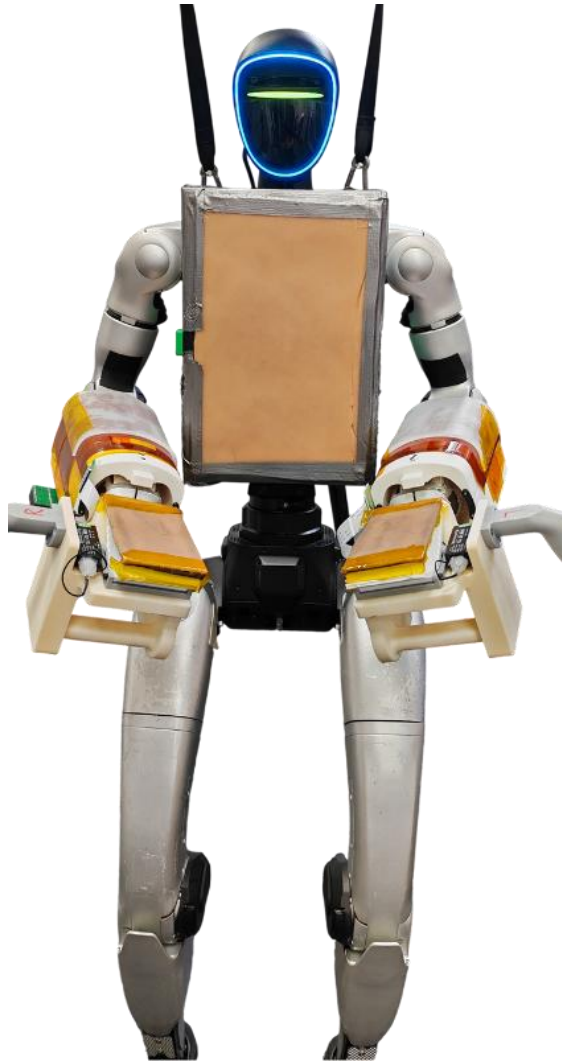




# WT-UMI Hardware Guide

*Whole-Body Tactile UMI for Force-Supervised Humanoid Manipulation*

## Bill of Materials

| Item                                      | Quantity | Link                      | Price Per Unit (USD) |
|-------------------------------------------|----------|---------------------------|----------------------|
| Unitree G1 EDU                            | 1        | <a href="#">Unitree</a>   | By Quote             |
| Bambu Labs PLA Basic Starter Classic Pack | 1        | <a href="#">Bambu</a>     | 91.96                |
| eSUN TPU 95A 1kg Spool                    | 1        | <a href="#">Amazon</a>    | 23.99                |
| TouchTronix SensX 187                     | 1        | <a href="#">DigiKey</a>   | 950.00               |
| PCB                                       | 1        |                           | Included             |
| TouchTronix SensX 160                     | 2        | <a href="#">DigiKey</a>   | 369.00               |
| PCB                                       | 2        |                           | Included             |
| Waveshare USB to TTL Converter            | 2        | <a href="#">Waveshare</a> | 6.49                 |
| FlexiTac Sensor                           | 2        | Custom                    | By Quote             |
| PCB                                       | 2        | Custom                    | By Quote             |
| Arduino Nano                              | 2        | <a href="#">Amazon</a>    | 25.70                |
| 32 Pin 0.5 Pitch FPC Cable                | 4        | <a href="#">Amazon</a>    | 7.59                 |
| 32 Pin 0.5 Pitch FPC Connector            | 4        | <a href="#">Amazon</a>    | 9.99                 |
| 20A Silicone Rubber                       | 1        | <a href="#">Amazon</a>    | 39.04                |
| PVC Backed Fabric                         | 1        | <a href="#">Amazon</a>    | 19.99                |
| M3 Screws                                 |          | <a href="#">McMaster</a>  |                      |
| L 8mm                                     | 22       |                           | 12.82 Per 100        |
| L 22mm                                    | 8        |                           | 13.29 Per 100        |
| M3 Nuts                                   | 12       | <a href="#">McMaster</a>  | 3.06 Per 100         |
| M2 Screws                                 |          | <a href="#">McMaster</a>  |                      |
| L 6mm                                     | 16       |                           | 16.02 Per 100        |
| Adhesives                                 |          |                           |                      |
| Polyimide Tape                            | 1        | <a href="#">Amazon</a>    | 15.99                |
| Duct Tape ( <i>Optional</i> )             | 1        | <a href="#">Amazon</a>    | 13.75                |
| 200 MP Adhesive Transfer Tape             | 1        | <a href="#">Amazon</a>    | 15.99                |
| Foam Mounting Tape ( <i>Optional</i> )    | 1        | <a href="#">Amazon</a>    | 10.99                |

