GelSlim 3.0 Hardware Quick Start Tutorial

MCube Manipulations and Mechanisms Lab

Foreword

GelSlim 3.0 is a tactile-sensing finger used for the high-resolution measurement of shape, force and slip. We are open sourcing this project to stimulate future research in tactile-sensing and provide the robotics community access to reliable and easily-reproducible tactile finger with a diversity of sensing modalities. **NOTICE: The MCube Manipulations and Mechanisms Lab NO LONGER distributes pre-made sensors by mail upon request.**

Please see the latest version of Gelslim, GelSlim 4.0 courtesy of Sipos et. al. (@University of Michigans MMint Lab) for an easily reproducible iteration of the sensor.

Step 1. Component Ordering

Purchase the following off-the-shelf components at the given links.

Component	Quantity
Odseven 160° Variable Focus Raspicam	2
Odseven Camera Cable Adapter	2
Raspberry Pi 3B Kit	2
MicroSD Card and Adapter	2
HDMI Cable	1
CSI to HDMI Adapter	2
Left-Angle Micro USB Cable	2

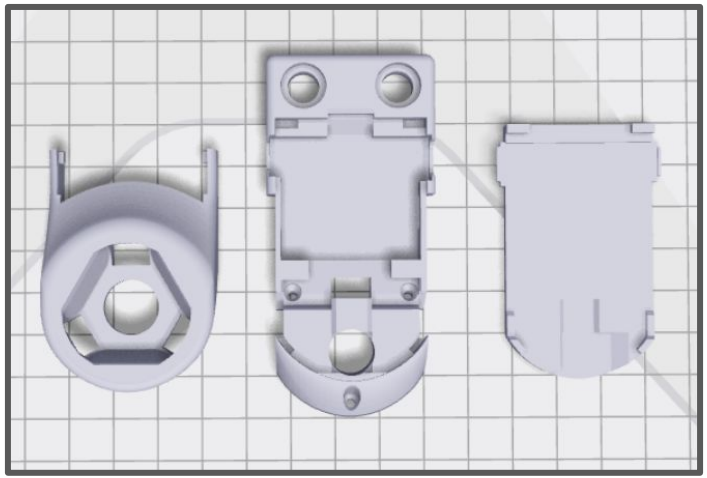
Step 1. Component Ordering Cont.

Purchase the following off-the-shelf components at the given links.

Component	Quantity
McMaster Carr - Oil Bearing	4
McMaster Carr - M2 Screws (Pack of 100)	1
McMaster Carr - M2 Heat Inserts (Pack of 100)	1
XP-565 Silicone	1
Black Print-On Silicone Ink	1
Gray Print-On Silicone Ink	1
NOVOCS Gloss Silicone Solvent	1
Gorilla Glue Clear Silicone Sealant	1
Sakura Pigma Black Ink Pen or Faber Castell Black Ink Pen	1

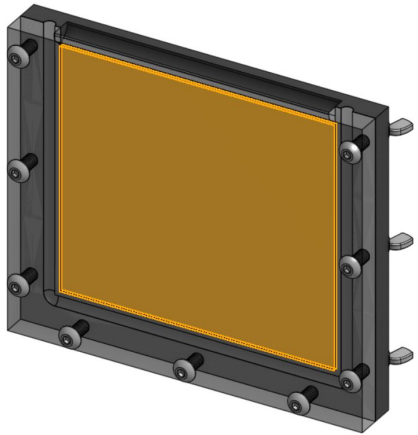
Step 2. Finger Fabrication

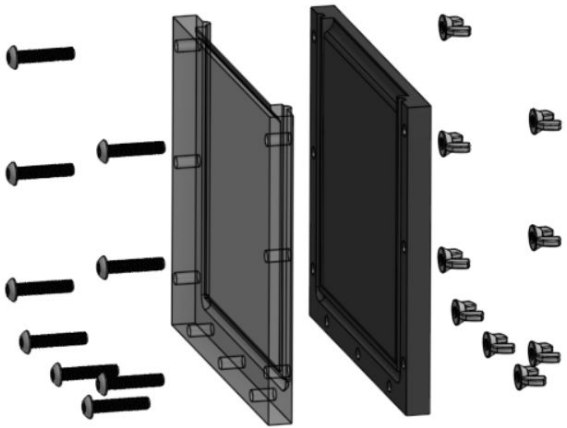
3D print the ***finger body***, ***back,*** and ***tip***. Orient the parts on the print-bed according to the diagram below. Use 0.1 mm layer height, supports, and 30-100% Infill (dependent on the application requirements of the application). Recommended 100% Infill for maximum stiffness.



Step 3. Gel Mold Fabrication

Order the acrylic mold from a turnkey fabrication service (we utilize SuNPe Inc.). Request polishing to a translucent finish on the inner faces of each of the mold halves as shown in the diagram below ***(LEFT)***. Assemble the mold according to the diagram shown below ***(RIGHT).***





Step 4. Gel Fabrication

Take proper precautions when fabricating the elastomer gel. Use of the following PPE is required during fabrication: Nitrile Gloves, Respirator, Safety Glasses. Perform all spraying and painting within an adequately ventilated spray-booth/fume-hood.

