Optron2.2 Build Guide

Glossary:

Summary:

Project Optron's objective is to provide the next step in music performance. The Optron was originally created by our team's director Dr. Udell, an assistant professor at OSU. Designed to be intuitive to operate, the Optron can be played like an air guitar. Our team was tasked with designing and building the next iteration of The Optron. We had two objectives. The first objective was to redesign The Optron so it was more accessible to those with impaired hearing. The second objective was to make it open source so the public can build and contribute to this device. To make these improvements possible, Dr. Udell enlisted the help of Cymaspace. This group is based out of Portland, Oregon and helps make the arts more accessible to the deaf and hard of hearing. Using their expertise our team has created the next iteration of the Optron in the form of a device that will bring music to those that cannot hear.

This guide has 3 main parts: Prep, Assembly, and Code. During the Prep section you will be gathering all the required physical parts to make the Optron via 3D printing, online purchasing, and hardware store scrounging. During the Assembly section you will be assembling all of the physical parts to make the Optron, with the assumption that you won't need to backtrack to the tasks of the Prep section. During the Code section you will learn how to compile, upload, and modify Optron firmware.

While following the build guide you will be referencing a few pieces of material:

- Github repo: https://github.com/udellc/Optron
- Bill of Materials (BOM): https://github.com/udellc/Optron/blob/master/Optron2.1%20BOM.xlsx
- 3D printing files: https://github.com/udellc/Optron/tree/master/STLs/2.1

Numbering

This build guide will reference parts on the BOM via part numbers. Use this handy guide below to identify what part the BOM the build guide is referencing.

Part numbers come in three parts, and are assigned to each part in the BOM:

1. A letter which indicates type of part

M - Mechanical	E - Electrical	H - Hardware

2. A number which indicates which part it is
3. A number indicating which duplicate of a part it is

For example:

M-26-0 is the first ZXGestureSensorMount2.1

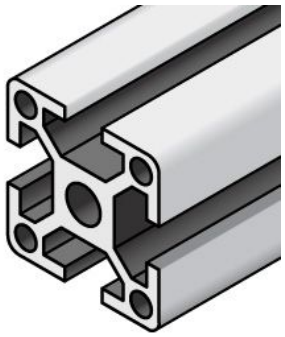
Prep:

The Optron requires many parts to be built to completion. The following sections describe the parts listed in the BOM, including hardware, 3D printed parts, electronic components, and the PCB. It is recommended to source all of these parts before trying to assemble the Optron. To find where to buy or download these parts, reference the BOM.

Hardware/Mechanical:

The Optron uses a bit of hardware to connect sensors to physical parts. A lot of these parts are generic, and can easily be found in hardware stores. Feel free to use whatever parts you can find around your house or at a store near you!

M-0	Al Extrusion Track 20x20 x 1220 mm



This part is the foundation of the Optron. It is what all other parts are mounted onto.

M-1	Muzata LED Channel

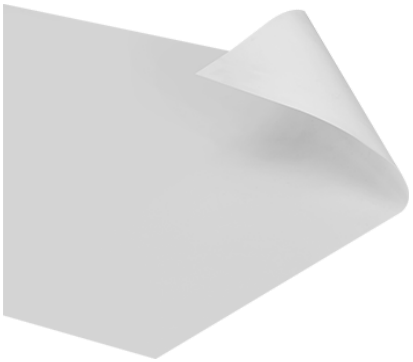
This part is where the LEDs for the Optron sit. It is essentially just an aluminum channel with a snappable diffuser on top. They come in a wide variety, all made by the company Muzata. Usually these LED channels come with a bunch of extra hardware that snaps to the bottom of the channel, allowing us to mount whatever we want to the bottom of them. The extra hardware is show below:

H-4	M3 Slide in T Nut for 2020 Series Aluminum Extrusion Profile Slot 6mm

These beauties provide a mount directly to the Al extrusion. They can slide into the extrusion channel, and other hardware can screw to them. They are used to mount the LED channel, of which will be discussed in the assembly section.

M-2	Teflon PFTE Film, 24" wide, 0.01" thick, 1ft length
M-3	Silicone Rubber Strip, Grey, High-temp, Adhesive back, 3/4" wide, 1/32" thick

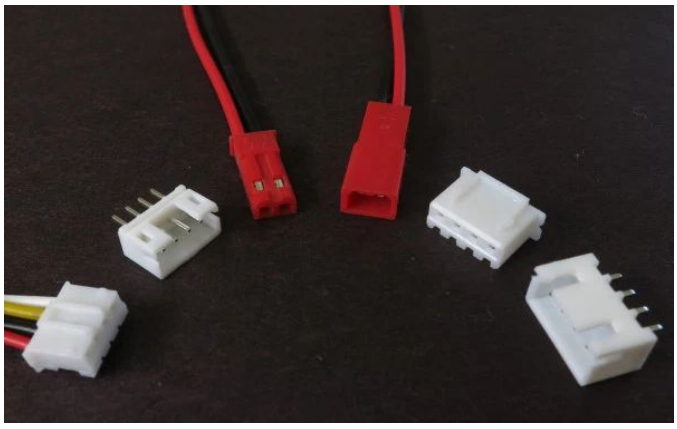
These 2 items are the covers for the 2 fretboard sensors, which will be discussed in the electronics section. Essentially they provide protection and ergonomics for those 2 sensors, which are very long, skinny, and thin. The teflon provides protection, and the silicon provides a pleasant surface to interact with.



H-5	M3 x 0.5 mm Thread Steel Phillips Flat Head Screws, 8 mm Long
H-6	M3 x 0.5 mm Thread Stainless Steel Hex Nut
H-7	M3 Stainless Steel Split Lock Washer
H-45	M3 x 0.5 mm Thread Steel Phillips Flat Head Screws, 12 mm Long
H-44	M3 x 0.5 mm Thread Nylon Slotted Flat Head Screws, 16 mm Long
H-8	M3 Nylon Plastic Washer
H-9	M3 x 0.5 mm Thread Nylon Slotted Flat Head Screws, 8 mm Long

These are all various pieces of generic hardware. They are used to mount the LED channel, mount IR sensors, mount the PCB, etc.

H-10	4 pin JST-XH Male thru-hole.
H-11	4 pin JST-XH Female thru-hole.
H-12	3 pin JST-XH Male thru hole.
H-13	3 pin JST-XH Female thru hole.
H-14	2 pin JST-XH Male thru hole.
H-15	2 pin JST-XH Female thru hole.
H-16	XH JST Contact



These are the various JST connectors you will need. For those unfamiliar with the JST standard, check out this: JST connect. In short, JST is a type of snappable wire connector that can be assembled by hand. You have probably seen a form of them on an RC car battery. Some resources for making your own connectors are listed in the assembly section.

3D Printed Parts:

The Optron uses a bunch of 3D printed parts for various tasks including mounting parts, managing wires, and providing ergonomic handling. To get these parts you will need to 3D print them. The BOM provides the STL file to do that, as well as provides the options required for printing them to specification. These STLs are hosted on Github, and Github provides a great lightweight viewer for STLs. I recommend looking at the Optron STLs on there rather than on this build guide.

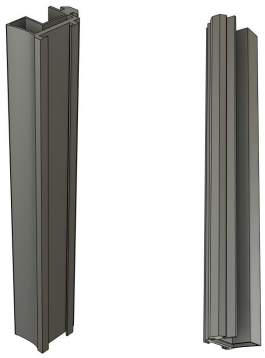
The Fretboard

The fretboard is a 3 part assembly that houses the *E-34 Long Linear Pot* and the *E-33 FSR Long*, as well as the *M-2 Teflon* and the *M-3 Silicon*. It gets its name from a guitar fretboard, since it is supposed to be interacted with in a similar fashion. It is printed in 3 sections because it is 660mm tall, which is taller than most 3D printers can handle.

M-19	FretBoardTop2.1

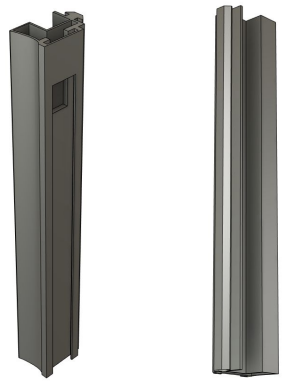
This is one of the 3 parts that make up the fretboard. More specifically it is the top part.

M-17	FretBoard2.1



This is one of the 3 parts that make up the fretboard. More specifically it is the middle part.

M-19	FretBoardTop2.1



This is one of the 3 parts that make up the fretboard. More specifically it is the bottom part.

The ZX Gesture Sensor Array

The ZX gesture sensor array dominates the top and back of the Optron. It provides a mount for the 8 ZX gesture sensors (which will be discussed later in the electronics section), the Optron strap, and the MPU6050 Gyro (which also will be discussed in the electronics section). Additionally it provides a channel for wires to run through and connect to the main PCB without getting in the way of the musician.

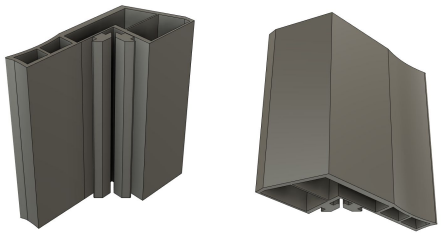
M-26	ZXGestureSensorMount2.1

These 4 parts provide a mount the ZX gesture sensors as well as a backing for the fretboard.

M-27	ZXGestureSensorMountSimple2.1

These 4 parts provide a mount the ZX gesture sensors.

M-22	SlidingWireManger2.1

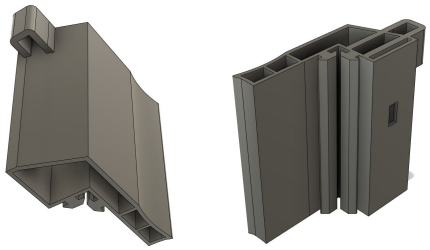


These 3 parts are a wire channel as well as a backing for the fretboard.

M-23	SlidingWireMangerSimple2.1

These 3 parts are a wire channel.

M-46	SlidingWireManagerSimpleStrapmountMPU6050Mount2.1

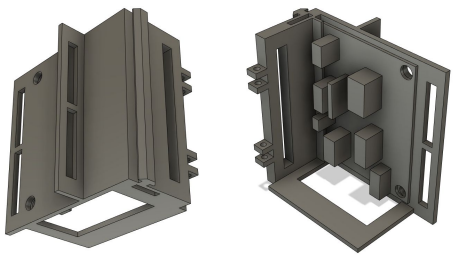


This 1 part is a wire manager, a backing for the fretboard, and a mount for the MPU6050 gyro.

The PCB Mount

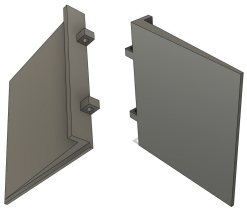
These 2 parts provide a mount for the main PCB to connect to. It sits at the bottom of the Optron, and all of the wires are channeled towards it.

M-48	PCBMountBottom2.1.2



This part is a direct mount for the PCB.

M-47	PCBMountTop2.1.2

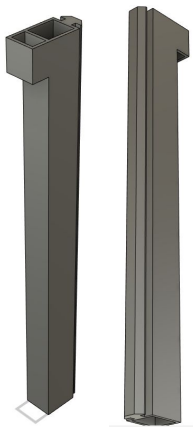


This part covers the PCB.

Additional Wire Managers

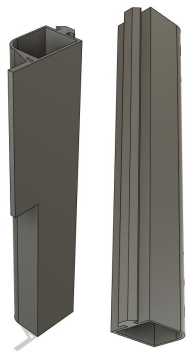
There are 2 additional wire managing parts. These both sit on the same side of the Optron as the fretboard and PCB mounts.

M-49	EPickWireManager2.1



The e-pick wire manager runs the fretboard wires as well as the e-pick wires. The e-pick wire manager also provides a square where the e-picak can be latched. The e-pick is discussed later in the electronics section.

M-50	FretBoardWireManager2.1.2

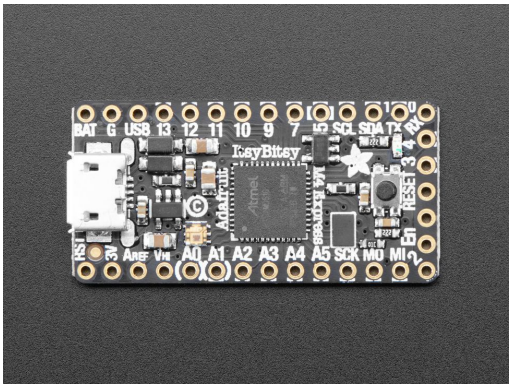


The fretboard wire manager runs wires from the fretboard sensors as well as provides a nice little platform for the e-pick to strum against. The e-pick is discussed later in the electronics section.

Electronics

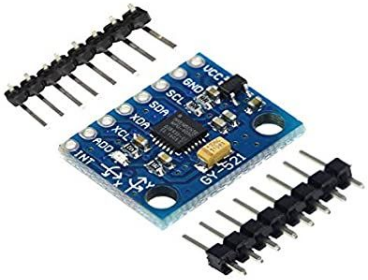
The Optron is in many ways just a fancy sensor mounting device. Most of the electronics are pre-built, and the parts that aren't go onto the main PCB. Reference the BOM to find links to purchase them.

E-28	ItsyBitsy



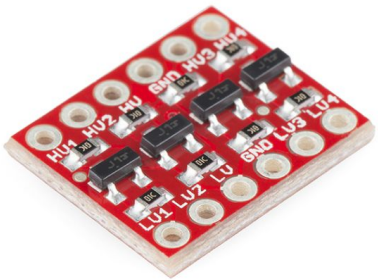
The itsybitsy is an Arduino breakout board powered by a ATSAMD51. It is the brains of the Optron.

E-32	GY521



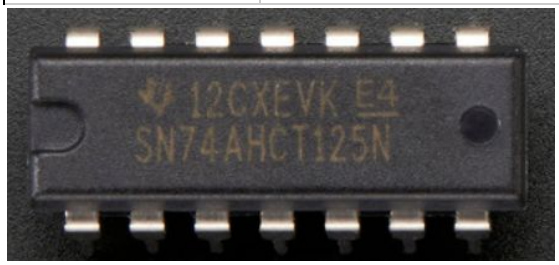
The GY521 is a breakout board for an MPU-6050. This sensor gathers both acceleration and rotation data. It is mounted on the SlidingWireManagerSimpleStrapmountMPU6050Mount2.1.

E-29	i2c Logic Level Shifter



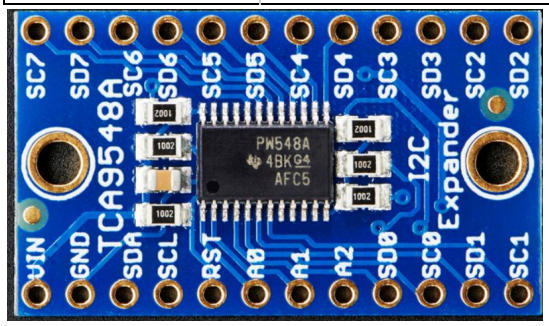
The BOB-12009 is a logic level shifter specifically created to work with I2C busses. This is required for this design as many of the sensors I2C lines operate with 5 volts while the ItsyBitsy requires 3.3V. This breakout board makes the two different levels work seamlessly.

E-30	Quad Level Shifter



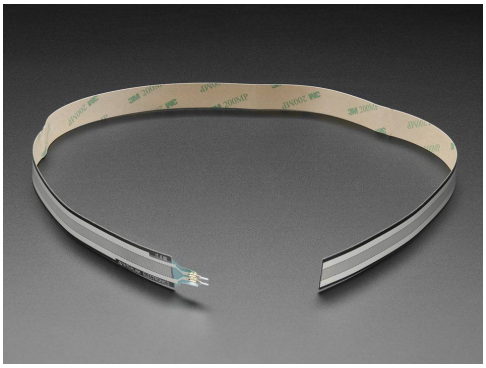
The 74AHCT125N chip is a 4 input and output logic level shifter. This IC as a connection point between the ItsyBitsy and the LED strip. The LEDs require clock and data lines at 5 volt logic while the ItsyBitsy lines are at 3.3 volt logic. This chip will boost that voltage to 5 volts to correctly work with the LEDs.

E-31	i2c Multiplexer 8ch



The TCA9548A is a 8 to 1 multiplexer breakout built to work specifically with high speed and high integrity signal lines such as the I2C communication lines. This allows the system to use many sensors while simplifying the connection points to the microcontroller.

E-33	FSR Long
E-34	Long Linear Pot



These are the two sensors that comprise the fretboard. The pressure sensor (FSR Long) and position sensor (Long Linear Pot) are shown, respectively, to the left. The pressure sensor senses how hard you are pressing, while the position sensor senses where you are pressing.