## 3D Printing Specifications

\* All prints for this project were performed on Bambu Lab P1S and Bambu Lab H2D

*All*

- Nozzle Diameter: 0.4mm
- Layer Height: 0.2mm
- Top Surface Pattern: Monotonic Line
- Bottom Surface Patter: Monotonic
- Wall Loops: x2
- Bed: Textured PEI 60°C

*PLA Prints*

- Infill: 15% Gyroid
- Supports: Tree (where necessary)
- Nozzle Temperature: 210°C

*TPU Prints*

- Infill: 25% Gyroid
- Supports: Linear (where necessary)
- Nozzle Temperature: 240°C

## Assembly Instructions

### *Chest Plate*

1. Cut **two** 304mm × 203mm pieces of PVC backed fabric



2. Using transfer tape, attach one layer of PVC backed fabric to the chest plate
3. Mold/Cut a 304mm × 203mm piece of silicone rubber, approx. 4mm thick



4. Carefully place the TouchTronix SensX 187 over the chest plate, making sure to align the flat flex cable with the PCB Slot on the side of the chest plate



5. Place the second piece of PVC backed fabric on top of the TouchTronix SensX 187



6. Place the silicone rubber sheet on top of the PVC backed fabric



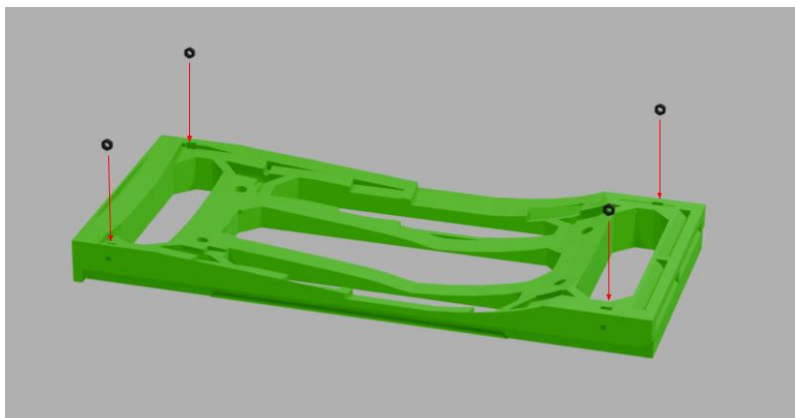
7. Secure the layers to the chest plate with duct tape. Ensure that the layers are not loose and remain firmly held to the chest plate



