GNG2101

Design Project User and Product Manual

Music & Talk Box User Manual

Submitted by:

Music & Talk Box - 5.3

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December 04, 2023

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Table of Contents

List of Figures

List of Tables

List of Acronyms and Glossary

Provide a list of acronyms and associated literal translations used within the document. List the acronyms in alphabetical order using a tabular format as depicted below.

Table 1. Acronyms

Acronym	Definition
OS	Operating System
UML	Unified Modeling Language
UI	User interface

Provide clear and concise definitions for terms used in this document that may be unfamiliar to readers of the document. Terms are to be listed in alphabetical order.

Table 2. Glossary

Term	Acronym	Definition

Raspberry Pi	N/A	A small, single-board computer
Unified Modeling Language diagram	UML Diagram	A general-purpose visual modeling language that is intended to provide a standard way to visualize the design of a system.

1   Introduction

This User and Product Manual (UPM) provides the information necessary for users to effectively use the Talk Box and for prototype documentation. This report also details the features and functions the Talk Box has available, created for our client Emilie and Arthur. The purpose of this product was to allow users who are non-verbal or have trouble speaking to have the opportunity to communicate throughout their daily life. The Talk Box also comes loaded with

music, Bird Noises, and an Audiobook as forms of entertainment for the user. It also accommodates for our clients limited vision, as it has a built in text-to-speech screen reader that will read aloud pre-selected options on the screen. This way any user with limited vision can navigate the screen by ear.

The purpose of this user manual is to provide the user and any caretaker role (parent, etc) with information on how they can use the Talk Box and its main functions and features. This includes adding and deleting categories and phrases, and how to use the Talk Box as a regular user.

Link to video manual: https://youtu.be/_c4LtJvYX9Q

2   Overview

A user of the TalkBox might be non-verbal with limited vision and motor skills. As such, they need a device that allows them to interact with others with minimal effort. The Talkbox allows for this with a joystick that has the capability to execute every instruction in a program, which contains a variety of speech options ready to be selected. Before selection, each speech option that is hovered upon is played to an earpiece connected to the Talk Box via Bluetooth and upon selection, it is played through a speaker for everyone else to hear. You will notice that previous TalkBox's lacked accessibility for those who must rely upon their sense of hearing.

Figure 2.1 Final Prototype

The major function of the TalkBox is its text-to-speech capability. This is done using a screen reader inside the program itself.

The Talkbox was programmed using the programming language C# in a .NET framework. It is using a Linux operating system on a Raspberry Pi. User input is provided using a connected joystick and all output is displayed on a connected screen.

The architecture of the program is as follows: a user opens the program and is met with the main menu, which contains all sub-menu options as well as the option to switch to French or English. The sub-menu "Phrases" has inner sub-menus that are the different categories of phrases which you can select, such as "General" or "School." At the bottom of these categories, there is the option to add/delete a category, and inside a category option, there is the option to add/delete a phrase. For example, in "General" you can delete the word "Hello" and add another if you wish.

2.1 Conventions

N/A

2.2 Cautions & Warnings

Please keep in mind that to use the Talk Box program properly, the Joystick must be plugged in via USB. For audio, bluetooth earbuds/headphones are required to use the Talk Box's screen reader, and the provided speaker (or any wired speaker) is required for words, music, sounds, and audiobooks to be played. The speaker must be plugged into the aux port on the side of the Talk Box. The Talk Box is not waterproof, so please do not get it wet.

3   Getting started

To use the Talk Box, please ensure that the TalkBox is connected to a power supply, whether that be the provided power bank or any USB-C power supply. It is also important to make sure that the joystick and speaker are both plugged in, and that a pair of bluetooth headphones are connected to properly use the text-to-speech screen reader.

To start the TalkBox program, you must open the file named "TalkBox.exe" on the main desktop screen. Once the program has been opened, you will see a variety of menus denoted "Phrases English", "Phrases French", "Sounds", "Music", and "Audiobook".
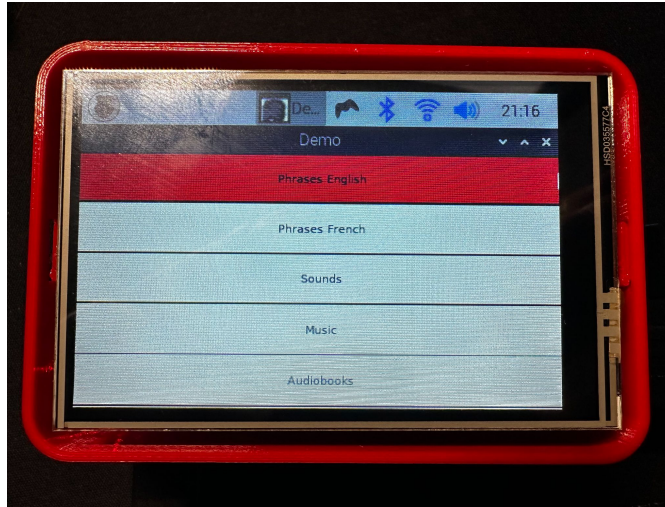

Figure 3.0.1 Main Desktop

Figure 3.0.1 TalkBox Program Home Page

To **scroll** through these menus, shift the joystick **up and down**. A red box will appear on any pre-selected menus, and any user using bluetooth headphones should hear the screen reader reading out the pre-selected options (if this is not happening, please see section 5.0). To **select** a menu, simply shift the joystick to the **right**. To go **back**, simply shift the joystick to the **left**.

3.1   Configuration Considerations

The TalkBox requires 4 other devices to be connected for proper use: The **joystick**, **power bank**, **speaker**, and **bluetooth headphones**. The power bank (or any USB-C power source) **must** be connected for the Talk Box to work. The joystick will plug into any of the four USB ports on the right of the Talk Box. The speaker should be plugged into the aux port, which can be found on the same side as the power source port.