E-35	ZX Gesture

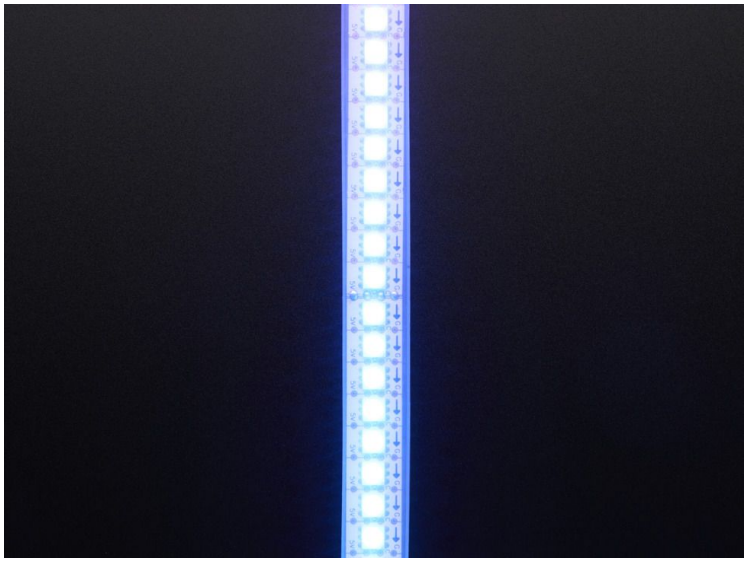
The ZX Gesture sensor is an IR sensor that detects how far away the user's hand is from the sensor in two directions. The board is made by sparkfun, and 8 of them total sit on the Optron.

E-36	Bend Sensor, 1in bidirectional male connector, polyester overlay

This is the sensor that makes up the epick. It is essentially a flex sensor, that is a sensor that changes its analog value based on the amount of bend in it. It fills the role of a reversed guitar pick on the Optron.

E-37	Adafruit Dotstars 144led/m white, 1m

E-38	Adafruit Dotstars 144led/m white 0.5m



These two strips of flexible multicolored provide a visual output for the Optron. They sit in the LED channel, as mentioned above in the Hardware/Mechanical section. You will need to cut up one of the LED strips to make it fit the Optron. This will be discussed later in this document.

E-39	Alitove 5V AC to DC

This is the power supply for the Optron. There is no onboard power supply. The itsybitsy is powered via 5V USB power.

E-42	Haptic Motor Driver
E-43	LRA Motor

These parts make up the haptics of the Optron.

E-32	6dof IMU breakout

E-40	2.1mm DC Barrel Jack (for breadboard)

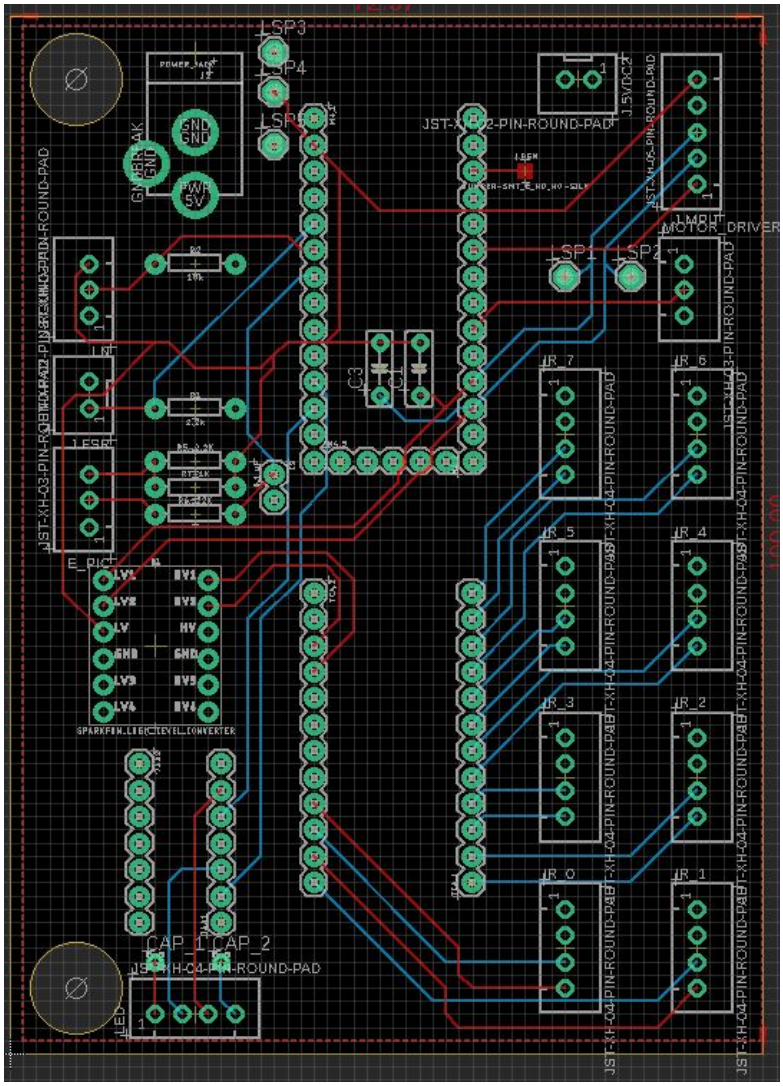
R1 2.2k
R2 10k
R3, R4 47k
C1, 1kuF
M4.1, M4.2
M4.3
J5VDC, J5VDC2
J.MPU
J. 74A1, 74A2
B1
J.FSR
J.C1, for 1000µFCap
J.DS
J.PIC
J.LN
i2c1.1, i2c2.1
i2c.1.2, i2c.2.2
J. TCA.1, TCA.2

These various pieces of electronics all go onto the main PCB. They compose of a few ICs as well as generic through-hole electronic parts

Main PCB

Below is the outline of the PCB with some guides to help find where pieces connect to.

PCB Outline



Steps

There are a couple of steps towards preparing the PCB for integration with the full system. A soldering iron will be heavily used throughout this process. The first step is to solder male headers onto the ItsyBisty, the BOB, and the 8 to 1 multiplexer.

Next the connectors on the board need to be soldered on. All of the white squared on the PCB resembled female JST connectors varying between 2 to 5 pins. The more open side of the female JST headers are faced in the direction of the two line marks on the PCB. There are a total of two 2 pin headers, three 3 pin headers, nine 4 pin headers, and one five pin header. Pay attention to the orientation of the header on the PCB, for example the five pin header for the MPU is facing the opposite direction as the eight 4 pin headers for the IR sensors.

With the headers installed the discrete components can now be soldered in. These are the resistors and capacitors used in the design. There are five resistors and four capacitors needed. There are labels next to the spots for each component regarding values. Note that the capacitors underneath the ItsyBitsy are very small, about 0.1 uF, and are for coupling. The largest capacitor is near the LED output at the bottom of the board.

Next the test points can be soldered in, although this is optional. These are for testing purposes only and will not change the behavior of the board. These are useful for checking important signals and voltages in case debugging is

needed although this can still be done if headers aren't soldered in. If wanted a single male header can be soldered into each of the points marked SP on the board. A total of five of them are included.
The next step is to prepare for the parts that male headers were soldered onto. For each of the long runs of through holes, for example the ones labeled M4.1, M4.2, and M4.3 will require female headers to be soldered in facing up. This is where the previously prepared components will plug into on the board.
The final chip to be added to the board is the 74AHCT125N which is just a chip with no headers. This can be placed in the bottom left corner of the board directly above the LED output connector. Orientation here is very important, make sure the indent of the IC is facing down towards the LED output.
And now for the final component, the power jack. This can be soldered on at the very top of the board and is used to plug in an AC to DC external power adapter (similar to a laptop charger). The prongs may need to be bent to hold the power adapter in place while soldering on.
Now the PCB is ready to be placed on the system.

Assembly

The assembly section details how to put together the Optron, and assumes that the prep section has been completed. I would suggest reading this section below before attempting it because there will be several points where you change gears from one type of task to another.

1) Prepping 3D printed pieces

Most of the 3D printed pieces are attached to the Optron via a sliding section that slides into the aluminum extrusion. The pieces use friction to keep in place, and as such are printed with a tight tolerance. You will need to work the excess material off the sliding parts of the pieces to be able to slide them effectively. The best way to do this is to press the piece into the aluminum extrusion a bit, remove it and the discarded excess material, and then repeat this several times until the piece will easily slide into the aluminum extrusion. You will want to keep chafing the piece inside the aluminum extrusion until you can easily slide it end to end. DO NOT TRY AND PUT THE WHOLE PIECE IN THE EXTRUSION BEFORE WORKING IT. It will get stuck, and be nearly impossible to remove. You can trust me on this.

For a video tutorial on doing this, go here: How To Prep 3D Printed Pieces for the Optron2.1.

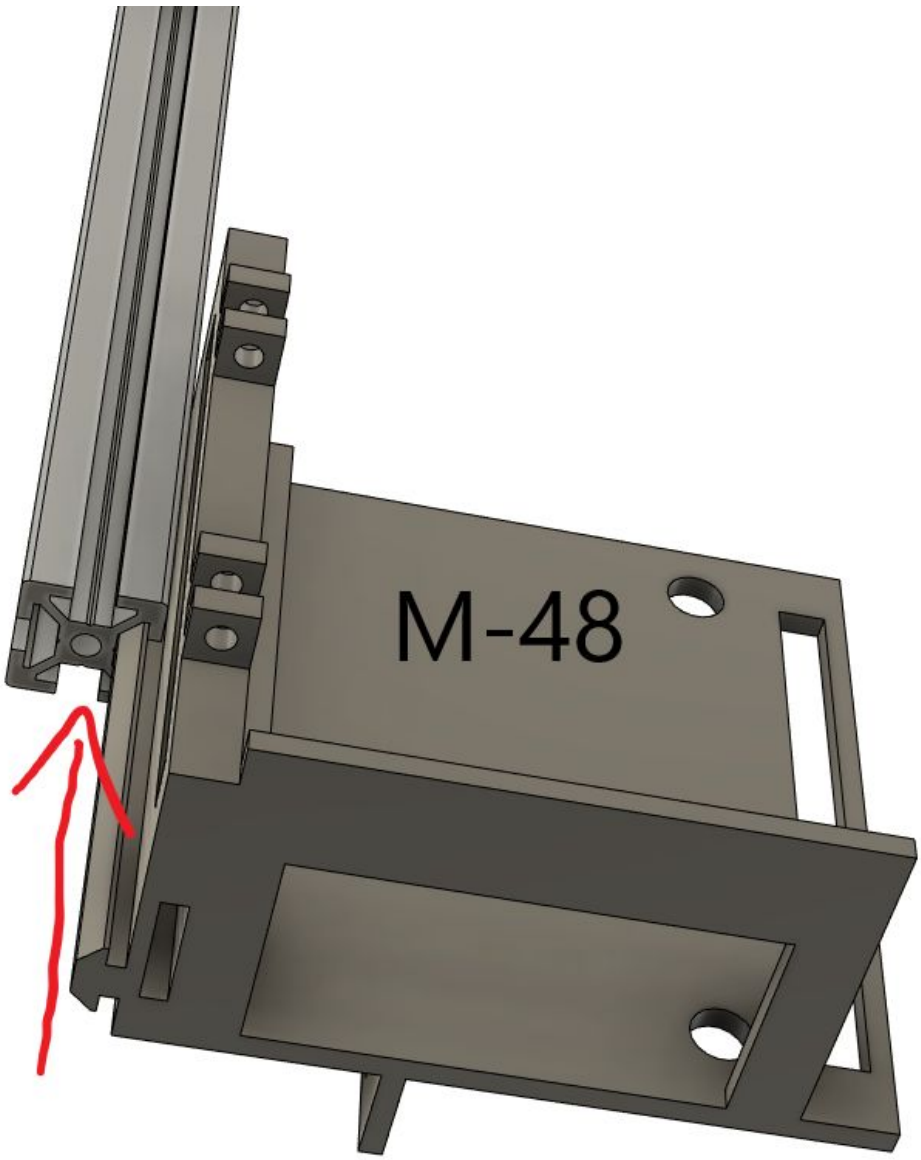
Work in the following pieces before proceeding to the next step:

Part Number	Name	Quantity
M-17	FretBoard2.1	1
M-18	FretBoardBottom2.1	1
M-19	FretBoardTop2.1	1
M-22	SlidingWireManger2.1	3
M-23	SlidingWireMangerSimple2.1	3
M-48	PCBMountBottom2.1.2	1
M-26	ZXGestureSensorMount2.1	4
M-27	ZXGestureSensorMountSimple2.1	4
M-46	SlidingWireManagerSimpleStrapmountMPU6050Mount2.1	1
M-49	EPickWireManager2.1	1
M-50	FretBoardWireManager2.1.2	1

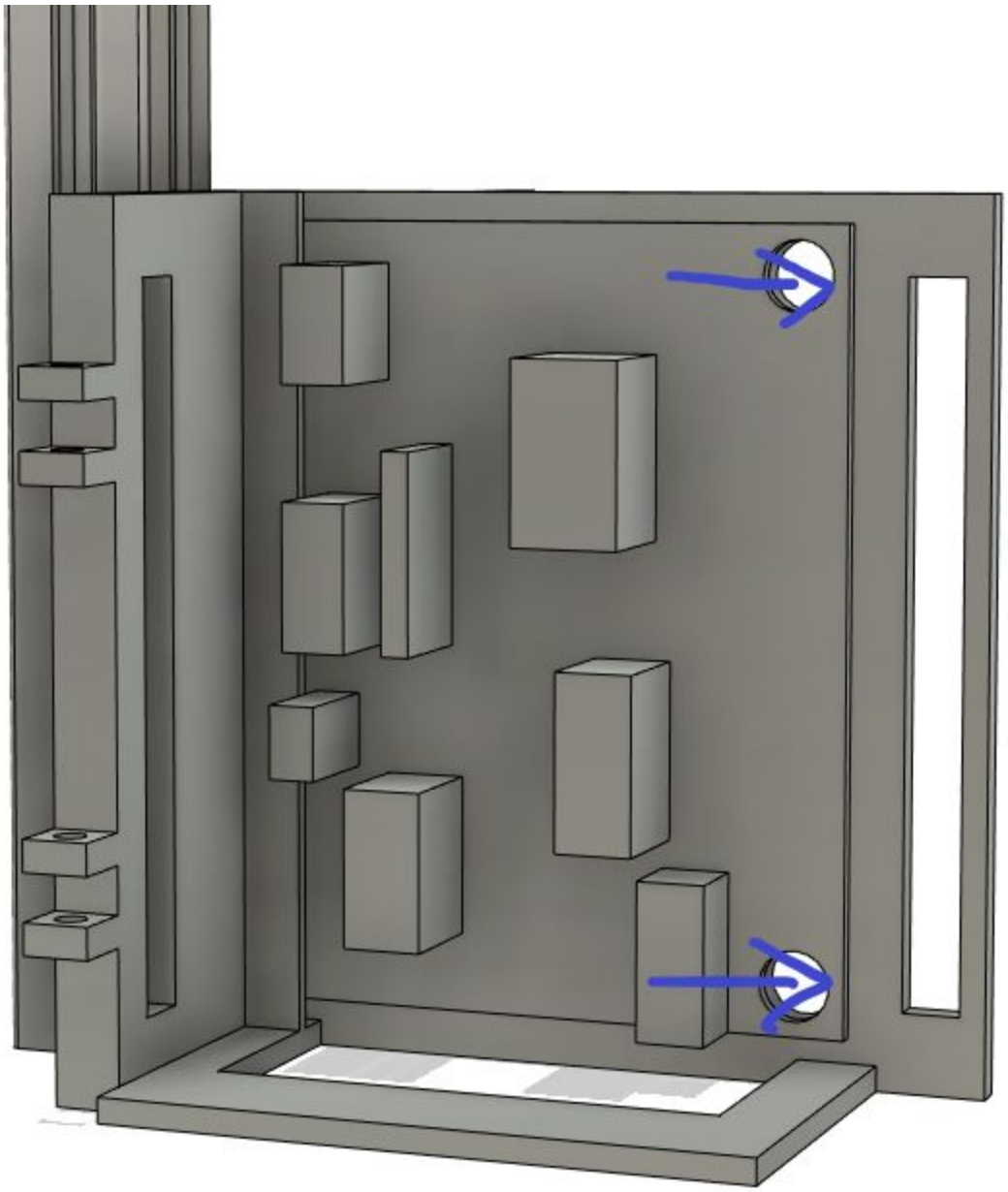
2) Attaching the main PCB

The main PCB should be fully assembled based on instructions during the prep step above. In this step we are going to slide on the PCBMountBottom2.1.2, mount the PCB to it, and then optionally attach the PCBMountTop2.1.2 to the top of the PCBMountBottom2.1.2.

