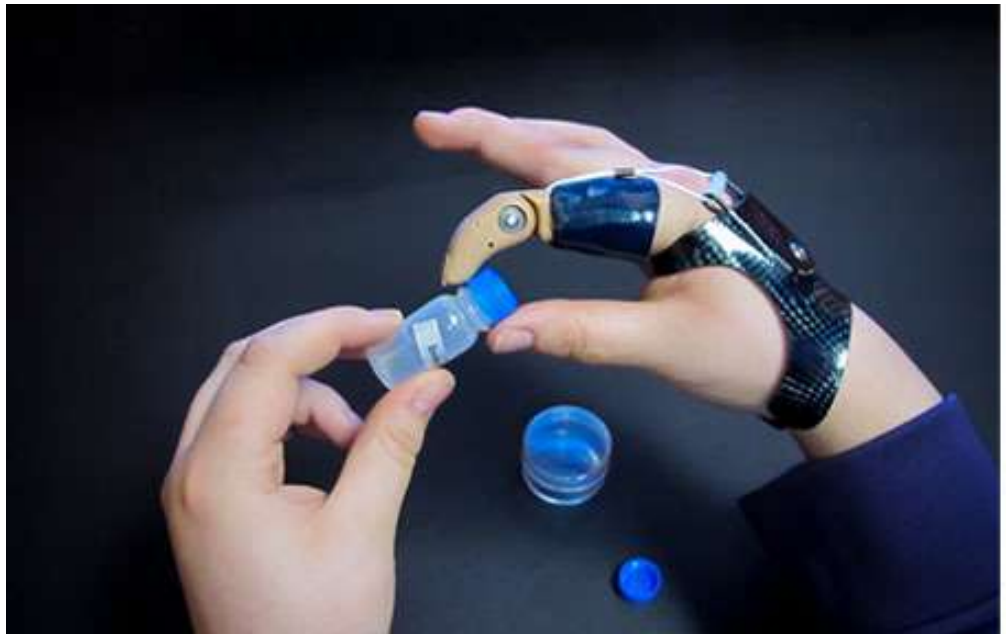


3D printed prosthetic finger: design, model and simulation

By

Krutika Kanfade and Heber Martinez

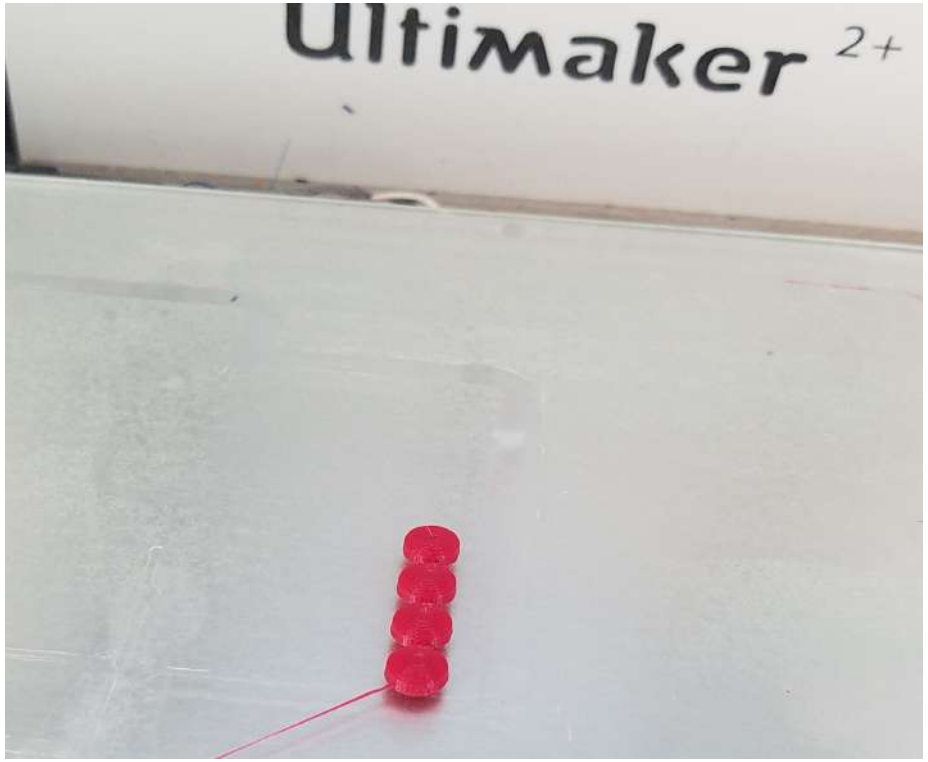
Project Goals

Build a 3D printed prosthetic finger

I. Open source prosthetic design
II. Create static model
III. Simulate finger motion using inverse kinematics

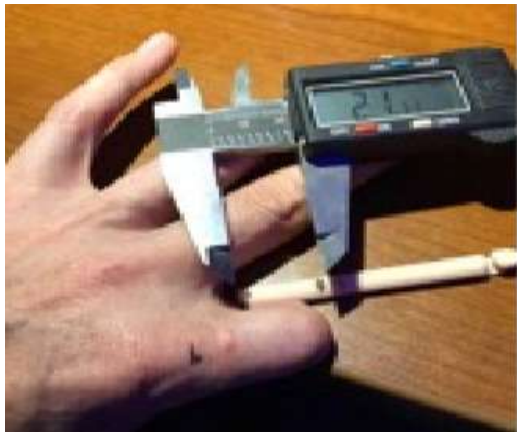
Design and 3D printing

- Finger measurements - input for the OpenSCAD
- Rendering to create that particular part
- Export individual file as STL
- Import STL files into Ultimaker 2+
- Change 3D printer settings based on the part and the type of material in Cura Software
- Transfer files from Cura software to Ultimaker 2+ printer with SD card
- Print layer-by-layer



