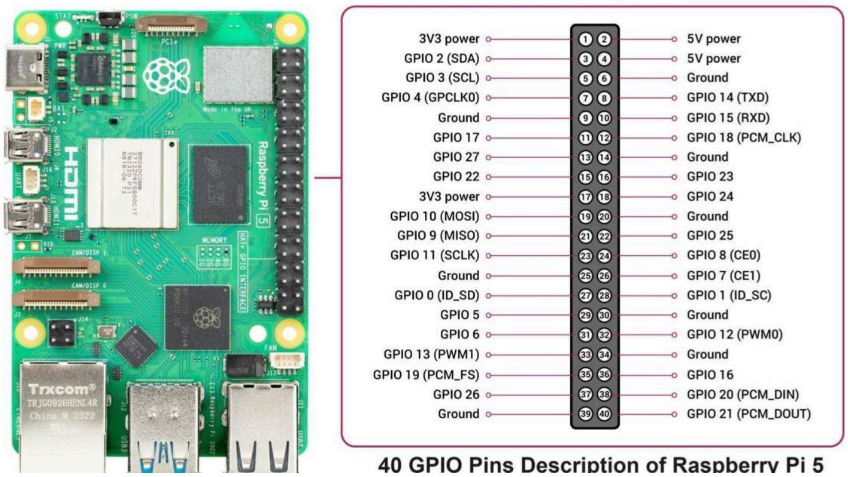
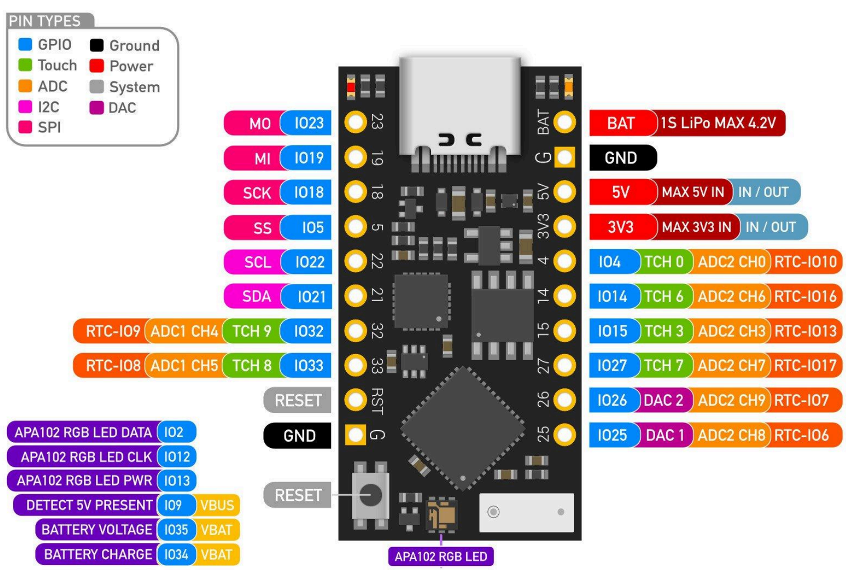
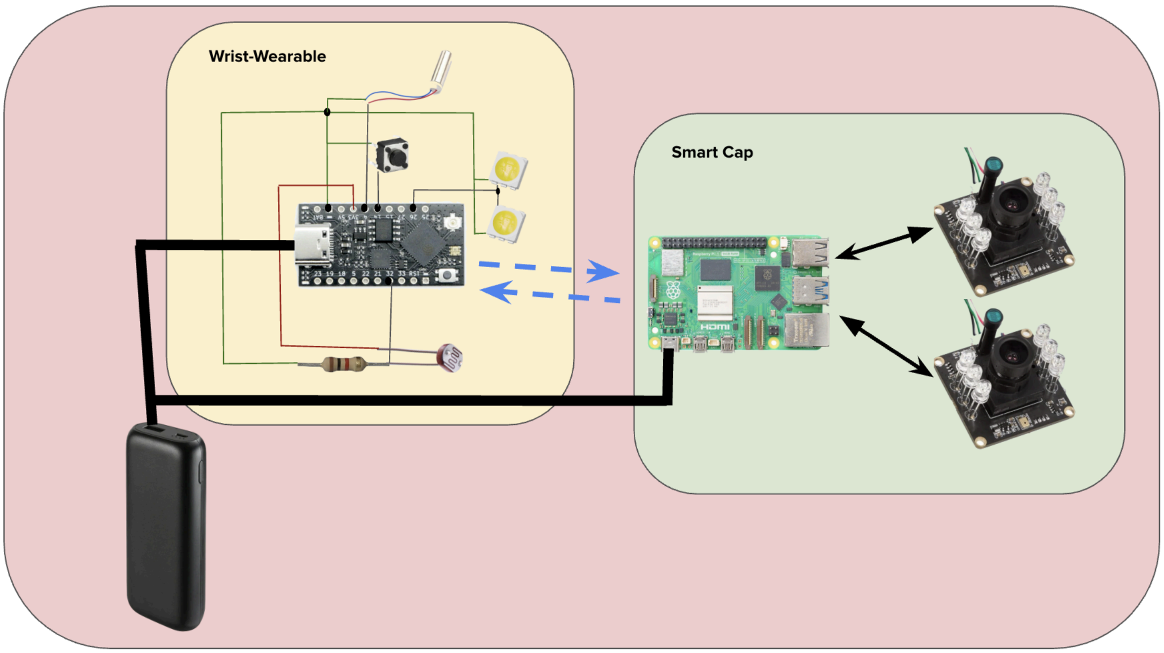
Hardware Report



