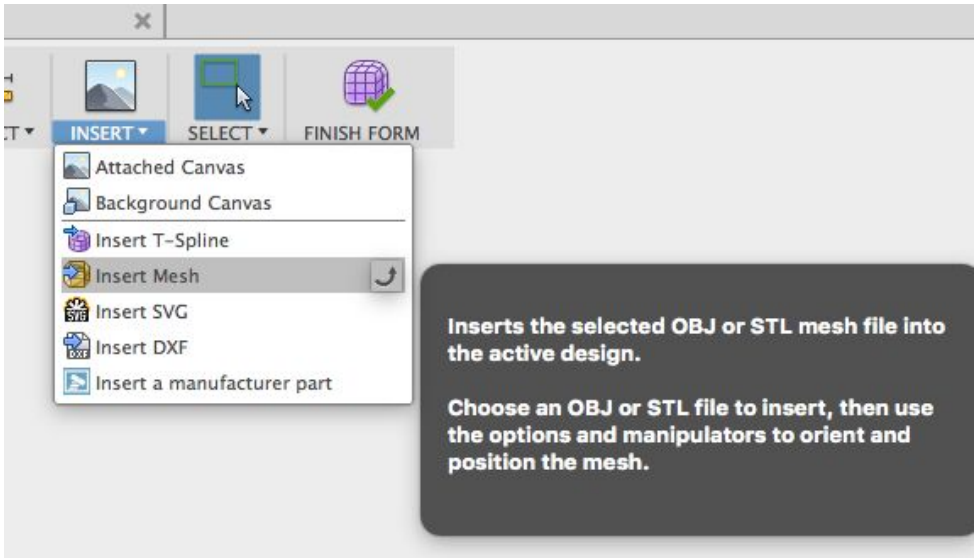


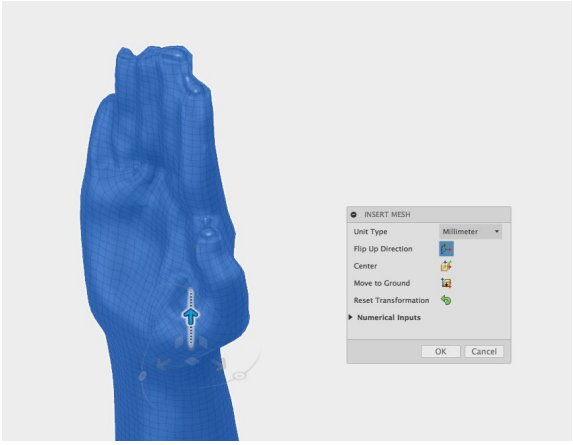
-> Make an analysis in order to close the whole surface
-> Export the model in OBJ Quads for 360 Fusion

Edition of the Model in 360 Fusion

Open a new file in 360 Fusion.
Go to the SCULPT environment in order to transform the mesh quads,
In this environment you can insert the mesh going to the top panel INSERT as the pictures show.



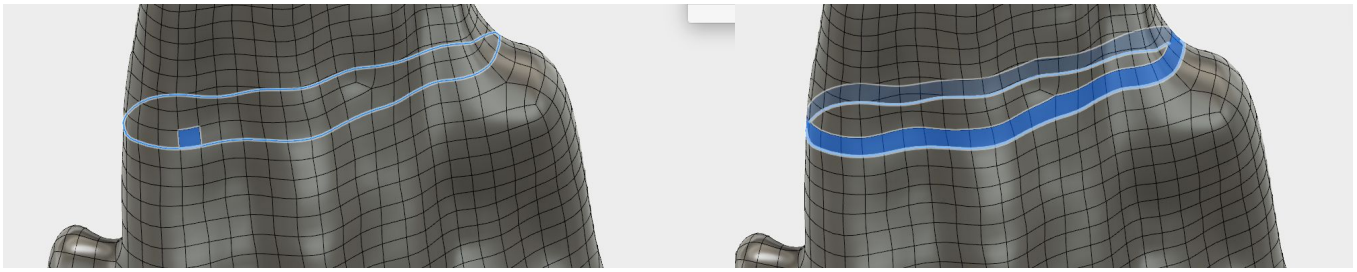


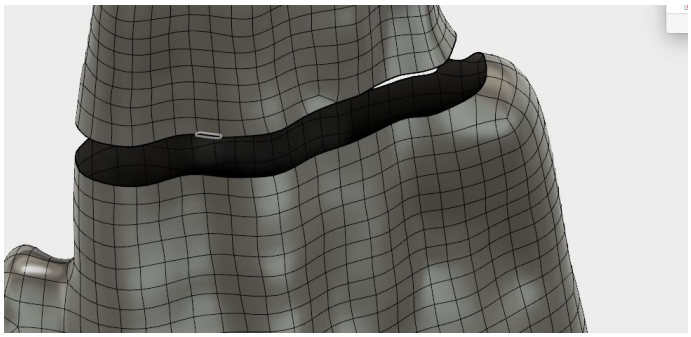


In *Utilities* you can convert the model

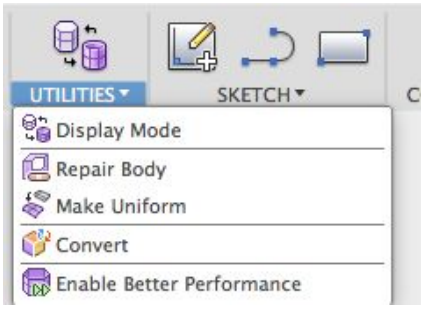
After this process you can proceed to transform this mesh to T-Splines. This process requires some patience!

Now you can edit the mesh in order to reduce the draft angles and make a homogeneous surface. This process will help to generate a smooth surface in the following forms:
-> Delete quads
-> Delete lines
-> Reconstruct areas





When the model is finished don't forget to do the analysis of the object by going to the UTILITIES
Repair Body > Select mesh > Close



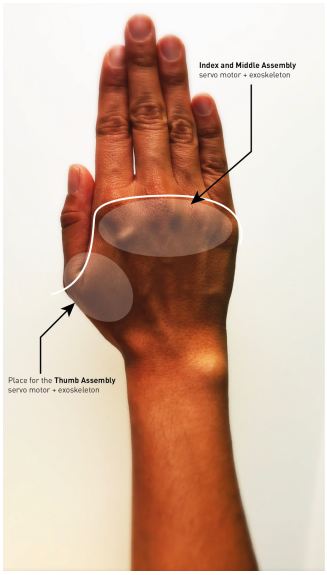
After repairing you can proceed to close the sculpt environment and continue to working in the Model Environment.