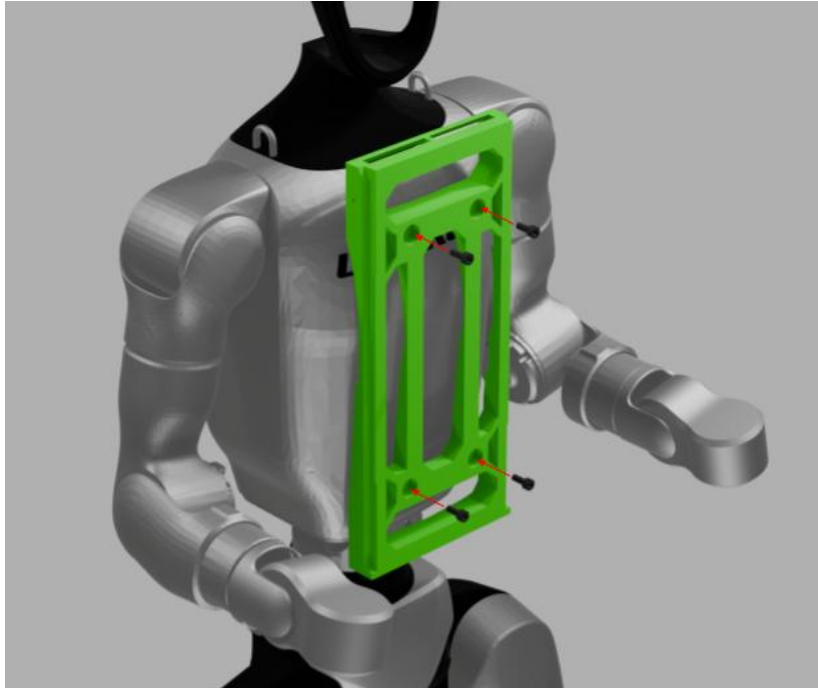
8. Insert the PCB into the PCB cover



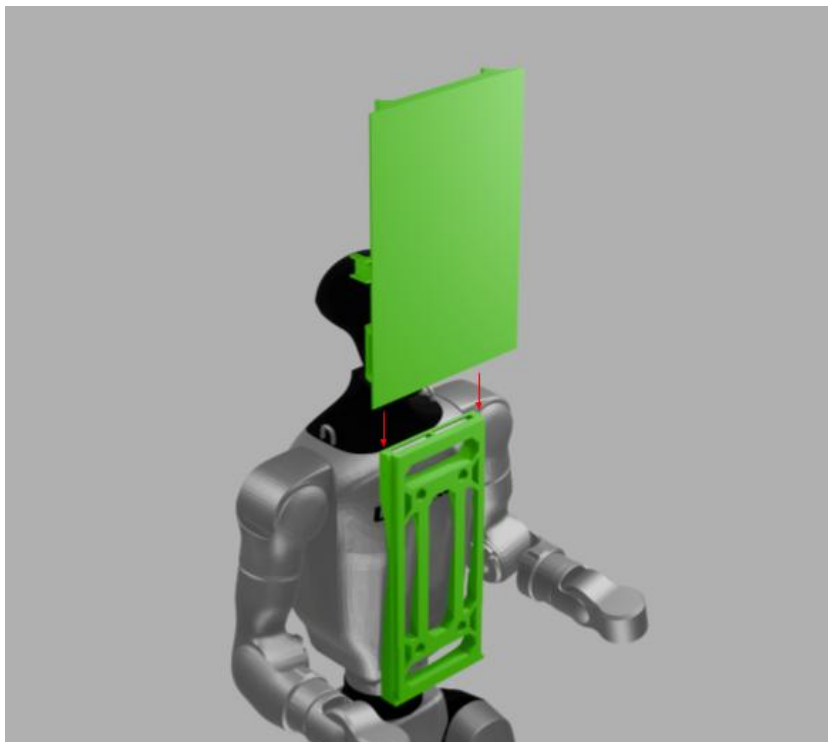
9. Snap the PCB cover into place on the side of the chest plate, being careful not to pinch the wire while doing so



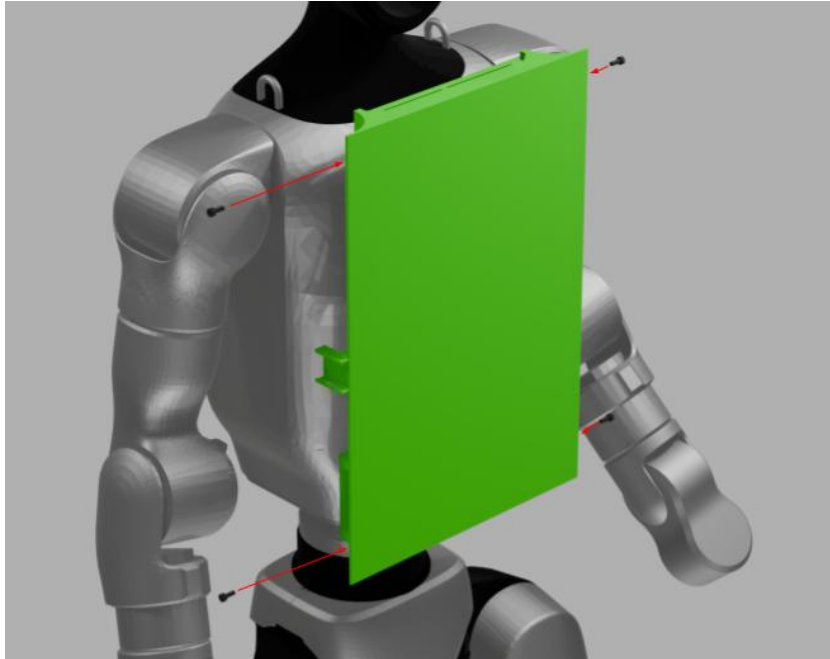
10. Insert 4× M3 nuts into the slots in the back of the chest plate adapter