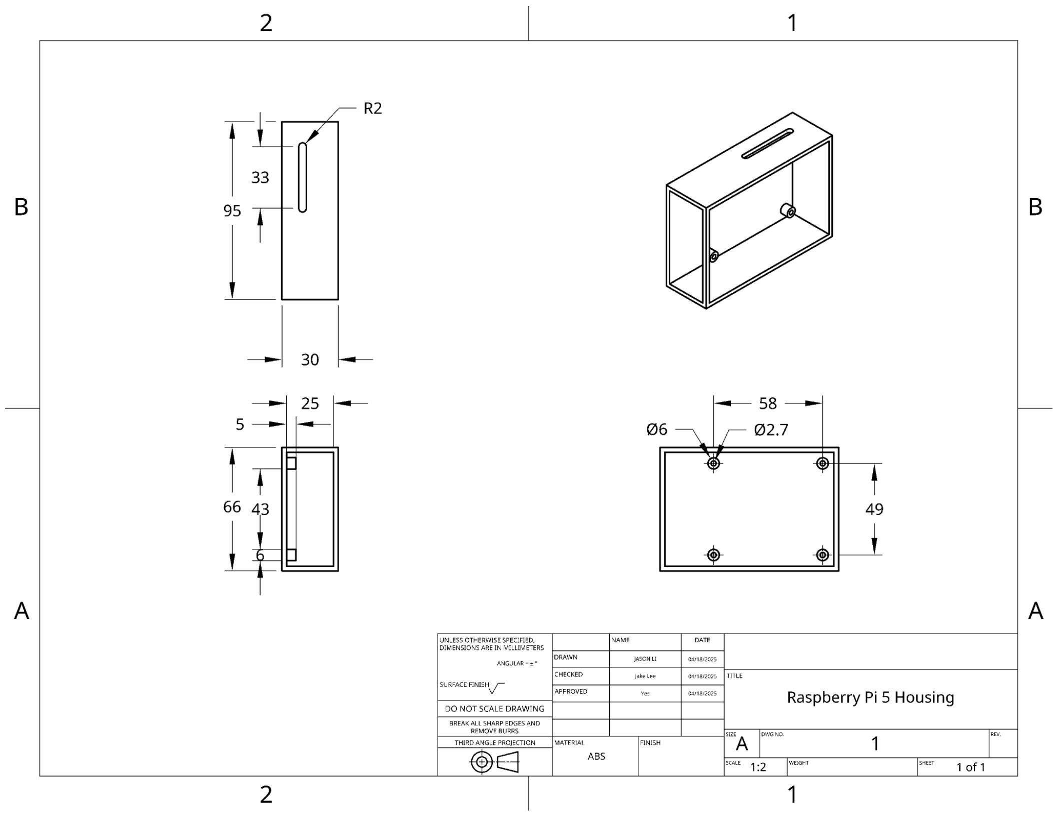
Raspberry 5 Pi 16GB model. We have it connected to our own wireless router, where we SSH'd into the Raspberry Pi to allow for seamless software development. None of the hardware pins were utilized for our final Smart System for Visually Impaired. We utilized just the two USB outs for both of the USB-powered cameras. The Raspberry Pi is powered by a dual-connecting portable charger that supplies the Raspberry Pi with 5V and 4.5A of power. The Raspberry Pi serves as the smart cap's main system.