To properly use the text-to-speech screen reader, a pair of bluetooth headphones must be used, while a speaker for selected audio output must be connected to the aux port. When connecting bluetooth audio devices, you must specify that device as the default audio device. To do this you must connect a mouse to the Talk Box to any of the USB ports. Then right click the

volume icon on the top right of the screen, and select your bluetooth audio device. Any selected

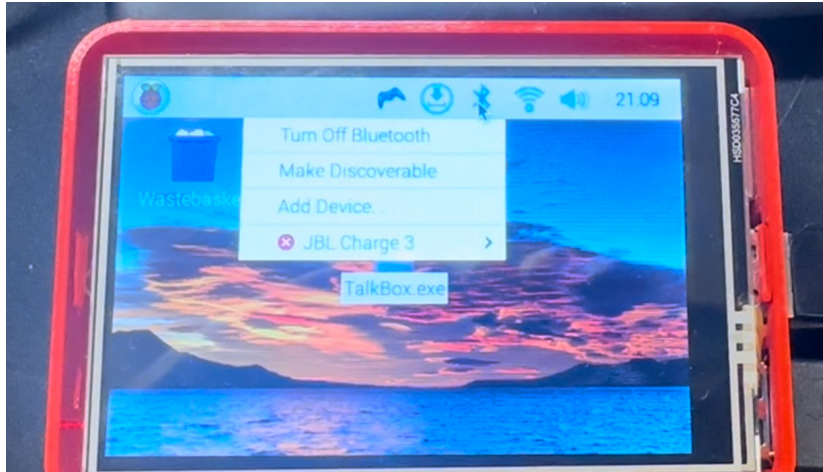phrases, music, audiobooks, or sounds will still be played out of the aux speaker.
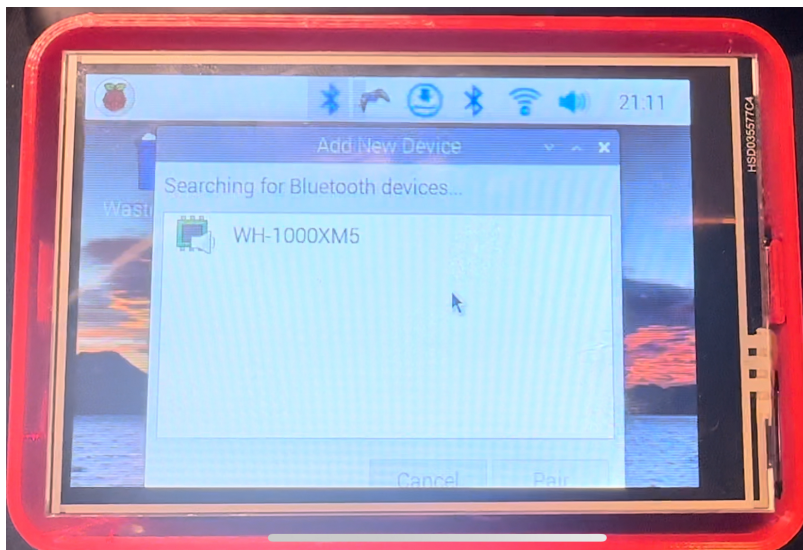

Figure 3.1.1 Bluetooth menu

Figure 3.1.2 Add new device screen
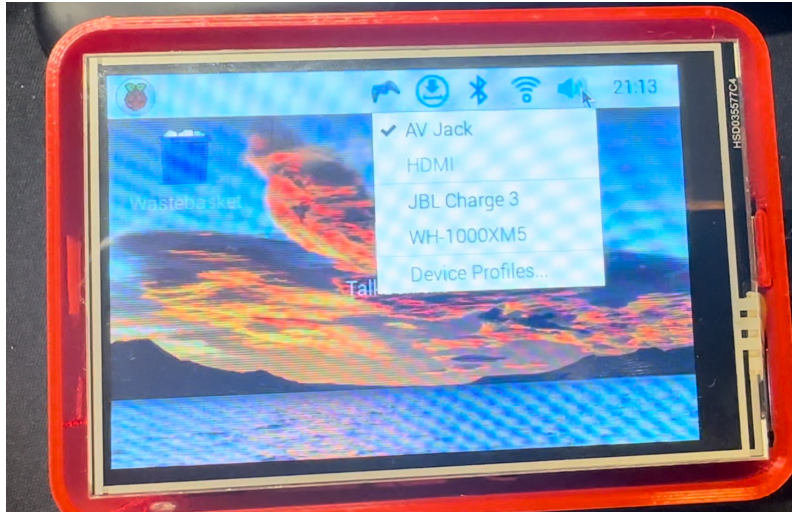
Figure 3.1.3 Change volume output

3.2   User Access Considerations

If the user wants to access the Linux command line for the Raspberry Pi, or for some reason you are required to log back in, please note that the system's username is "pi" and the password is "talkbox".

3.3   Accessing/setting up the System

To turn on the Talk Box, simply plug in the provided (or any USB-C) power supply. The

screen will promptly turn on. Once the screen has loaded and you see the main desktop, open the

"TalkBox.exe" file in the middle of the screen with either a mouse or with the touch.

If needed, the login information for the Raspberry Pi is username: "pi" and password: "talkbox".

3.4   System Organization & Navigation

Hardware

Main components:

1. Raspberry Pi: Central processing unit, managing system operations and interactions.
2. LCD Screen: Display interface for user interaction and information display.
3. Joystick: Input device for navigating the LCD screen.
4. Portable Charger: Power supply for the entire system.
5. Speaker: Output for sound or speech.
6. Earpiece: Personal audio output for the user.

Connections:

Raspberry Pi:
- The main computer of the Talk Box that runs the Talk Box program.

LCD Screen:
- Directly connected to the Raspberry Pi for displaying the user interface.

Joystick:
- Connected to the Raspberry Pi by USB for UI navigation.

Portable Charger:
- Powers the entire system.
- Connected to the Raspberry Pi for power.

Speaker:
- Plugged into the Raspberry Pi for user selection audio output.

Bluetooth headphones:
- Connected to the Talk Box by bluetooth for the text-to-speech screen reader

Software

Main Components:

1. C# Program: The main application that manages interactions, processes data, and controls the functionalities of the talk box.
2. LCD Screen: The graphical user interface displayed on the LCD screen that hosts the C# program.

