GNG2101

Design Project User and Product Manual

TalkBox User Manual

Submitted by:

Soundgarden: Group 2.4

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Table 1. Acronyms

Acronym	Definition
I/O	Input/output. Refers to any component that allows the user to interact with the device.
UPM	User and product manual i.e., this document
RAM	Random access memory. A general indicator of the speed of a computer
GPIO	General purpose input/output. The long array of metallic bars (pins) that extend out of the Raspberry Pi. The LCD is connected to the Raspberry Pi with these pins.
LCD	Liquid-crystal display. The type of screen that is installed on this product.
BOM	Bill of materials. Outline of items purchased along with their costs

Table 2. Glossary

Term	Acronym	Definition
TalkBox	TB	Our project
Captionist	N/A	The person who transcribes audio. Also known as a stenographer
Jumper cable	N/A	Wire that extends out of the screen and contains a plastic sheath on its end. This plastic sheath connects to the pins on the Raspberry Pi, securing an electrical connection between the two components

1 Introduction

This User and Product Manual (UPM) provides the information necessary for end users to effectively use the TalkBox (TB) and for prototype documentation.

The document herein serves the purpose of providing sufficient information for the use, and additional engineering of TB. This document is sufficient if a new feature is required, or the user intends to recreate the project. The scope of the user manual goes through how to use the TB for its intended purpose and underlaying components should there be a need for replacement or rebuild of the project.

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2 Overview

The problem is that modern laptops and portable devices do not have supported I/O that connect to standard microphones required for assisting hard-of-hearing users. The desired solution is a standalone streaming device that a student can bring to a class and integrate with the provided microphones to transmit audio to a captionist to assist users that are hard-of-hearing. Figure 1 shown below presents an overview of the desired functionality of the TB within this desired setting.

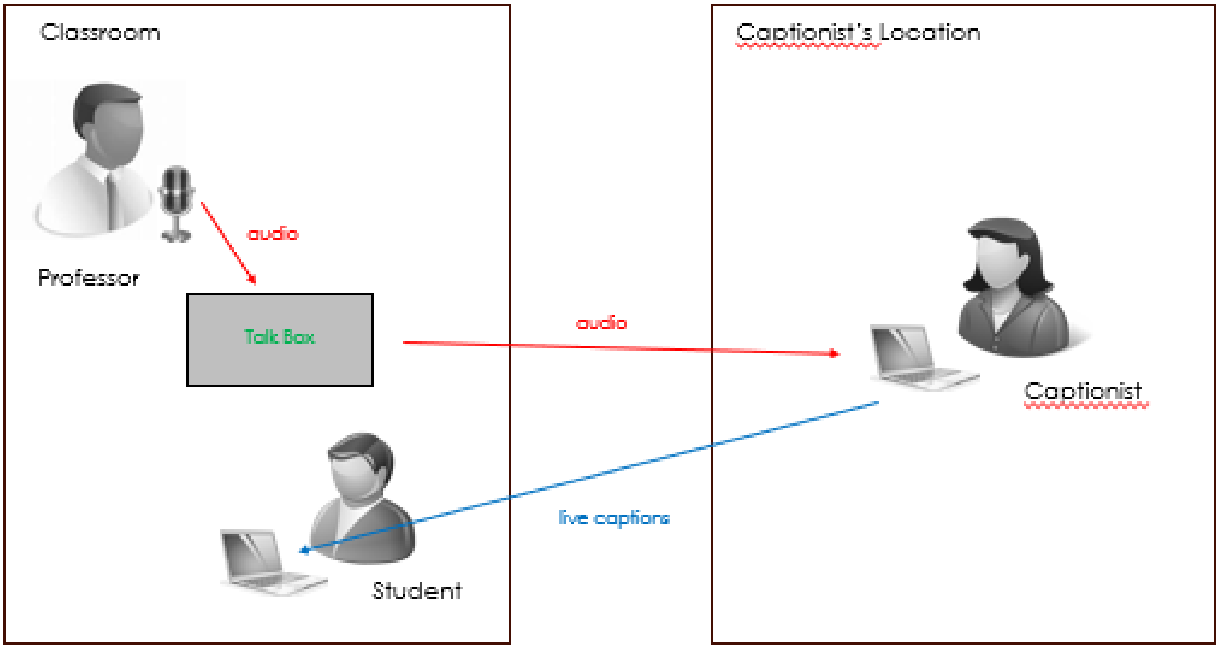


Figure 1: Overview of the system requirements and integration of the TB within the operational functionality.

TB is a stand-alone device which connects to Zoom to establish a stream of audio for a captionist to provide live generated captions to students who are deaf or hard of hearing. The functionality of the product is defined such that a student would initially provide a microphone to the professor, whose speech is detected by a video conferencing tool such as Zoom. A capitionist who listen into the livestream is then able to interpret the speech and provide captions to the student through a third-party tool called StreamText. Based on this description alone, it was furthermore possible to identify that the device would need to be user-friendly for both the student and the captioner, the device would need to be able to easily connect to the institution's network, and the device would need to be configured such that troubleshooting could be conducted in the case of any technical difficulties. Initially, there were also several elements that were unknown relating to desired functionality of the device. Namely, it was not understood how the StreamText tool would integrate within the scope of this project and if the capitionist was sending the captions directly through the product. Furthermore, uncertainties remain relating to if there exists feasible hardware and microphone systems from a cost perspective that would be able to support these desired functionalities.

2.0 Conventions

Figure 2 shown below provides the naming convention that is used to describe the TB, as it will be used in the continuity of this report.

