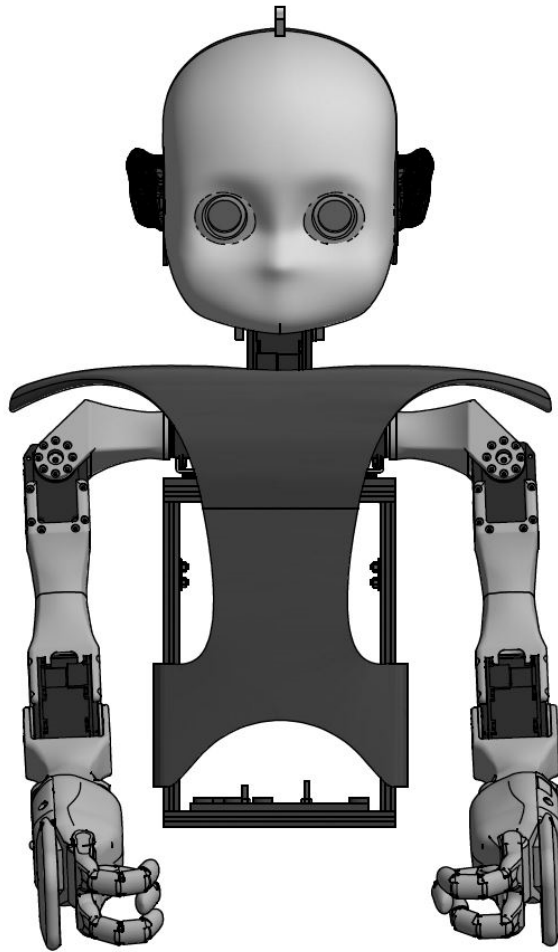# Documentation:

How to print and build your own NICO (CAD)

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1) A short Introduction:

This paper is a step by step on how to 3D-print and build your own NICO (Neuro inspired COmpanion) robot. In the following, we will give an overview of which parts you will have to download and then proceed to go through on how to print the parts and which steps require sharper attention. All parts named in this paper are uploaded in our GitHub NICO-CAD repository (https://github.com/knowledgetechnologyuhh/NICO-cad). The files we want to utilize to print the NICO are mostly "xxx.stl" files.

The NICO can be divided into several assembly groups:

- Head
- Body
    - Arms
    - Neck
    - Shoulders
    - Cover
    - Framework
- Laser cut parts
- Additional Requirements

Frame

All of our self-printed NICOs are built on and around a frame made out of beams from the toolkit "MakerBeam".
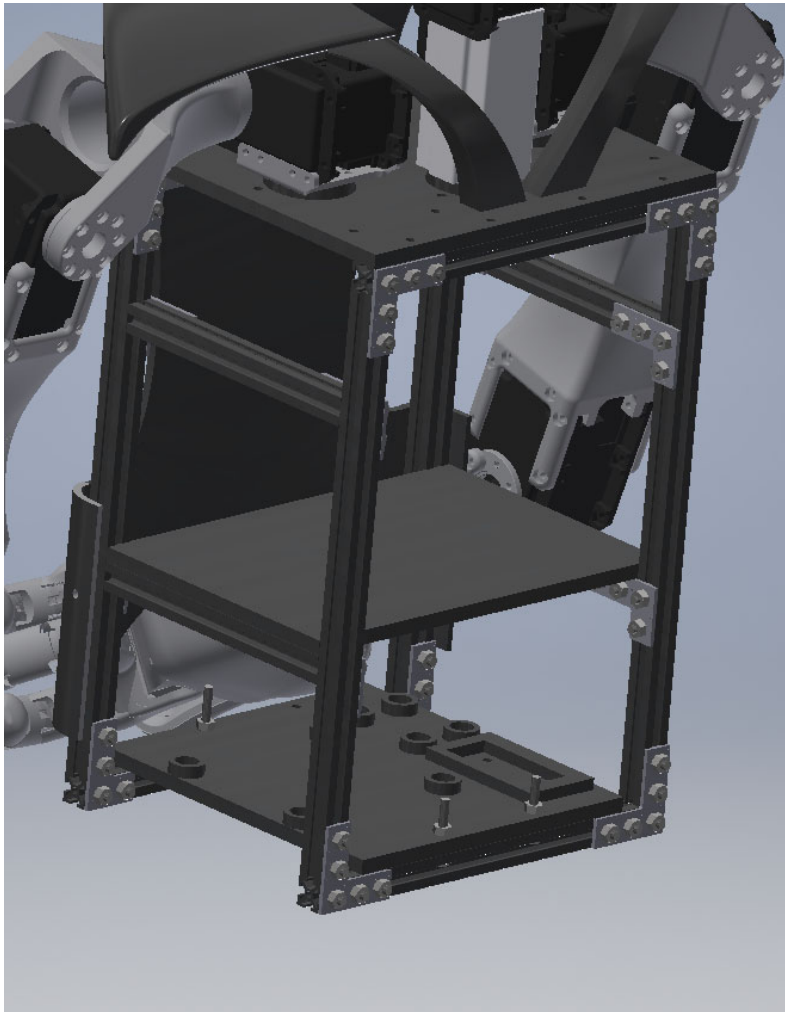
The frame consists of four 200mm (Art.Nr.100090), four 150mm (100089) and four 100mm (100088) beams connected to one another by 16 right angle brackets (Art.Nr.100326), secured by square headed M3 bolts (6mm, 100359) and M3 nuts.