Navigation Paths:

- Talk Box Home Page:
    - Displayed upon running the "TalkBox.exe" file on the main desktop.
    - Provides access to the main functions of the Talk Box program.
- Navigation via Joystick:
    - Users navigate through the Talk Box application using the joystick.

- Moving the joystick up/down corresponds to navigating through different menus
- Moving the joystick left corresponds to exiting the menu/going back.
- Moving the joystick right corresponds to selecting a menu/phrase.
  - Main Functions:
    - The system menu leads to various sub-menus.
    - Each function is accessible from the system menu/home page and can be selected using the joystick.
  - Selection and Execution:
    - Users can select a function by moving the joystick to the right.

3.5   Exiting the System

To exit the program, you may click the "x" on the top right of the window. To shut down the Talk Box itself you may unplug the power source. It is recommended however to shut down the talk box manually in the Raspberry Pi OS. To do this, you may use the given pen, but using a mouse to do this will be much easier.

First, using the pen or a mouse, click on the top left Raspberry Pi icon. After seeing the list of menu items, scroll down to the bottom of that menu until you see "Shutdown" as the very last option. Click that option and wait for the pop-up. You will see "Shutdown", "Reboot", and "Log out". Click on the "Shutdown" option and the Talk Box will proceed to shut down. Once the screen turns white you may unplug the power.
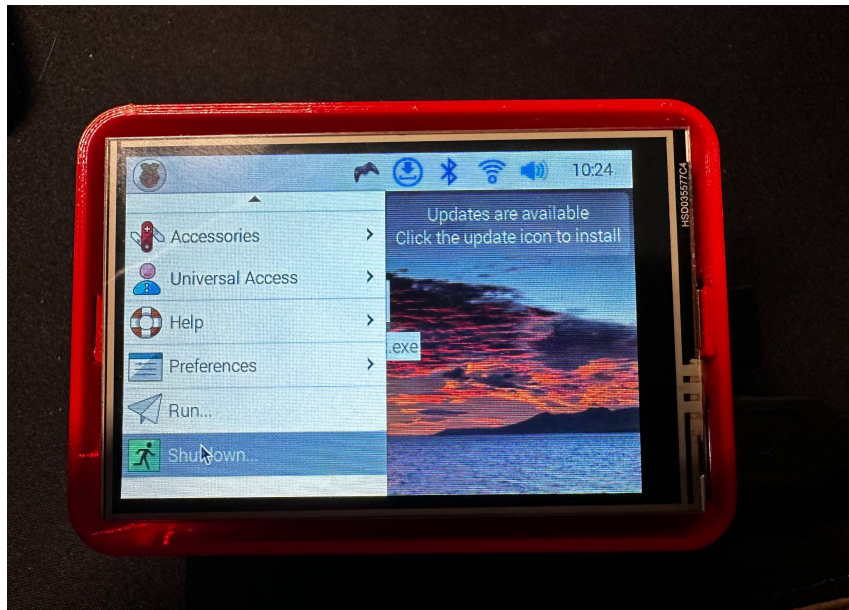

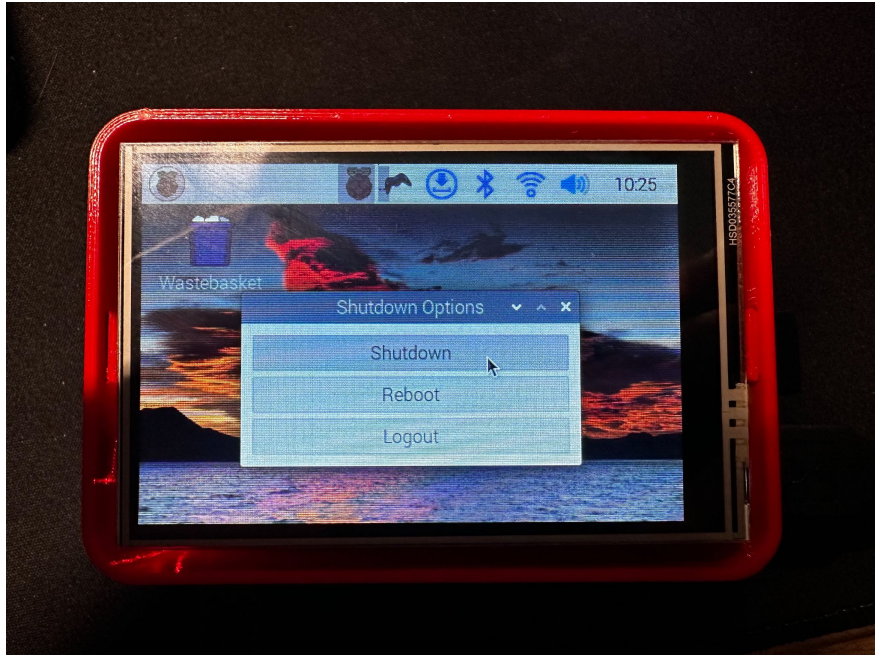*Figure 3.5.1 Shutdown button in Menu*

Figure 3.5.2 Shutdown menu

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Talk Box.

4.1 Using the Joystick

To use the joystick, each direction corresponds to a specific command. **Up and down** are used to scroll through menu options, **right** is to select an option, and **left** is to go back. Right and left can be thought of as **select** and **back** buttons.

For proper orientation of the joystick, please ensure that the wire coming out is facing the user.