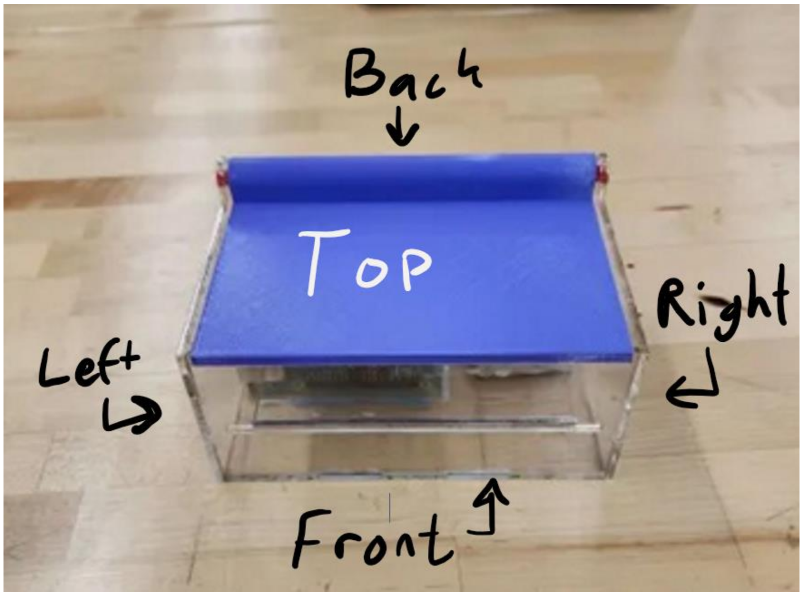


Figure 2: Names for each side of casing

2.1 Cautions & Warnings

Caution the Raspberry Pi can become hot to touch. It is recommended to keep the circuity within the acrylic container. It is also recommended to be prudent when manipulating the physical system of the design. The external casing has been designed to rigid in its use, however excessive impact and unreasonable load on the system could result in damage to the system. The Raspberry Pi microcontroller as well as the internal circuitry of the system are also relatively fragile, as such caution should be generally exercised when manipulating the physical system in its entirety to ensure that all internal and external components remain intact. A representation of all of these mentioned components contained within the final design of the TB is shown below in Figure 3.

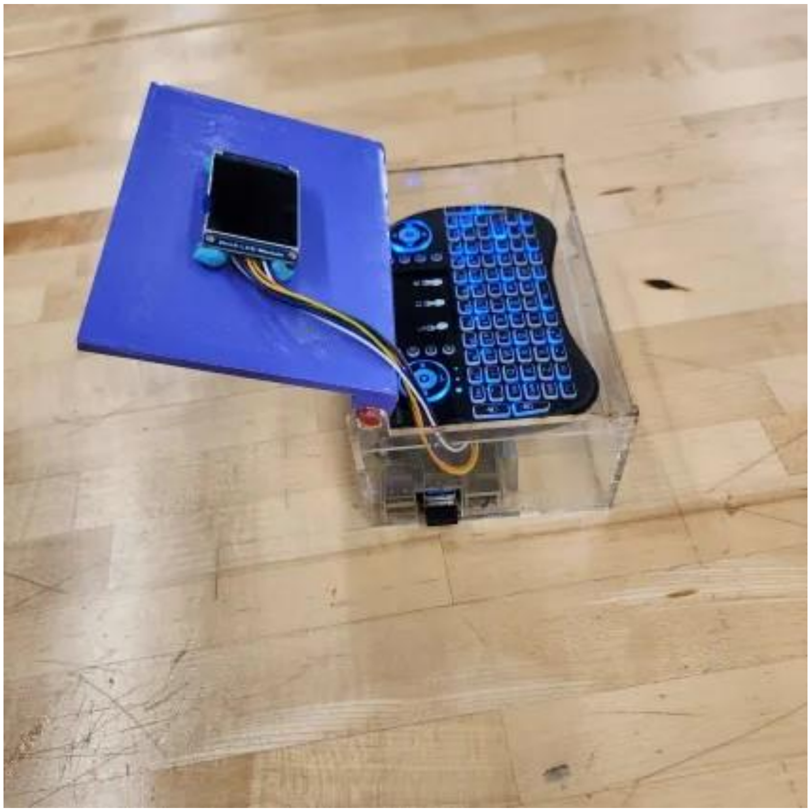


Figure 3: Representation of entire TB system illustrating system components (screen, keyboard, circuitry, Raspberry Pi and casing).

3 Getting started

The Talk Box can be configured according to the steps show below:

1) Turn on the Pi via plugging a USB-C cable to power source
2) Using the intern keyboard within the compartment, log in to the Raspberry Pi,
3) Login Credentials
4) Username: admin
5) Password: admin
6) Connect to the Wi-Fi using the bottom right of the screen and click the Wi-Fi button and select your network.
7) Plug in a microphone to the USB-A port.
8) Click the desktop icon centered on the desktop to join the Zoom meeting with the captionist.
9) Audio shall begin transmitting to the captionist to generate captions.
10) Captions shall show on stream text on the user’s device of choice. See stream text webpage for instructions.

Configuration Considerations

The device is configured to a Bluetooth keyboard that connects by plugging in a USB A transmitter in the board on the side of the casing. The power for the Raspberry Pi is plugged in via the USB-C port located on the back of the Talk Box

3.0 User Access Considerations

The device is simple to use and does not require user restrictions, simply log in and connect to the captionist via zoom.

3.1 Accessing/setting up the System

The system can be accessed in referencing the instructions provided above. Additionally, if the jumper cables that connect the LCD to the GPIO pins become disconnected, they can be re-connected to the Raspberry Pi with the following configuration:

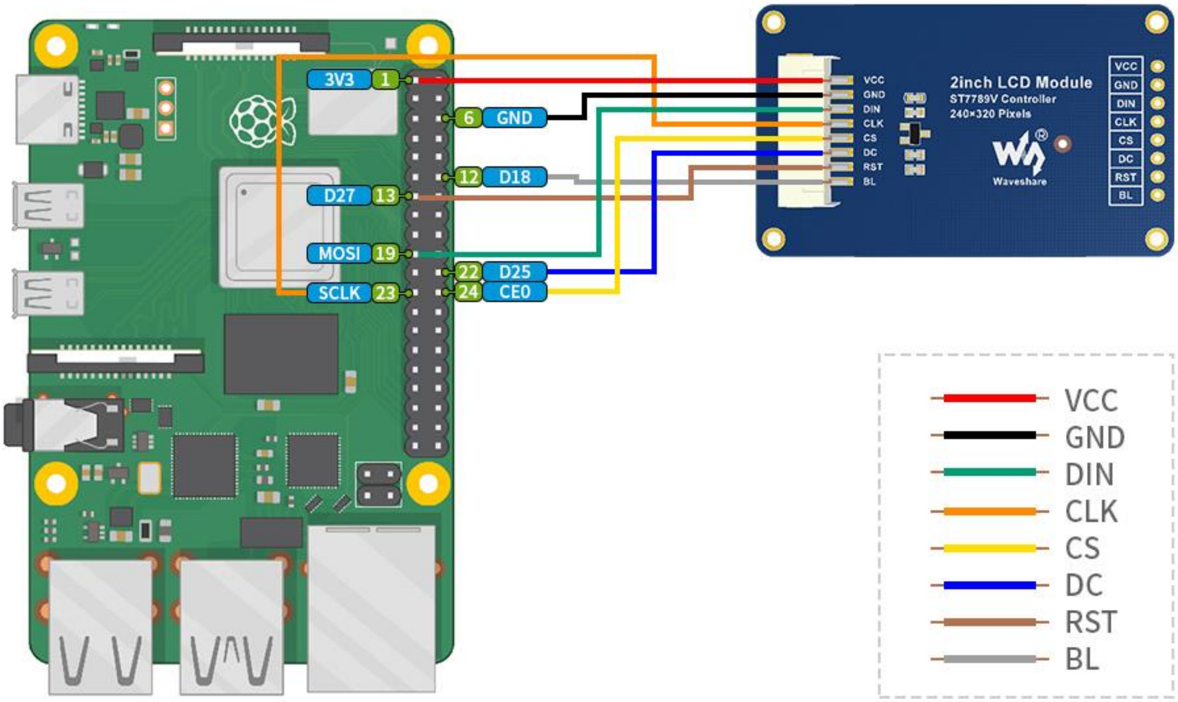


Figure 4: Configuration of jumper cables from LCD to GPIO pins on Raspberry Pi

3.2 System Organization & Navigation

The pi board is housed in an acrylic casing, the screen is on the top of the casing, the keyboard is inside the case. The raspberry pi comes with Raspian (https://www.raspberrypi.com/software/), a Debian distribution of Linux pre-installed. Zoom will be preinstalled on our product from distributions at https://zoom.us/download. The product is easily accessible with just needing to log in and connect to Wi-Fi and connect to Zoom via clicking the only desktop icon available. The interface between the raspberry pi and the user is conducted using the keyboard provided within the casing. Specifically, the keyboard is used to access the product and provide the required user credentials as previously required. Once the user has accessed the network, it is imperative to ensure that the microphone is properly configured and that the professor's speech is adequately being transferred to the third-party listener-typist. At this point, the system's organization and navigation per say is complete, however it remains important to ensure that the captions are being transmitted to the student's screen through the StreamText software. As such, troubleshooting considerations will be further elaborated within the contents of this user manual.

3.3 Exiting the System

Open the terminal opening the terminal app format the toolbar. Type in “shutdown -h now”. Pertaining to the physical system, it is also recommended that the system be closed when the user is not interfacing with either the keyboard and screen, in order to protect the internal component of the system. This closed representation of the TB is shown below in Figure 5.

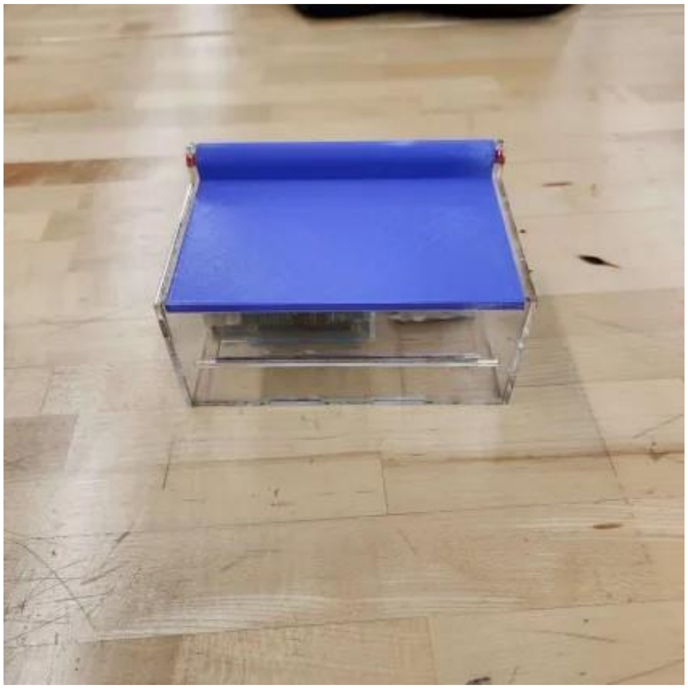


Figure 5: Closed final assembly of the TB which represents the requested configuration when the system is not in use.

4 Using the System

As it has been elaborated, the required functionality of the TB is to transmit audio from a University lecture to a third-party remote captionist (listener-typist), who will then provide real-time accurate captions to the user's screen. The TB is introduced within this complex series of events in order to initiate the zoom calls which connect the class proceedings to the captionist who then relays it to Stream Text. As it has been mentioned, it is required that the user connect the product to the intternet and activate bluetooth to connect to the keyboard. Thereafter, the configuration of the system will allow for the desired functionality to be conducted as a result of audio transmission and subsequent human entered captions within the StreamText software.

4.0 Preparing the device

Before starting to use the device, we must first set it up with a microphone. To do this, we can connect the microphone to the TalkBox using the USB A ports on the left side of the device. After this is done, we can connect the battery to the device, using the USB C port on the back of the device.