Actual 3D printed parts

Socket width top



Socket scallop depth

Socket depth top

Socket depth bottom

Socket width bottom

Middle section length

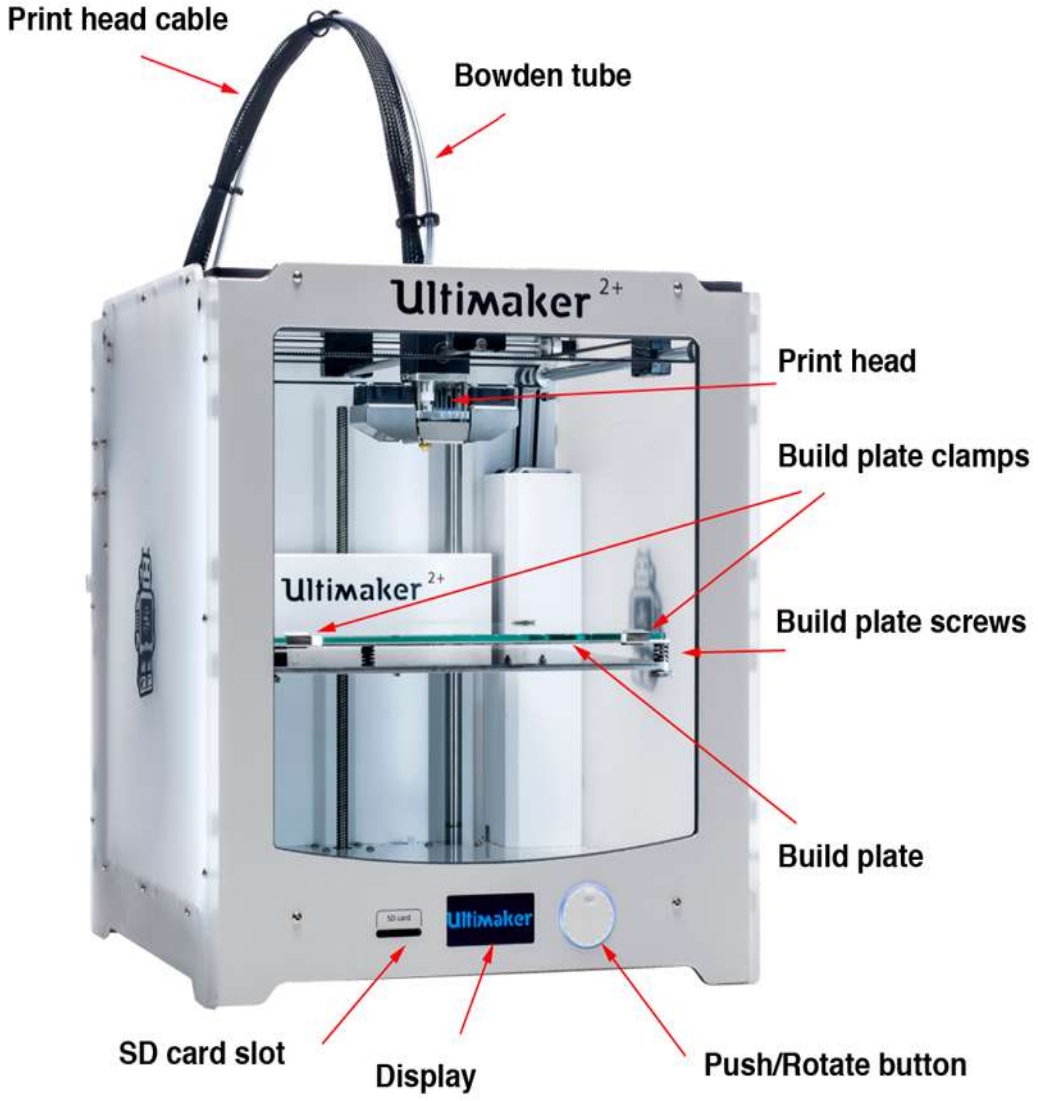
Tip length

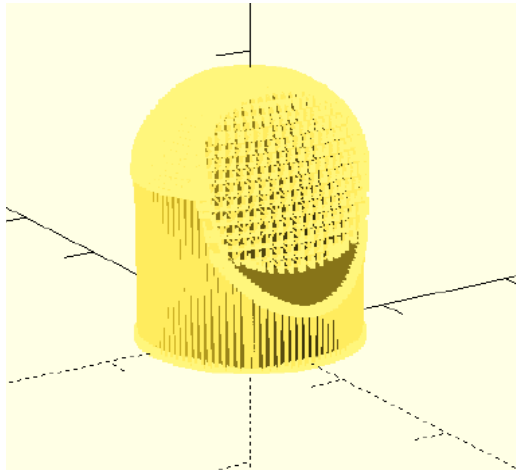
Linkage length

Material used

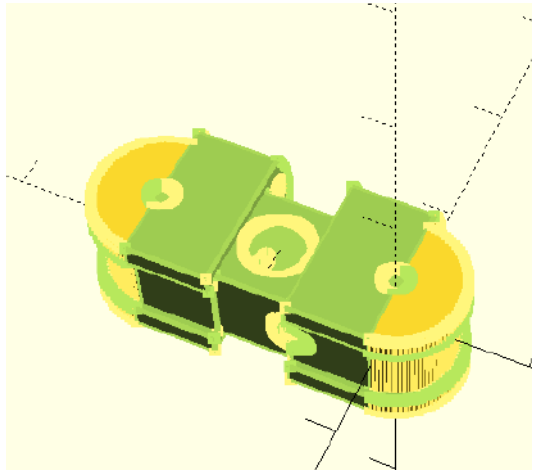
- PLA – Polylactide , for hard items (2 knuckles, middle section and linkage)
- TPU – Thermoplastic polyurethane, for flexible items (socket, tip cover, hinge plugs)
- Aluminum wire – for metal knuckle pins
- Elastic cord – for connecting the two knuckles
- Strong braided fishing line – to built tension for actuating the movements