4.2 Selecting Phrases

To select a phrase to be read aloud through the aux speaker, the user must first pick either "Phrases english" or "Phrases french". These are the first two options on the main menu. Once a language has been picked, a list of categories will be shown. Please note not all categories are shown on the screen, and you might have to scroll down by continuously moving the joystick down to see more options. Once a category has been selected (moving the joystick right) a list of all the phrases within that category will be shown. From here the user can pick any phrase they wish to say and select it (moving the joystick right). This selected phrase will then be read out through the speaker connected to the aux port of the Talk Box.
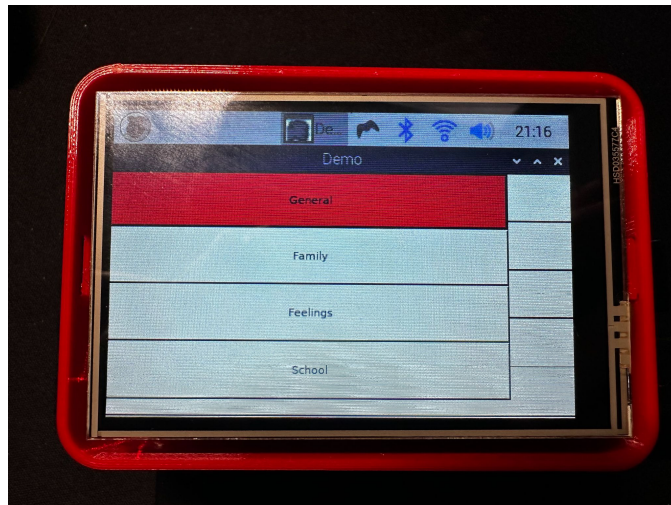

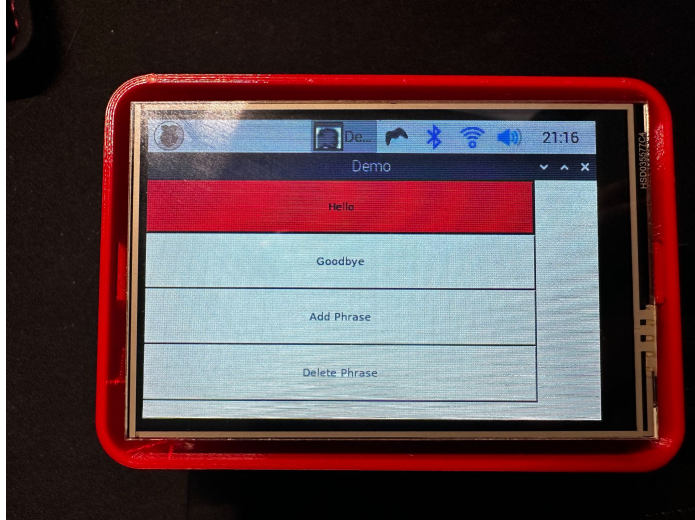*Figure 4.2.1 Phrases English - Categories*

Figure 4.2.2 General Phrases

4.4.1 Add/Delete Categories and Phrases

If a parent or caretaker wishes to add or delete categories and phrases, a similar set of instructions must be followed. First pick either "Phrases english" or "Phrases french". If the caretaker/parent would like to add or delete a category, they must simply scroll all the way to the bottom of the list. At the bottom of the list there are two buttons denoted "Add category" and "Delete category". Please note that these two buttons **cannot** be selected with the joystick, and must either be selected by touch (provided pen recommended) or with a mouse connected via USB. This is to avoid any confusion if a user who cannot see accidentally clicks these options.

If the caretaker/parent decides to add a category, simply click "Add category". A menu will pop up with a text box and an "Add". It is highly recommended to connect a keyboard via USB, however there is the option to use an on-screen keyboard (see the last paragraph). Type in the name of the category you want to add, then select the "Add" button, either by touch or with a

connected mouse. The categories page will reload, and you will see your new category at the bottom of the list.
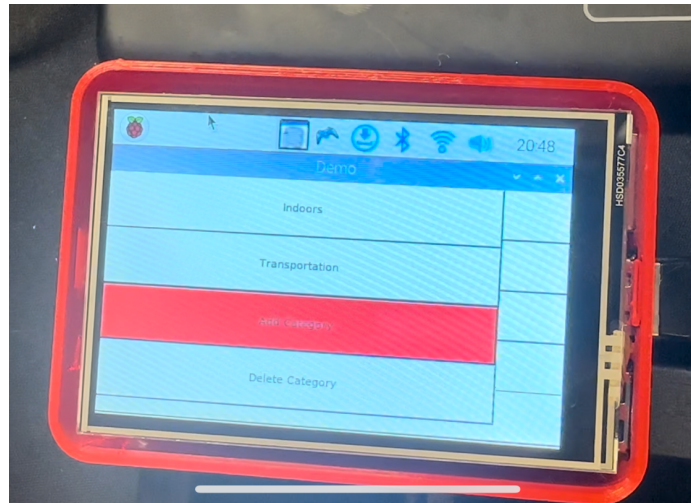
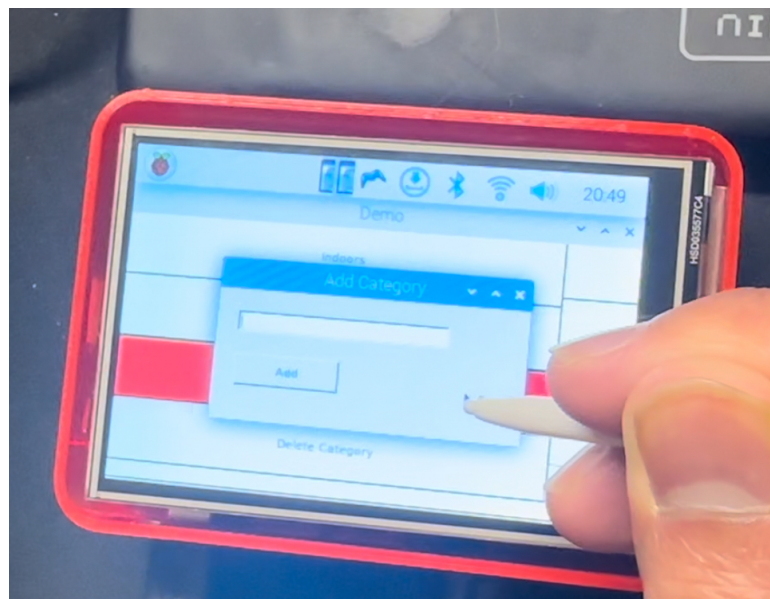