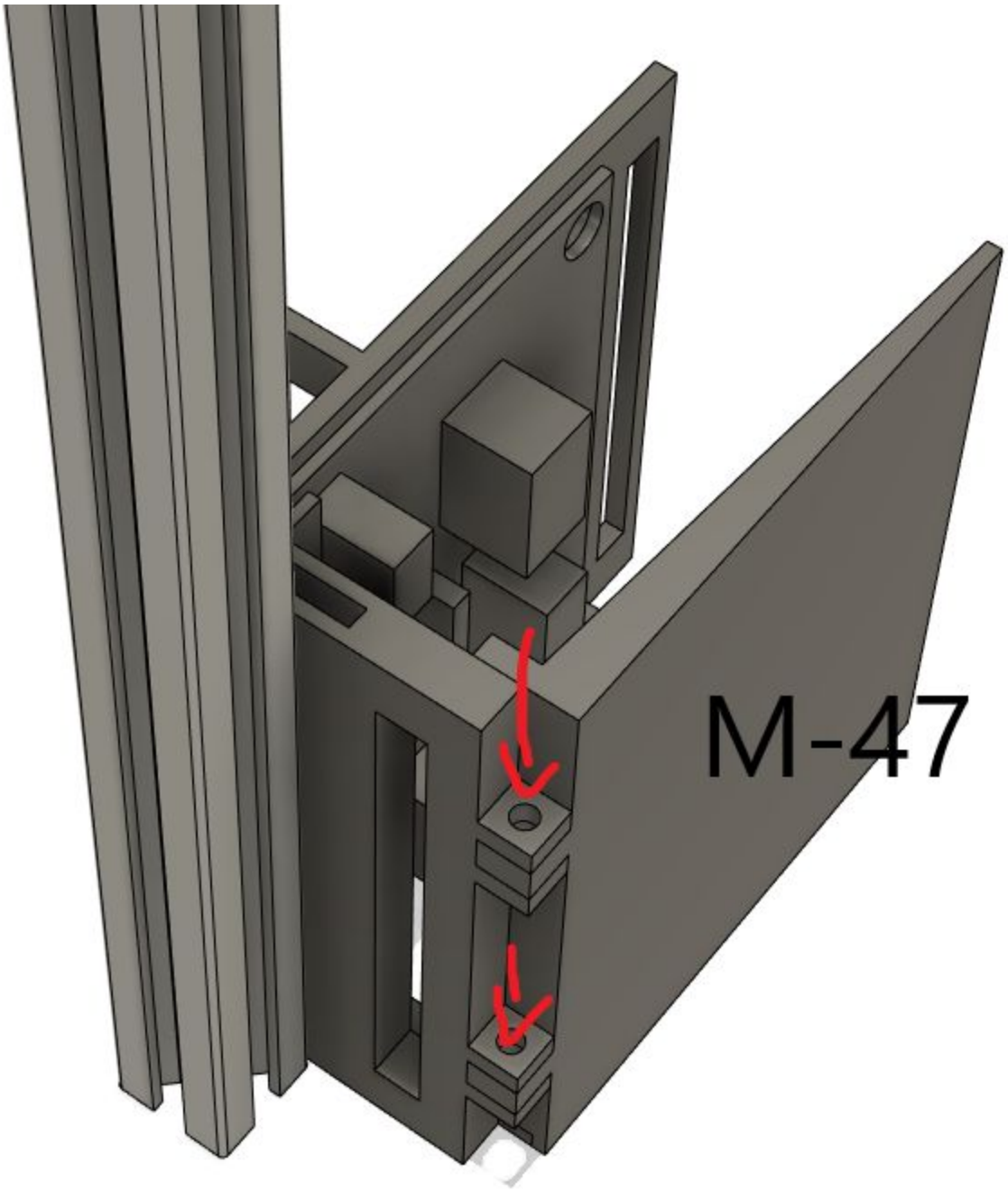
2.1 Slide the PCBMountBottom2.1.2 on



2.2 Attach the main PCB



2.3 Attach the PCBMountTop2.1.2



3) Learning how to make JST connections

This next step, Assembling the ZX Gesture sensor array, will be the longest part of assembling the Optron purely because it involves creating many of the aforementioned JST connectors, which takes a long time. As such, it makes sense to become adept at creating JST connections prior. As a note to all you JST experts, we are using XH w/ 2.50mm pitch JST connectors.

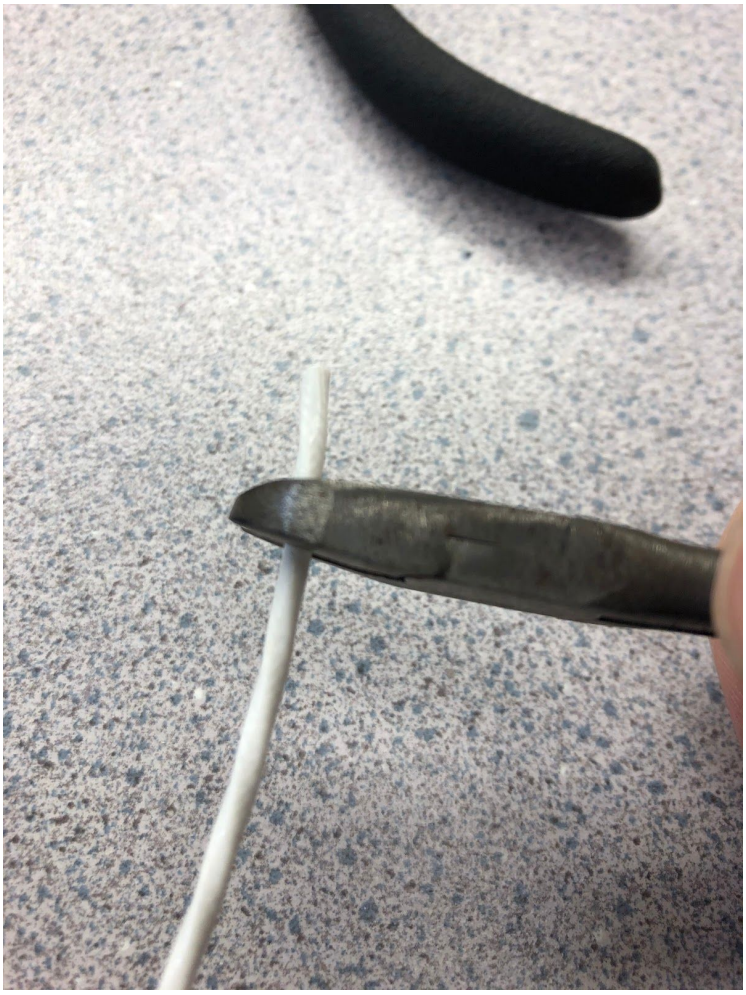
3.1 Prep a connector

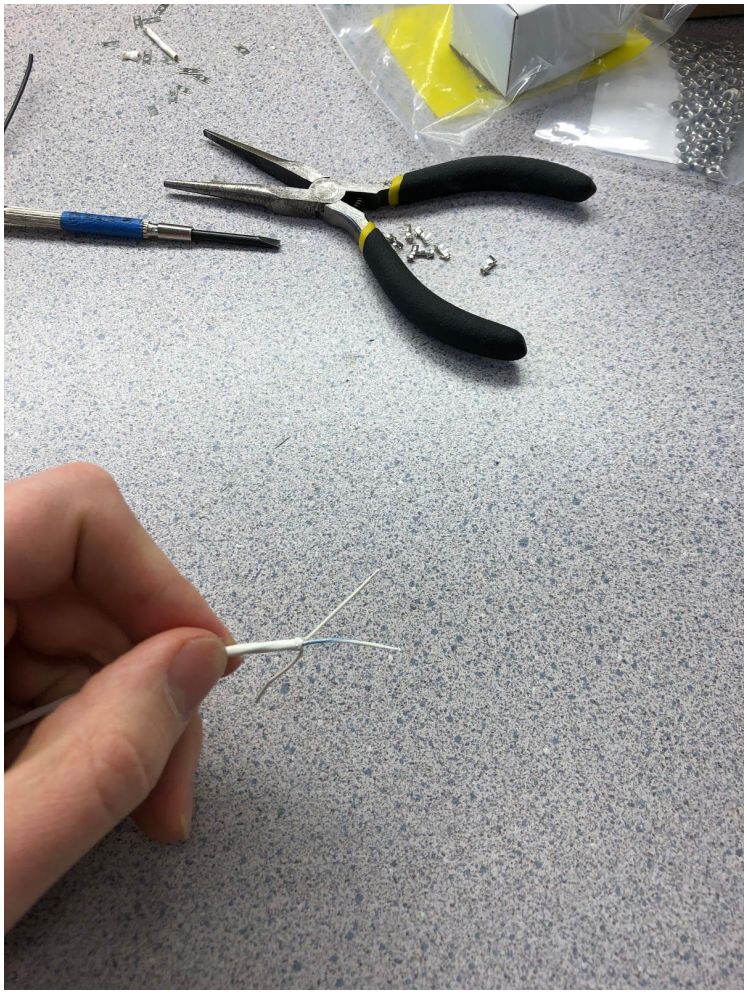
Clip off one JST crimp (See BOM H-16)

Place the JST crimp into the crimp tool. Click it down until the JST crimp is held in place, but not crimped.

3.2 Prep a wire

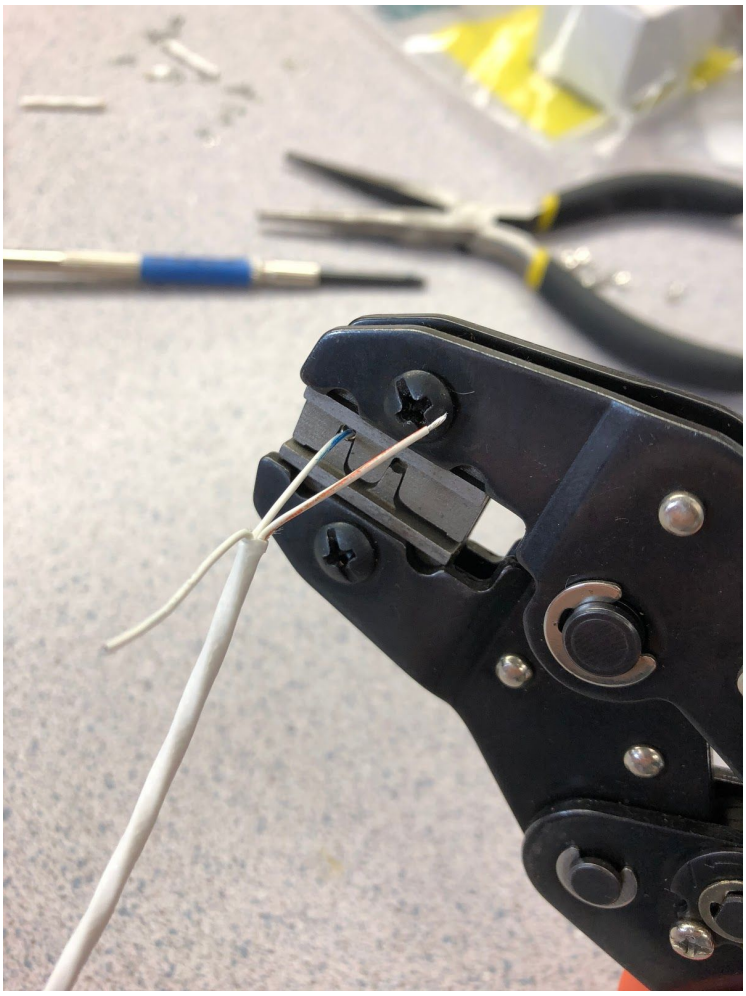
Strip the end of a wire so about 1~2 mm is bare. Usually the amount of bare wire is less than you think, so it will take some practice to get the length correct consistently. I do not recommend using solid core wire with JST connections, only stranded. Between 18~26 GA usually works best for this size.





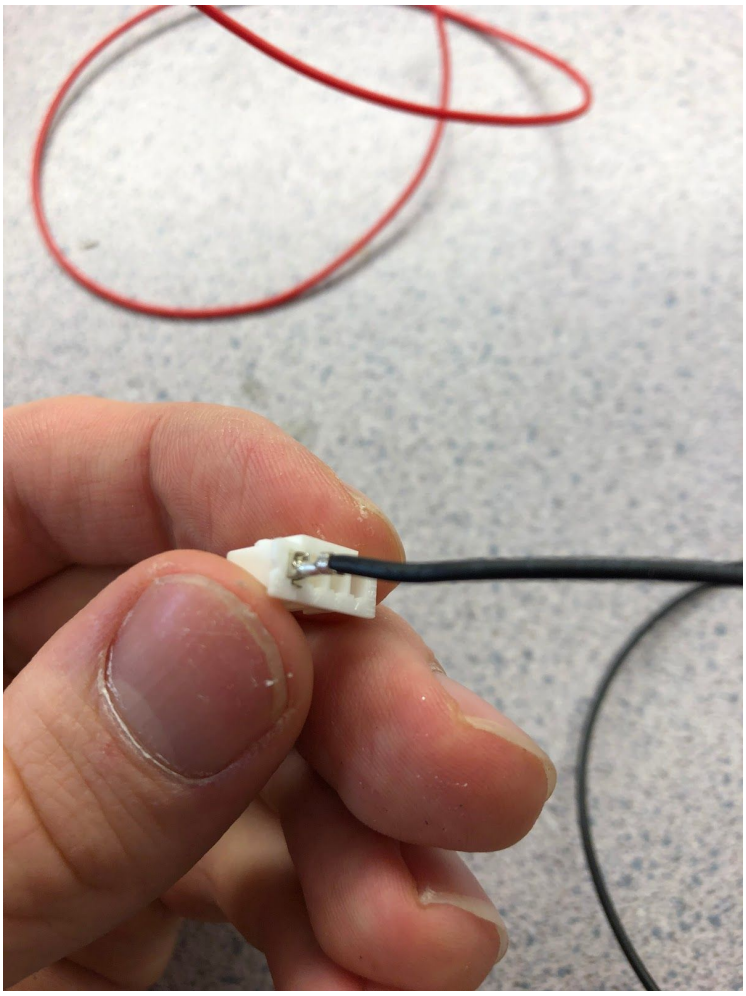
3.3 Crimp a wire

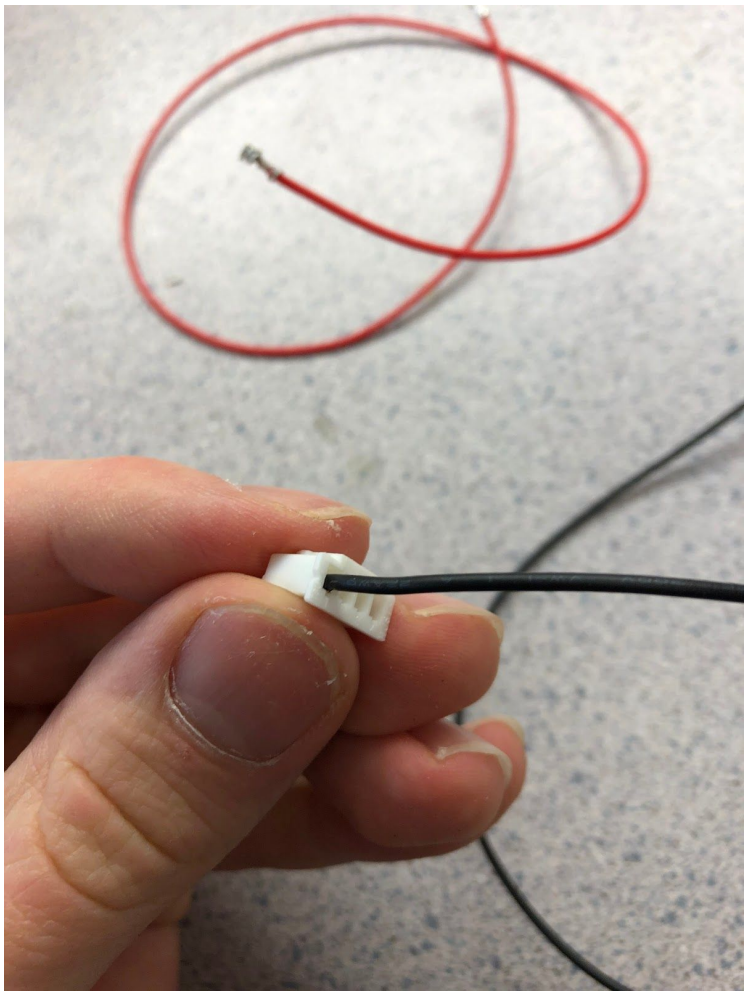
Delicately insert the wire into the JST crimp until it butts up against the end of the crimp. Then, while holding the wire, clamp down the crimp tool. Resist the urge to re-clamp the tool after the initial clamp, as this will actually make the connection worse. Trust the tool. After clamping remove the crimp from the tool and make sure that it has a solid connection.



3.4 Insert crimp into a socket

Insert the crimp with wire attached into a JST connector until you feel a very slight click. I recommend never applying pressure to the wire while inserting, and instead using a tool like a screwdriver to press the crimp into the connector. The connector used in the images below is a H-11.