The model should look as smooth as possible and with less sub divisions the probabilities of an optimal surface will increase.
If you want to check the angles and curvatures in more detail go to ANALYSIS > draft analysis and zebra analysis, as illustrated in the following pictures.
.

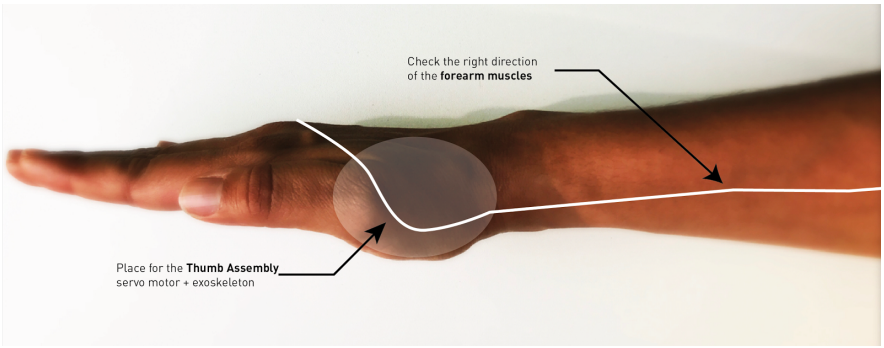
CUTTING TOOLS

We will define the form of the splint, first by drawing the lines that will be used to cut the T-splint body.

Go to the SKETCH > Spline and draw a line in the back of the hand as a first sketch. This will define the support of the Thumb Motor.



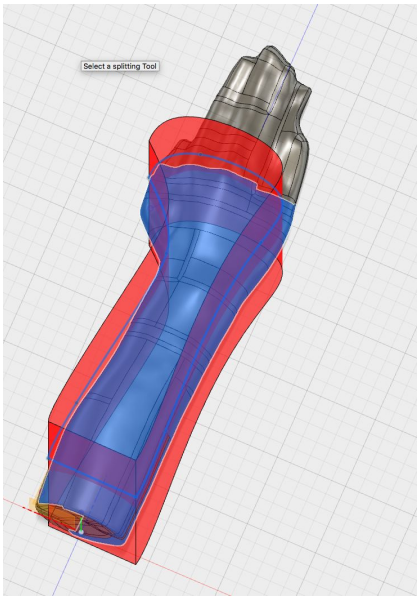
In the second sketch is the lateral line. Here we have to consider the point in which we will attach the belts for the adjustment of the splint.

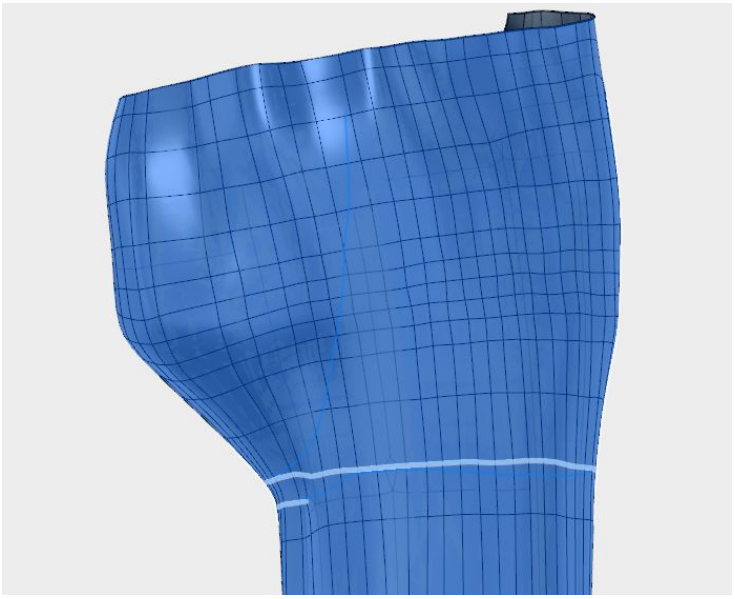


In the second step we will go to the environment PATCH : this environment enables easy workflow with surfaces. You can stitch and delete surfaces just by selecting and transforming them and the object will keep the parametric properties.

Goto the panel MODIFY > Split Body and proceed to cut the body using the spline that you draw previously, as splitting tool.
For more details please check in the description of the MyOrthotics Fab Academy Adriana Cabrera.
In PATCH environment you can do offset of your material in case you want to make a cover or integrate another layer in between the splint and the hand.

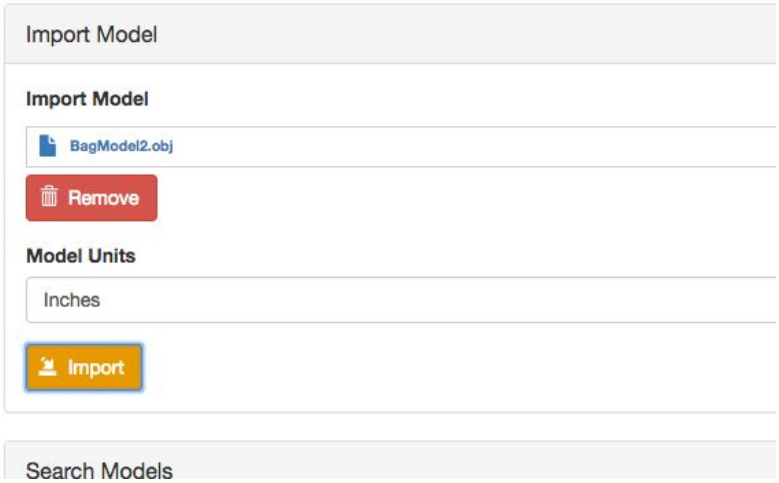
If you will work in the online version of Exact Flat, please Export ONLY the surface as a STL data,