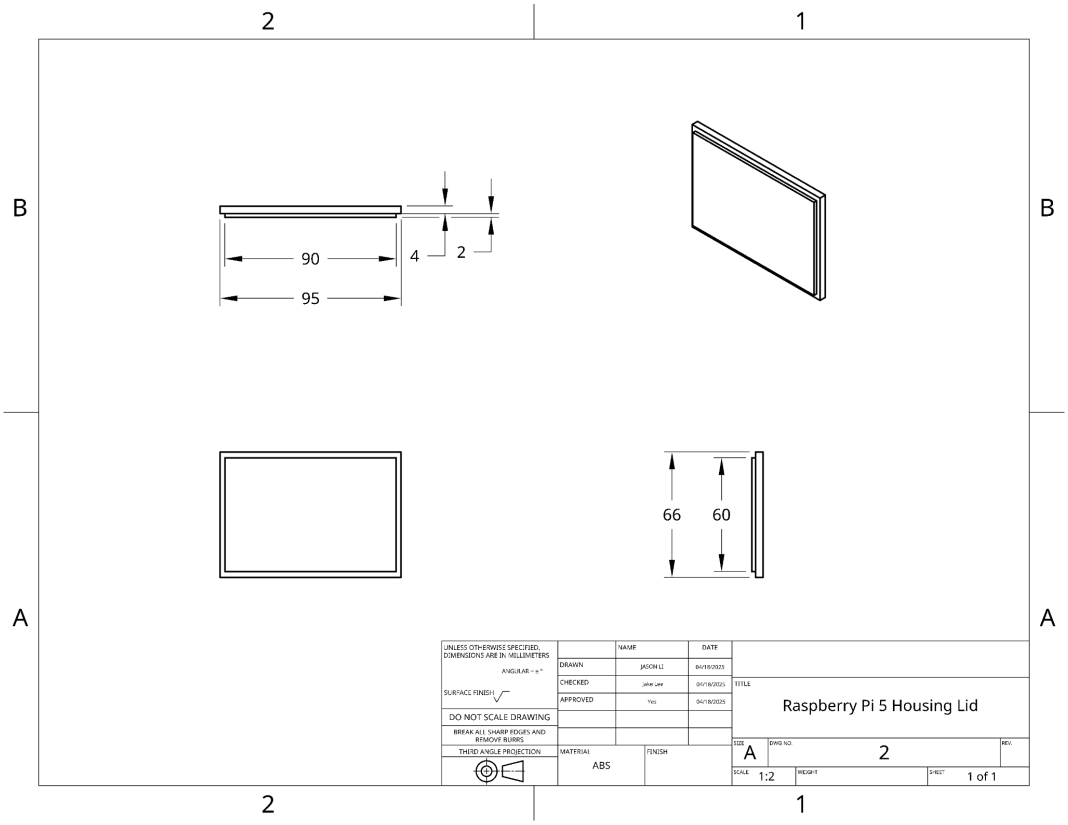
TinyPICO ESP32 model. We have this microcontroller connected to our own wireless router as well. Using a UDP server, we allow seamless connection between the TinyPICO ESP32 and the Raspberry Pi. We utilized multiple GPIO pins on the TinyPICO ESP32: GPIO 27 for both LEDs, GPIO 4 for the vibration motor, GPIO 14 for the button, and GPIO 32 for the photoresistor. We ensured that all of the pins we utilized were ADC compatible despite only the LEDs, vibration motor, and photoresistor needing them. This allowed for better debugging and seamless integration of all of our parts. Code testing each component can be found in our github repository. The TinyPICO ESP32 serves as the wrist-wearable main system.