3D printer used – Ultimaker 2+

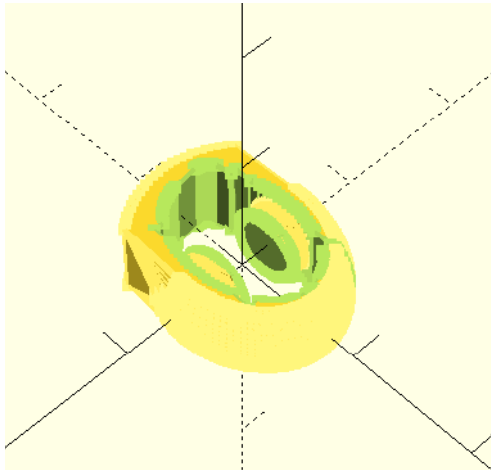




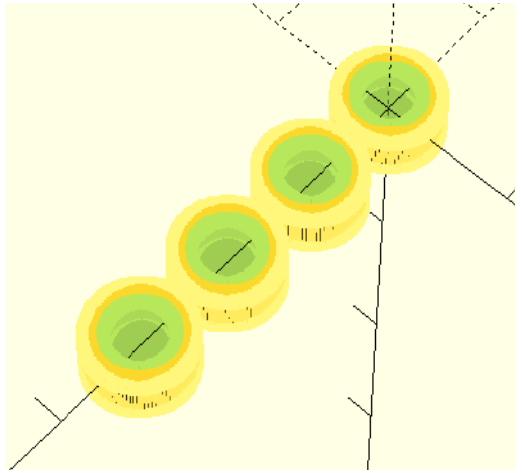
Tip cover



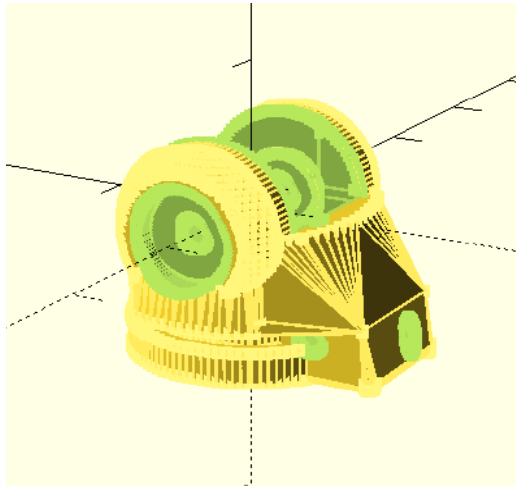
Middle segment