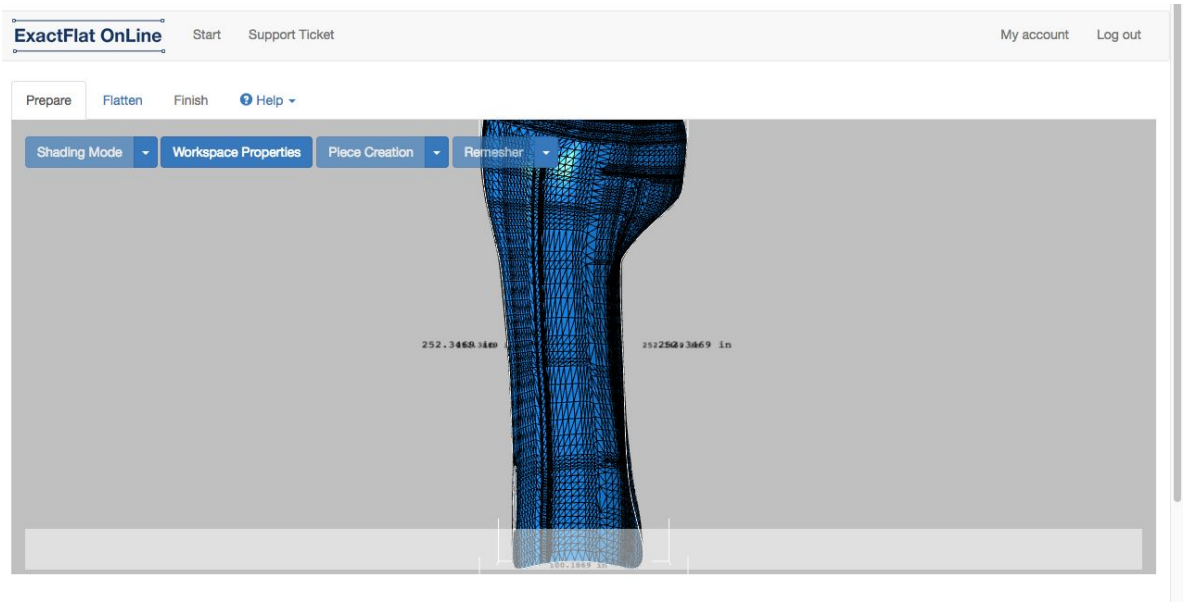




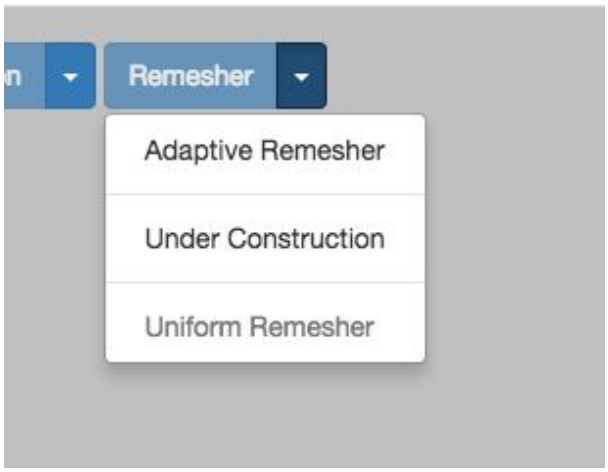
FLATTERING SPLINT -> EXACTFLAT

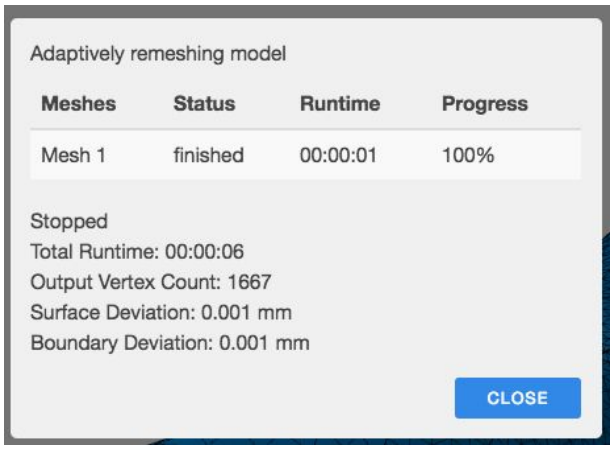
You can go directly from 360 Fusion to the ExactFlat environment installing the plugin, otherwise you can use the online version.
For the people that have an online version, upload the model and please pay attention to the Units.