4.1 Zoom Calls

The TB makes zoom calls by connecting to the captionist via clicking the only desktop icon available. This opens zoom in the browser and begins the zoom call. Audio is transmitted through the attached microphone and the captionist is able to return captions through stream text. It is imperative to ensure that audio capture through the microphone system is configured correctly, as in correct use of the microphone will result in the inability to transmit audio to the third-party listener-typist. Figures 6 and 7 shown below demonstrates the TB's ability to run Zoom, using the Rasberrry Pi.

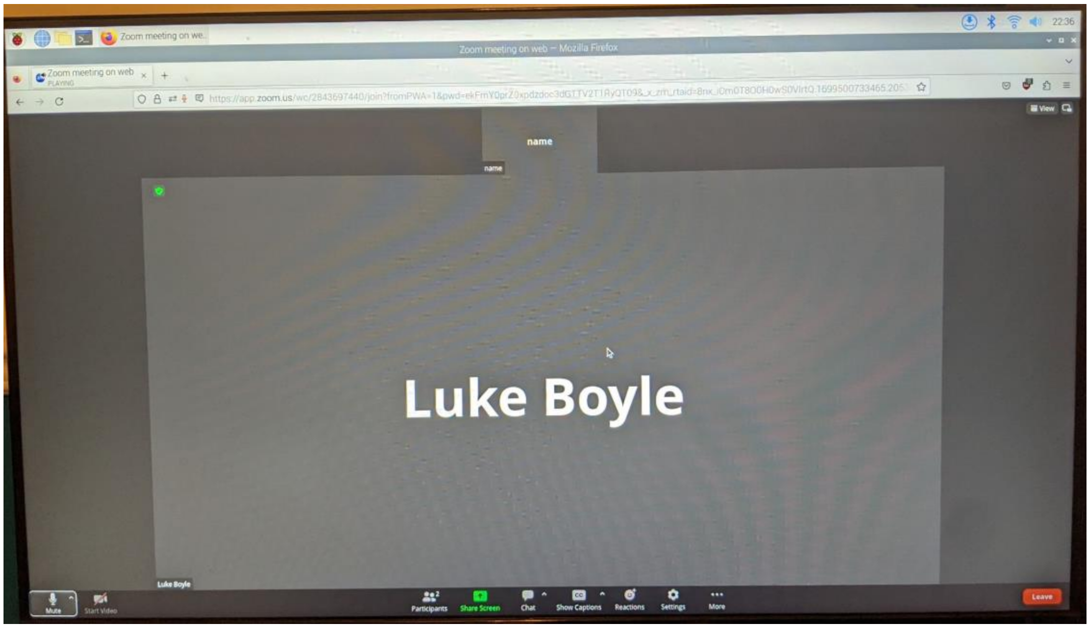


Figure 6: Representation of Zoom meeting running through Firefox browser on Raspberry Pi contained within TB system.

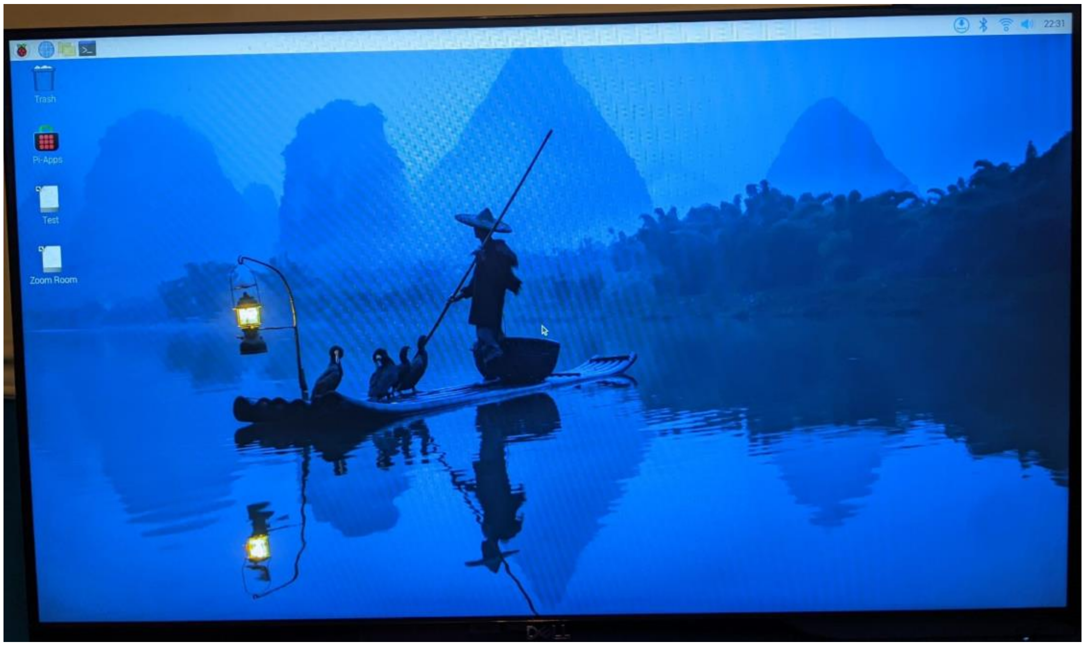


Figure 7: Representation of Raspberry Pi home screen with a Zoom Room shortcut that can be seen on the left side of the screen.

5 Troubleshooting & Support

5.0 Error Messages or Behaviors

The following error messages and behaviour are to be considered when using the TB. Troubleshooting instructions are also included.

- No Wi-Fi connection: try connecting to a new network or use a hot-spot mobile device to connect.
- No audio: plug the audio device into another USB port and check audio via Zoom.
- Zoom crash refresh browser or close browser and click the desktop icon again.
- Low battery: Connect system to the configured system battery pack or any external power outlet source.

5.1 Special Considerations

Sensitive electronics with delicate connections reside within the TB. Given that there are also loose parts and connections in the same container, the user should not shake or flip the device to minimize damage. This should reduce the chance of the TB breaking and increase the lifespan of the device. In addition to this, it’s important that the user handles the device with care, since the parts of the device are currently held together with blue tack.