Figure 4.4.1.1 Add category button

Figure 4.4.1.2 Add category menu

The same goes for adding a phrase. Just click on the category you would like to add a phrase to, then scroll down to the "Add phrase" option at the bottom of the list of phrases, and follow the same steps as before.
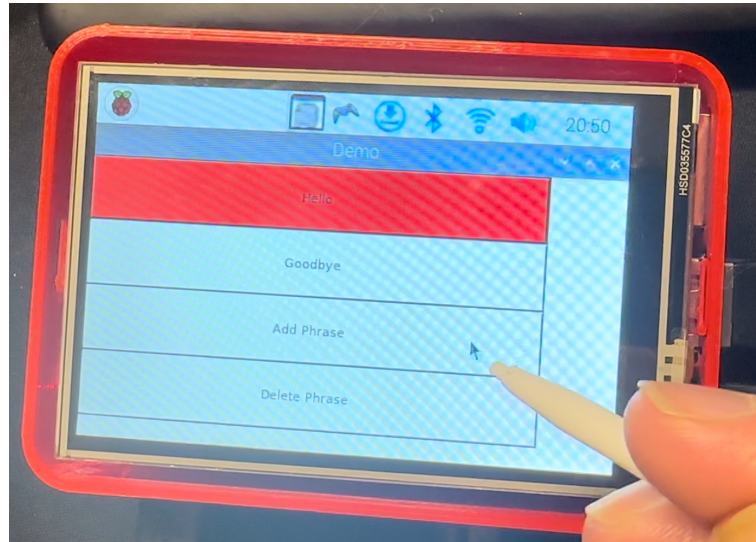
Figure 4.4.1.3 Add phrase button
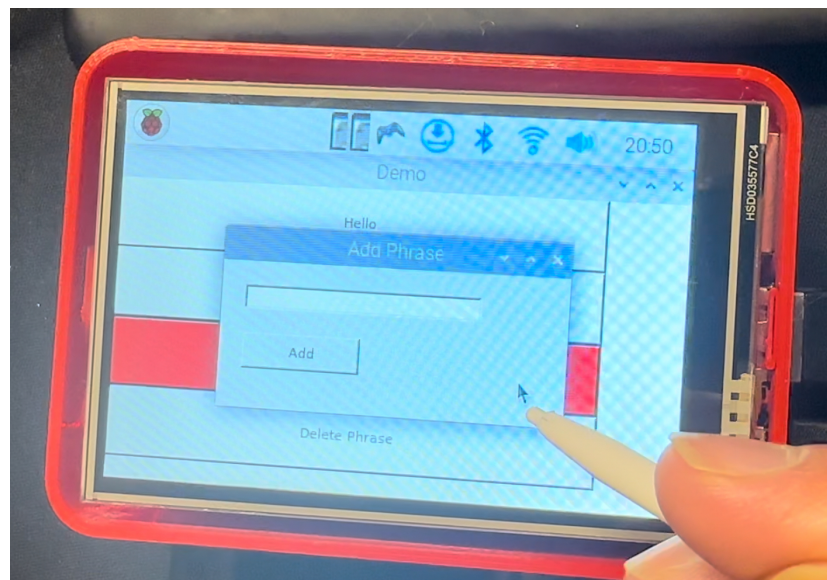
Figure 4.4.1.4 Add phrase menu

To delete a phrase or category, simply click on the button directly below the "Add category/phrase" button, "Delete category/phrase". Once this button is clicked, a menu will pop up with a drop down menu. Click the dropdown menu either by touch or with a mouse, and you will see a list of categories (if you are deleting a category) or a list of phrases (if you are deleting a phrase within a category). Select an option and hit the "delete" button. The page will reload and that option will be gone.
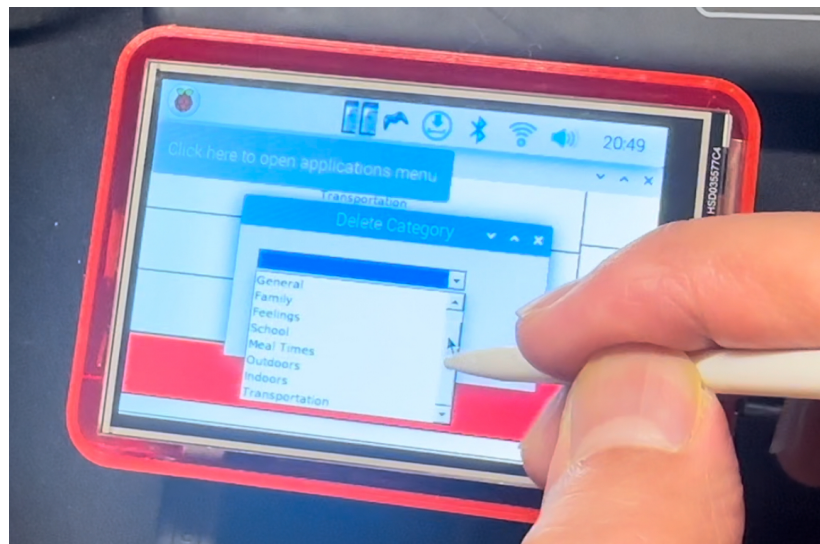
Figure 4.4.1.5 Delete category
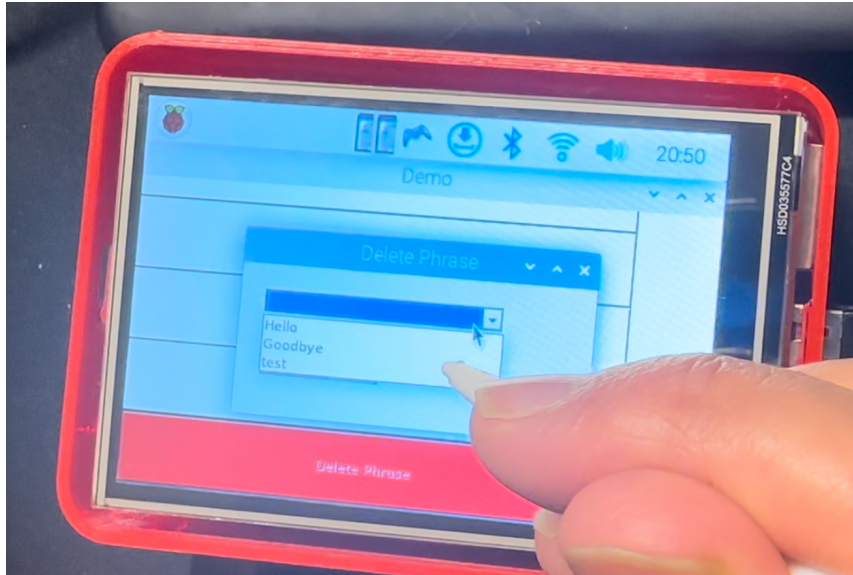
Figure 4.4.1.6 Delete phrase button