11. **If using for teleoperation:** Mount the chest plate adapter to the Unitree G1 with 4× M5 bolts (Otherwise, skip this step. Remaining steps are unaffected)



12. Slide the chest plate over the chest plate adapter, making sure to align the grooves



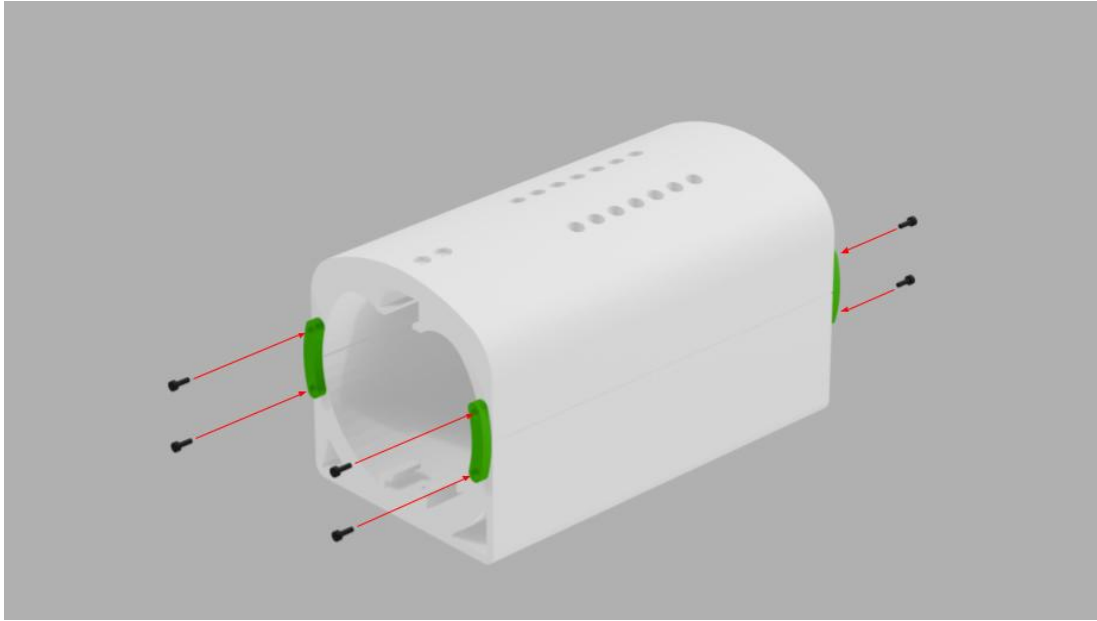
13. Use 4× M3 L8 screws to fasten the chest plate to the chest plate adapter

### *Forearm Covers*

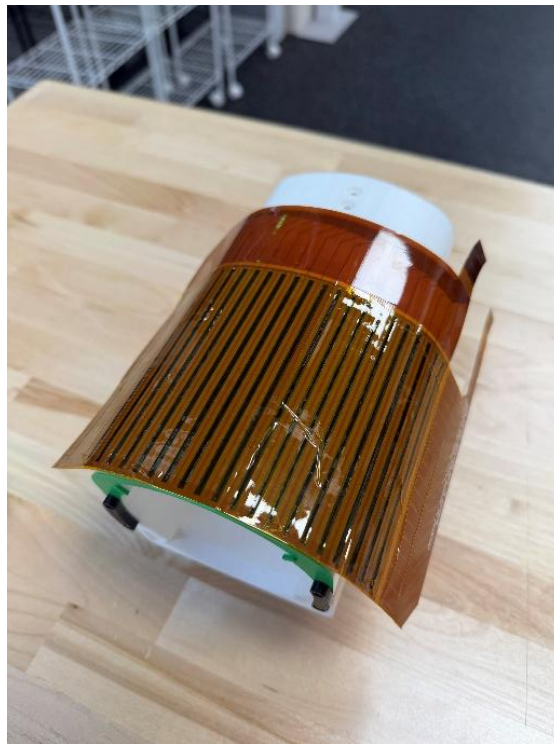
1. Assemble FlexiTac sensors according to <https://flexitac.github.io/>



2. Align the top and bottom pieces of the forearm covers along their grooves



3. Fasten 2× connectors to each side using 2× M2 screws for each of the connectors
4. Cut/mold a 160mm×100mm piece of silicone rubber, approx. 4mm thick