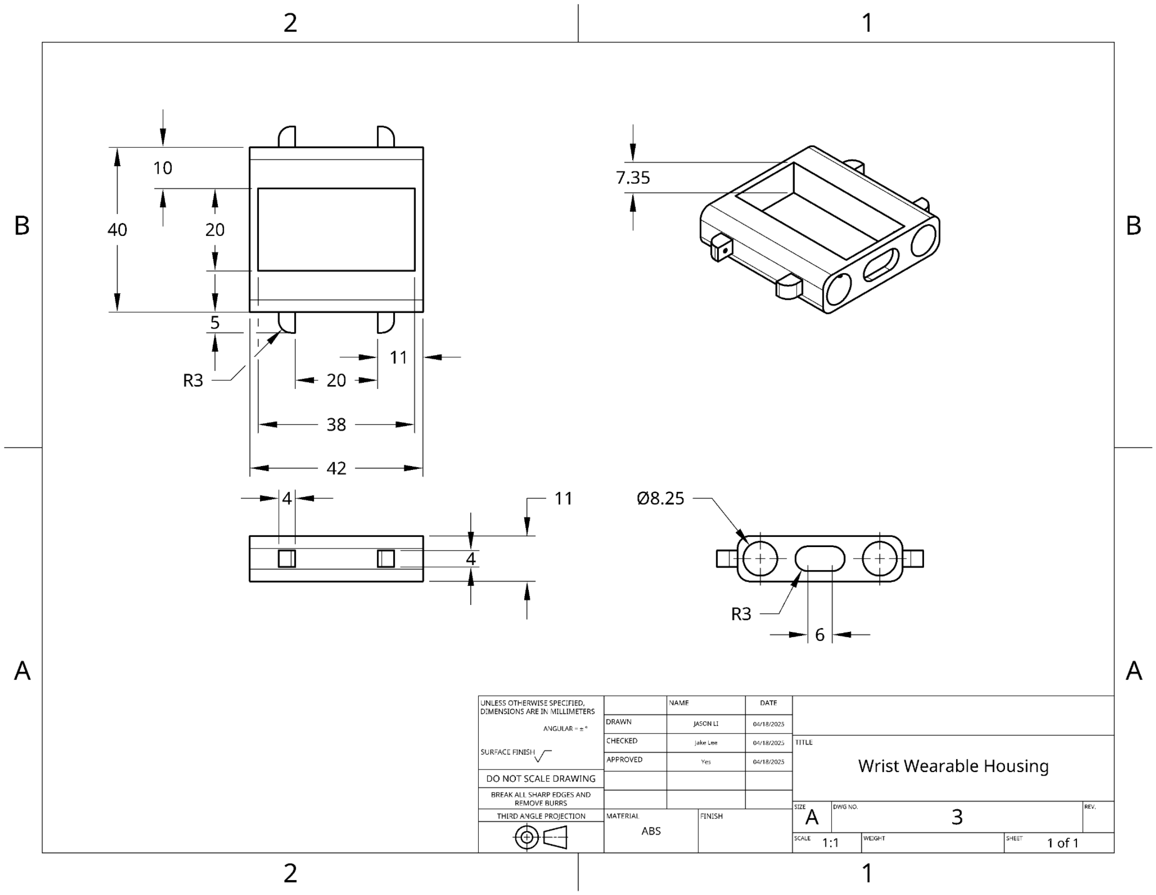
A brief hardware diagram illustrating how our components connect with each other and which GPIO pins connect to which components for the wrist-wearable. Should a customer or user want to replicate this design, feel free to do so as long as pinouts are viable and appropriate. This will allow the customer or user to also utilize our test programs and scripts to test their implementation.