As seen in the picture above an upper plate is mounted to the top of the framework. The following file is to be 3D-printed:

- upper_plate.stl

Before placing the upper plate onto the framework, slide in 6mm or 12mm square headed M3 bolts from MakerBeam [Art. Nr. 100359 or 100360]. After placing the upper plate on top of the framework onto the bolts secure the upper plate with M3 nuts.

Head

The head of the NICO mainly consists of the face, the back of the head and the inner support frame. Additionally, ears as well as optionally sub-assemblies can be printed for holding cables in place, etc.

STL files to be printed:
- face.stl
- spider.stl
- occiput.stl
- ear_left.stl
- ear_right.stl

Optional:
- head_cable_clamp.stl
- several support parts (not essential for first print)

It is mandatory that before printing you open the parts in an stl-Editor (e.g. Cura) and make required changes to orientation and adjust printing settings to your 3D-Printers needs. Make sure the orientation of your choice uses least amount of support structure to use printing time and material efficiently.

To assemble the head, take the NICO face and screw and secure the spider to the inside. Then, attach the occiput to complete the head and mount to the tilting motor with M2 bolts.

Arms

To manufacture the arms, the following parts are to be 3D printed:
- upper_arm.stl (2x)
- lower_arm_thick.stl (2x)
- connector.stl (2x)
- shoulder.stl (2x)
- shoulder_spacer.stl (2x)