1. Mix the XP565 (Silicones Inc.) platinum-based silicone in a 1:10 ratio of activator to base.
2. Degas in a vacuum chamber.
3. Pour into the acrylic mold and leave to cure for 24 hours.
4. Mix the reflective layer using a Gray Print-On Silicone Ink using a 10:1 ratio of silicone ink to its catalyst.
5. Add a NOVOCS Gloss Silicone Solvent to dilute the silicone ink in a 1:10:30 ratio of ink catalyst to ink to solvent.
6. Airbrush the reflective layer on top of the elastomer until the surface is no longer translucent.
7. Let the reflective layer cure for 24 hours.
8. Laser cut holes in a grid pattern on the painted surface of the elastomer and adding Black Print-On Silicone Ink.
9. Seal the marker layer was sealed by spraying an additional layer of black silicone ink using the previous 1:10:30 ratio of ink catalyst to ink to solvent.
10. Let the marker grid cure for 24 hours.
11. Cut the gel to shape using the cutting template.

Step 5. PCB Ordering and Fabrication

Order the PCBs from one of the following turnkey fabrication services. The capabilities of each service is listed.

Service	PCB Fabrication	PCB Assembly
Advanced Circuits	✔	✔
PCBWay	✔	✔
OSHPARK*	✔	✘

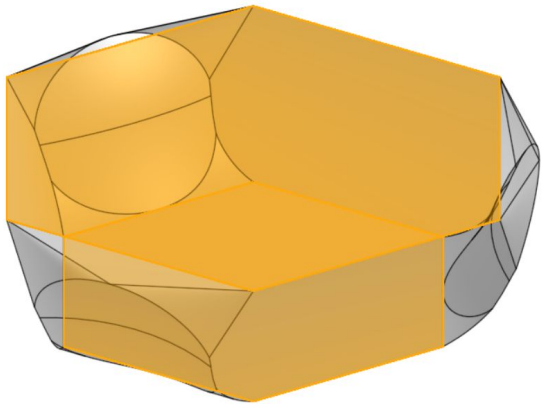
*DIY surface mount soldering tools are listed in the following section.

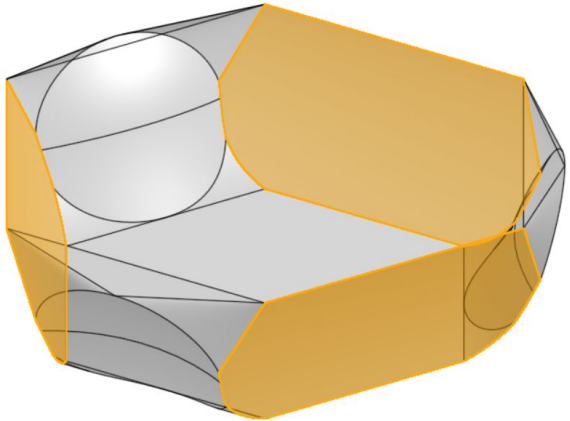
Step 6. PCB Fabrication

Component	Quantity
X-Acto Precision Knife	1
Lead Free Solder-Paste	1
SMT Solder Plate	1
Precision Tweezer Set	1

Step 7. Shaping Lens Fabrication

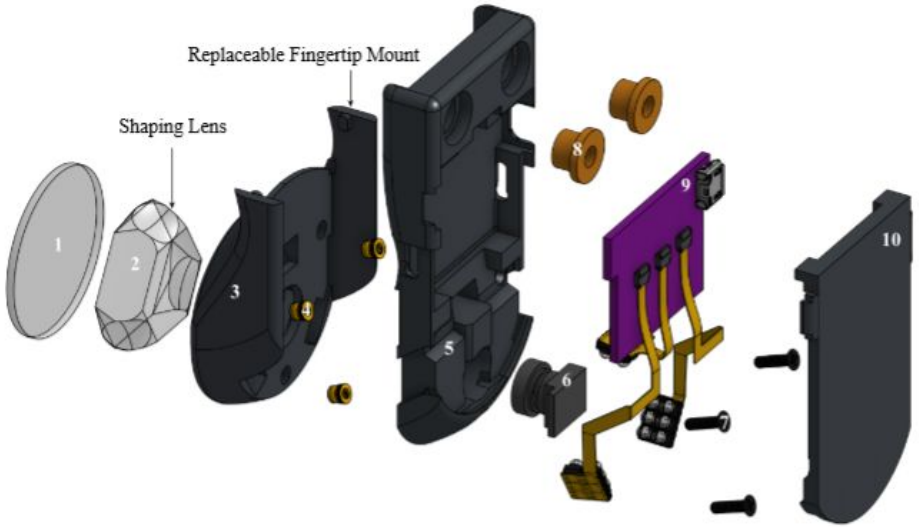
Order the acrylic lens from a turnkey fabrication service (we utilize SuNPe Inc.). Request polishing to a translucent finish on the top and bottom faces as shown in the diagram below ***(LEFT)***. Paint the flat faces opposing the acrylic lens's shaping geometry with a black ink pen as shown in the diagram below ***(RIGHT)***.





Step 8. Assembly

1. Use a soldering iron to place the M2 Heat Inserts in the Finger-Tip.
2. Press-fit the following components into place according to the diagram below. *Note: fold the camera module cable to exit the routing hole prior to press fitting the finger back into position*.
3. Bond the gel to the acrylic lens and finger-body using Gorilla Silicone Clear Sealant.
4. Leave to cure for 24 hours.



1 Elastomer w/Reflective Skin
2 Acrylic Lens
3 Fingertip
4 Heat Inserts
5 Finger-Body
6 Camera Module
7 Screws
8 Mounting Bearing
9 Integrated Illumination Controller
10 Finger-Back