5.2 Maintenance

The TB requires minimal maintenance. The primary piece of equipment that needs to be maintained on the TB is the battery. To maintain the battery, you must charge it using a USB-C input. Along with that, it is important to clean the screen if it gets dirty. This can be done by using a microfiber cloth to ensure the screen is visible and usable.

5.3 Support

For any issues relating to device software please contact the Raspberry pi team for help with your device software at https://www.raspberrypi.com/contact/.

For documentation of the screen that comes with this product, please refer to the Waveshare wiki at http://www.waveshare.com/wiki/2inch_LCD_Module.

For any other issues relating to the general use of the TB, the following team members can be contacted and will be able to provide support to the user.

- Nicholas Pulido: npuli051@uottawa.ca
- David Ulak: dulak029@uottawa.ca
- Devon Knight: dknig074@uottawa.ca
- Haider Kadhom: hkadh008@uottawa.ca
- Luke Boyle: lboyl052@uottawa.ca

6 Product Documentation

6.0 Power System

The power system is designed to provide sufficient energy at 5V for the Raspberry Pi to be functional at full capacity. This can be accomplished with either replaceable batteries such as 9V or AA batteries or a battery bank found with most mobile device chargers. The problem with using replaceable batteries is reaching the 5V threshold to sufficiently power the Raspberry Pi and its processes. This would require many batteries together and a voltage regulator. The issue with replaceable batteries is the wasted energy in heat when bringing the voltage down to 5V form 9V batteries. The decision to use a mobile battery pack is to the client’s liking and could provide the appropriate 5V needed to run the raspberry pi. The client also was positive to the idea of being able to switch out battery packs when in need, so Velcro will be needed to attach the battery pack to the raspberry pi casing. The battery interfaces with the raspberry pi through the micro-USB port found on the pi that is accessed through the 3D modeled housing through a port.

6.0.1 Design Process

Below in Figure 8, the detailed design of the final casing subsystem design is shown. Dimensions for each detail is specified. Not all drawings are perfectly to scale with other drawings or themselves, but the general idea can still be seen.

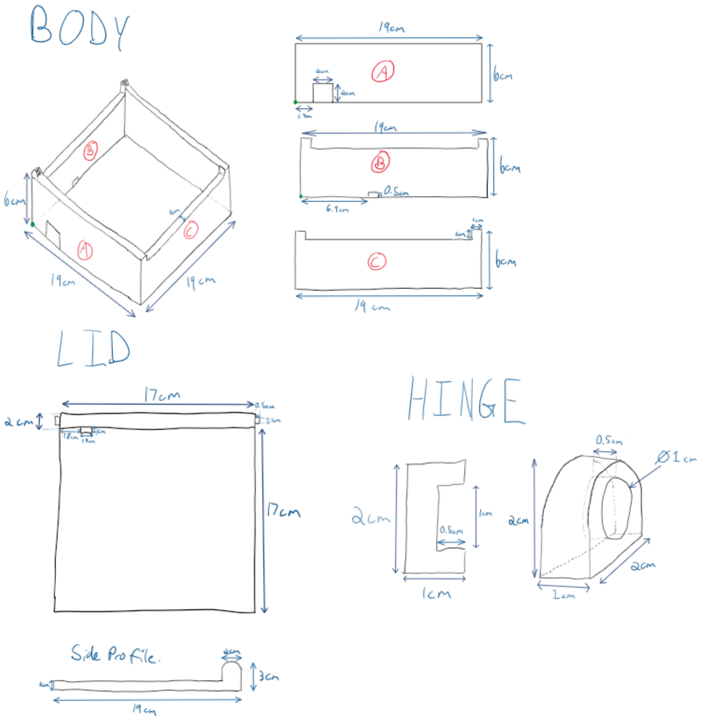


Figure 8: Representation of casing sub-system design.

Below in Figures 9 and 10 a detailed representation of the keyboard and screen sub-systems is provided. Again, the drawings are not completely to scale, however they provide an accurate depiction of the desired systems to be incorporated into the design.

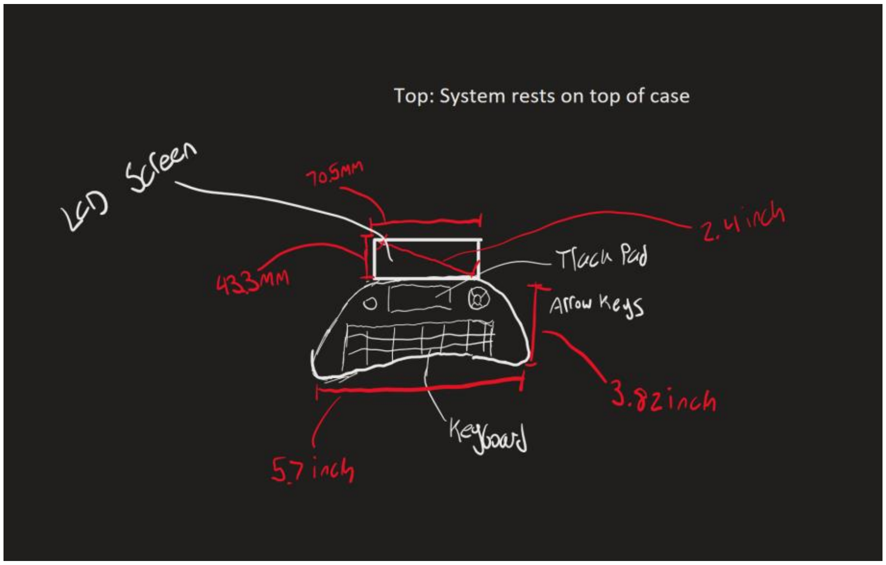
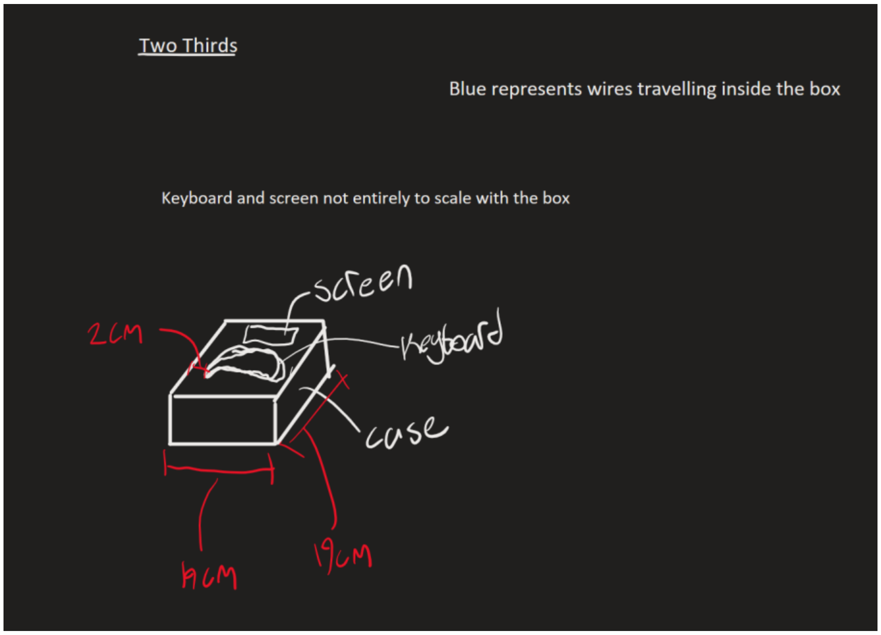