5. Align the FlexiTac sensor with the bottom of the edge of the rounded cover, such that the taxel area is centered on the cover, and leaving the two mounting holes exposed
  - a. **Optional:** It may be beneficial to reinforce the flat flex cable portion of the sensor with additional polyimide to prevent unwanted damage



6. Using duct tape or polyimide tape, secure the FlexiTac sensor to the cover



7. Place the silicone rubber pad over the taxel area of the FlexiTac Sensor so it fully covers the taxel area



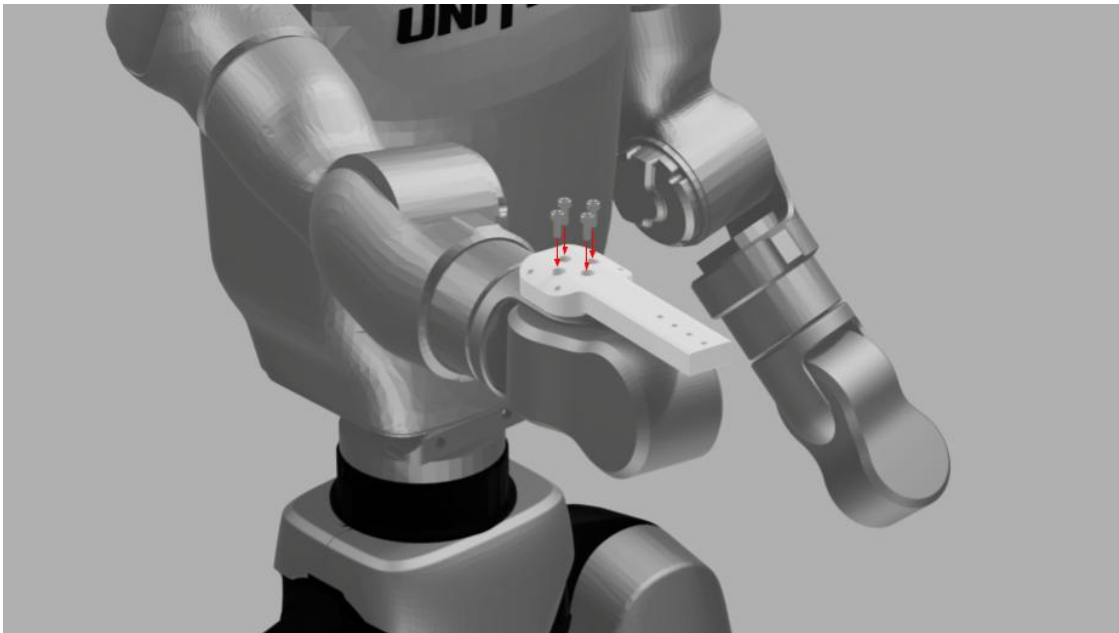
8. Secure the silicone rubber pad with duct tape or polyimide tape
  - a. **Optional:** Also secure the flat flex sensor ends down with polyimide



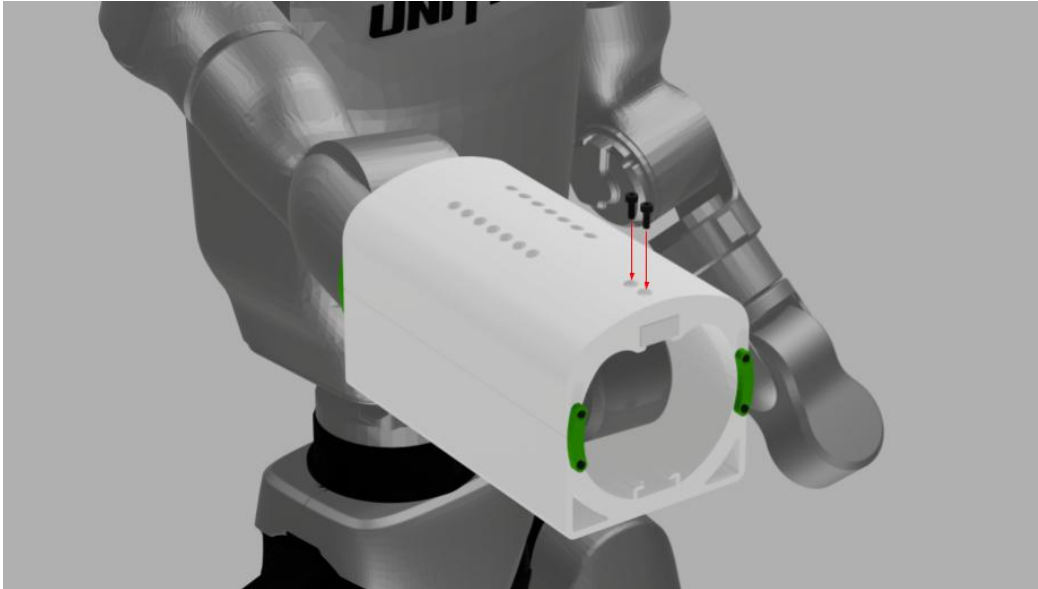
9. Connect flat flex ends of sensor to flat flex connector boards