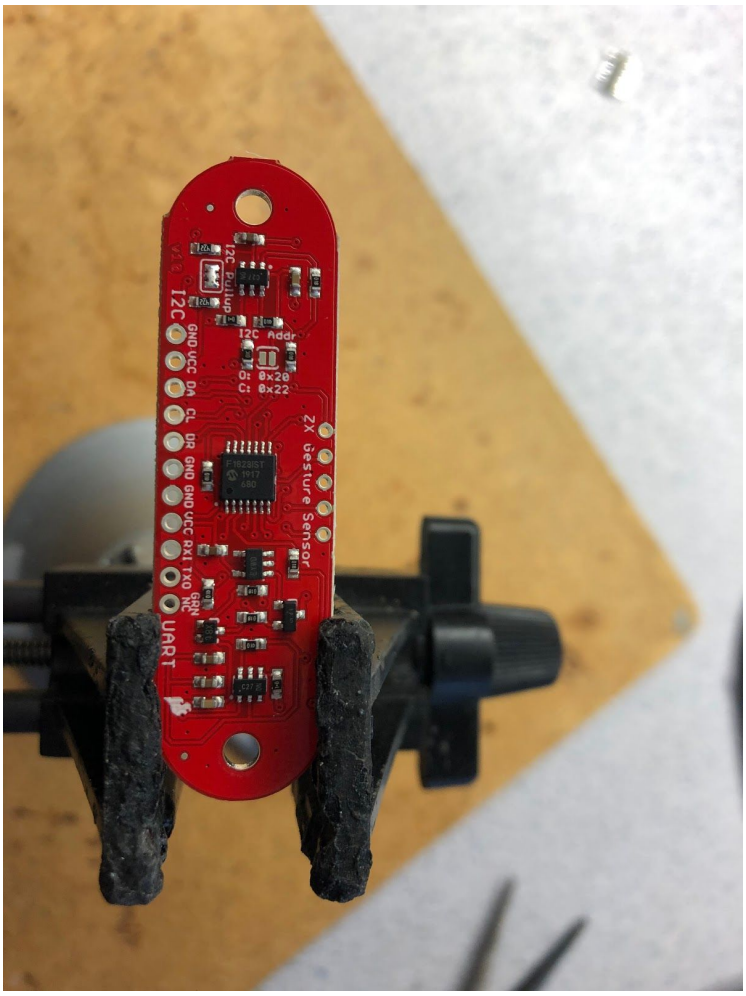


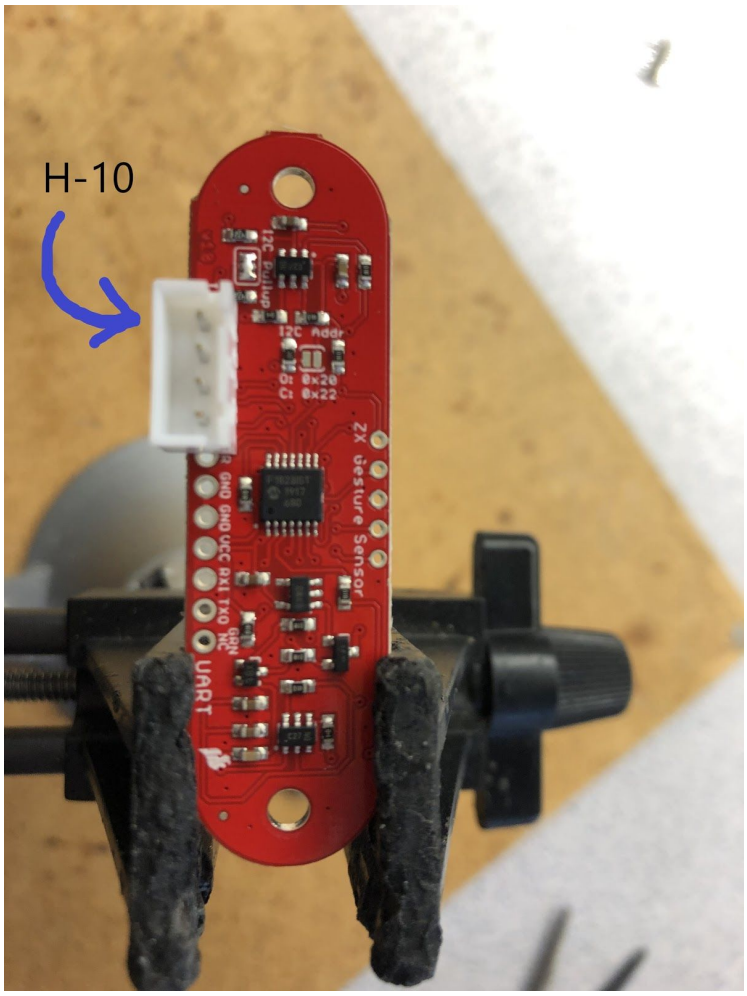
4) Assembling the ZX Gesture sensor array

This section entails assembling and wiring all 8 ZX Gesture sensors (E-35), as well as the MPU 6050 Gyro (E-32). You will start by soldering the JST connectors onto the ZX Gesture sensors and the MPU 6050 Gyro, then you will wire each sensor up and slide it and it’s corresponding 3D printed part onto the Optron.

4.1 Solder the 8 ZX Gesture sensors (E-35)

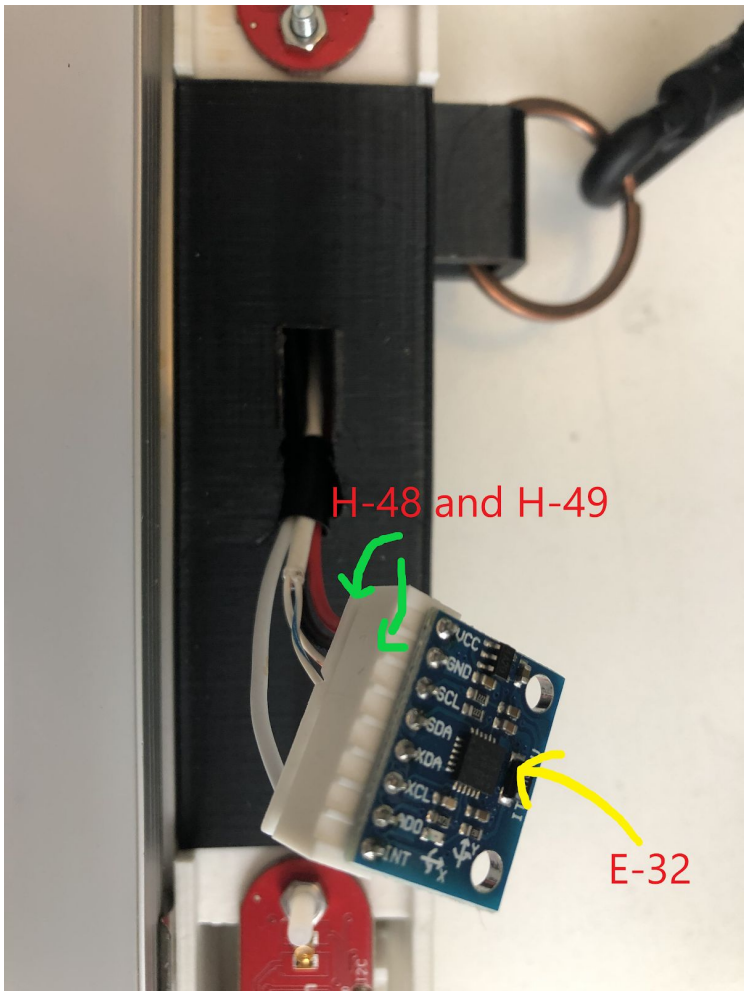
Solder the sensor as shown below. Use a 4-pin Male JST (H-10), solder it facing opposite the infrared LEDs, with the JST notch facing towards the center of the sensor.





4.2 Solder the MPU-6050 Gyro (E-32)

Solder the sensor as shown below. Use a 8-pin Male JST (H-46), solder it facing opposite the infrared LEDs, with the JST notch facing towards the center of the sensor.

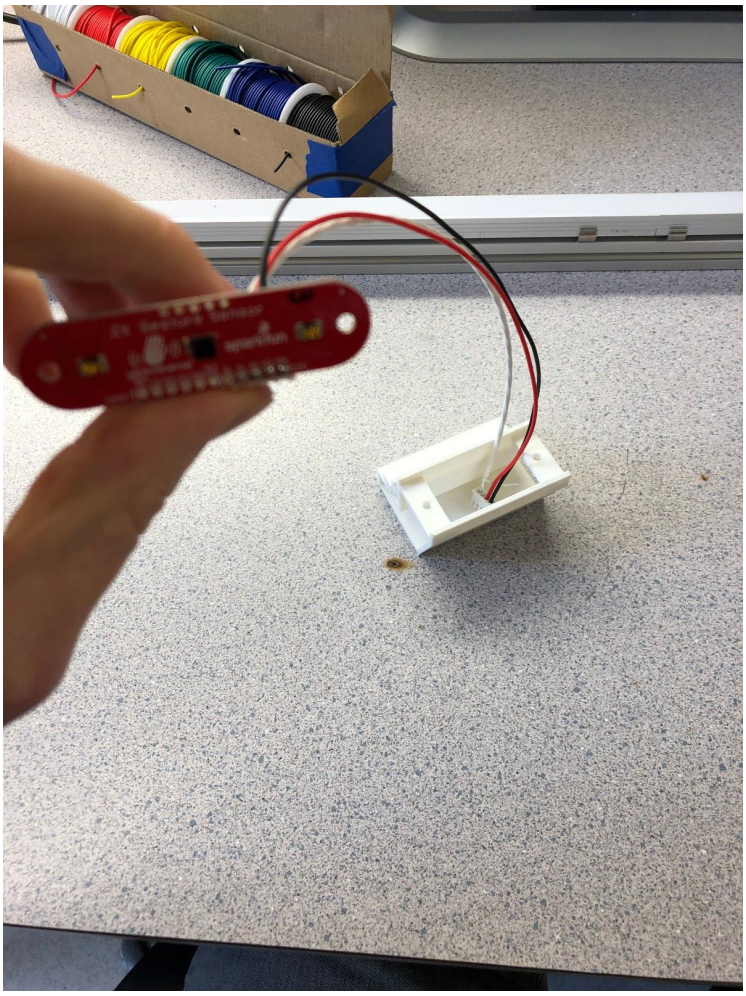


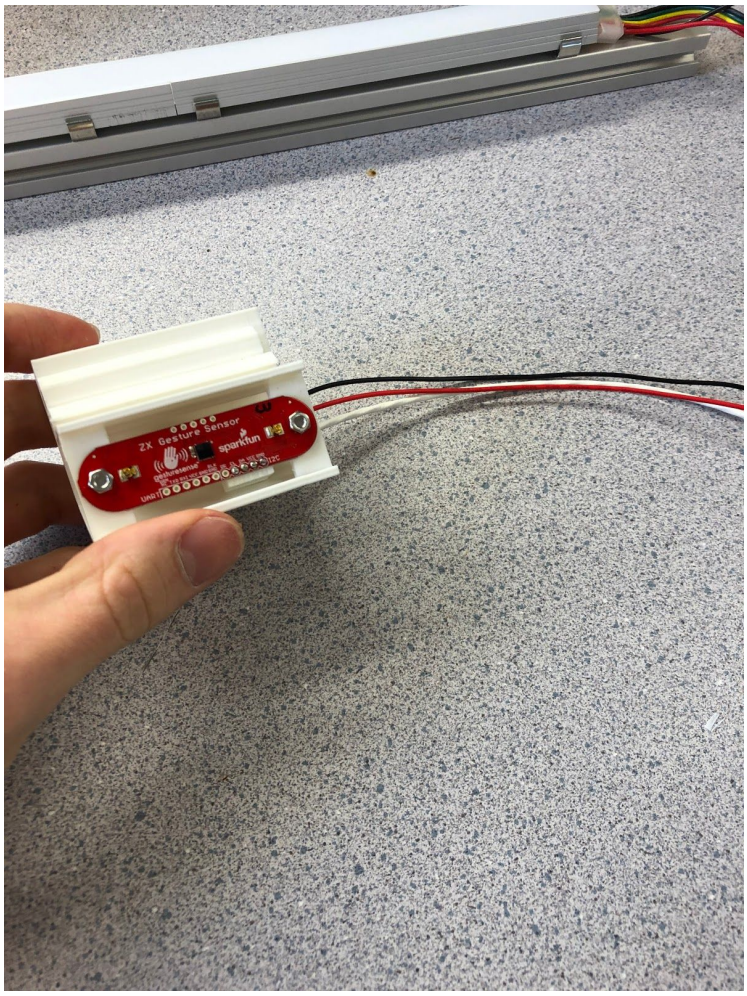
4.3-4.17 Side Notes

The next few steps share similar actions, so a few things should be noted before starting. The ZX Gesture sensors use 4 wires. The GND and VCC can be any type of wire. However, the DA and CL wires need to be shielded. This is because they are I2C lines, and the I2C communication protocol has a tough time communicating over long distances. In any case, for each sensor you will prepare 8 JST crimps with the appropriate wire types, and then plug them into female 4-pin JST connectors (H-11) on both ends of the wires. When preparing the length of the wires, keep in mind how far the wires need to travel to plug into the main PCB. The MPU6050 Gyro will follow the same idea, except its JST connection to the actual sensor is a 7-pin female connector, and the end that will attach to the main PCB will be a 5-pin female connector. This is because only 5 of the connections on the sensors are used: the GND, VCC, DA, CL, and INT.

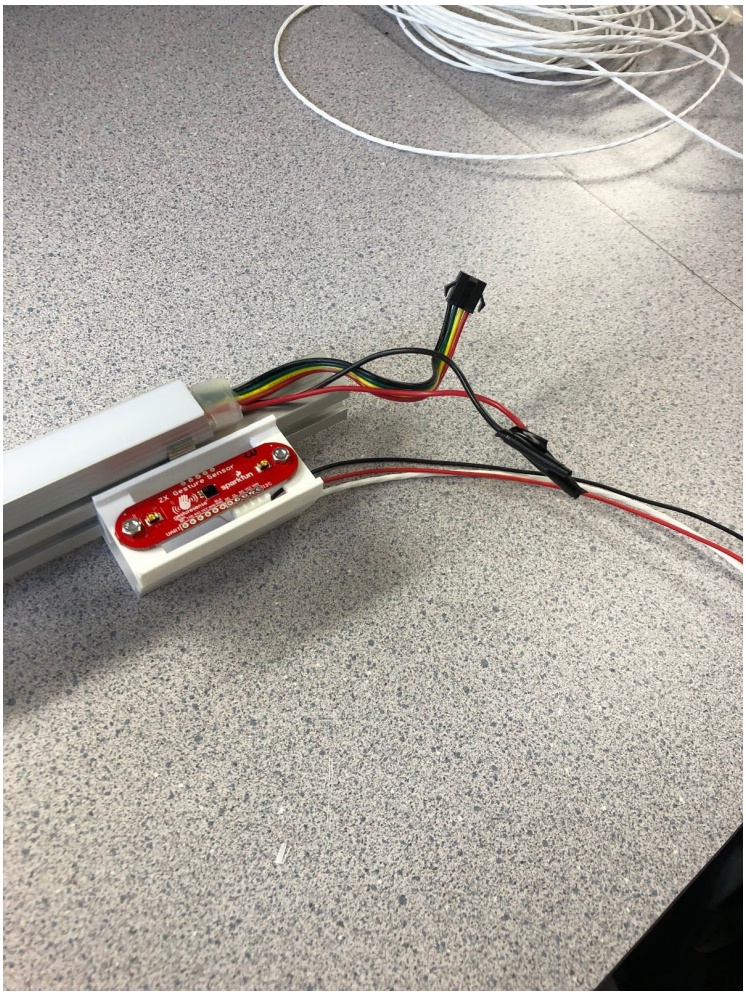
4.3 Simple ZX Gesture Sensor Mount 1

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMountSimple2.1 (M-27).





Slide the 3D printed piece, a ZXGestureSensorMountSimple2.1 (M-27), with the sensor attached onto the base of the aluminum extrusion closest to the main PCB mount.