To open the on-screen keyboard, simply click on the Raspberry Pi icon on the top right of

the screen. Scroll down and open "Accessories", and click the keyboard option.
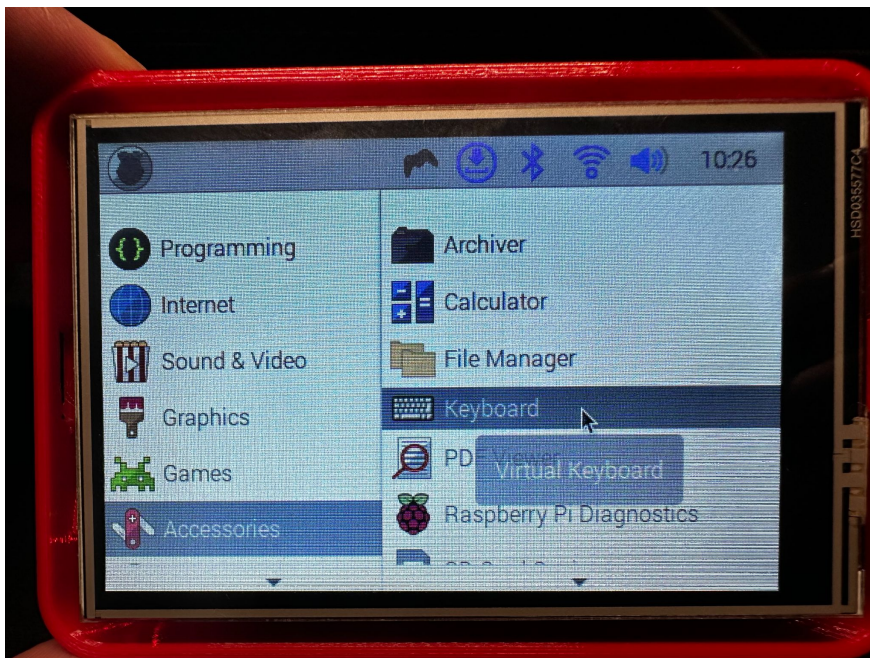
Figure 4.4.1.7 On-screen keyboard

4.5 Selecting Entertainment Options

The entertainment options in the Talk Box program include "Music", "Sounds", and "Audiobooks". To use these options, simply scroll down to either of these options using the joystick, then select them by moving the joystick right. The corresponding sub-menu will appear. To play these entertainment options, simply select again by moving the joystick right. To stop the audio, just go back to the main menu by moving the joystick left.
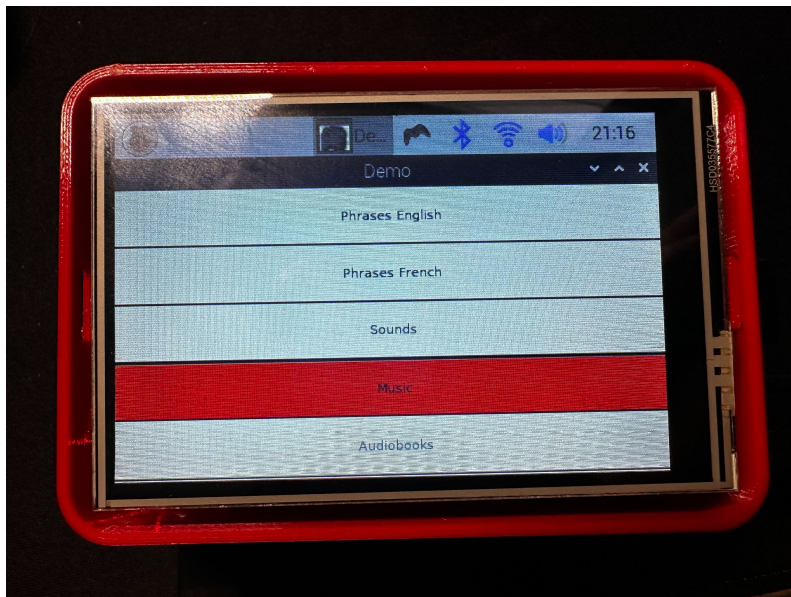
Figure 4.4.1.7 Music button
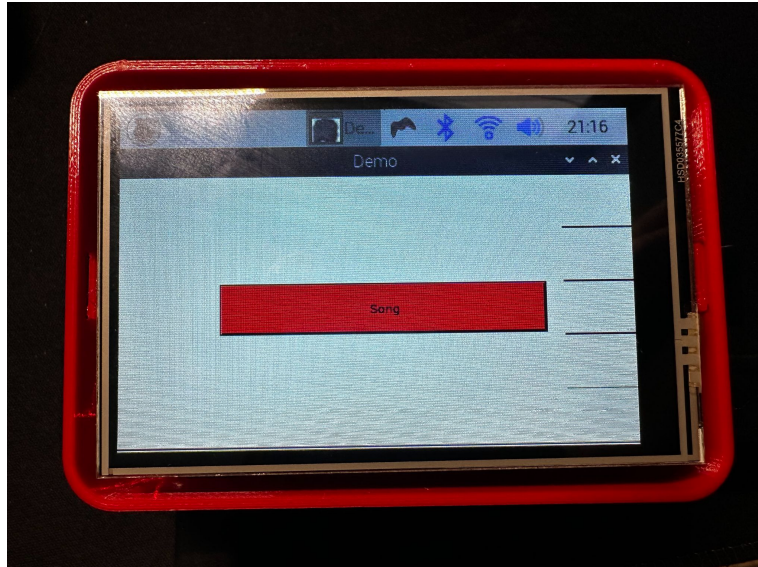
Figure 4.4.1.8 Music page

5   Troubleshooting & Support

5.1   Error Messages or Behaviors

If the TalkBox.exe file is not running or seems to be glitching, please close the window and rerun the file. If that does not solve the problem, please restart the device.