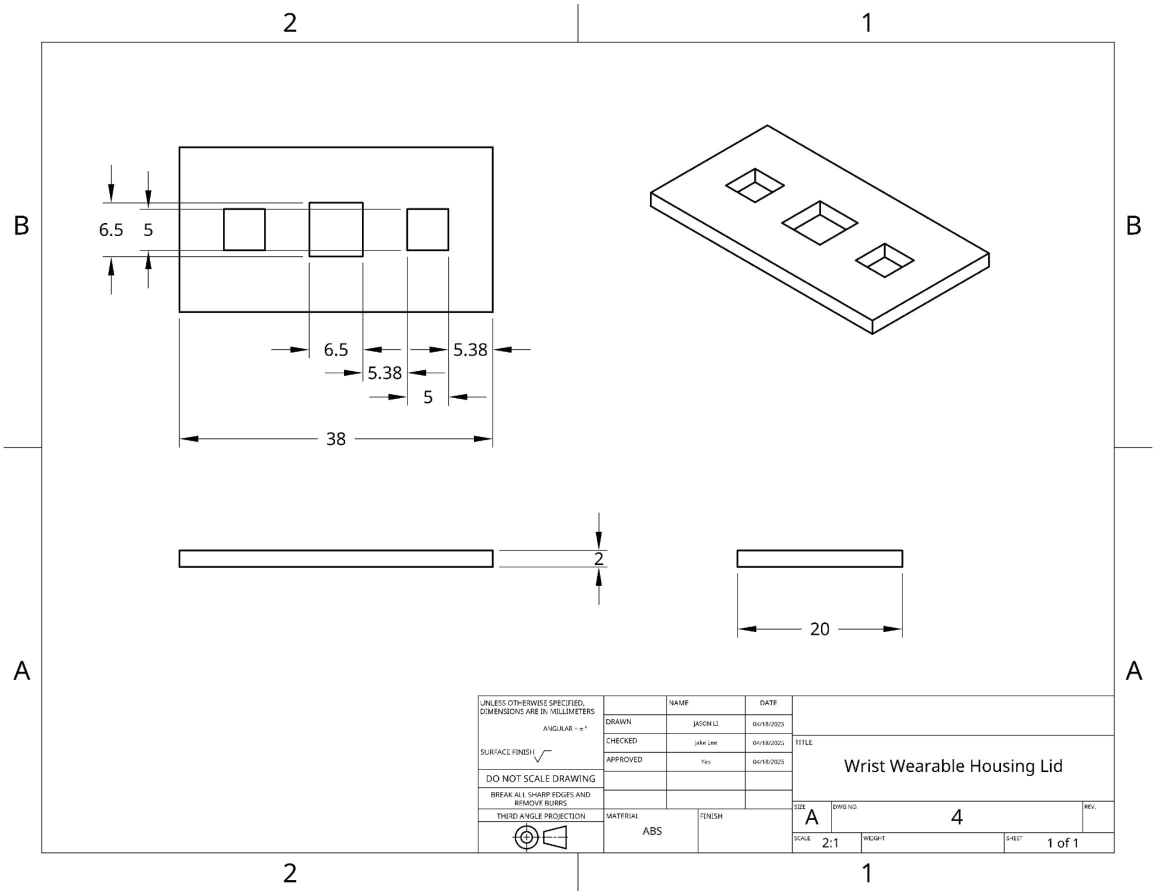
Housing designed for Raspberry Pi 5. There are mounting slots to screw the Raspberry Pi on to the housing and slots for the board's connection ports. The housing is printed using Acrylonitrile Butadiene Styrene (ABS) material.



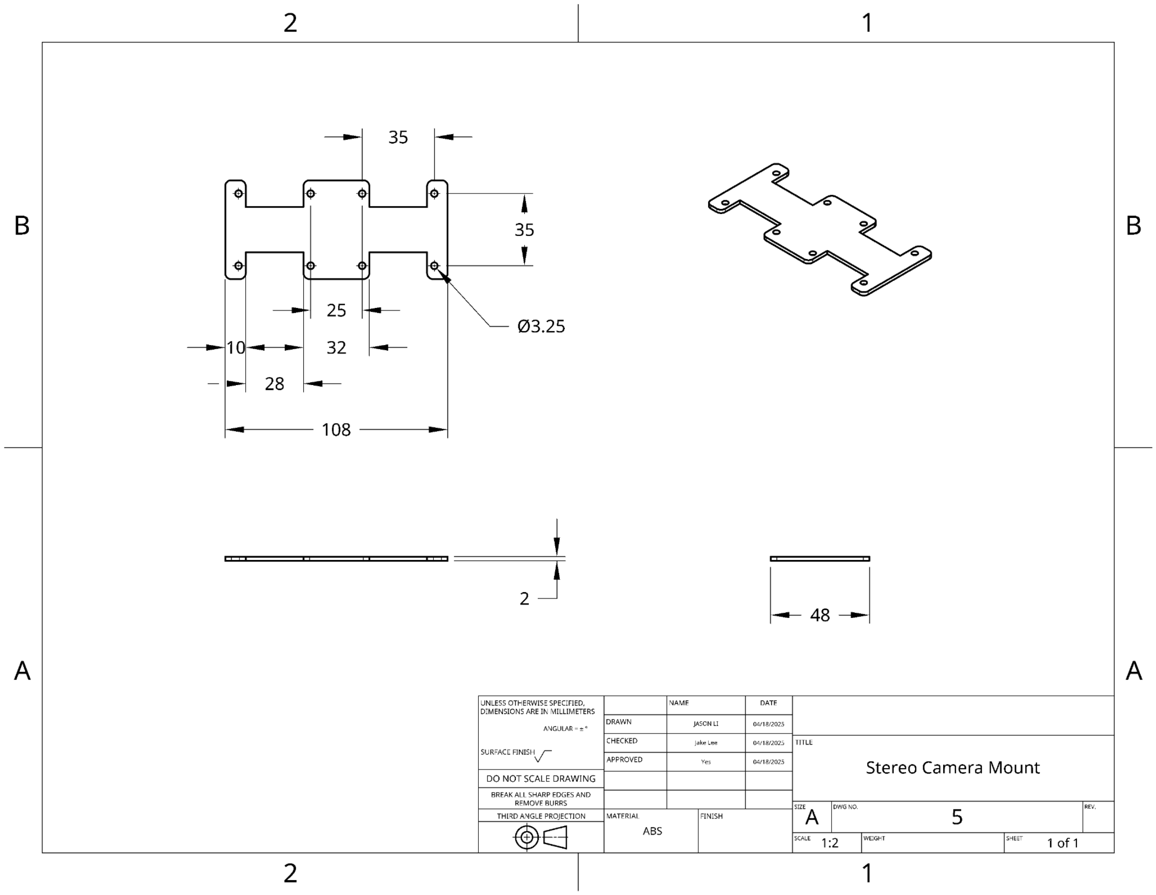
This lid is designed specifically for the Raspberry Pi 5 housing, offering a snug, secure fit while remaining easy to attach and remove as needed. The housing lid is printed using Acrylonitrile Butadiene Styrene (ABS) material.