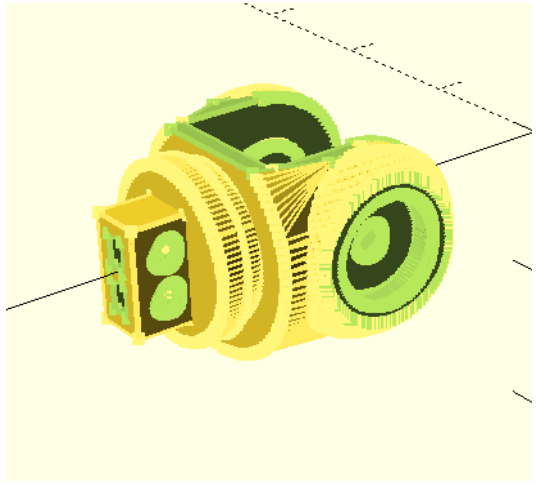
Middle bumper



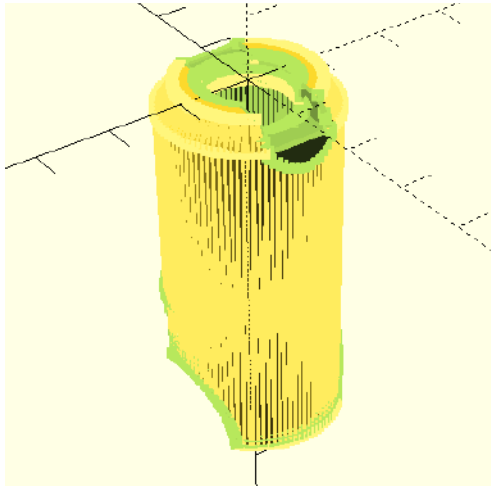
Knuckle plugs



Base knuckle

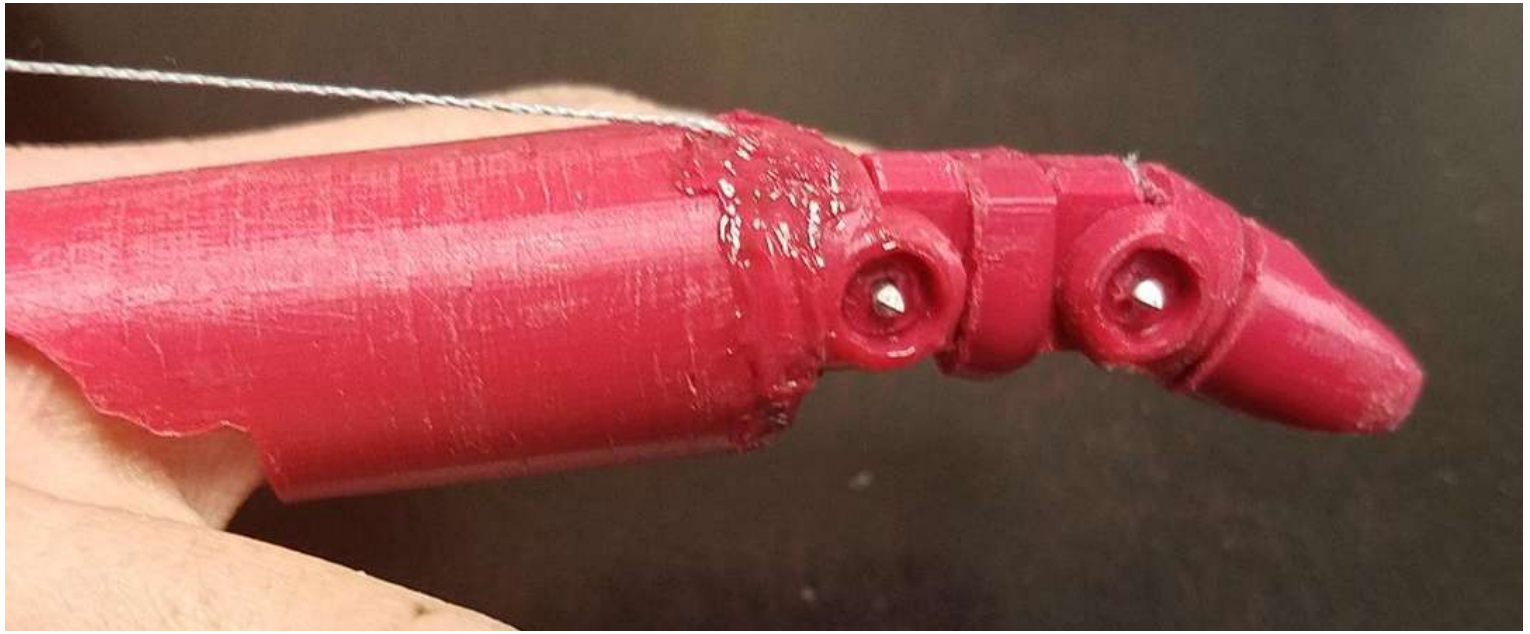


Tip knuckle