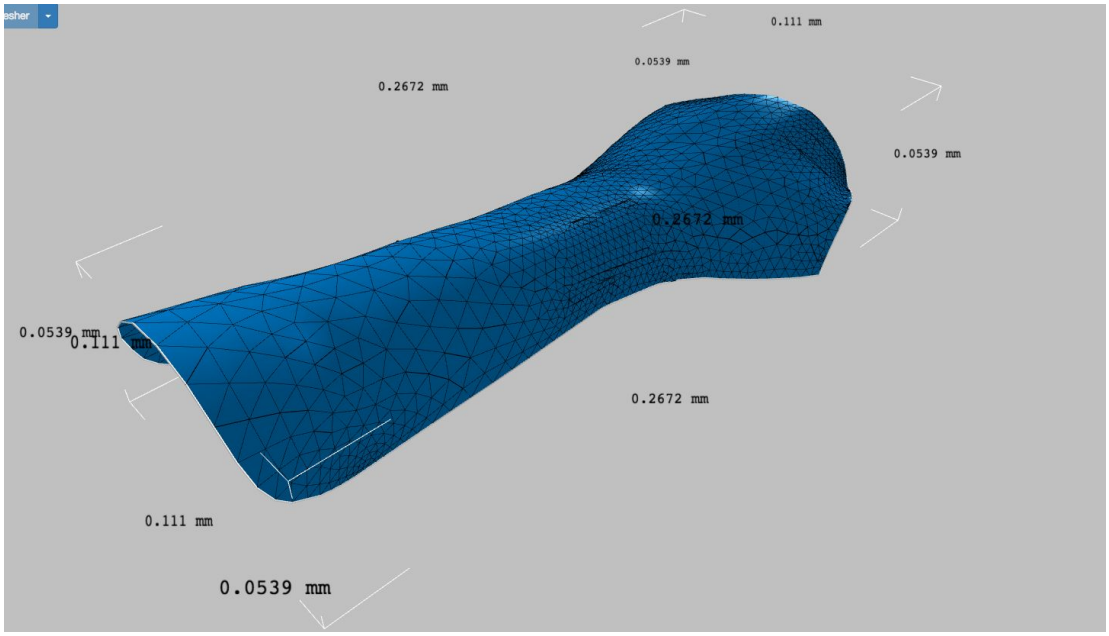




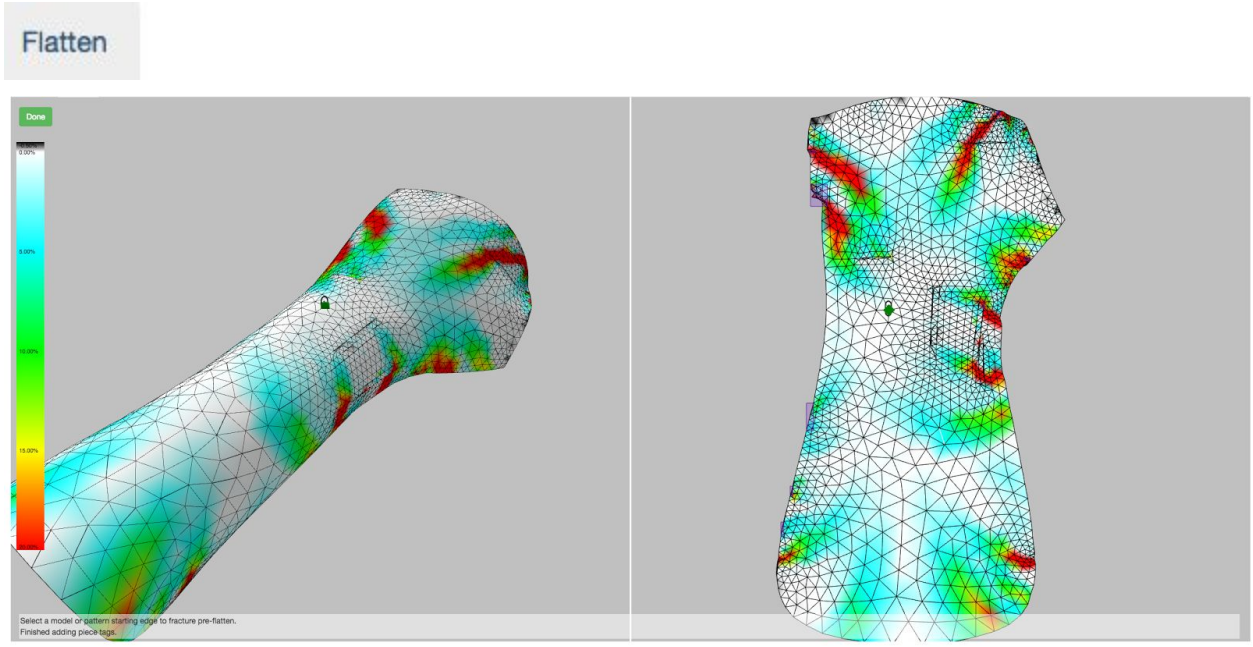
After uploading you can proceed to open the file and if necessary, reduce again the number of triangles using the tool Adaptive Remesher.







When the mesh is ready, you can proceed to flattening the surface by clicking on FLATTEN Don't forget to select the body.



Select a method in this case FRACTURE, which permits to extend the surface and make cutting if it is needed.
To finalize the process you can proceed to optimizing it by using the panel OPTIMIZE. In this option you can select the material that you will use, in my case I selected Vinyl.

You can go to finish and export your template in PDF or DXF.

2D EDITION

You can use the design file of the Belts which you can edit in Rhino or Illustrator, the file is included in the repository.
The folding pattern is the aggregation of patterns generated from a cone shape. The splint is made based on the art of folding, in which the material transforms to a memory shape through the semi cuts, which also provide the device the required stability.

Proceed to cut the material depending on your settings of the laser cutter.
Before beginning, test the material in order to test the semi cuts and have clean edges!!!

Settings for the Epilog Laser Cutter:

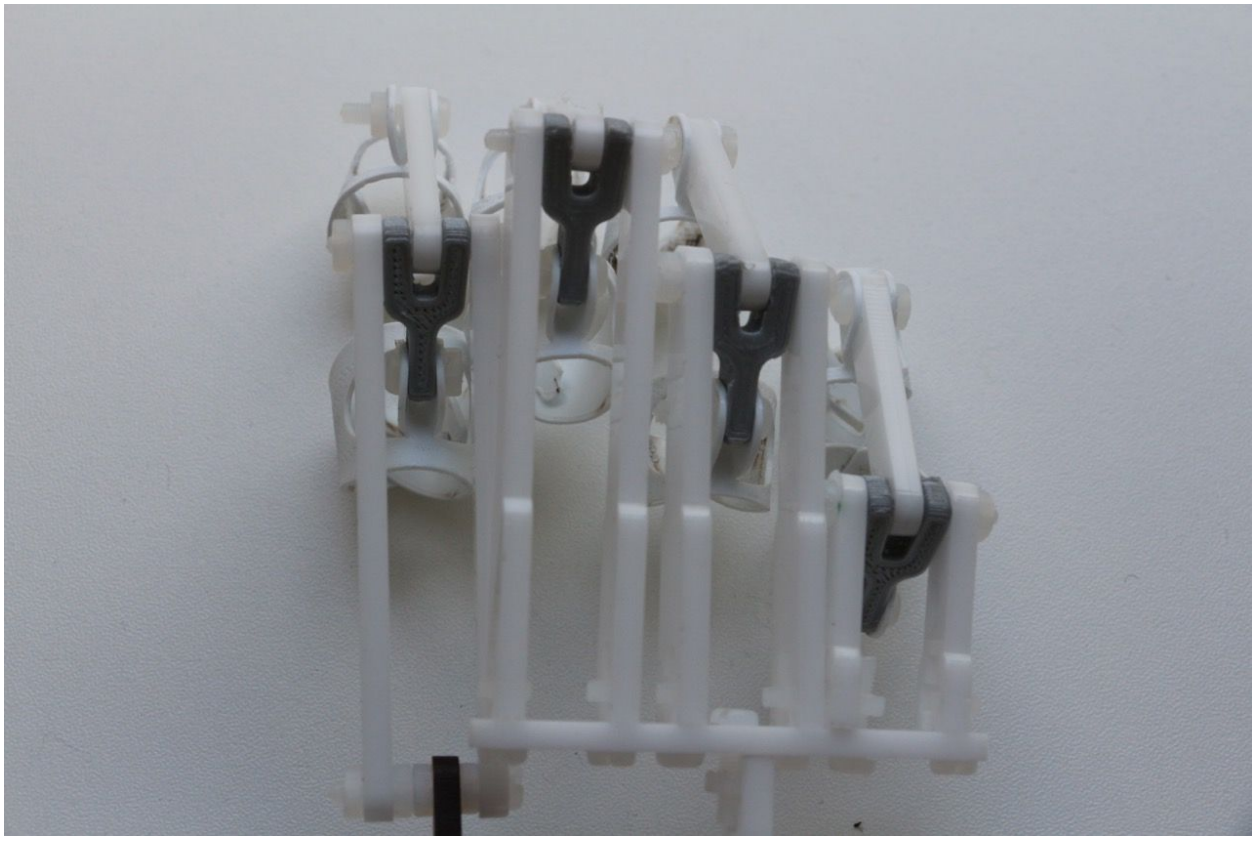
Cuts: Power:80 Speed: 20 Frequency:100
Semi-cuts: Power:20 Speed: 70 Frequency:100

Settings for the Trotec Laser Cutter:

Cuts: Power:80 Speed: 20 Frequency:100
Semi-cuts:

Exoskeleton and Adjustments of the Phalanges

For this step you can take measurements with the measuring tape, if the scanner is not precise, or verify the measurements from the 3D scanner model. When you are measuring the space between your fingers, remember to take in consideration the space needed in-between each finger and the thickness of the material. See picture below.