The wrist wearable housing features a central chamber for installing the TinyPICO. It also includes side slots for two vibration motors, a port for USB-C connection to the TinyPICO, and holds on the sides for attaching the adjustable nylon wrist strap. The housing is printed using Acrylonitrile Butadiene Styrene (ABS) material.



The wrist wearable housing lid includes three slots: two side slots for the LEDs used in the Intelligent Visibility System, and a center slot for mounting the button. The housing lid is printed using Acrylonitrile Butadiene Styrene (ABS) material.



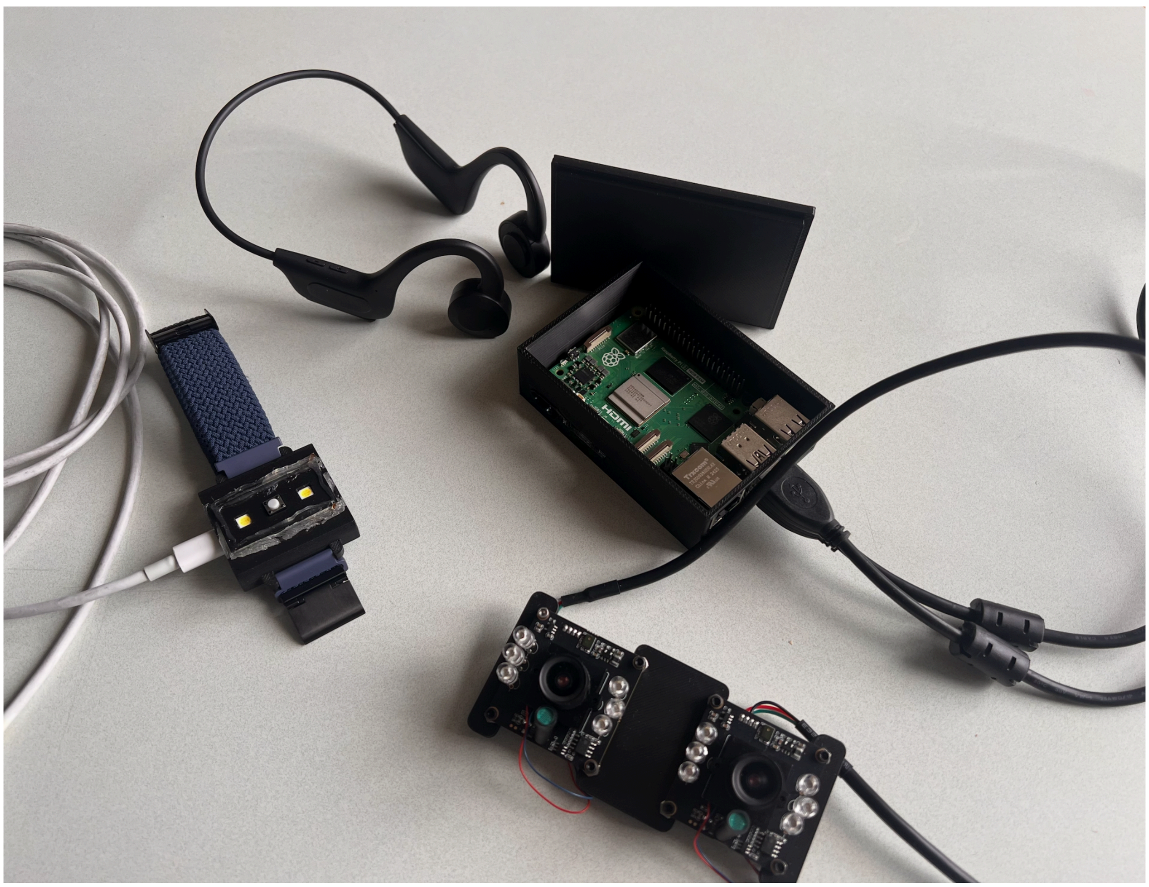
The stereo camera mount securely holds two Arducam USB cameras, using eight mounting holes and nuts to ensure both cameras are aligned on the same imaging plane. The mount is printed using Acrylonitrile Butadiene Styrene (ABS) material.