Top: System rests on top of case

Figure 9: Representation of desired keyboard sub-system.


Two Thirds

Blue represents wires travelling inside the box

Keyboard and screen not entirely to scale with the box

Figure 10: Representation of desired keyboard-screen interface.

Figure 21 further illustrates the user interface (i.e the desktop that appears on screen) that will be incorporated in the design and Figure 22 presents the operational functionality of the software component of the design through a flow chart.

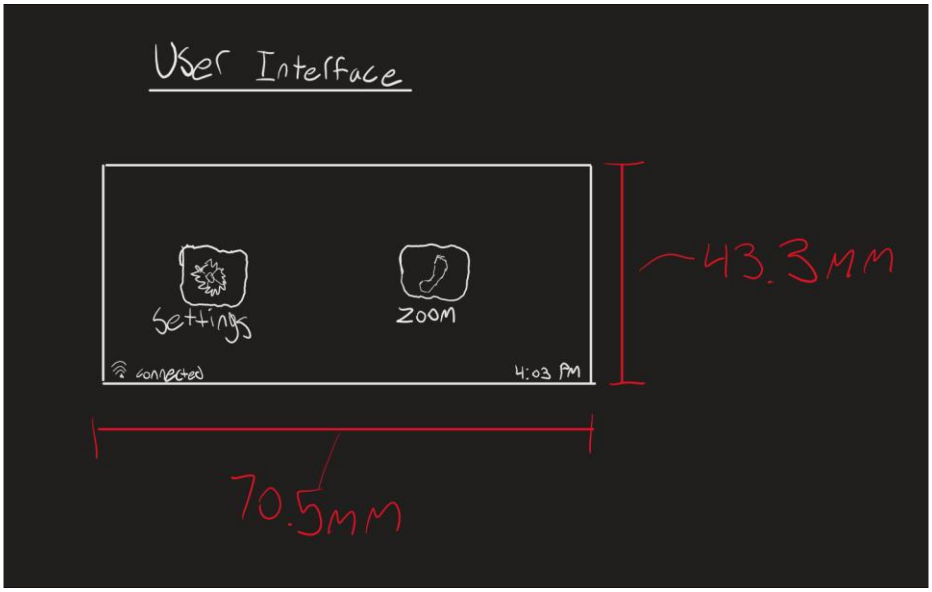


Figure 11: Representation of desired user interface system.

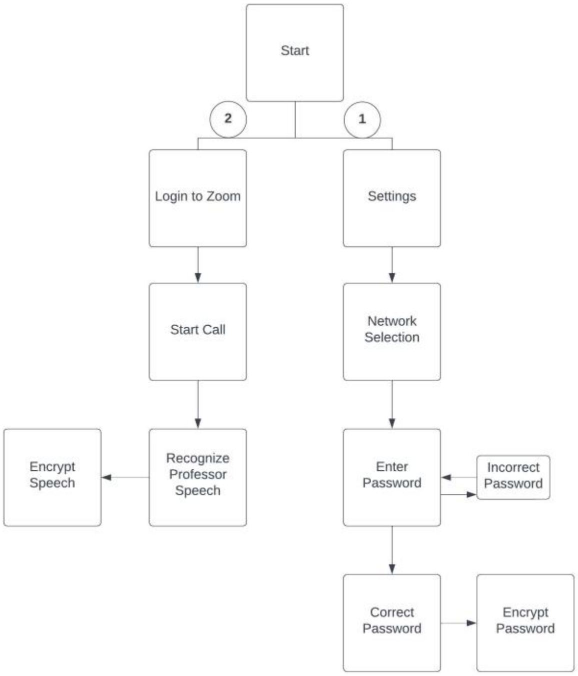


Figure 12: Flow Chart representing software functionality of the system.

After having conducted these initial design considerations, it was possible to begin the prototyping process. Prototypes 1, 2 and the final prototype are represented below in Figures 13-15.