Please note that for the text-to-speech screen reader to work properly, you must use a pair of bluetooth headphones.

If the joystick directions are not working as expected, please ensure you have the wire coming out facing the user.

5.2   Special Considerations

The Talk Box is not a waterproof device, so please do not get it wet. If the TalkBox.exe file is not running properly, or it seems to be glitching, please either close the window and re-run the file, or restart the device.

5.3 Maintenance

If the Talk Box is not going to be used for a long period of time, please turn the power off to avoid it from overheating. Please store the device in a dry, low dust environment.

5.4 Support

If there are any issues with the device, please email tkhan083@uottawa.ca. You will receive a reply in one to two business days.

6 Product Documentation

There were two main parts for our project, the software and the hardware. The software component is the program which the Talk Box is actually running, which is the main functionality of the entire project. This program was built in C# with the .NET framework, and is running on the Raspbian OS. The hardware of the Talk Box consists of a Raspberry Pi as the main "computer" running the Raspbian OS. Another big piece of the hardware is the Joystick, which we use as the main input device that interacts with the Talk Box software.

The software, which is build in C#, consists of separate pages, each for each menu and sub-menu in the Talk Box. The most important part of the program that we had to figure out was how to deal with the words/phrases that would be stored in the Talk Box. We first started with an excel spreadsheet, which would hold all the words along with their corresponding categories. This worked fine until we tested it on the Raspberry Pi and found out that the C# Excel Library is incompatible with the Linux operating systems, including Raspbian. We then tried to switch to a SQLite database which would be a more clearly structured way to store words within categories, and is something we found should be more compatible. However, we ran into another issue where the SQLite system that works with C# has more incompatibilities with Linux, which made it another option we couldn't use. The final decision we made was to use a basic Text file. We organized the text file in a way that all words and categories could be recognized by a specific algorithm we programmed. This worked the best as a basic Text file works on any operating system.

The hardware of the Talk Box consists of a Raspberry Pi as the main computer, a joystick as the navigation device, a speaker, an LCD screen, and a power supply. A bluetooth earbud is required (but not provided) to properly utilize the text-to-speech screen reader. The casing for the

Raspberry Pi and for the joystick were both 3D printed using designs found online (see bibliography). Our project did not have much physical designing to keep in mind, as most of the user interaction with our project is all software based, however there were some things we had to keep in mind.

The client requested we make the Talk Box itself red, therefore we aimed to make the casing for the Raspberry pi red. We were also asked to avoid sharp edges and corners, especially on the joystick. Therefore we found a design online that had softer, rounded out edges, and the material we used was the default material found in the MakerSpace 3D printers. We were also asked to make it a portable and compact device, therefore we opted for a smaller screen, speaker, and power bank to ensure portability.
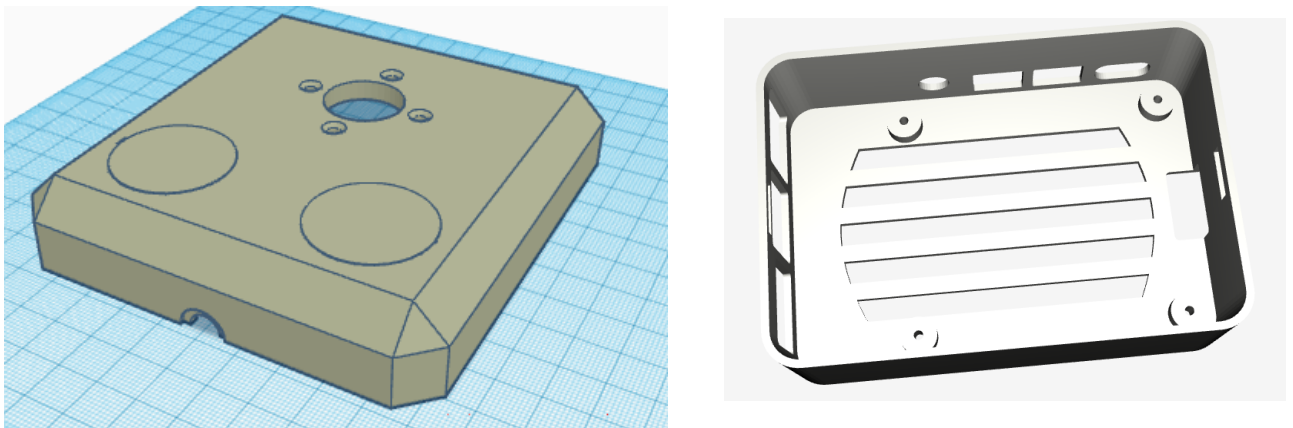
Figure 6.0 STL Files

6.1   Physical Talk Box

6.1.1   BOM (Bill of Materials)

Item Name	Description	Quantity	Units	Unit Cost (CAD)
Raspberry Pi	Low cost small computer that plugs into devices and runs the program.	1	1	$54.99
Battery Pack	Portable, chargeable battery pack, has the required amount of power needed for Raspberry Pi	1	1	$33.89
Small speaker	Speaker to play out the users selected options	1	1	$16.94

LCD Screen	flat panel which uses liquid crystals to display	1	1	$29.93
Micro SD Card - 16gb	Storage used for Raspberry PI, required to boot up OS	1	1	$12.42
Non slip pads	To be placed under the talk box and joystick to keep them from sliding on the wheelchair tray	1	16	$5.02
				Total: $153.19