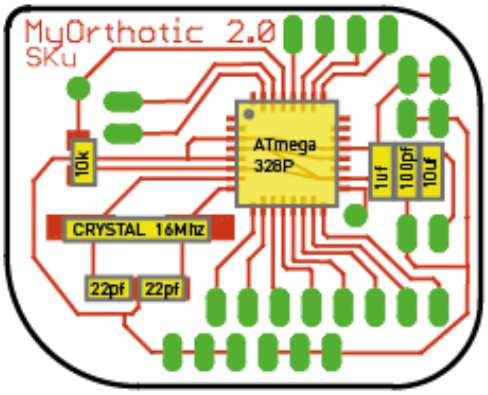
Electronics

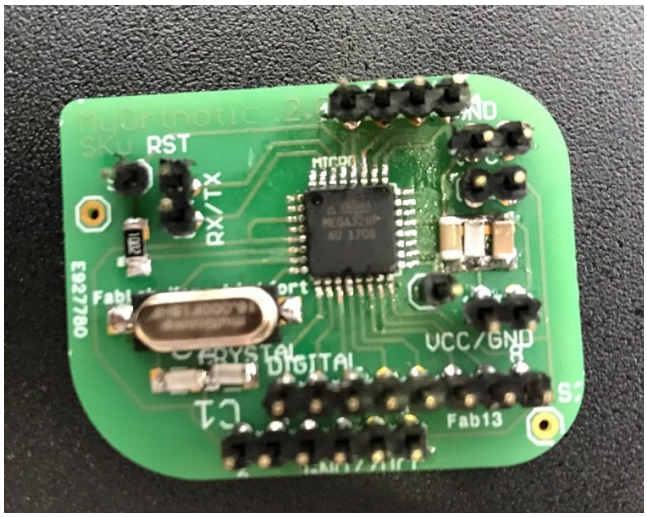
The electronic part is based on the project MyOrthotics on the Satshakit Micro[1] which is an open source hardware that you can fabricate by yourself, milling the board and soldering the components, or you can use an Arduino Nano. You can find the data of the MyOrthotics-Sku board in the repository

Soldering the board:

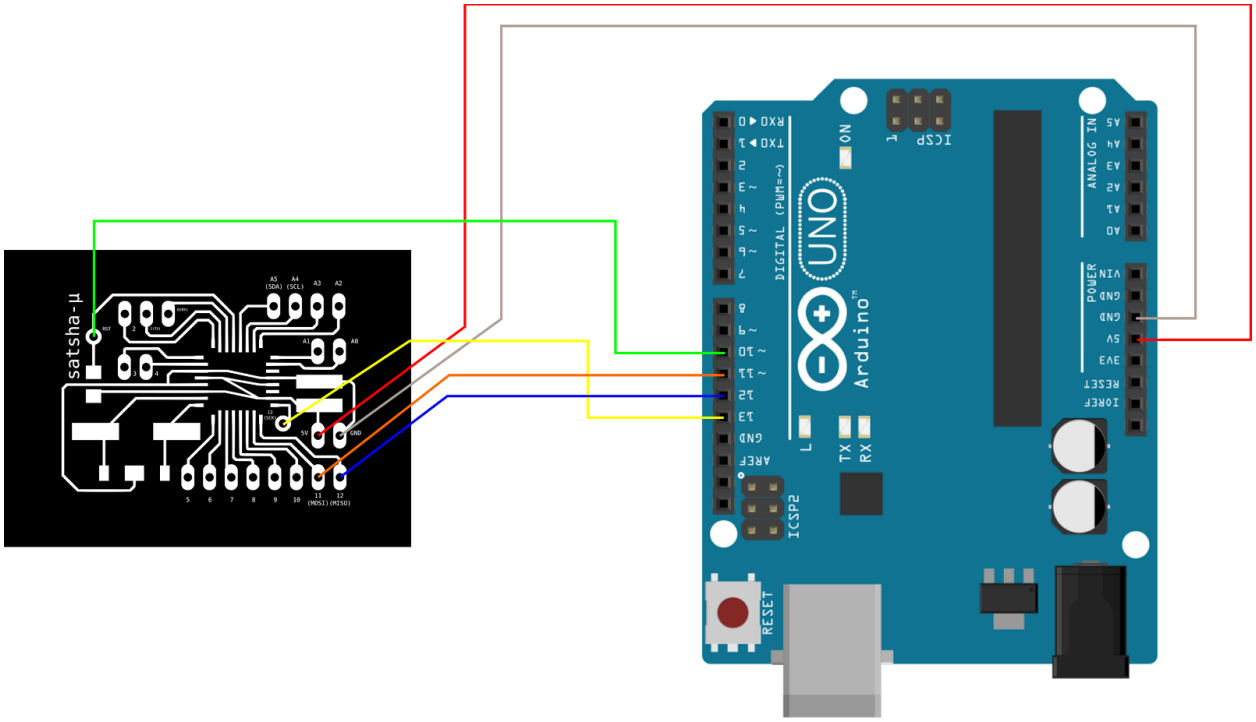
In the following graphic you can find the right position of the components and how you can solder them.

[1] from Daniele Ingrassia who designed the board.