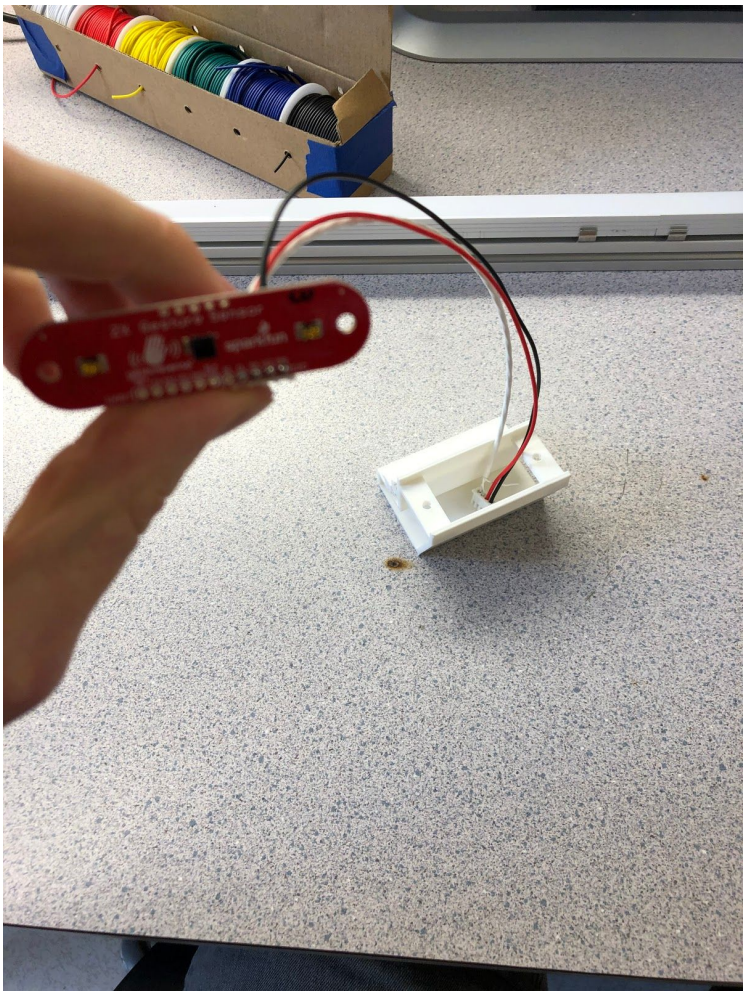


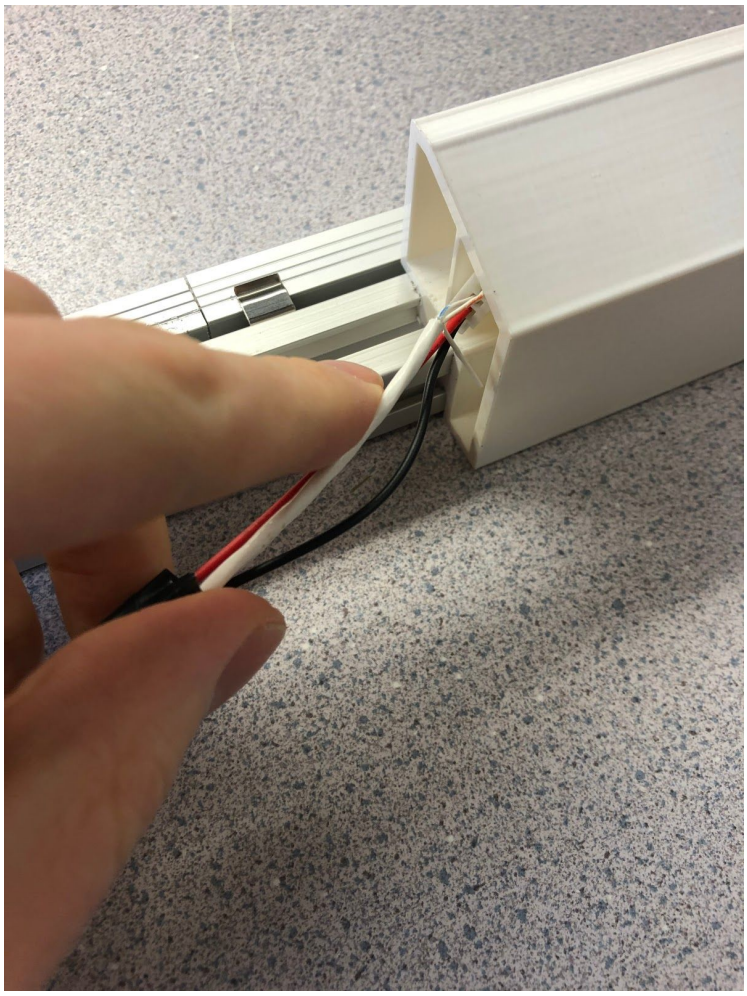
4.4 Simple Wire Manager 1

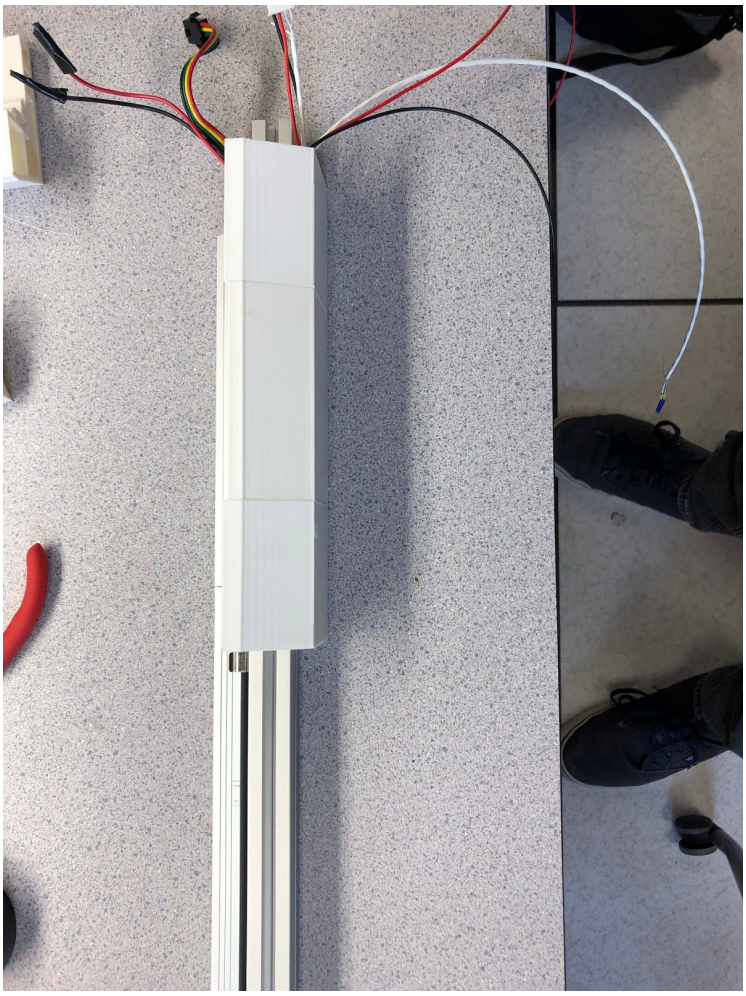
Slide on a SlidingWireMangerSimple2.1 (M-22)

4.5 Simple ZX Gesture Sensor Mount 2

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMountSimple2.1 (M-27).
Then, slide the 3D printed piece, a ZXGestureSensorMountSimple2.1 (M-27), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.

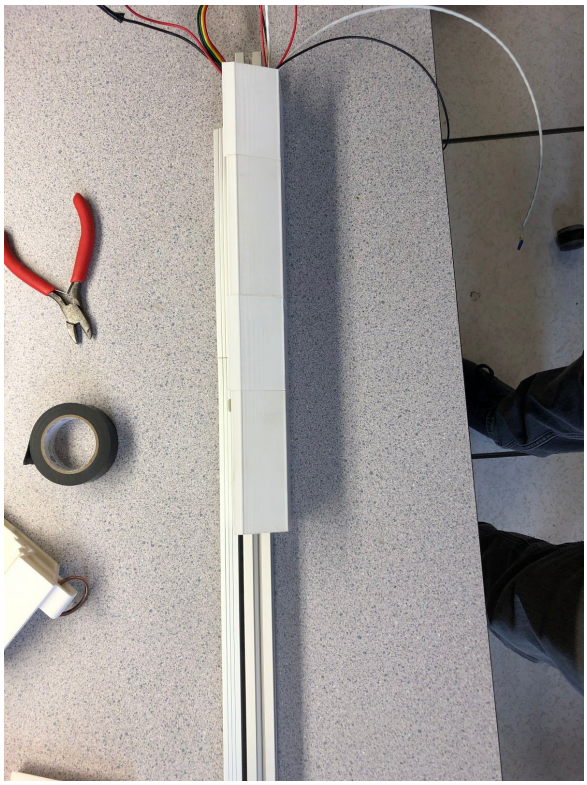






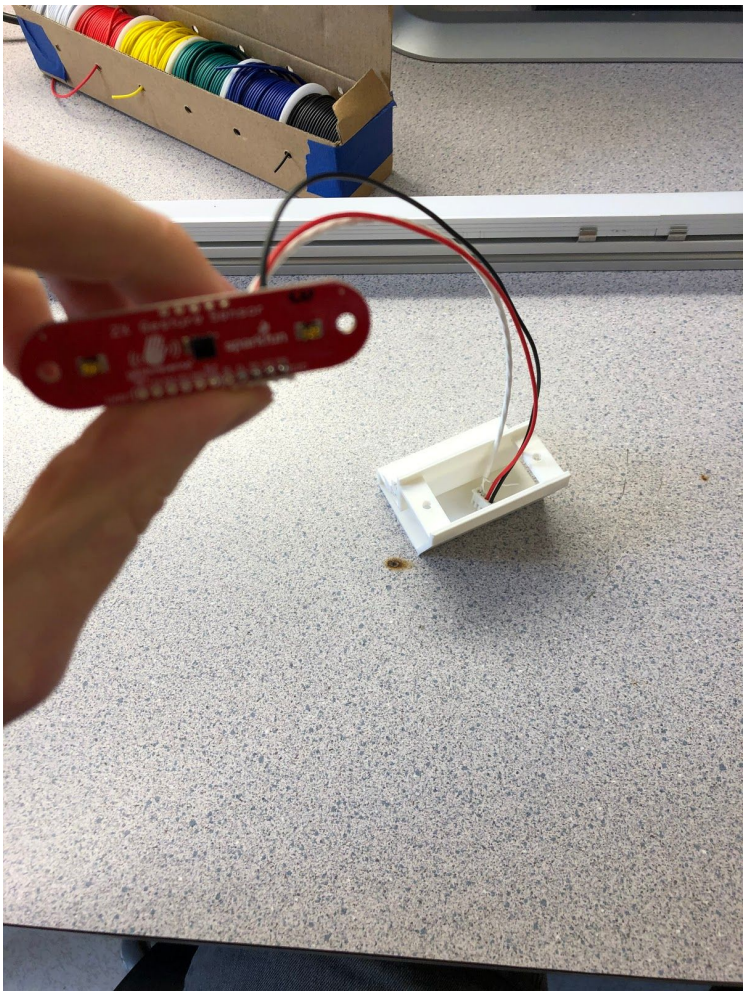
4.6 Simple Wire Manager 2

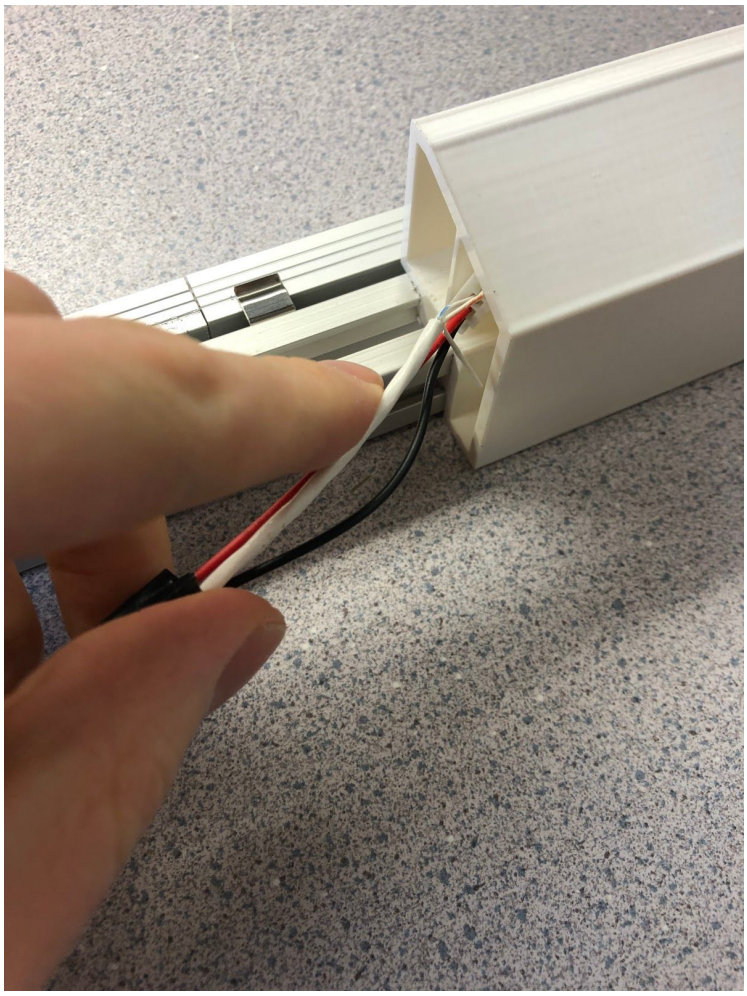
Slide on a SlidingWireMangerSimple2.1 (M-22)



4.7 Simple ZX Gesture Sensor Mount 3

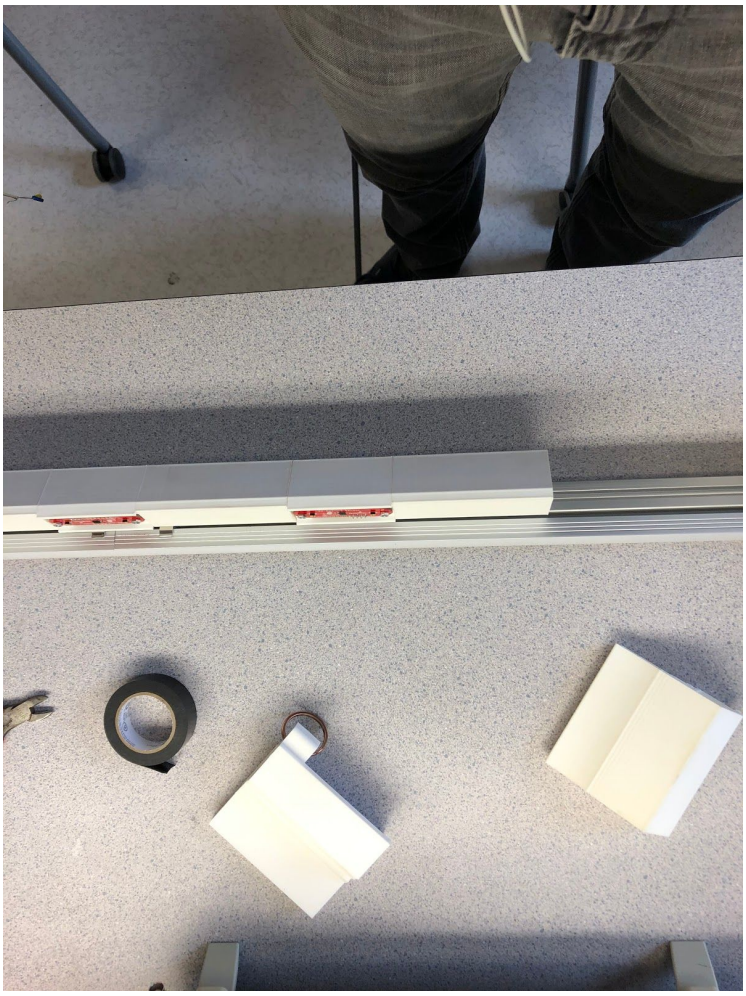
Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMountSimple2.1 (M-27).
Then, slide the 3D printed piece, a ZXGestureSensorMountSimple2.1 (M-27), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.





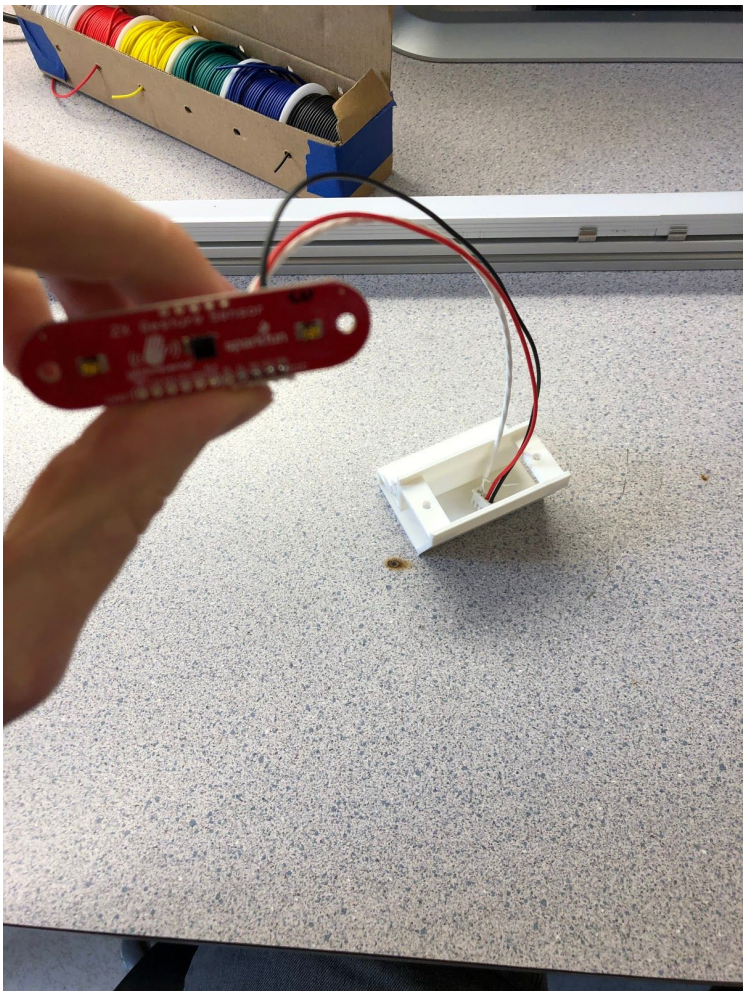
4.8 Simple Wire Manager 3

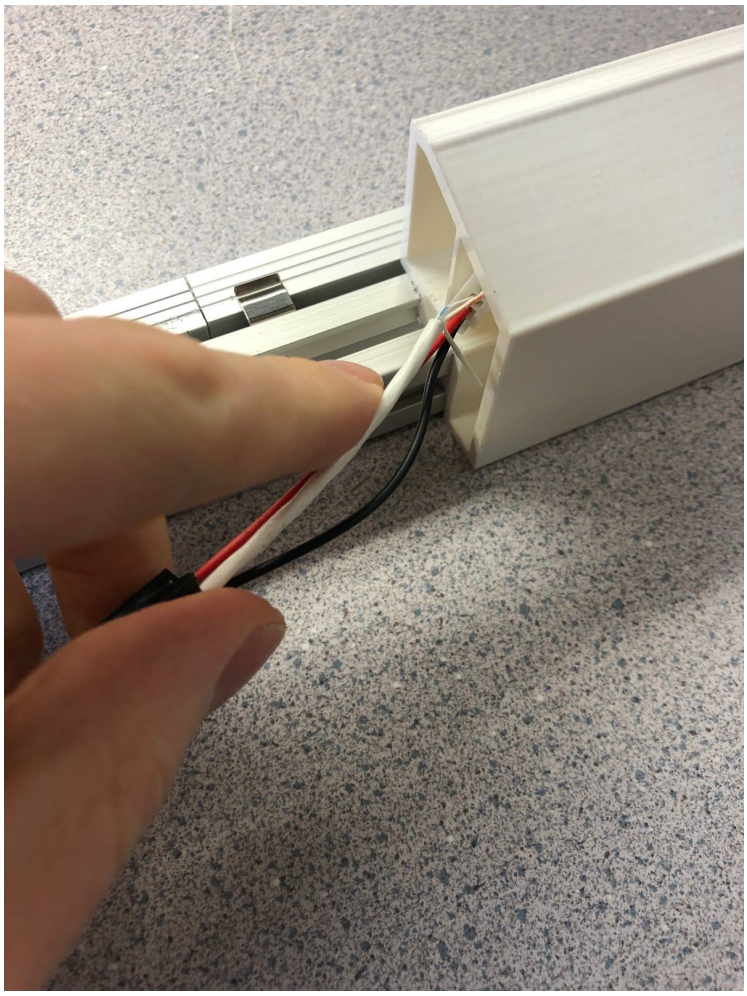
Slide on a SlidingWireMangerSimple2.1 (M-47)