10. Using flat flex cable connect the connector associated with the smaller flat flex sensor end to FPC-1 and the other to FPC-2 on the FlexiTac PCB
  - a. Use foam adhesive to mount the PCB to the flat side of the forearm cover, leaving some slack in the flat flex cables
  - b. **Note:** BOM lists only 32 Pin flat flex cables. Here, a 16 pin cable was used for clarity.
11. **If using for teleoperation:** Remove the 4× screws in the Unitree G1 wrist pitch joint (otherwise stop here, and repeat the above steps for the other cover)



12. Mount the forearm adapter to the Unitree G1 using the same 4× screws



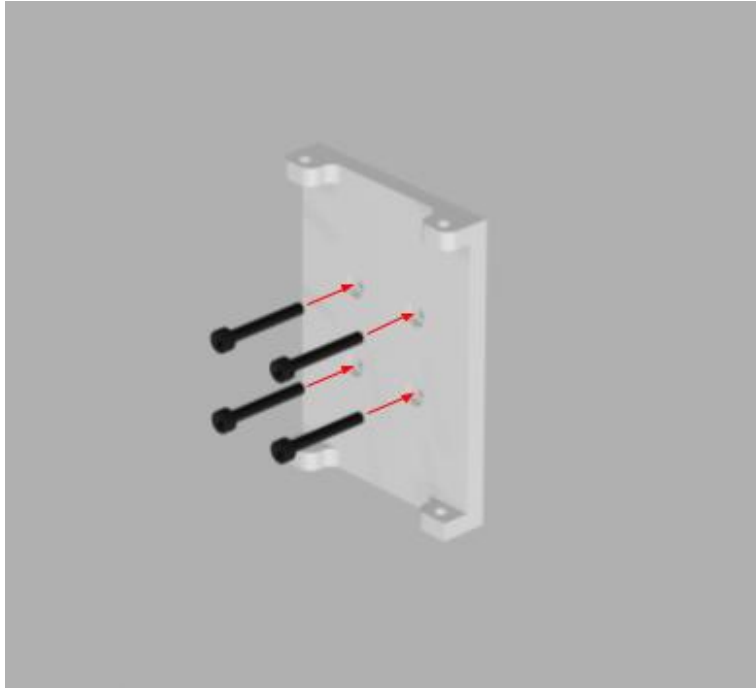
13. Slide the forearm cover assembly over the adapter so the adapter holes line up with the mounting hole, then using two M3 L8 screws, secure the forearm cover to the adapter
14. Repeat for both forearm covers

### *GripTac - Pictures*

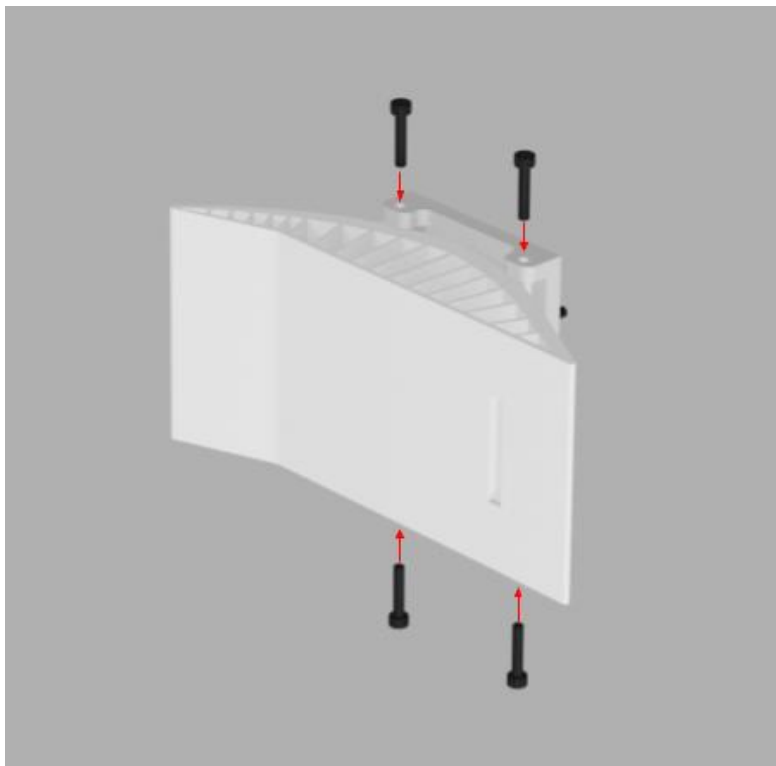
1. Cut a 104mm × 67mm piece of PVC backed fabric
2. Mold/cut a 104mm × 67mm piece of silicone rubber, approx. 4mm thick