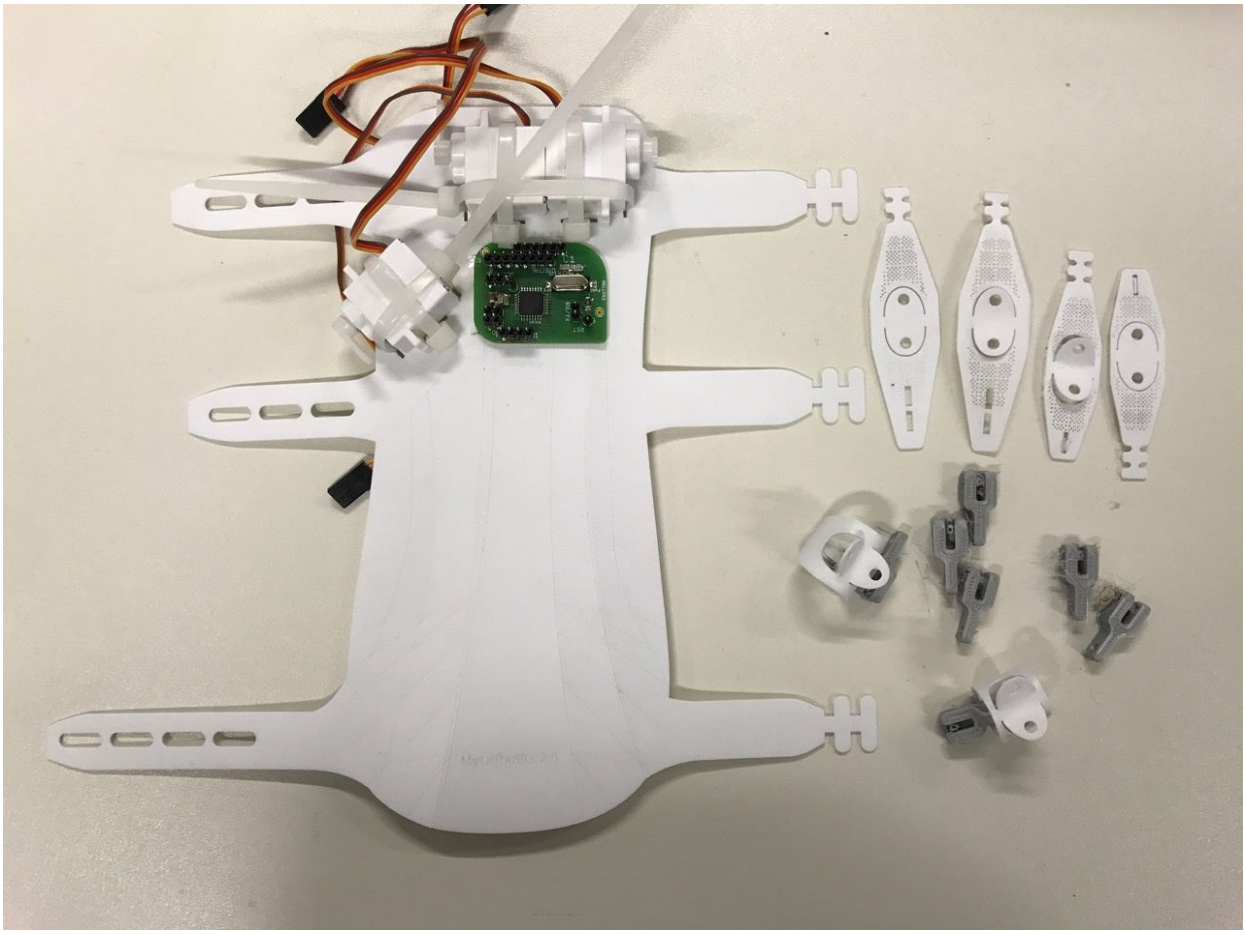


To program the Satshakit, from Daniele Ingrassia, you can find the list of components needed in the following link.: https://github.com/satshas/satshakit



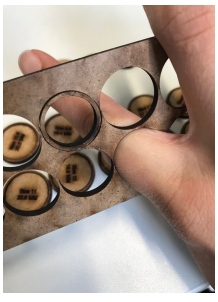
Wiring and Assembly

After programming the board you can proceed to attach the board and motors to the splint. Assembling the exoskeleton and adjusting the phalanges.

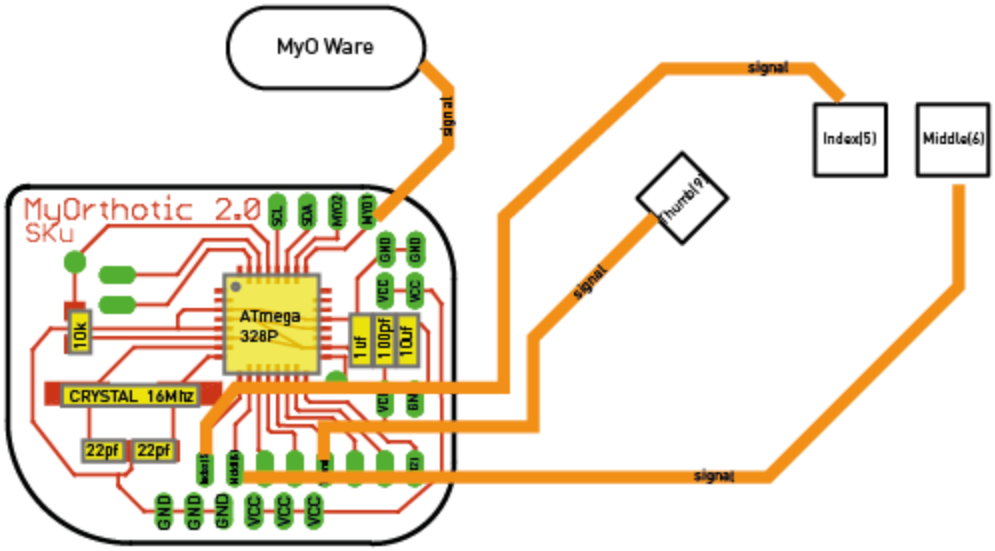


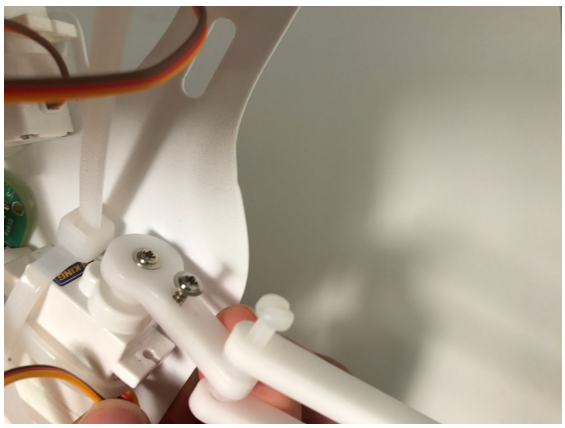
Phalanges:

In this version, the size of the fingers is predetermined, In order to have right dimension of the orthosis please check the template of the rings, that is included in the repository. In the photo you can see the adjustments of the fingers.

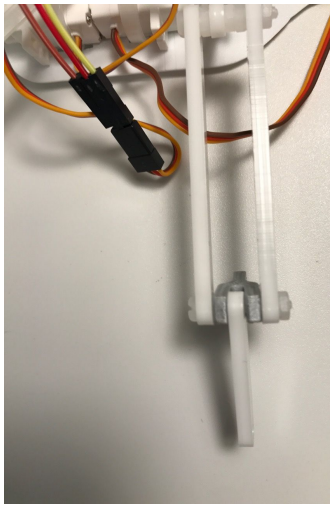


After assembling the phalanges you can proceed to connect the motors to the microcontroller board MyOrthotics SKu as the following picture shows.