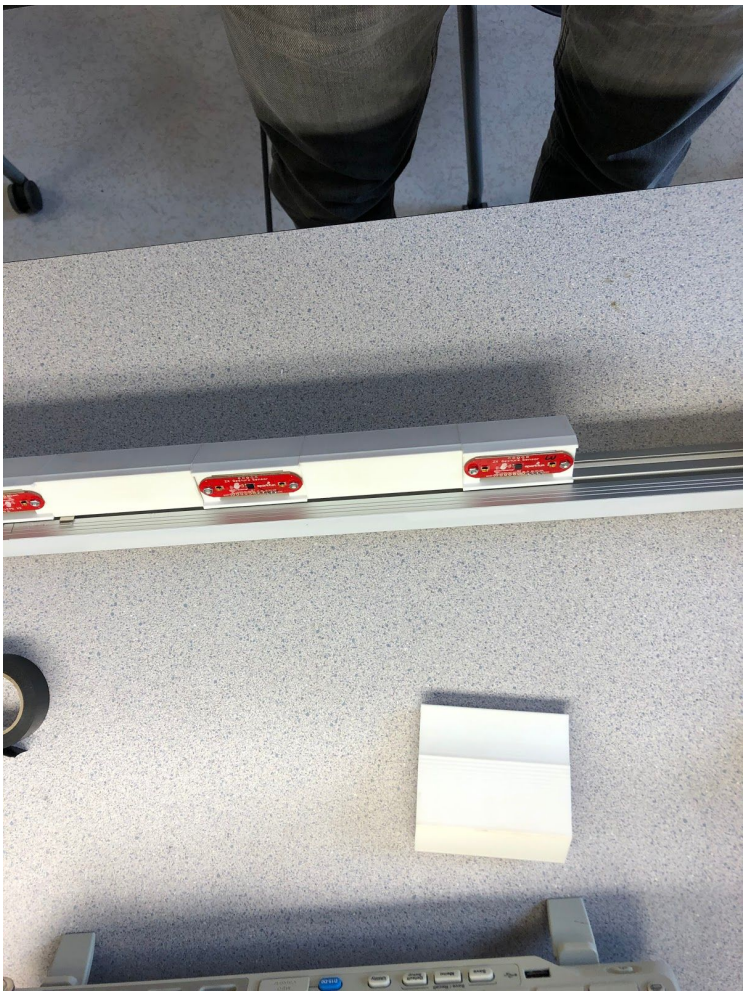


4.9 Simple ZX Gesture Sensor Mount 4

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMountSimple2.1 (M-27).
Then, slide the 3D printed piece, a ZXGestureSensorMountSimple2.1 (M-27), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.

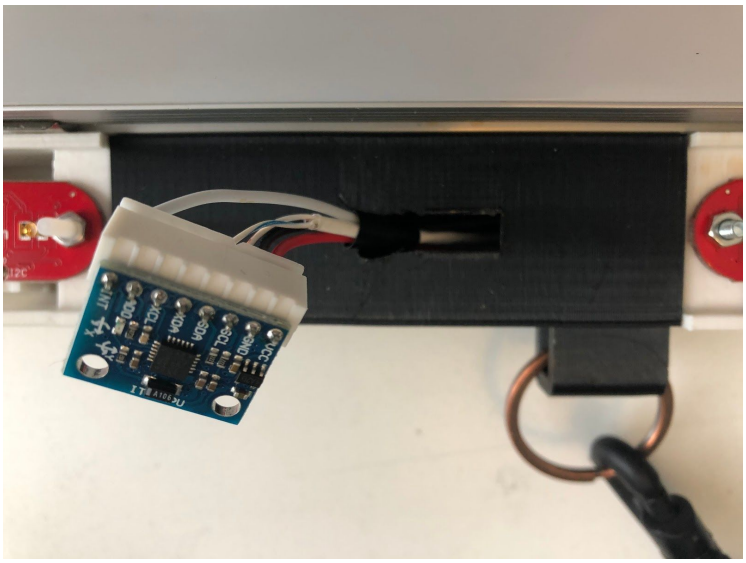


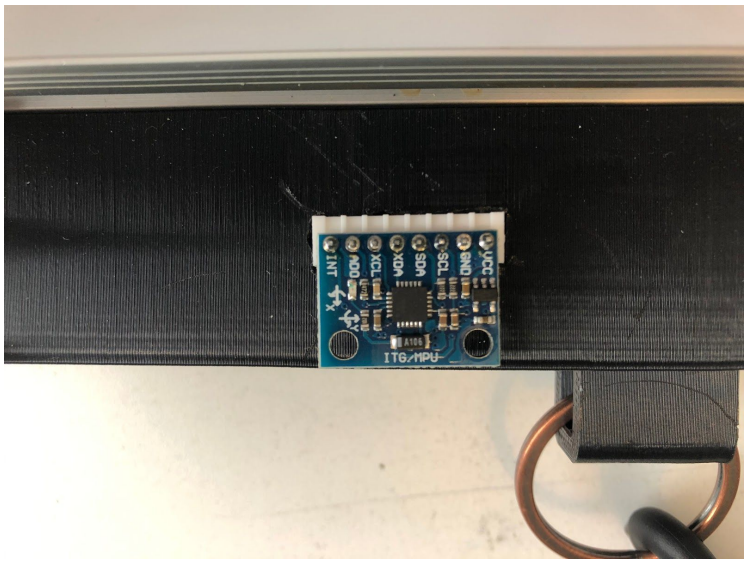




4.10 Wire ManagerSimple Strapmount and MPU6050 Mount

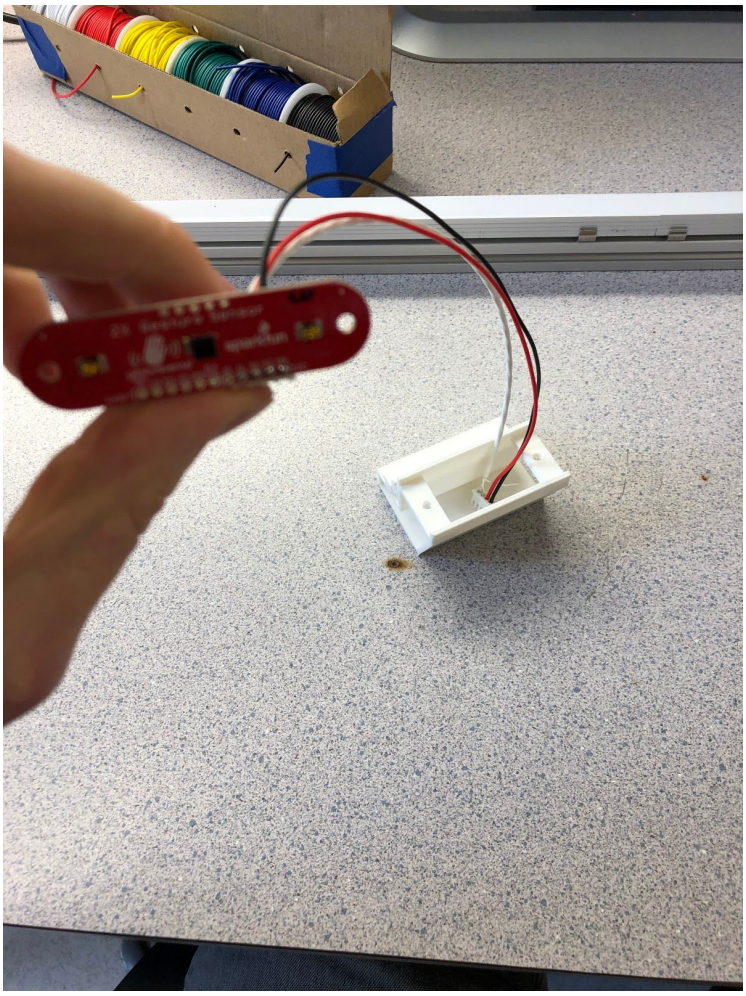
First of all you will need to make the MPU6050 Gyro wiring as detailed in the notes above. Next slide on the SlidingWireManagerSimpleStrapmountMPU6050Mount2.1 (M-50) from the top, feed in the MPU6050 with wires attached, and then run the wires through the previous wire managing 3D printed parts.

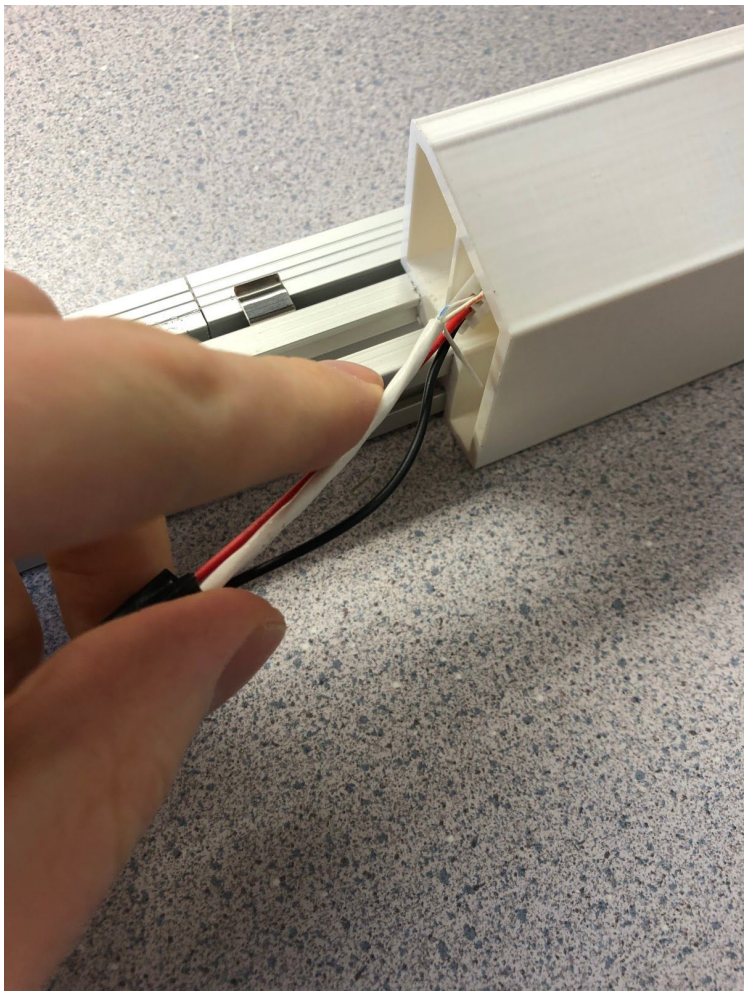


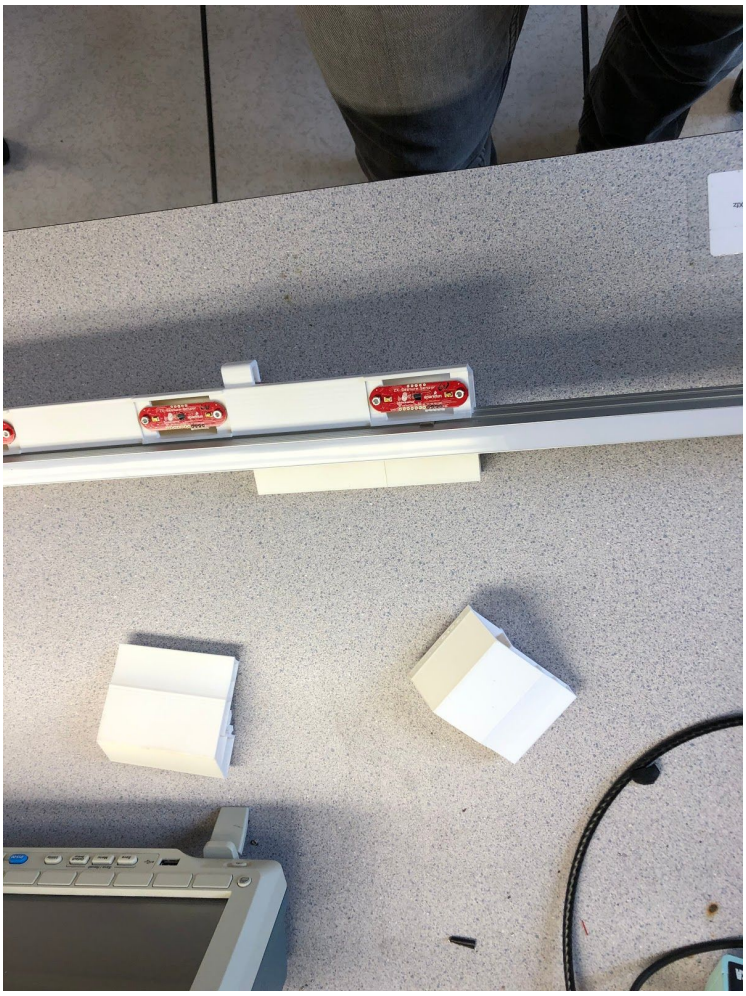


4.11 ZX Gesture Sensor 1

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMount2.1 (M-26).
Then, slide the 3D printed piece, a ZXGestureSensor2.1 (M-26), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.