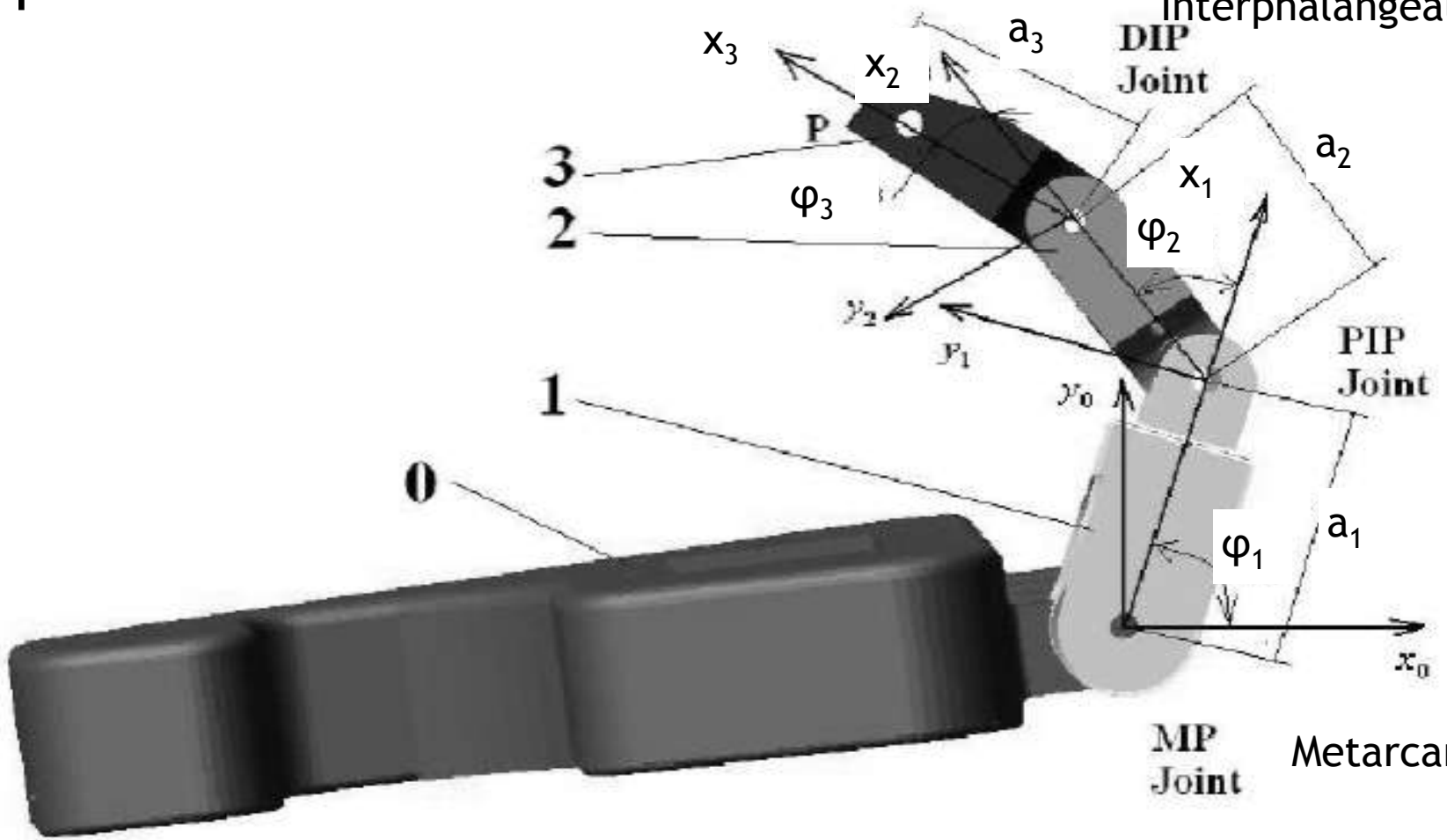
Finger socket

Wrist linkage



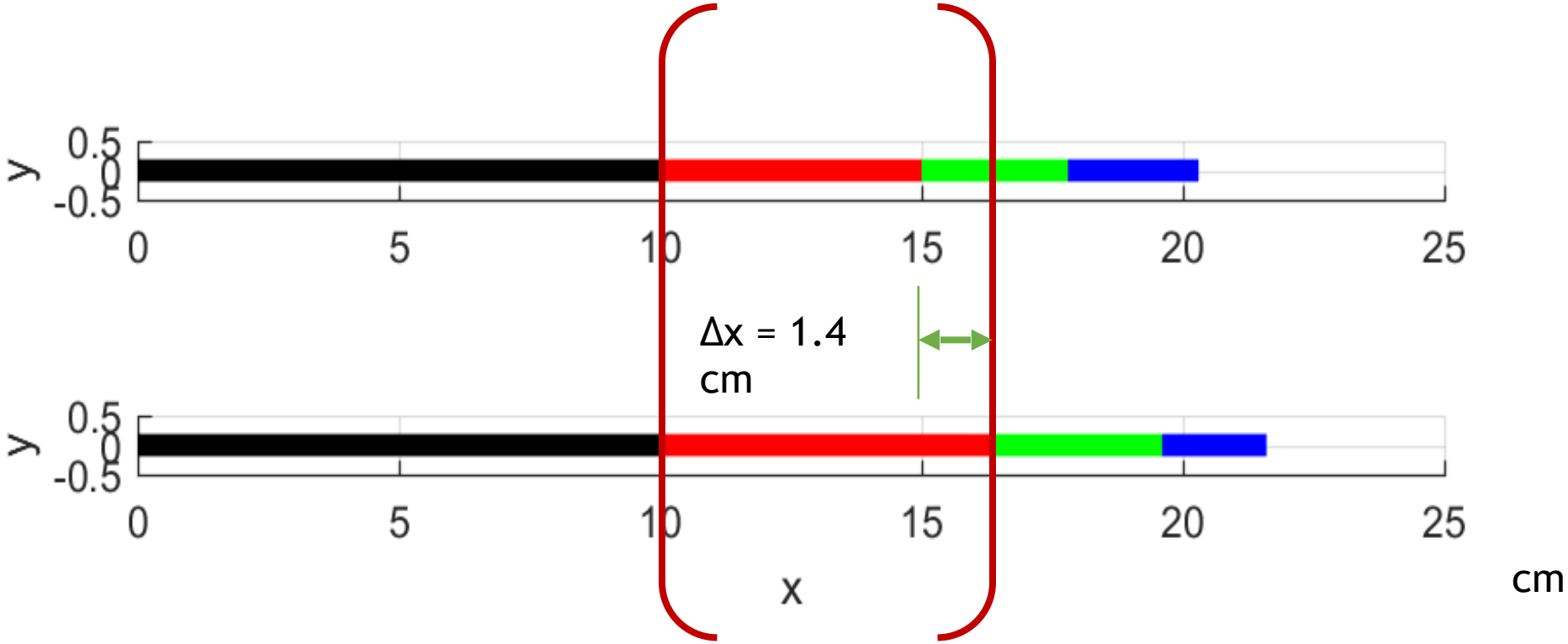
Final assembled finger

Proposed Static Model



Modified from C. Berceanu et al.