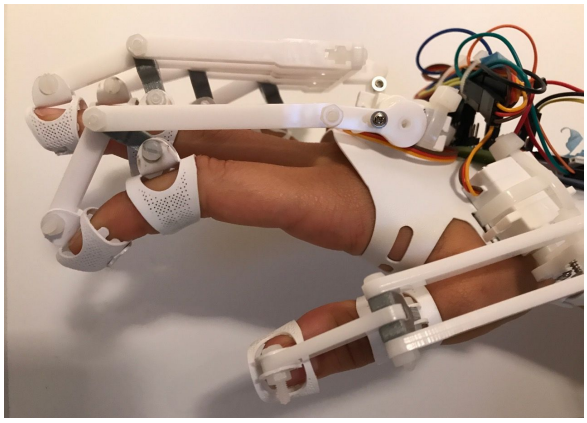


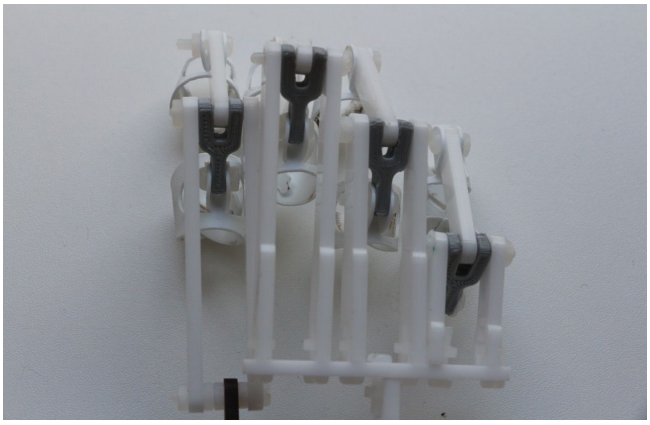


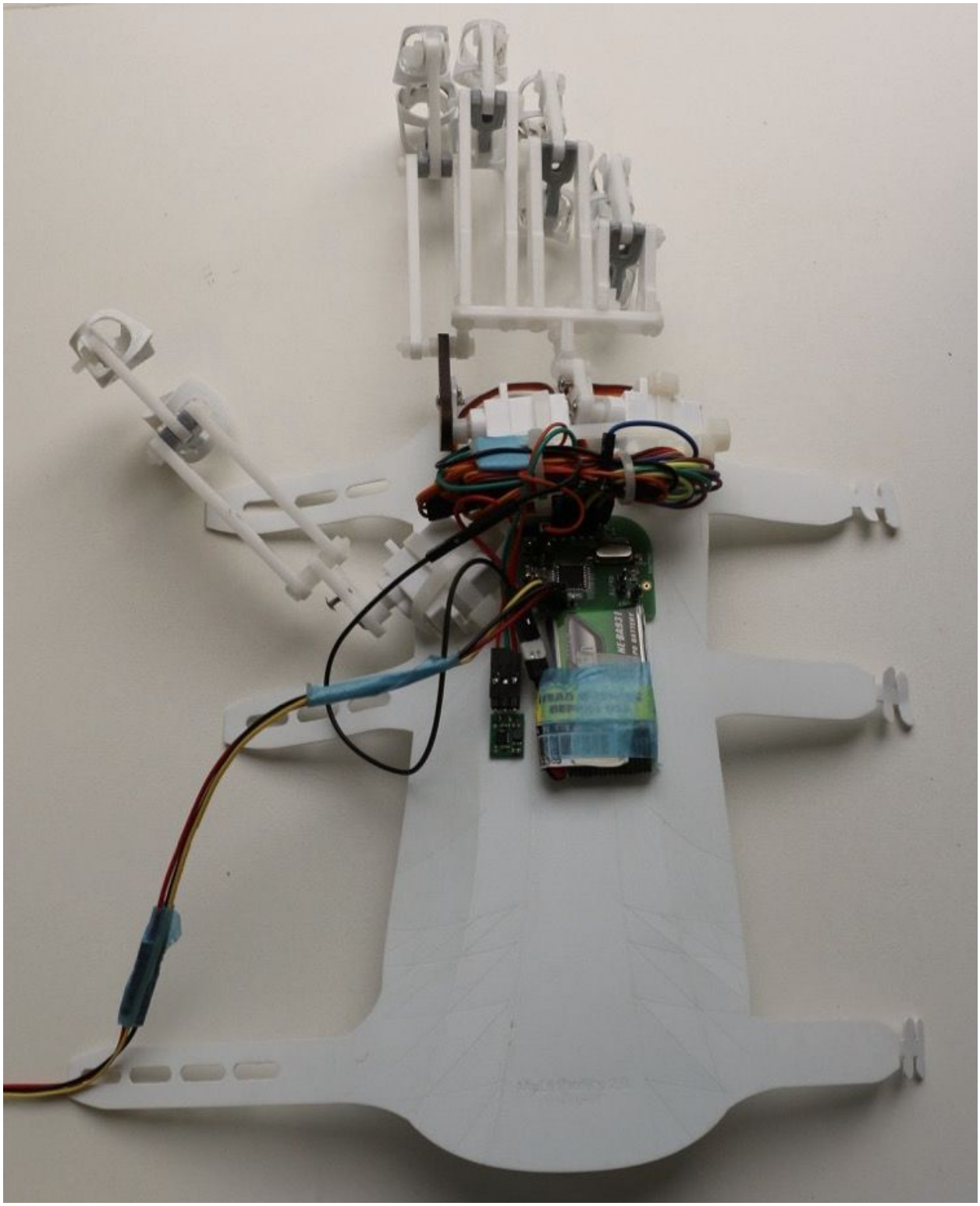
Test the direction of the torque of the motors before fixing the screws of the servos. Check that the torque angle is rotating 90° in between the splint and the normal of the motor after finalize to fix the screws.