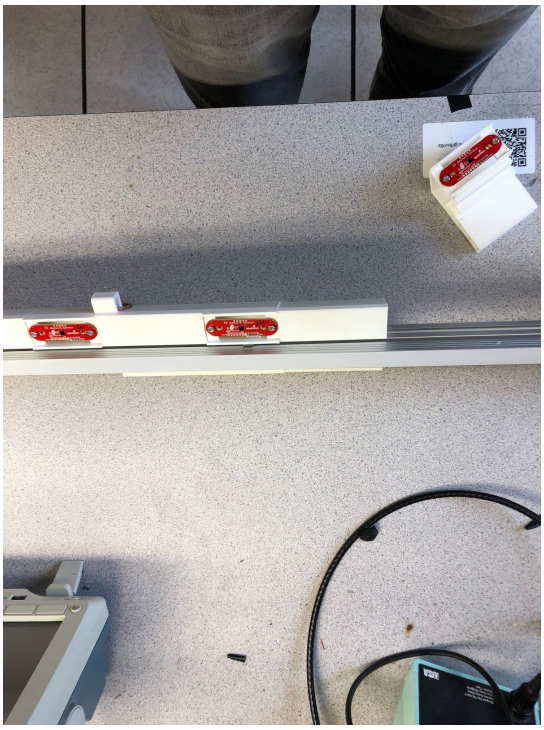






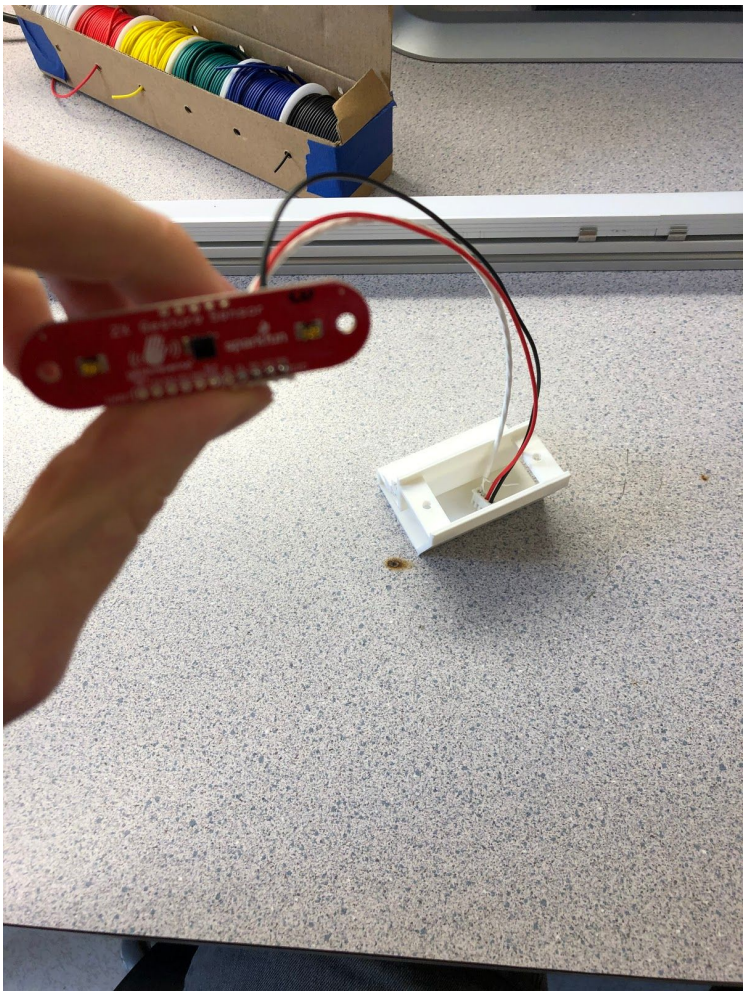
4.12 Wire Manager 1

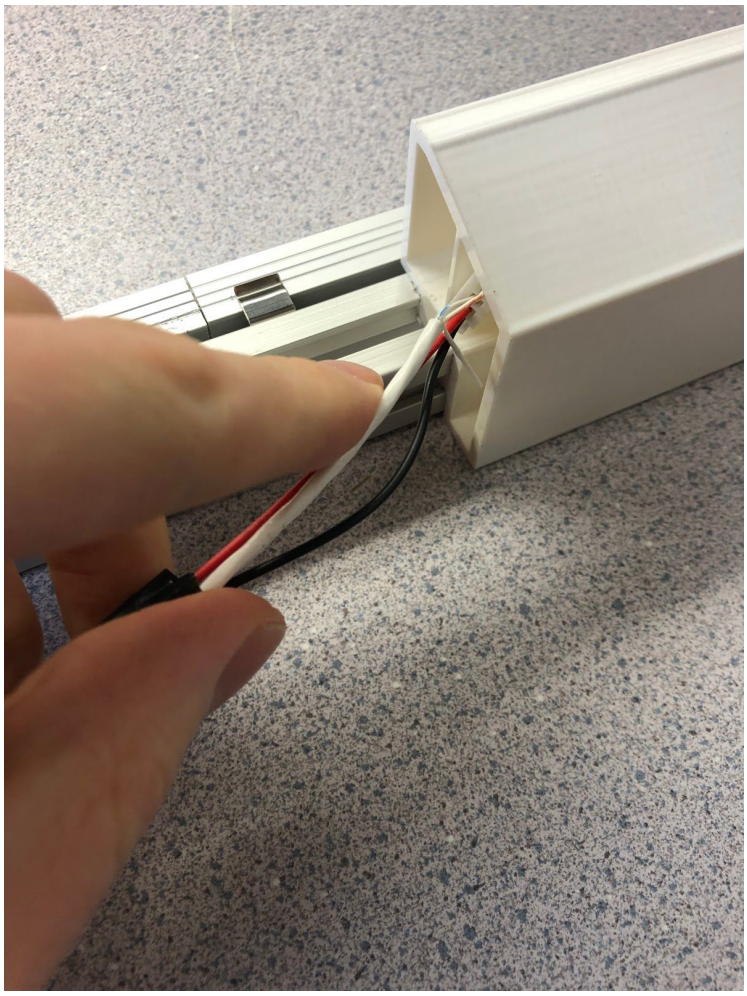
Slide on a SlidingWireManger2.1 (M-22)



4.13 ZX Gesture Sensor 2

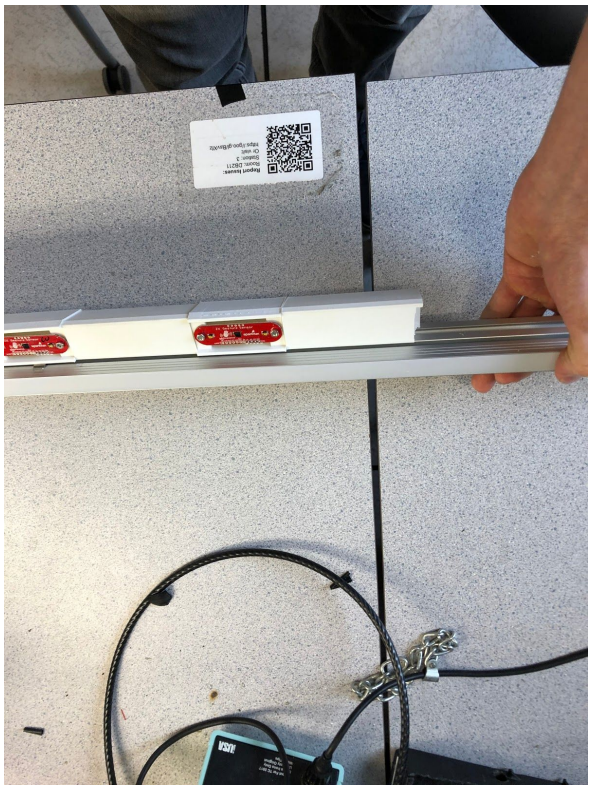
Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMount2.1 (M-26).
Then, slide the 3D printed piece, a ZXGestureSensor2.1 (M-26), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.





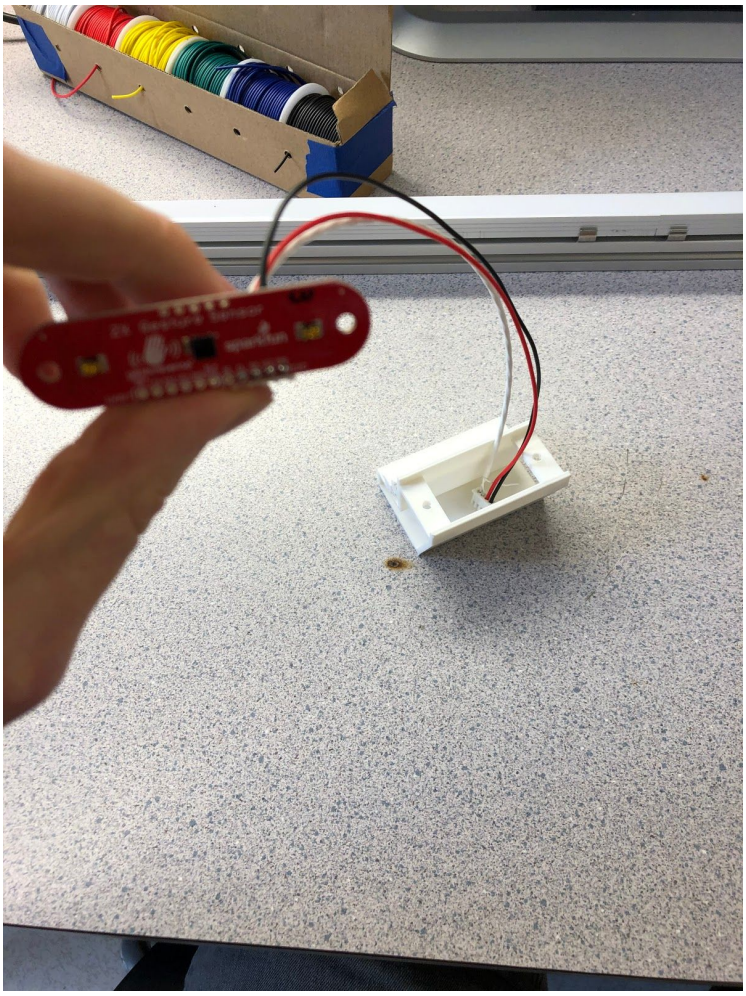
4.14 Wire Manager 2

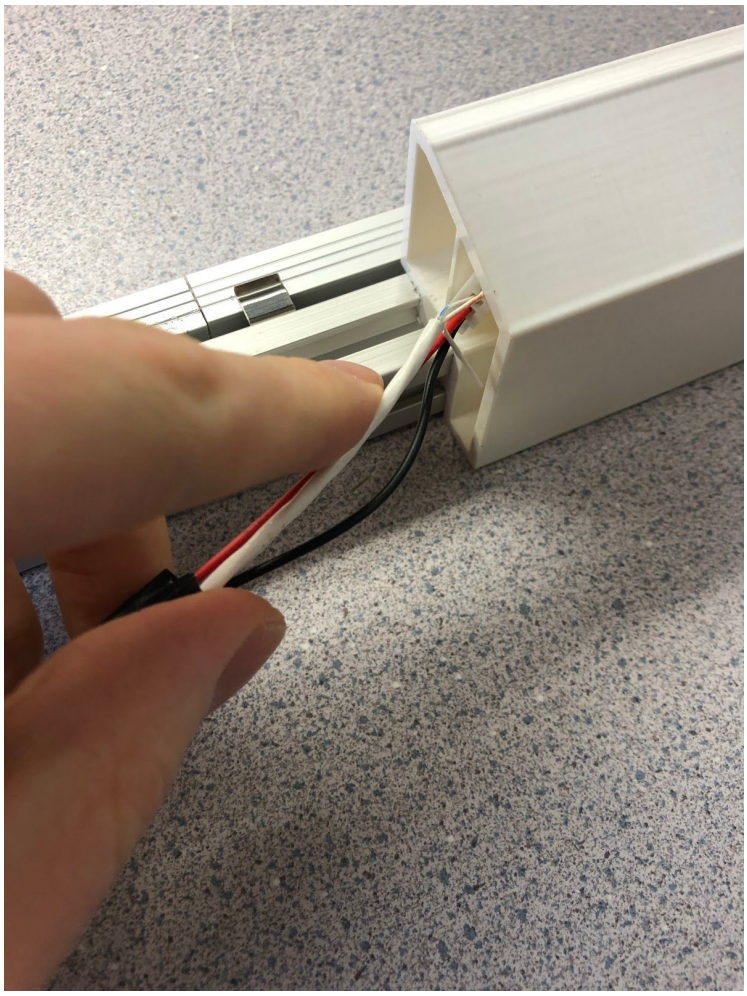
Slide on a SlidingWireManger2.1 (M-22)

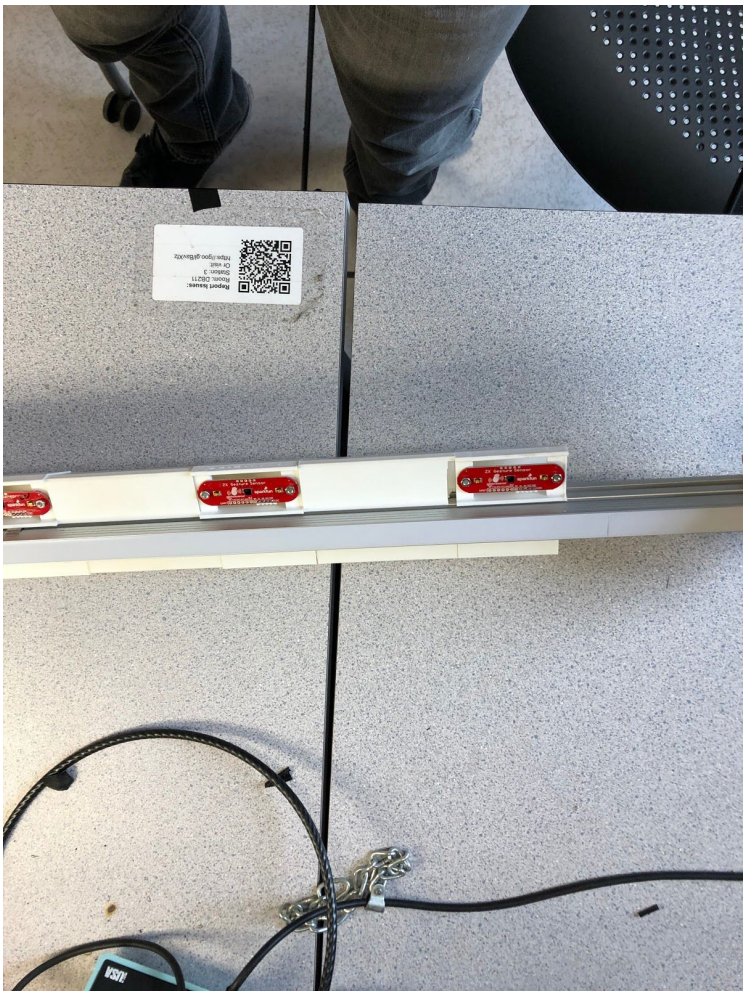


4.15 ZX Gesture Sensor 3

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMount2.1 (M-26).
Then, slide the 3D printed piece, a ZXGestureSensor2.1 (M-26), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.

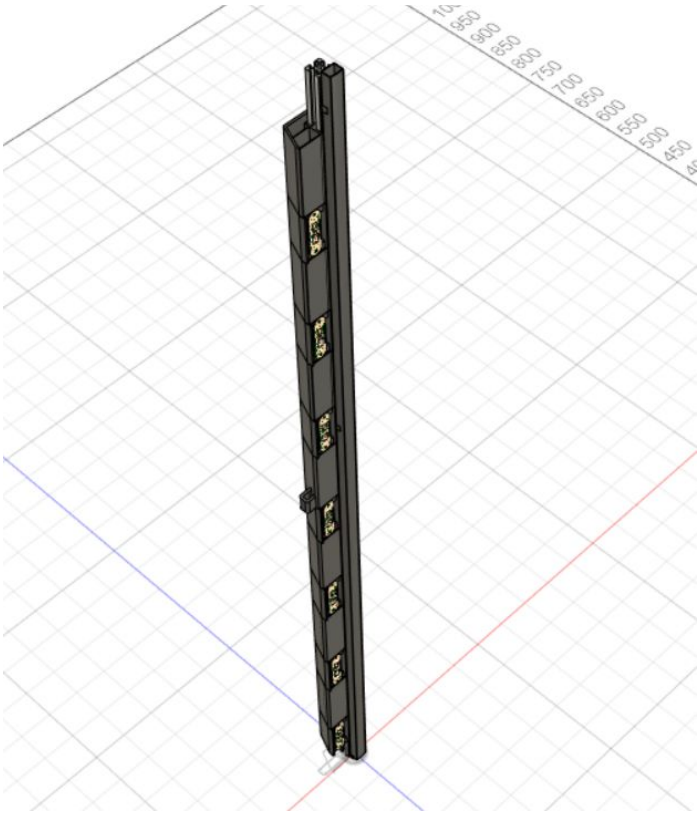






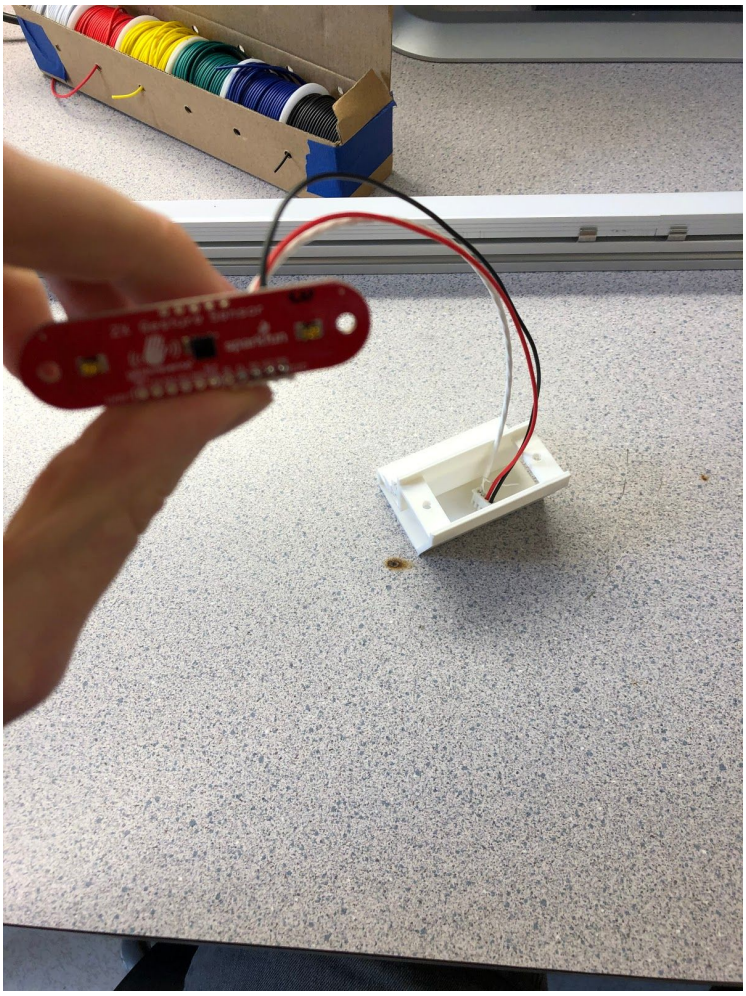
4.16 Wire Manager 3

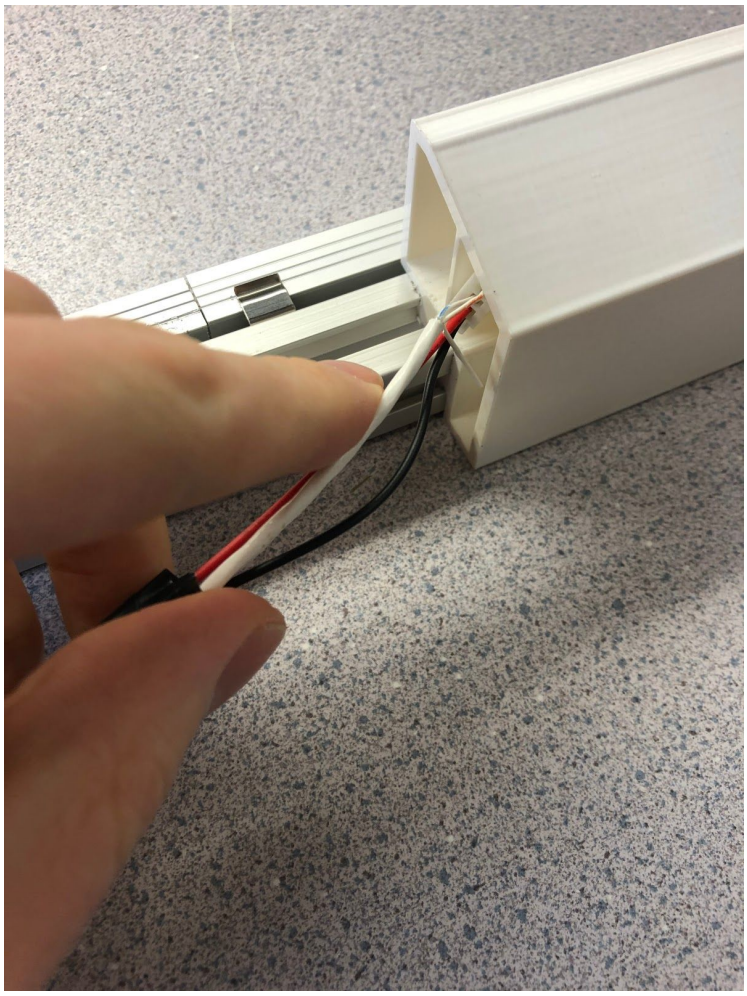
Slide on a SlidingWireManger2.1 (M-22)