Motors: Robotis Dynamixel MX64

Starting from the inner body to the outer; The shoulder spacer between motor (vertical axis rotation) and motor (horizontal axis rotation) is there to grant the shoulder enough freedom for rotation. Attached to the horizontal axis rotation motor is the shoulder itself followed by the shoulder-arm joint motor. Then the upper arm is attached after which the elbow joint motor follows. To the end of the arm the lower arm is followed by the connector, to which the hand (we used the RH5D respectively RH4D versions) is manufactured. All parts are to be connected with the motors with M2 nuts and bolts.
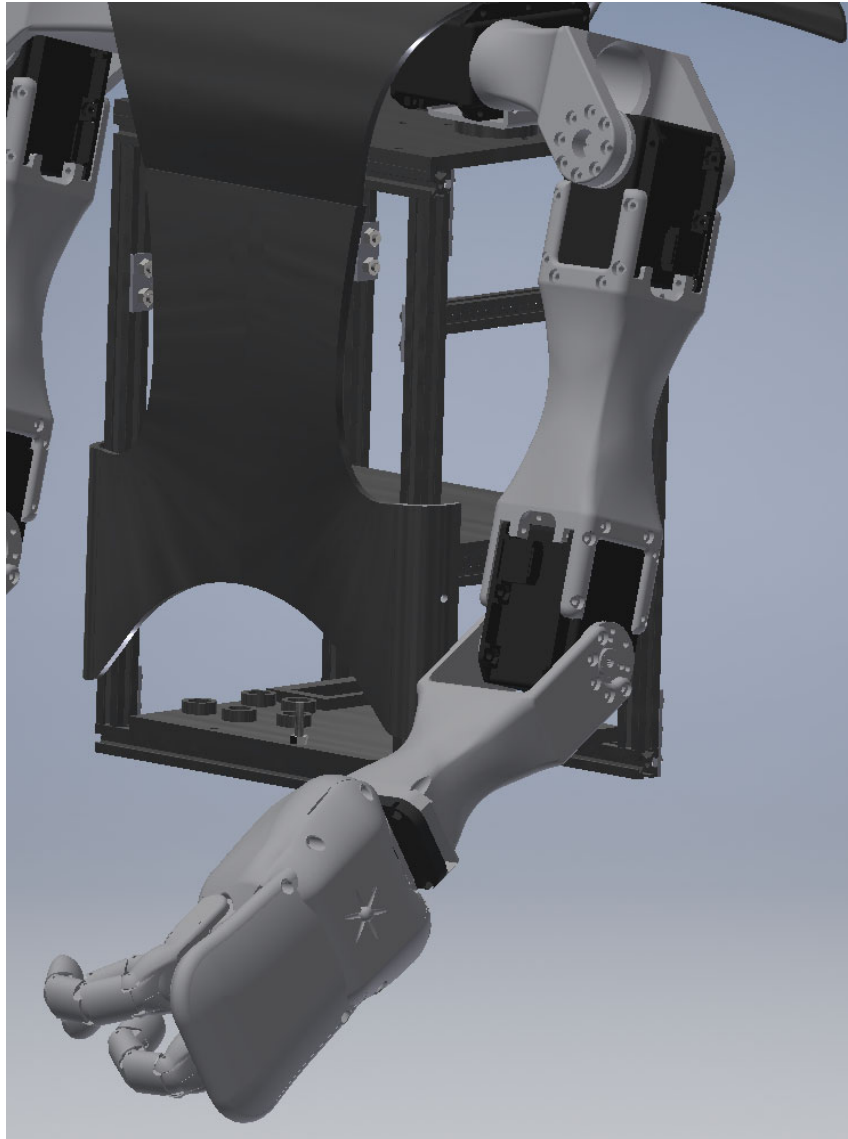
Neck

The neck is simply just bolted to the shoulder spacer connected to the neck motor. The motor for tilting action of the head is mounted on top of the neck.
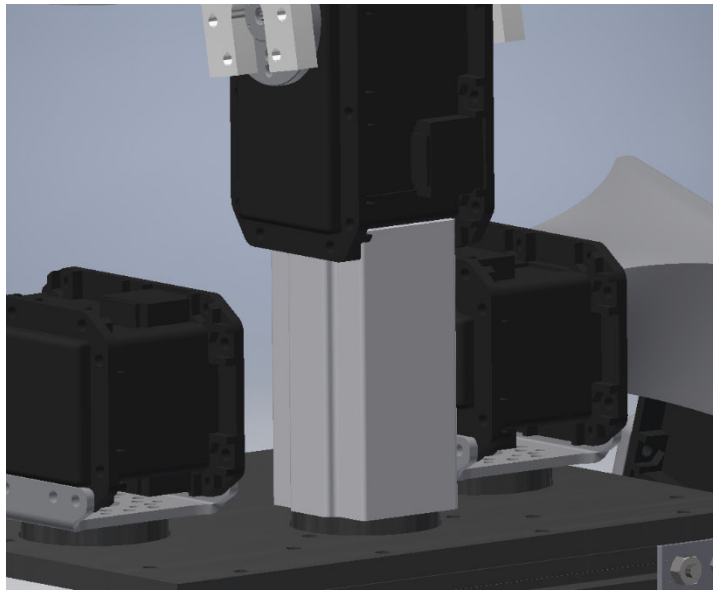
Shoulder cover

For aesthetics we designed a body and shoulder cover to give the NICO a better appearance to the eye. Additionally, our goal was to design the cover as handy and as practical as possible to ensure a quick mount and demount for the occupant. It is optional for you to print and use and no functionality will be restricted if not.

To mount the shoulders, undo to of the M3 nuts holding the upper plate in place from the front of the NICO. Slide the Shoulders onto the bolts and refasten the shoulders with the M3 nuts. Finally, slide square headed MakerBeam bolts on either outer side of the front beams. Then mount the body cover and fasten with nuts.

Laser cut parts

Due to the fact, that we want to offer an open source NICO, where one only needs a 3D-printer, we designed all parts to be enduring and stress-resisting as possible, whilst being 3D-printed.
If you wish and have the possibility to laser cut parts, you can still use the following dxf.-files to laser cut specific parts:

- upper_plate.dxf

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