3. **Optional:** If desired, remove the end from the TPU finger



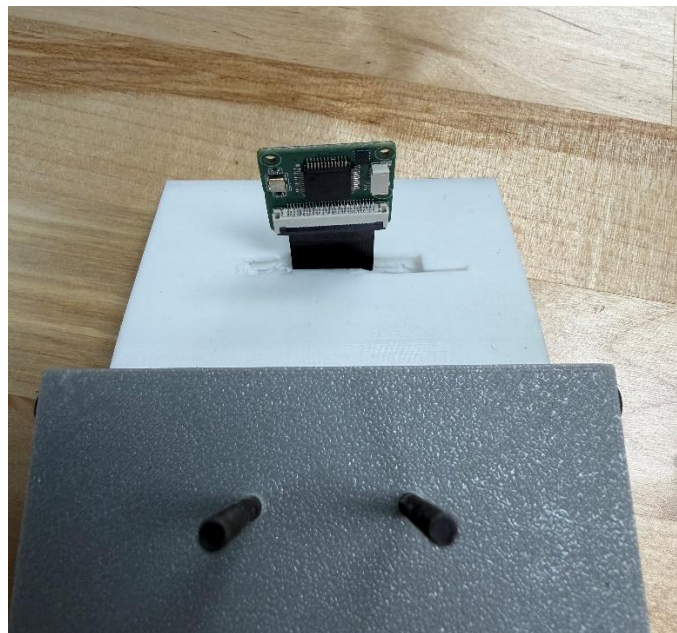
4. Place 4× M3 L22 screws through the holes in the finger adapter



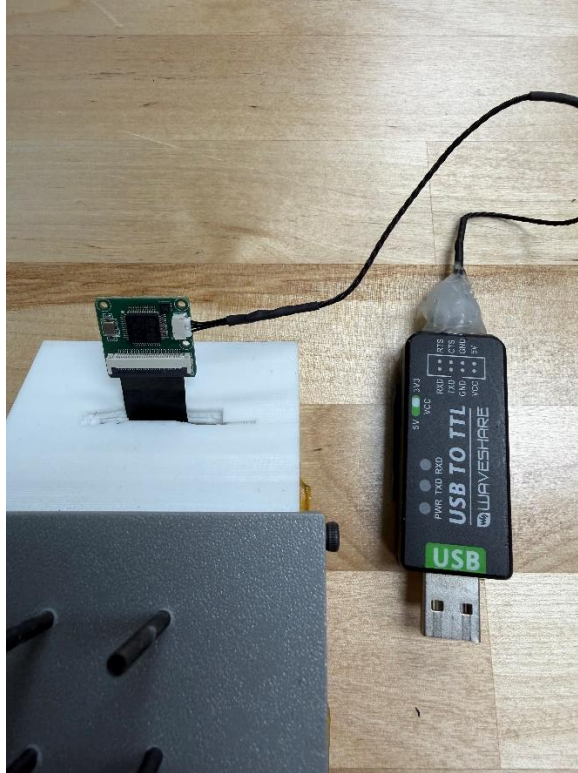
5. Line up the holes in the TPU finger with the holes in the adapter, then secure it with 4× M3 L8 screws