Links

Raspberry Pi	https://makerstore.ca/shop/ols/products/raspberry-pi-4-computer-model-b
Portable Battery Pack	https://www.amazon.ca/INIU-Slimmest-10000mAh-High-Speed-Flashlight/dp/B07G34JZG2/ref=sr_1_6?crid=1OGMWLBJTZ5S9&keywords=lightweight%2Bbattery%2Bpack&qid=1698350822&sprefix=light%2Bweight%2Bbatter%2Bpack%2Caps%2C92&sr=8-6&th=1
Small Speaker	https://www.amazon.ca/dp/B0C6KXLH6N?psc=1&ref=ppx_yo2ov_dt_b_product_details
Non slip pads	https://www.amazon.ca/Shepherd-Hardware-3602-Adhesive-16-Count/dp/B00FFY7X3S/ref=sr_1_1?crid=2TIVOGSXQNF0X&keywords=non%2Bslip%2Bfeet&qid=1700768857&refinements=p_85%3A5690392011&rnid=5690384011&rps=1&sprefix=non%2Bslip%2Bfeet%2Caps%2C94&sr=8-1&th=1
LCD Screen	https://www.amazon.ca/dp/B08GCRWY7M?psc=1&ref=ppx_yo2ov_dt_b_product_details
Micro SD Card	https://www.amazon.ca/dp/B074B4P7KD?psc

6.1.2 Equipment list

● 3D Printer in MakerSpace

● Screw driver

● M.2 Screws

6.1.3 Instructions

1. 3D print the case with the link for "TalkBox Case" found in the bibliography
   a. Note: top lid is not required as we did not print that
2. Get two small M.2 screws, and with a screwdriver, screw the Raspberry Pi board into the case. There will be 4 small holes that match up with the Raspberry Pi and the case.

Figure 6.1.3.1 Top View of Case

3. After screwing the board onto the case, attach the LCD screen onto the Raspberry Pi by matching it up with the GPIO pins and pushing it in.
4. Follow the online documentation on how to boot up the Raspbian OS onto a micro SD card, and insert the SD card into the designated slot under the board.
5. Finally, to turn on the Raspberry Pi, plug in the power

6.1 Joystick

6.1.1 BOM (Bill of Materials)

Item Name	Description	Quantity	Units	Unit Cost (CAD)	Was it bought?
Joystick	Device to be used by the client to navigate the UI	1	1	$29.37	**Yes**
				Total: $29.37	

Links

Joystick	https://www.amazon.ca/dp/B07BN97FN8?psc =1&ref=ppx_yo2ov_dt_b_product_details

6.1.2 Equipment list

- 3D Printer in MakerSpace

- Screw driver

- Screws

6.1.3 Instructions

1. Print the two joystick STL files on our MakerRepo page:
   a. https://makerepo.com/rynak/1900.gng2101talkbox
2. Screw off the top ball of the joystick and place the top part of the printed joystick case onto the joystick
   a. Line up the holes with the holes on the joystick
3. With a screwdriver and 4 screws, screw the top part of the case onto the joystick

4. With the joystick decoder inside the case, align the bottom part of the printed case under the joystick, and use 4 long screws in the four holes in each corner. This will attach the two halves of the case together

5. Finally, plug the joystick into the Raspberry Pi in one of the 4 USB ports

6.2   Testing & Validation

To test if the Talk Box was working, we powered on the Raspberry Pi with the power bank and ensured that it turned on. We also made sure the screen was working properly and waited for any display to come up. Finally we tested the program for the Talk Box on the Raspberry Pi to ensure there were no incompatibilities with our program and the Raspbian OS.

To test if the joystick was working before and after assembly, we plugged it into the Raspberry Pi via usb and validated the input with the Talk Box program.

7   Conclusions and Recommendations for Future Work

One of the biggest lessons we learned is to ask questions thoroughly, and to encourage our client to not withhold any information that may be only slightly relevant. During our second client meeting, it was brought to our attention that our client is using a pacemaker, which would interfere with the technology we had planned on using due to their magnetic frequencies. As such, we needed to drastically change our design, which could have been circumvented by extracting this information from our client earlier.

We have several ideas regarding how one might improve the TalkBox. The first is a case that would cover the screen to prevent any accumulation of dust. The second is a customizable user-interface - for example, the ability to change font-size and colour. This was not a

consideration for our current implementation of the TalkBox because our client cannot see and as such, this feature would not be useful for them. The third way to improve upon our design is to provide the option for a variety of screen sizes. As mentioned, our client cannot benefit from any visual improvements to our design but future clients who have the ability to see can. Also, the speaker being enclosed inside the case with the screen would provide for better portability.

If we had a few more months to work on this project, we would add the functionalities mentioned above, such as a lid for the screen, a customizable user-interface, various screen sizes, and an internal speaker. Also, given more time, we would have liked to provide additional narrator voices and accommodate for additional languages other than English and French.

8   Bibliography

3D Printing Files:

- TalkBox Case: https://www.printables.com/model/174099-raspberry-pi-4-case/files
- Joystick Case: https://www.thingiverse.com/make:705799

APPENDICES

9   APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Raspberry Pi 4 Case	https://www.printables.com/model/174099-raspberry-pi-4-case/files	April 18, 2022
ARCADE JOYSTICK	https://www.thingiverse.com/make:705799	September 15, 2019

LCD Screen Drivers	https://github.com/goodtft/LCD-show	August 15, 2016

10 APPENDIX II: Other Appendices

N/A

10 Conclusions

The lessons we learned are to ask plenty of questions and to apply our expertise as engineers to situations where we have a lack of detailed requirements given to us in a project. The greatest issue posed to us during the creation of the TalkBox is the health concerns of our client, such as their pacemaker and risk of seizure. We needed to navigate these problems intelligently, so we scrapped our initial plan for a wired headset to a wireless one and smoothed out the corners of the box itself to prevent potential harm. Though accommodating our client's needs proved a challenge, it was a satisfying hurdle to overcome and one that we anticipated to run into.

Overall, the work done toward our project was mostly software-based. From the joystick to the display on the screen, most of the components had to be tinkered with on a programming level to be compatible with all the other parts. And of course, the program itself was entirely software, more specifically C# in a .NET framework, implemented on a Linux OS. 3D printing was used to create a casing for the Raspberry Pi and screen and the joystick.