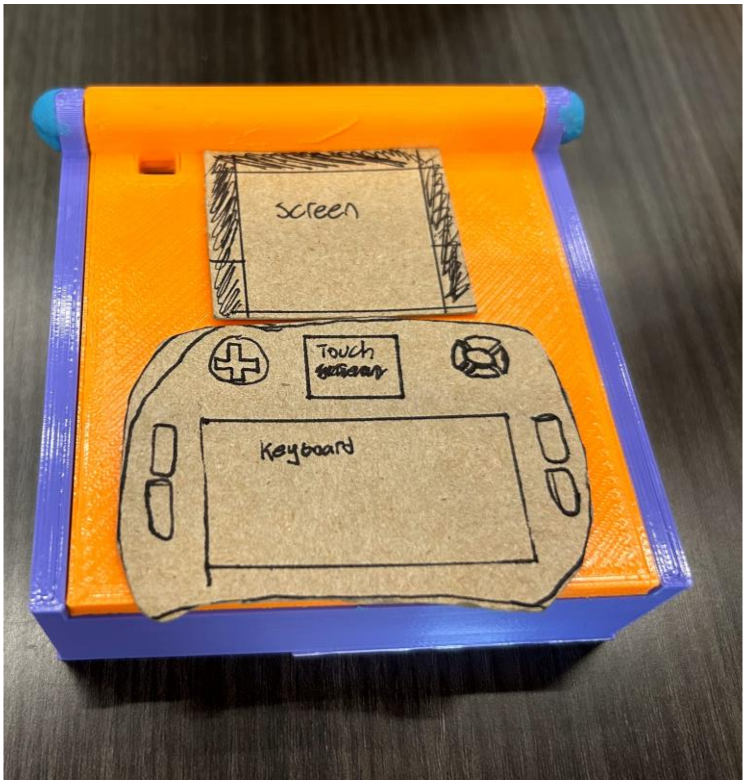


Figure 13: Representation of prototype 1.

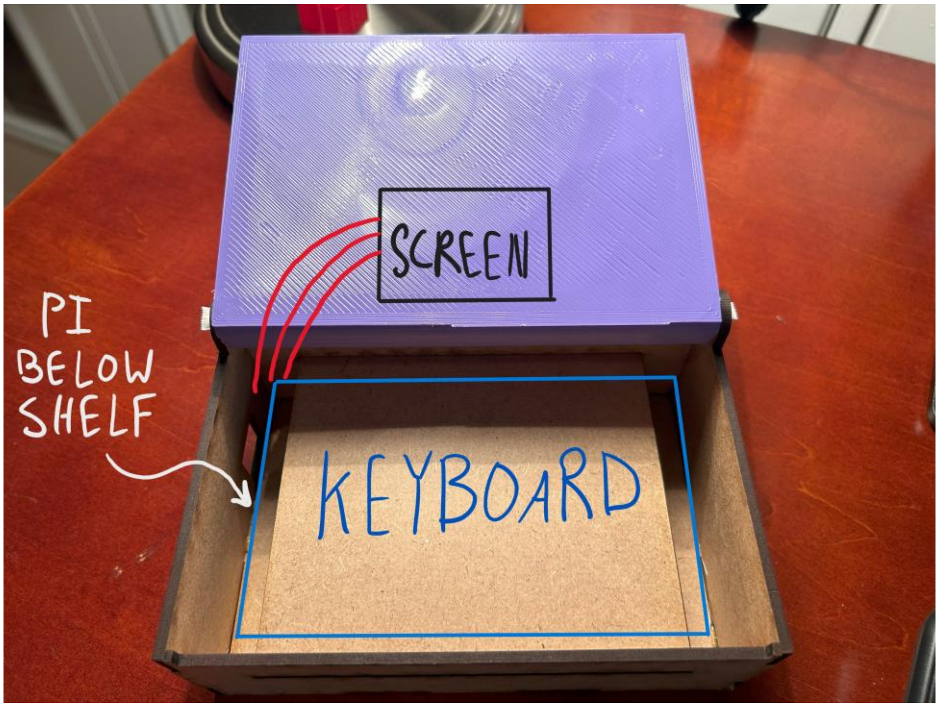


Figure 14: Representation of prototype 2.

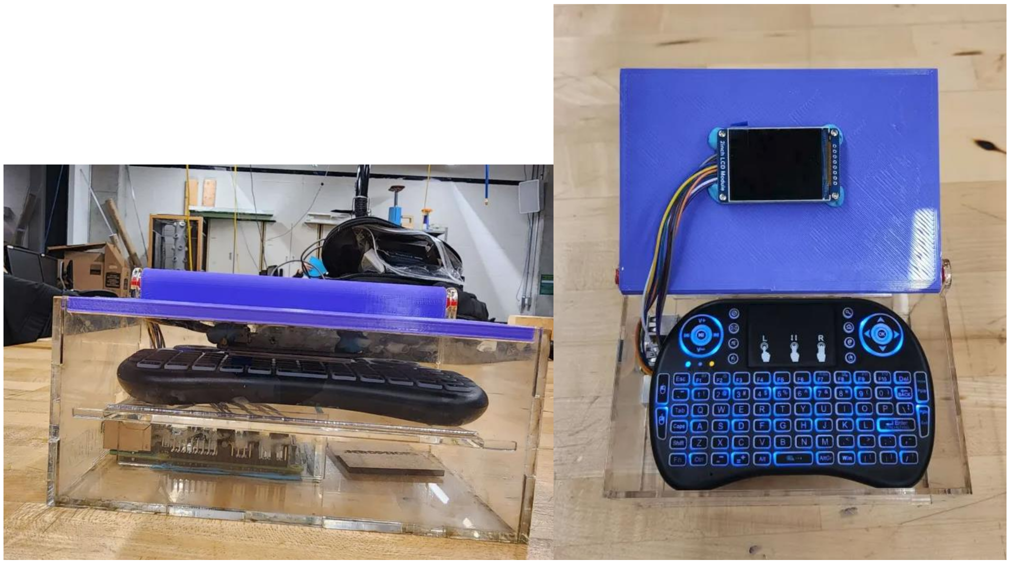


Figure 15: Representation of final prototype.

Evidently, the development of this product required the procurement and integration of several materials. The BOM that was developed and used in this project is shown below in Figure 16.