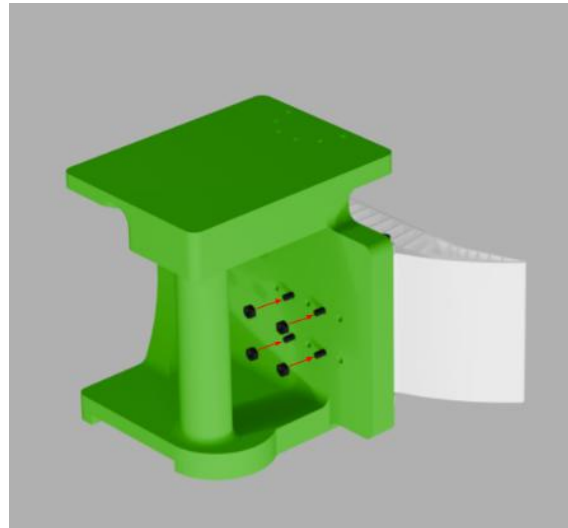
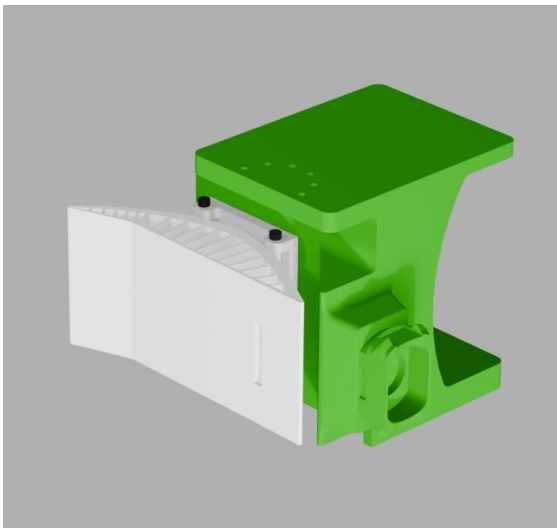
6. Place the TouchTronix SensX 160 on the flat face of the TPU Finger and feed its flat flex end through the slot. Place a layer of polyimide tape over the sensor and across the flat face of the TPU finger, being careful to avoid trapping dust or air bubbles



7. Connect the PCB to the flat flex end of the sensor



8. Connect the USB to TTL converter to the PCB



9. Slide the 4× screws sticking out of the finger adapter through the one set of mounting holes in the main GripTac body, and fasten them with 4× M3 nuts



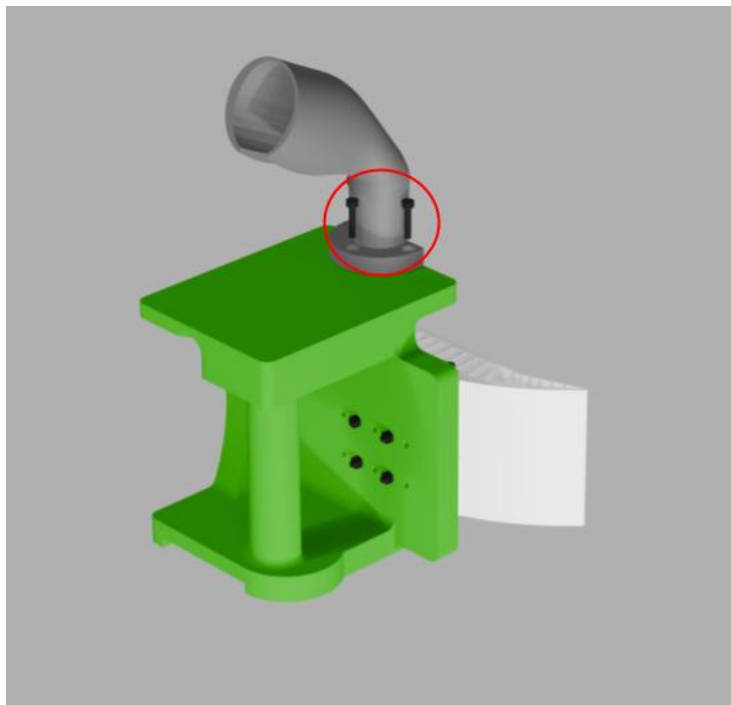
10. Place a layer of transfer tape over the polyimide layer on the TPU finger, then cover it with the previously cut piece of PVC backed fabric



11. Place another layer of transfer tape over the PVC backed fabric then cover it with the molded silicone rubber



12. Using foam tape, attach the USB to TTL converter somewhere out of the way of the sensor



13. **If using for human data collection:** mount the Pico controller holder to the top of the GripTac with 3× M3 L8 screws, then slide the correct Pico controller in
14. **If using for teleoperation:** Replace the default hands on the Unitree G1 using the adapter end of the GripTac