Project Costs for Production of Beta Version (Next Unit after Prototype)				
Item	Quantity	Description	Unit Cost	Extended Cost
1	1	Raspberry Pi 5 w/ 16 GB of RAM	$159.99	$159.99
2	1	TinyPICO ESP32	$21.95	$21.95
3	1	Bone Conduction Headphones	$17.88	$17.88
4	1	DC Coreless Vibration Motor	$8.99	$8.99
5	2	Arducam 1080P USB Camera	$34.99	$69.98
6	1	100 count 5mm x 5mm LED Lights	$4.99	$4.99
7	1	Braided Nylon Watch Band	$11.99	$11.99
8	1	10 Count 10k Ohm Photoresistor	$7.90	$7.90
9	1	100 Count Push Buttons	$5.39	$5.39
10	1	Power Supply (5V, 4.5 A)	$26.98	$26.98
11	1	3d Printing Filament	$3.00	$3.00
12	1	Fanny Pack Holster	$8.95	$8.95
13	1	Jumper Wires Pack	$2.00	$2.00
			Beta Version-Total Cost	$349.99

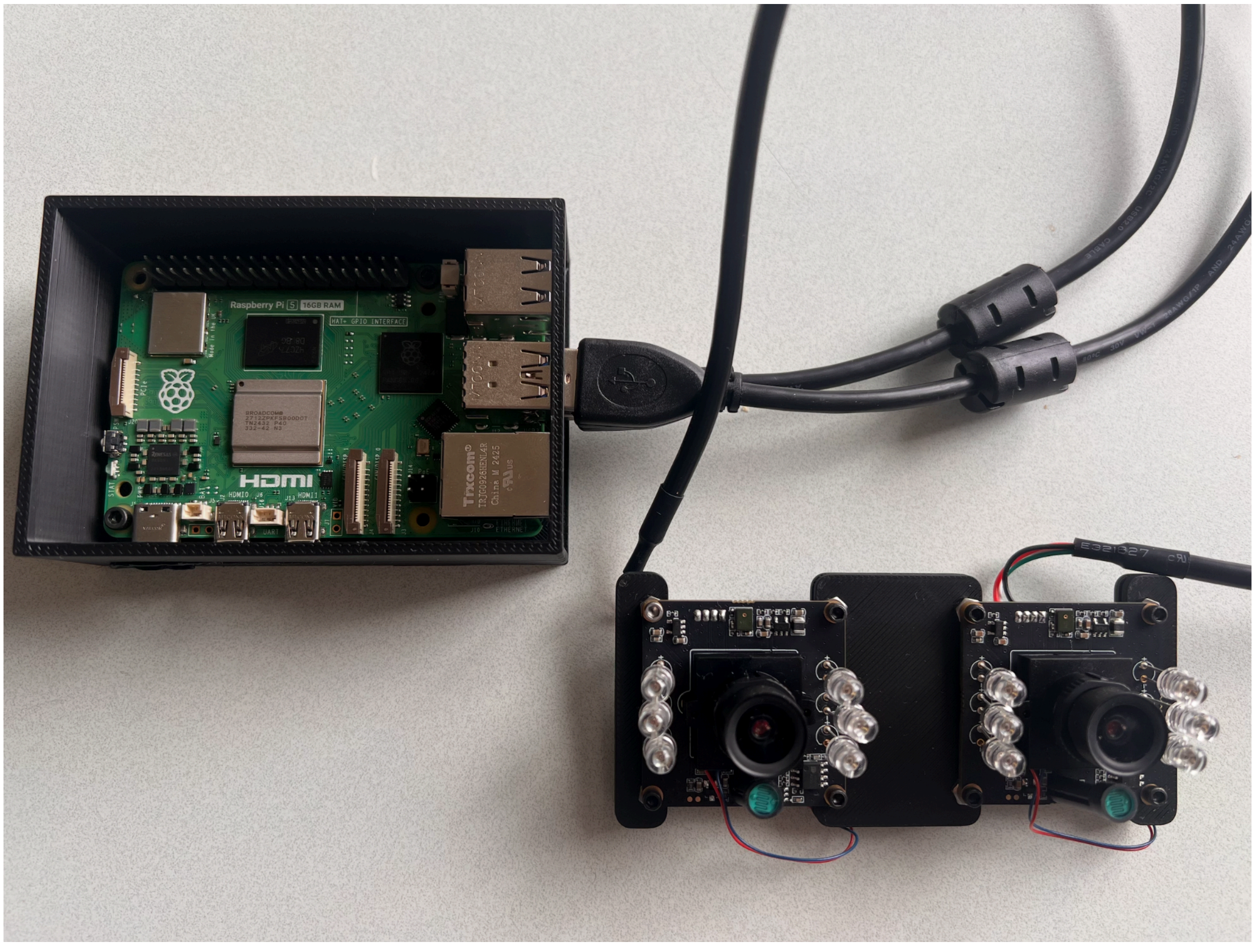
Our vendors for all of the parts are a combination of Amazon and Adafruit, though many other providers for these parts exist as they are fairly common electronic parts. Our total cost came out to $349.99 to create our product. If we were to mass manufacture our product in the future, we hope to get the total cost down to below $200 if possible.