*All products are x1 quantity and include delivery fees

Subsystem	Product Name	Description	Link	Price	Final Cost with tax/fees	Final cost of Subsystem
Computer	Raspberry Pi	Model 4, 2GB RAM.	https://makerstore.ca/shop/ols/products/raspberry-pi-4-computer-model-b	$54.99	$54.99	$61.08
	Data Storage	128gb microSD Card	https://www.canadacomputers.com/product_info.php?cPath=11_175_177&item_id=158901	$4.99	$6.09	
Casing	MDF	Prototype Housing for Product	https://makerstore.ca/shop/ols/products/mdf	$4.00	$4.00	$18.00
	Acrylic Casing	Final Housing For Product	https://makerstore.ca/shop/ols/products/acrylic-12-inch-x-24-inch	$14.00	$14.00	
Power	SuperGlue	Attaches power bank to casing.	Provided by Nicholas Pulido	$0.00	$0.00	$0.00
	Battery	12500 mAh capacity with cables	Provided by Devon Knight	$0.00	$0.00	
Input	Screen	2 inch LCD	https://www.amazon.ca/2inch-IPS-LCD-Display-Module/dp/B082GFTZQD?refinements=p_85%3A5690392011%2Cp_36%3A-2000&rps=1	$19.57	$22.11	$49.54
	Keyboard and trackpad	Physical keyboard, wireless	https://www.amazon.ca/%E3%80%91ARTRONIX-Multi-media-Portable-Backlight-Raspberry/dp/B079HPLYH7?refinements=p_85%3A5690392011%2Cp_36%3A-1500&rps=1	$14.28	$16.14	
	microHDMI to HDMI	Interface with Raspberry Pi	https://www.amazon.ca/dp/B088JYGZWX?ref=ppx_yo2ov_dt_b_product_details&th=1	$9.99	$11.29	
					Total	**$128.62**

Figure 16: Representation of the final BOM.

6.0.2 Equipment list

To manufacture this product, it was necessary to use the following processes and equipment.

- Laser Cutter
- 3D printer
- USB Key
- Computer

6.0.3 Instructions

The following instructions can be referenced if it were to be desired to self-sufficiently manufacture the TB using the materials as presented in Figure 16 and the in referencing the equipment list as described previously.

1) Build acrylic box
2) Place raspberry pi in box
3) Connect USB-A receiver for keyboard into Raspberry Pi
4) Connect USB-A microphone into Raspberry Pi
5) Turn on Raspberry Pi by connecting to a power course to USB-C
6) Log in with admin
7) Connect to Wi-Fi
8) Open Zoom meeting by clicking the desktop icon
9) Begin recording audio automatically
10) See StreamText output form captioner form another device
11) Turn off Raspberry Pi when needed with command “shutdown -h now”

6.1 Testing & Validation

The final steps of the design process consisted of ensuring the functionality of the product. Testing and validation was conducted accordingly to achieve such ends. Specifically, it was necessary to verify the Raspberry Pi’s ability to run a Zoom program. The results of the testing are shown below in Figure 17.

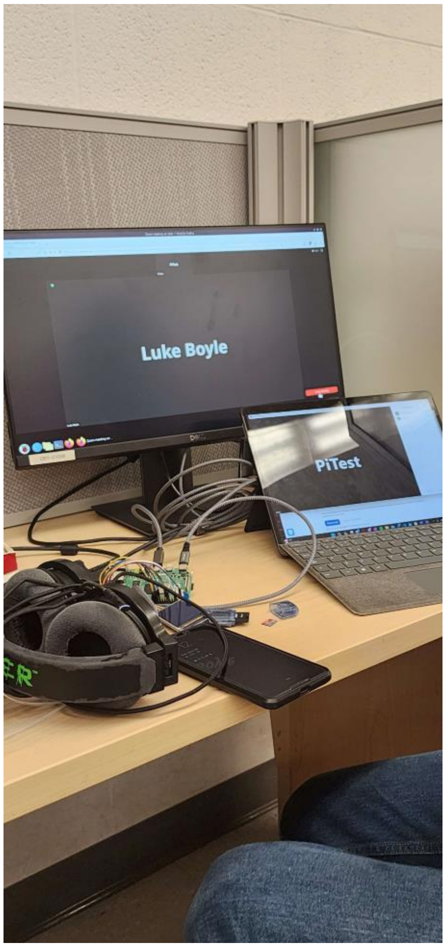


Figure 17: Representation of final testing conducted for the Raspberry Pi.

The product was tested using a separate laptop to host a zoom meeting just like the captionist would. Audio was tested using a Razer Kraken Chroma Headset and audio received on the captionist end. Seeing that it was possible to run Zoom using the Raspberry Pi, the success of the testing and validation can be confirmed.

7 Conclusions and Recommendations for Future Work

In conclusion, a successful design has been achieved on the account on the adherence of the final product to the initial design requirements established. Throughout the design process, several lessons were learned. Specifically, it was identified that a better Raspberry Pi is required to run the browser for Zoom. It is suggested that additional $50 should be invested to purchase a raspberry pi with 8Gb of RAM isntead of the 4Gb RAM version. Additionally, it is advised that there be a screen used that interfaces with the microHDMI ports of the Raspberry Pi so there is less of a need for external GitHub libraries to run a GPIO ported screen that was used for this prototype. These GitHub libraries and other modules can be found at https://www.waveshare.com/wiki/2inch_LCD_Module. This would reduce the complexity and troubleshooting required to get the product working. There are other further opportunities to expand the development of this product. Namely, if the StreamText software were to be integrated within the operation of the system, the design would account for all the main requirements associated with the product. Furthermore, large-scale manufacturing techniques could be researched for this design in order to obtain a working process that would for allow for mass production. To reiterate, the design can be deemed a success due to the functionality of the product, as well as the internal satisfaction that the team members achieved while working on this product. It can only be hoped that the user finds as much satisfaction in using the TB as the team did in designing it.

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Zhang, P., Hu, Z., Xie, H., Lee, G.-H., Lee, C.-H. (2020). Friction and wear characteristics of polylactic acid (PLA) for 3D printing under reciprocating sliding condition, Industrial Lubrication and Tribology, *72*(4), 533-539. https://doi.org/10.1108/ILT-11-2016-0280

APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Nics_Rod_Updated.SLDPRT		11/29/2023
Lid_Updated.STL		11/29/2023
dividers.svg		11/29/2023
box8th_toCut_112423.svg		11/29/2023