4.17 ZX Gesture Sensor 4

Wire 1 ZX Gesture sensor to length. Attach it to a ZXGestureSensorMount2.1 (M-26).
Then, slide the 3D printed piece, a ZXGestureSensor2.1 (M-26), onto the extrusion. Run the ZX Gesture sensor with wires attached into the slot, and work the wires through the existing 3D printed parts down to the end of the Optron.



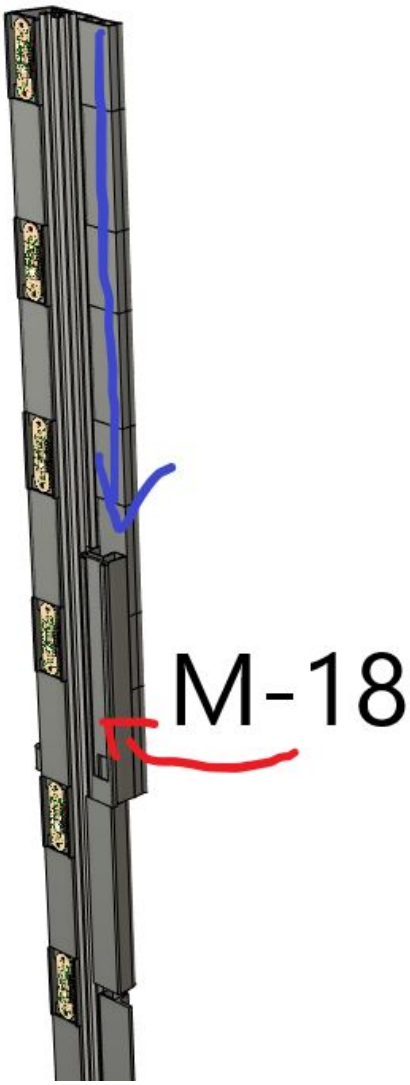


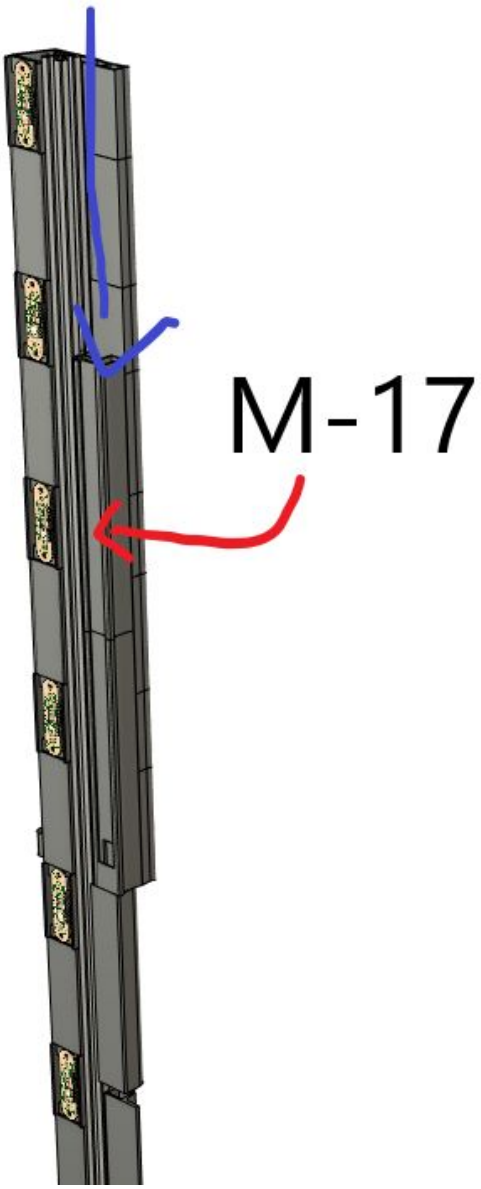
5) Assembling the epick

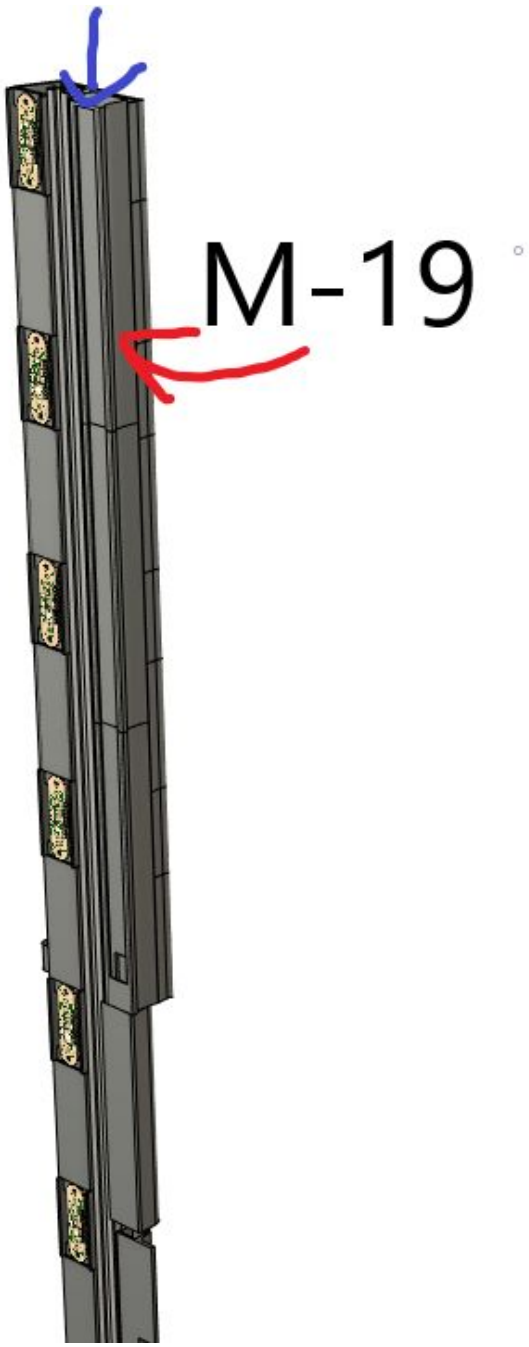
6) Assembling the Fretboard

6.1 Putting on the 3D printed parts

Slide on the 3 3D printed parts of the fretboard. The FretBoardBottom2.1 (M-18), then the FretBoard2.1 (M-17), then finally the FretBoardTop2.1 (M-19).

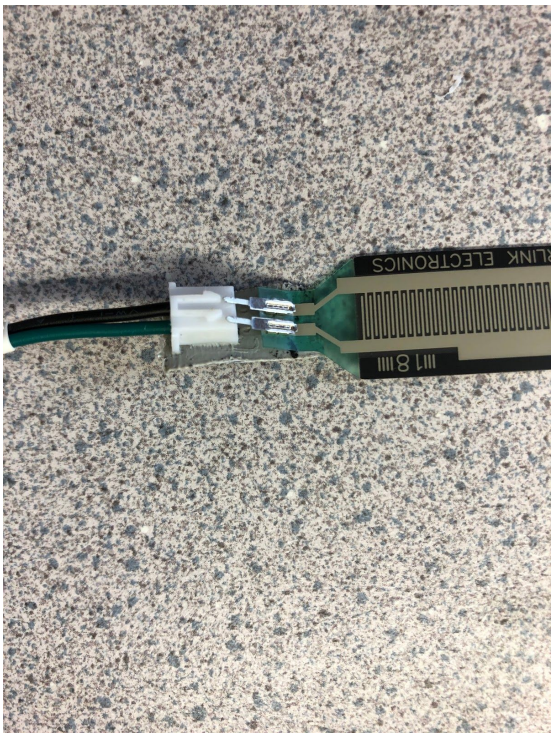

M-18


M-17

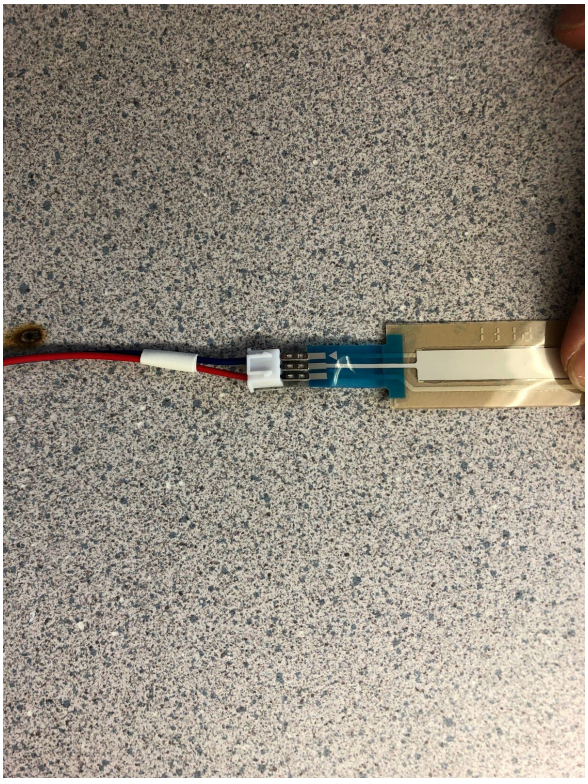


6.2 Wiring the sensors

Prepare the pressure sensor (E-33) JST wiring by prepping JST female 2 pin connectors (H-15) for both sides of 2 wires cut to length. These wires can be any type that work with the JST crimps since the signals on them are just analog. Then attach the wires by simply pressing them into the sensor pins, or by soldering a male 2 pin JST (H-14) to the end of the sensor and connecting to that.



Prepare the pressure sensor (E-34) JST wiring by prepping JST female 3 pin connectors (H-13) for both sides of 3 wires cut to length. These wires can be any type that work with the JST crimps since the signals on them are just analog. Then attach the wires by simply pressing them into the sensor pins, or by soldering a male 3 pin JST (H-12) to the end of the sensor and connecting to that.

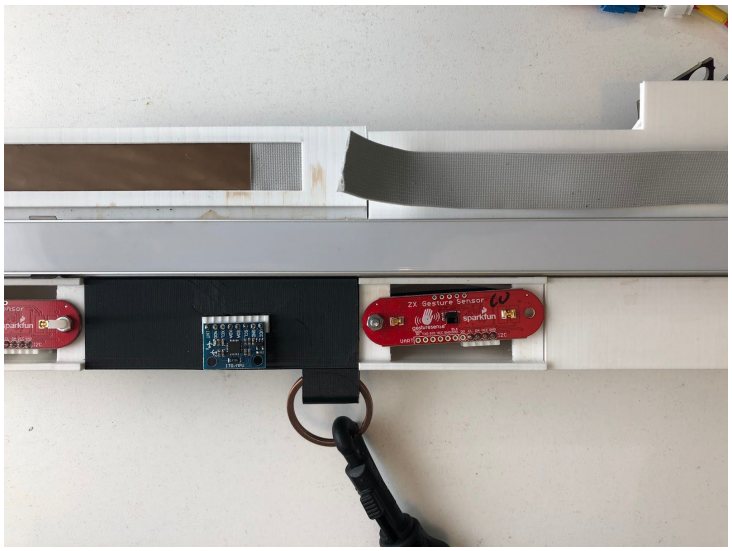


6.3 Cutting the teflon

Cut the teflon (M-2) to size. You can do this with a laser cutter and can find the file to do that on the BOM. Also, you can attempt to cut it by hand. The dimensions are 21mmx590mm.

6.4 Cutting the silicon

The silicon should be the correct width, you just need to cut it to 590mm length.



6.5 Sandwich

Layer the aforementioned parts in this order from the bottom: pressure sensor, position sensor, silicon, teflon. Run the wires for them through the EPickWireManager2.1 and FretBoardWireManager2.1.2.

Code:

Arduino IDE Set-Up

Download and install the latest version of the Arduino IDE
NOTE: If installing on Linux see the official Linux install guide

- Start the IDE and navigate to File->Preferences (Windows/Linux), Arduino->Preferences (MacOS/OSX)
- Find "Additional Boards Manager URLs" dialog box and copy/paste the following url:
- https://adafruit.github.io/arduino-board-index/package_adafruit_index.json
- Click OK and restart the IDE

Install Board Drivers

- Install M4 board support for
    - Arduino SAMD Boards (32-bits ARM Cortex-M4+)
    - Adafruit SAMD Boards
- Install boards short instructions:
    - Open the Board Manager by navigating to Tools->Board->'Boards Manager'
    - Install Arduino SAMD Boards Support (version 1.6.11 or later), by typing Arduino SAMD in the top search bar. Click install on the entry named "Arduino SAMD Boards (32-bits ARM Cortex-M4)
    - Install Adafruit SAMD Package to add board file definitions. Type Adafruit SAMD or feather in the top search bar. Click install on the entry named "Adafruit SAMD Boards". The description of the package should mention support for feather M4 Itsy Bitsy
    - Close the board's manager and restart the IDE

- Navigate to Tools->Board, the Adafruit Feather M4 boards should be listed, select Adafruit Feather M4 Itsy Bitsy
- Install drivers if on Windows 7

Setup Settings

Set your Board Profile to the Adafruit ItsyBitsy M4 (SAMD51)
Select: Tools > Board > Adafruit ItsyBitsy M4 (SAMD51)

Turn on Verbose output for Upload

- PC: File > Preferences
- Mac: Arduino > Preferences
- Show Verbose output during: [check the upload box only]
- Plug in your Feather M4 Board

Connect a USB Micro Cable between your Feather M4 and computer USB port, then select your device via:

- PC: Select: Tools > Port > COMx
- Mac: Select: Tools > Port > Feather M4 Itsy Bitsy

Run the Blink Sketch to confirm configuration

- Select: File > Examples > 01.Basics > Blink
- Click the check-mark icon on the top-left of the IDE window to “Verify” the code compiles correctly. This may take a little while.
- You should get a message saying: Sketch uses 10704 bytes (x%) of program storage space. Maximum is xxxxx bytes.

Compilation Issues

If you get an alert that looks like
<Cannot run program "{runtime.tools.arm-none-eabi-gcc.path}\bin\arm-non-eabi-g++">

- Make sure you have installed the Arduino SAMD boards package, you need both Arduino & Adafruit SAMD board packages

If you get an alert that looks like
<error: 'dtostrf' was not declared in this scope>

- Make sure you have included "#include <avr/dtostrf.h>" in your "libraries/MPU6050/MPU6050.cpp" file

If you get an alert that looks like
<'BGi' was not declared in this scope>

- Make sure you include "#include "Headers.h"" in your M4_OptronSensorsFastLED6.24.19 file

Manually bootloading

If you ever get in a 'weird' spot with the bootloader, or you have uploaded code that crashes and doesn't auto-reboot into the bootloader, click the RST button twice (like a double-click)to get back into the bootloader.

The red LED will pulse, so you know that its in bootloader mode.

Once it is in bootloader mode, you can select the newly created COM/Serial port and re-try uploading.
You may need to go back and reselect the 'normal' USB serial port next time you want to use the normal upload.