Power Requirements

Smart System for Visually Impaired is completely powered using a dual-connecting portable charger. The dual-connecting portable charger is a 20000mAh/74Wh lithium-ion battery that has a DC input of 5V and 3A, 9V and 2.2A, or 12V and 1.5A. The output of the portable charger is 5V and 4.5A for both USB outs. The USB outs power both the Raspberry Pi and the TinyPICO ESP32 with beyond sufficient power for all of our components. This includes the Raspberry Pi's two Arducam USB cameras and the TinyPICO ESP32's photoresistor, vibration motor, and two bright LEDs that output at 6000K with a maximum brightness of 18 lumens.



Entire blown out view of Smart System for Visually Impaired. Wireless headset connects to the Raspberry Pi 5 via bluetooth and the TinyPICO ESP32 and Raspberry Pi connect via a UDP server over the same internet connection. Both the Raspberry Pi 5 and the TinyPICO ESP32 are powered by the same dual-connecting portable battery that is attached to the user's waist. The dual-connecting portable battery as mentioned previously, powers both the two devices simultaneously at 5V and 4.5A which is beyond sufficient power for Smart System's uses.



Clear view of the smart cap component of the Smart System for Visually Impaired. Features a custom 3D-printed enclosure that neatly tucks away the Raspberry Pi 5. A top cover plate covers the enclosure and is secured on by simply pressing onto the enclosure. The top cover plate can be easily removed if diagnosis or reprogramming of the Raspberry Pi is needed.

The two Arducam USB Cameras are seen connected to the Raspberry Pi via USB 3.0 connections. The Arducam USB Cameras are fastened to a custom 3D-printed mount. This 3D-printed mount can be attached to a cap or other head-wearable item for full functionality. The mount is vital for our stereoscopic vision feature as well as our depth mapping feature. The mount provides consistent alignment and spacing for the two cameras so that they are always calibrated accordingly. A predefined calibration that we have carefully implemented can be seen in our main repository. Should the user recalibrate the cameras for any reason, we have provided recalibration scripts and instructions to do so accordingly.

Wrist-wearable side view showing photoresistor mounted in place on the side of the enclosure. The photoresistor points towards the user's posterior hand so that light from the outside environment can be read in accurately. The power cable is on the opposite side, and as of now, is meant to be hidden through the sleeve of the user and connected to the dual-connecting portable charger for power.

On the top-facing side of the wrist-wearable, a white push button and two bright LEDs are mounted in place. The vibration motor is secured inside of the housing. All of these components are connected to the TinyPICO ESP32 that is mounted securely inside of the enclosure. All components are soldered and connected using various methods such as shrink wraps and hot glue. The wrist-wearable has been tested extensively including 6-feet drops, and the product still works as intended.

Relevant Data Sheets, Application Notes, Design Templates, and Web Resources:

- **TinyPICO - Documentation + Guide**
- **Raspberry Pi 5 - Guide**
- **Arducam 1080p Day/Night USB Camera Specifications**
- **SK9822 White LED Specification Sheet**
- **Vibration Motors Specification Sheet**
- **Photoresistor with ESP32 Guide + Resources**
- **Open Source Computer Vision Library GitHub**
- **Orthographic Drawing with OnShape**