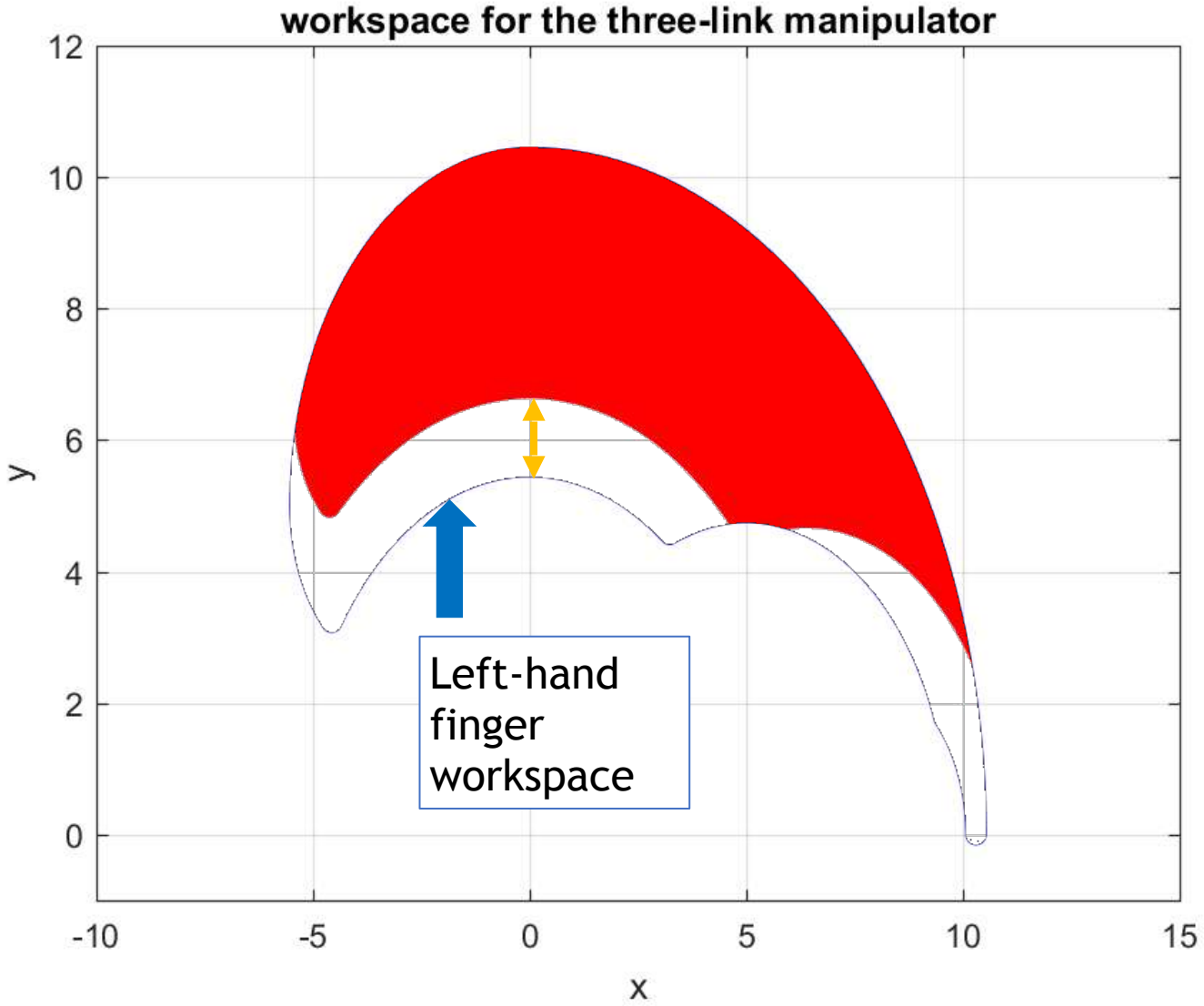
MATLAB Static Model



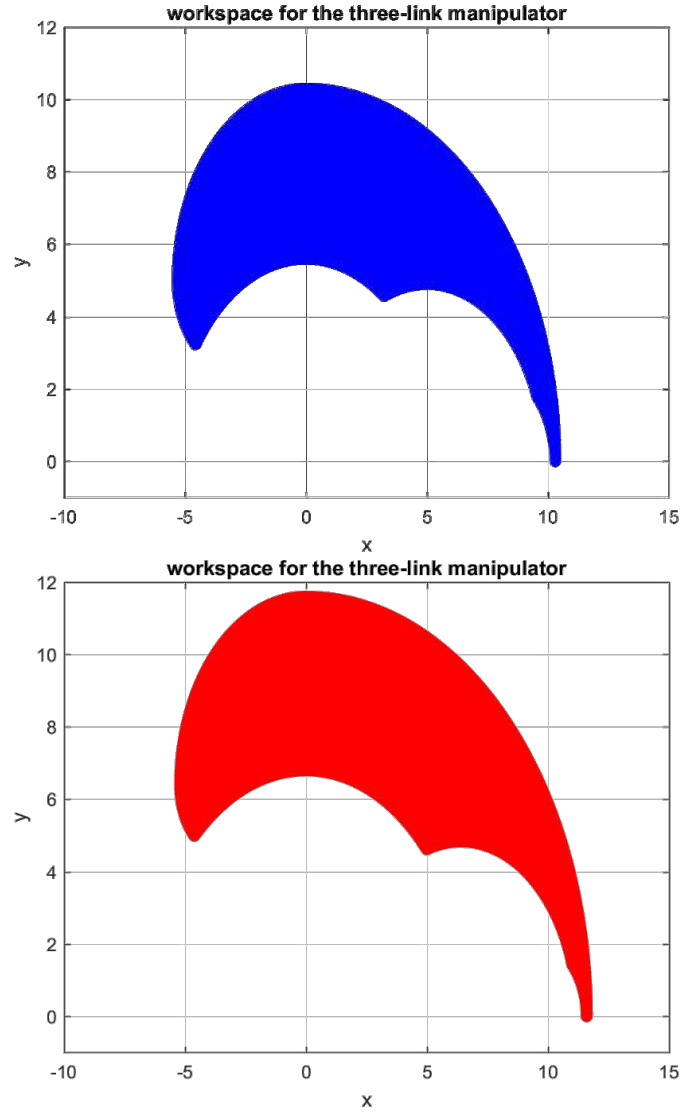
Left Hand Finger

Right Hand Prosthetic Finger

(b)