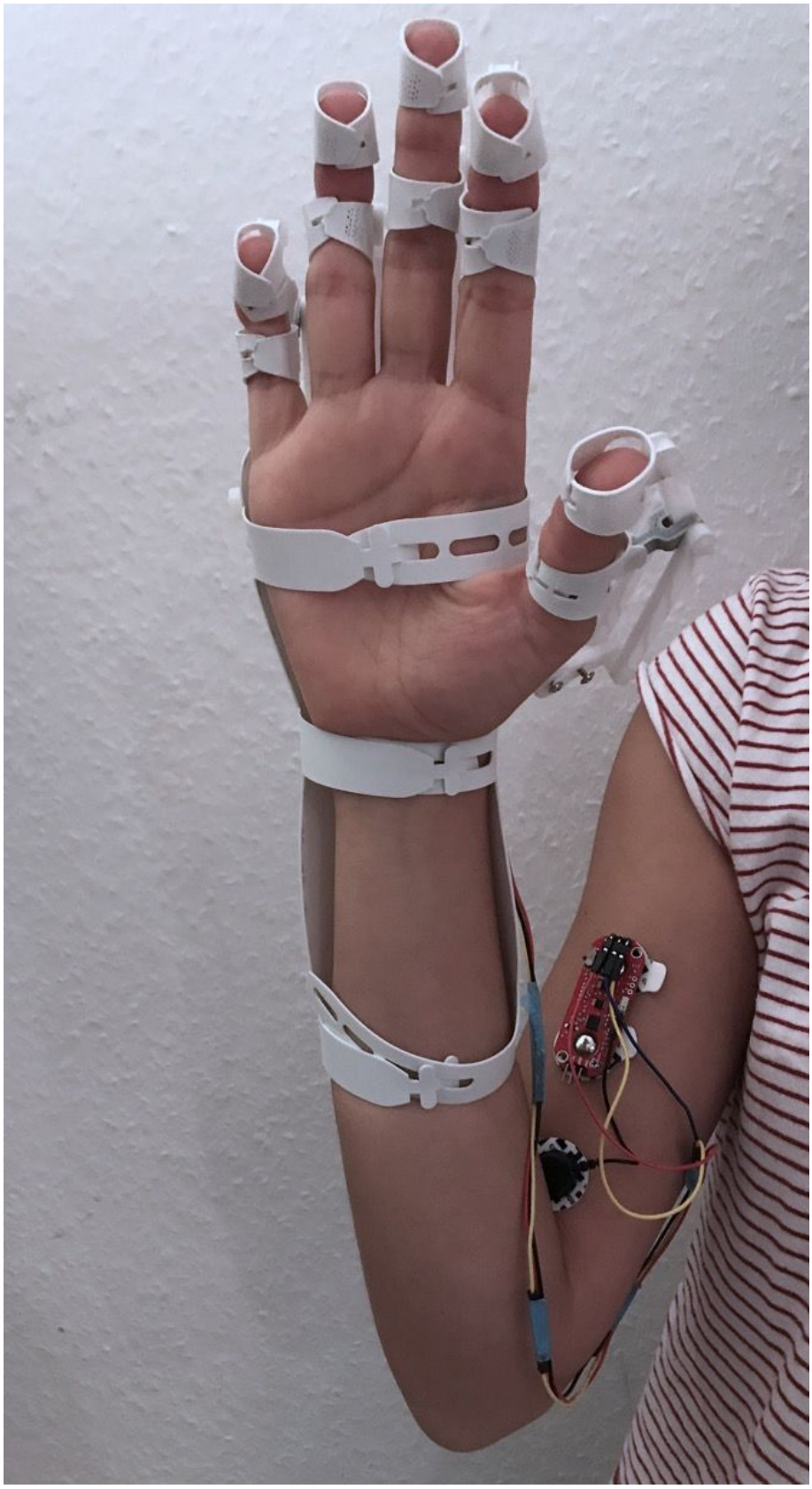
Final assembly of the exoskeleton.



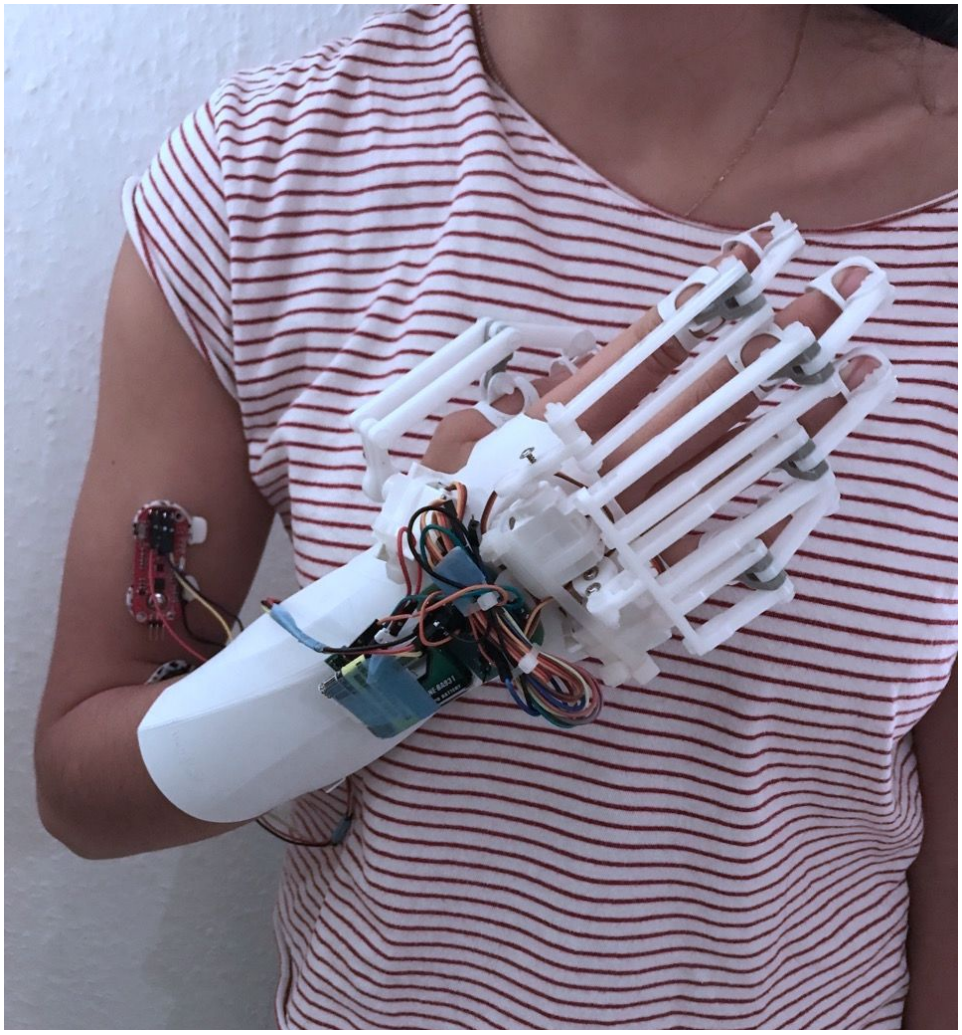




Final assembly.



Final assembly, adjusting the belts.



Final assembly, positioning the sensor on the muscles.