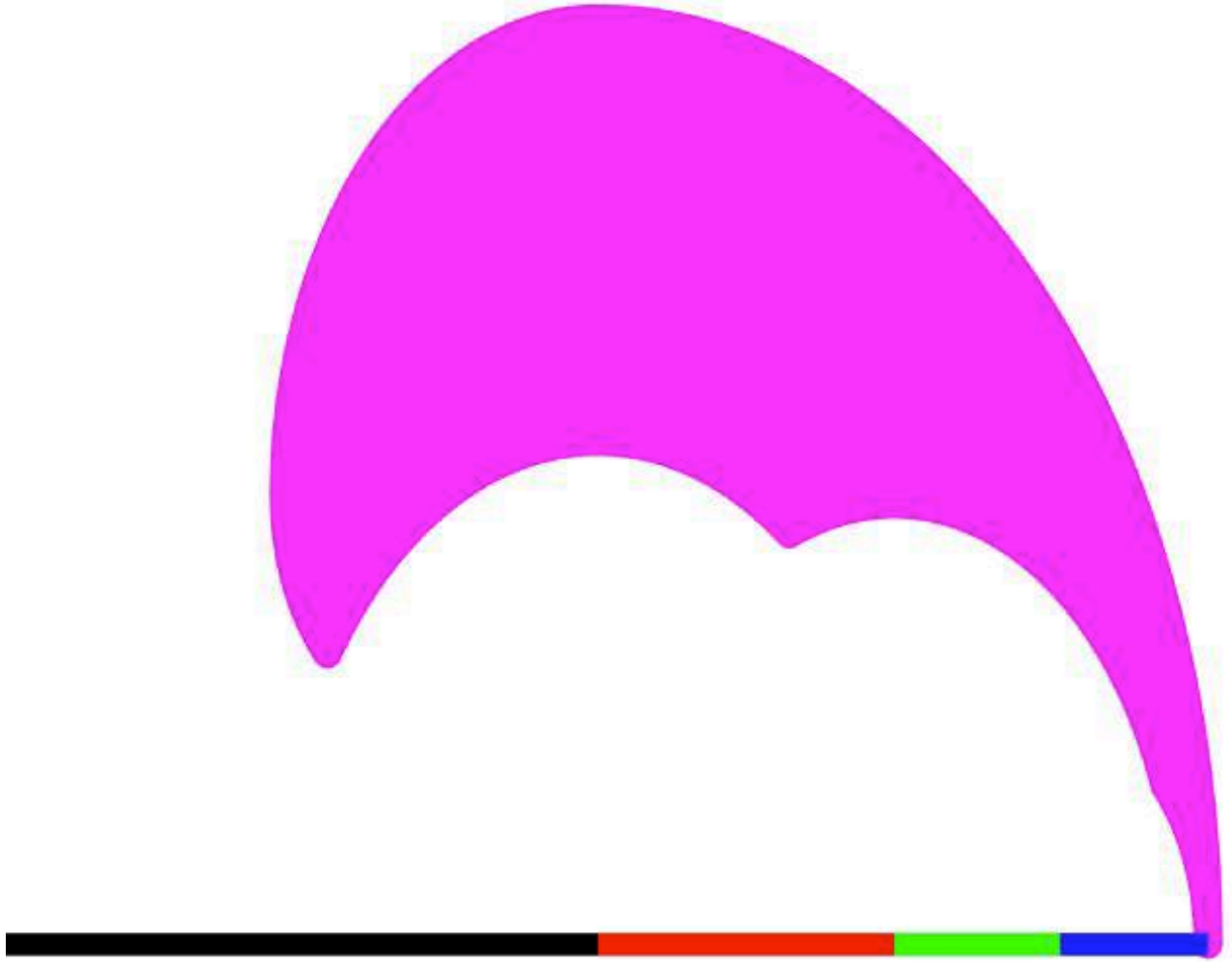


(a)



Blue – Left-Hand Finger
Red – Right-Hand Prosthetic Finger

Original Design for Left Finger



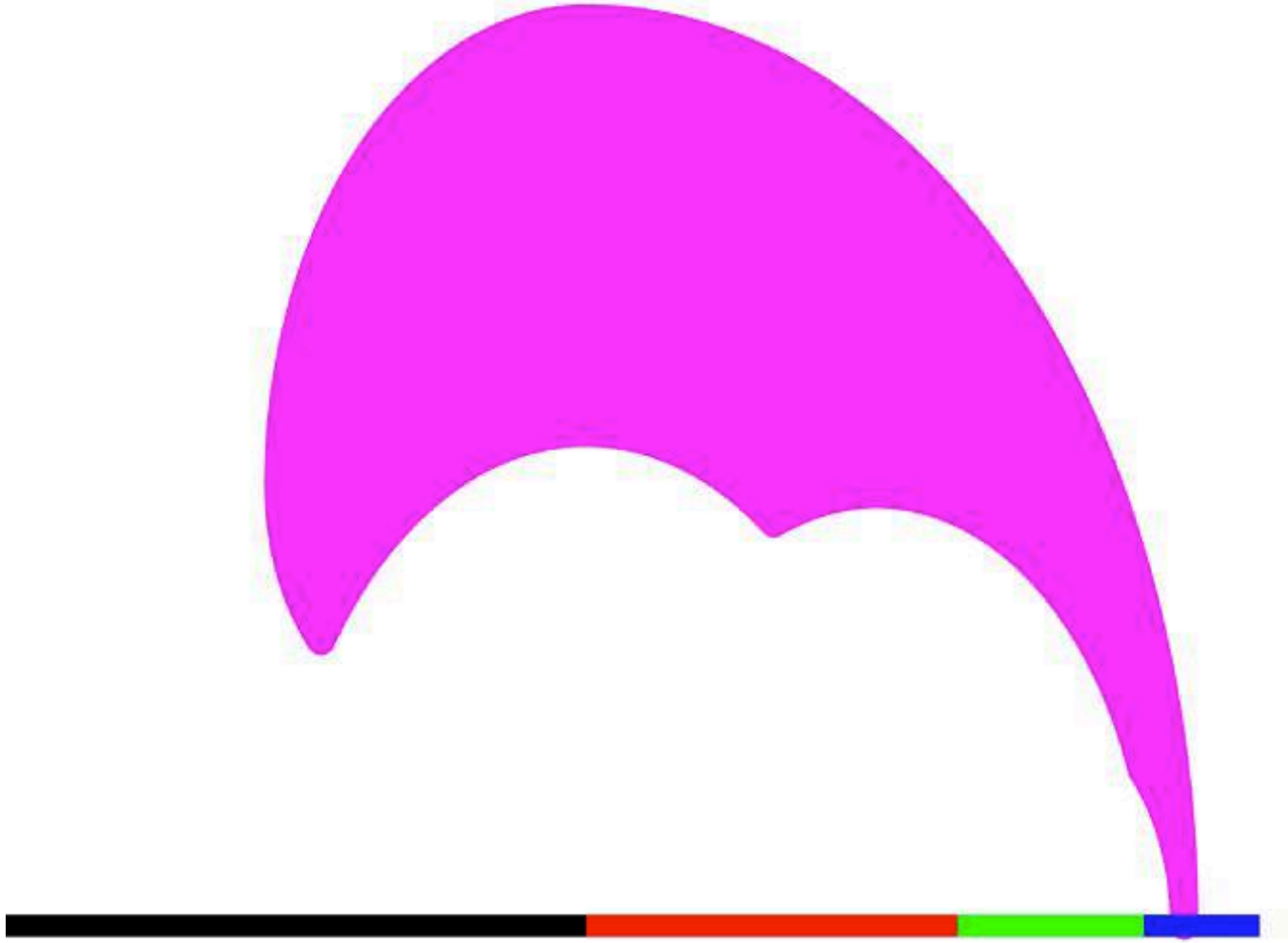
Constraints:

$\theta_1 = 0$ to $\pi/2$

$\theta_2 = 0$ to $\pi/2$

$\theta_3 = 0$ to $\pi/4$

Original Design for Prosthetic Finger



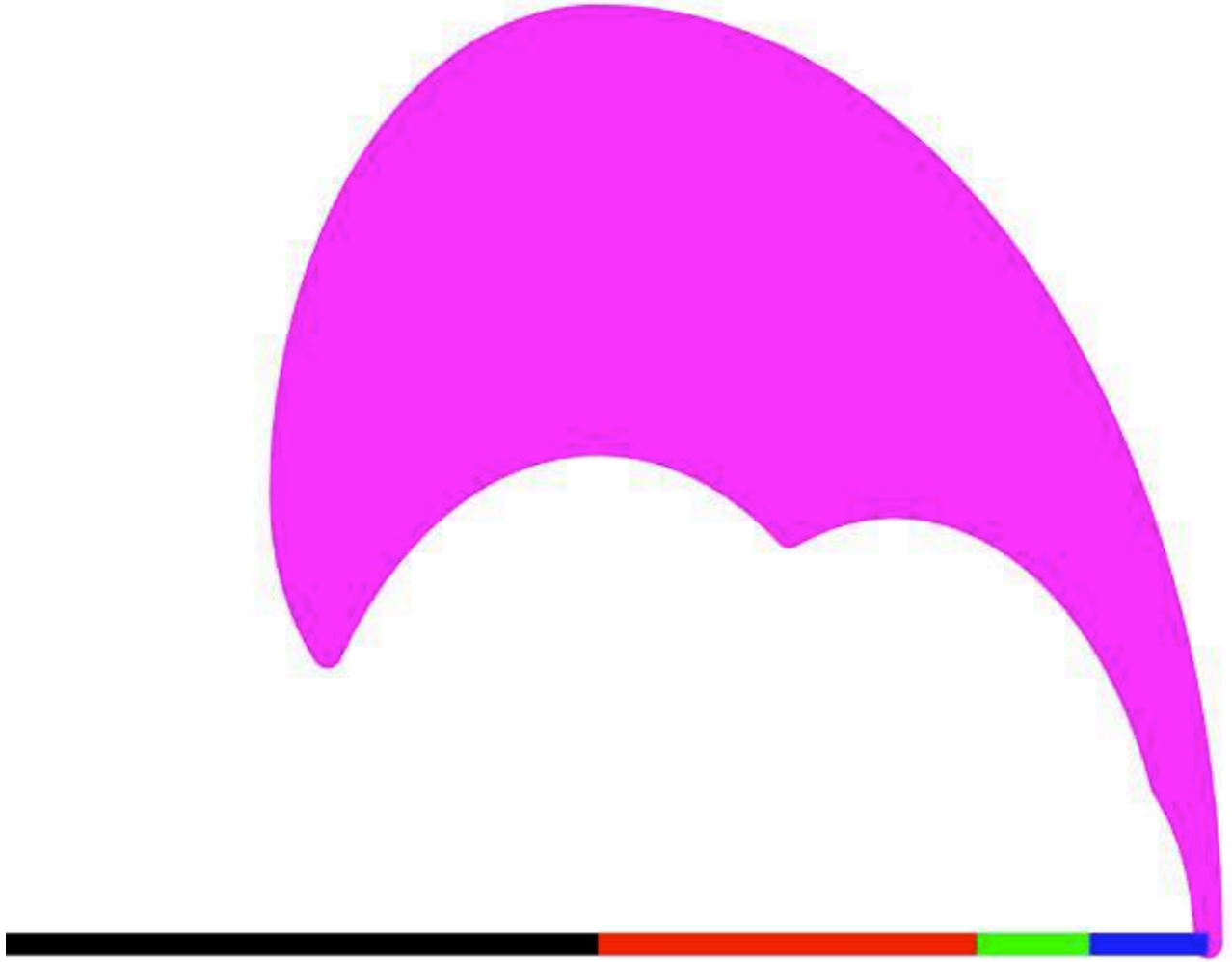
Constraints:

$\theta_1 = 0$ to $\pi/2$

$\theta_2 = 0$ to $\pi/2$

$\theta_3 = 0$ to $\pi/4$

New Design for Prosthetic Finger



Constraints:

θ_1 = 0 to π/2

θ_2 = 0 to π/2

θ_3 = 0 to π/4

L_{tot} = 10.3 cm (3 links)

a_1 = 6.4 cm

Future Work

i. Automatically optimize length of middle and top section

ii. Re-design of prosthetic finger using SolidWorks

References

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- Knick's 3d printed prosthetic finger v3.5: https://www.youtube.com/watch?v=G6F8aj2A8MY
- openSCAD (free-source): http://www.openscad.org/
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